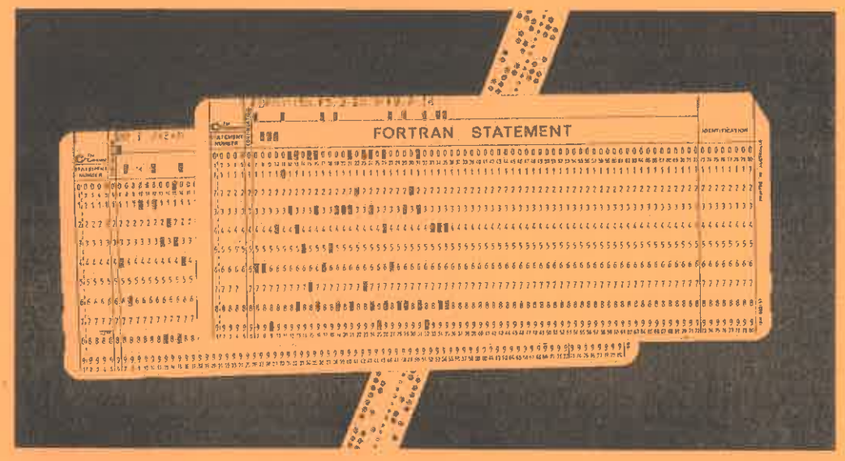
THE UNIVERSITY OF ADELAIDE

PAPER TAPE AND PUNCHED CARDS

THE EARLY HISTORY OF COMPUTING AND COMPUTING SCIENCE AT THE UNIVERSITY OF ADELAIDE

BARBARA KIDMAN
and
RENFREY POTTS



Celebrating 125 *years*

PAPER TAPE AND PUNCHED CARDS

THE EARLY HISTORY
OF
COMPUTING AND COMPUTING SCIENCE
AT
THE UNIVERSITY OF ADELAIDE

BARBARA KIDMAN
formerly Senior Lecturer in Computing Science

and

RENFREY POTTS
formerly Professor of Applied Mathematics

1999

Published: Adelaide, South Australia, 1999

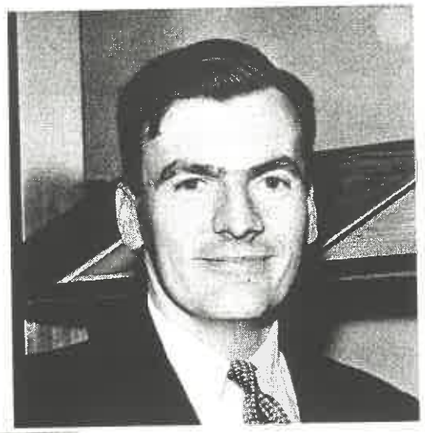
ISBN 0 646 38632 8

Ad. 13/8/64 -

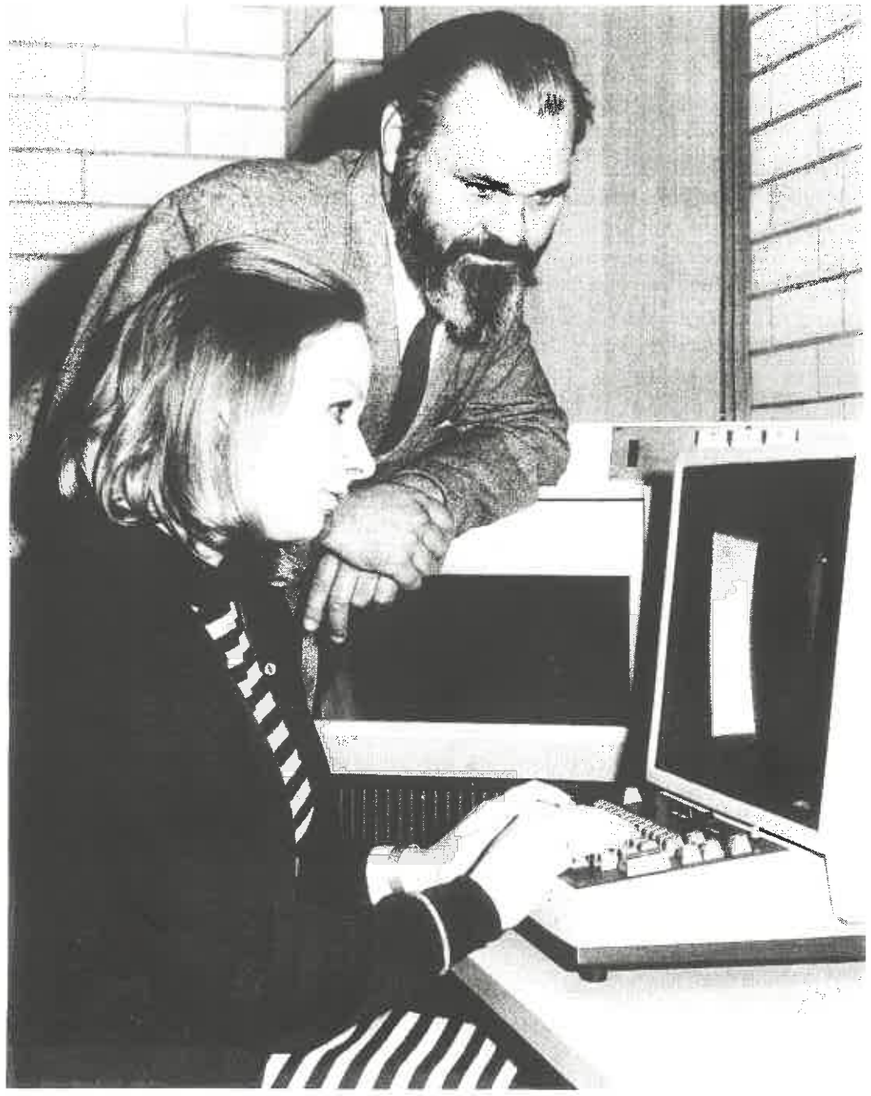
Clipping from the Adelaide Advertiser

CONTENTS

Top Row: M. W. Allen, I. N. Capon
Middle Row: R. Culver
Bottom Row: F. Hirst, B. P. Kidman



Top Row: J. P. Penny, R. B. Potts
Middle Row: G. A. Rose
Bottom Row: J. G. Sanderson, D. W. Simmons



J. A. Ovenstone
with Operator A. Gready at a CDC 6400 Remote Terminal
Photograph courtesy of The Advertiser

PREFACE

At the time of retirement from the Department of Computing Science in 1987 I undertook the writing of this history. That was over ten years ago; despite an early start there have been many interruptions, mainly stemming from personal commitments. It soon became clear that Ren was an invaluable source of information for the early years, and eventually he agreed to be a co-author.

We have been greatly encouraged in this undertaking by Professor Barter, Dr Capon, Professor Tuck and other members of the Computer Science and Applied Mathematics fraternity. Our thanks are due to many people who have helped in various ways. The University archivist, Kylie Percival, has been unfailing in her support and patience over our many requests for help. We are also particularly grateful to a number of people who have lent or given us very useful material; this includes Nick Capon, Bob Culver, Frank Hirst, Les Howard, David Knight, John Noye, Gloria Sanderson, Betty Simmons, and Ernie Tuck. We have had innumerable discussions, correspondence and email exchanges with many people, including Murray Allen, Chris Barter, John Bennett, John Blatt, Bob Culver, Werner Dorfl, Andrew Duncan, Sylvan Elhay, Terry Fanning, Malcolm Gray, Bert Green, Peter Hawryskiewzcz, Frank Hirst, Les Howard, Bob Jones, David Knight, Robyn Lewis, Fred Low, John Macaskill, Ian McCarthy, Harry Medlin, Margaret Meyler, Bob Northcote, John Penny, Rob Potter, John Roach, Gordon Rose, Gloria Sanderson, Peter Sandery and John Weadon. Thank you also to all who responded to our appeal for help in the Adelaidean. We apologise for any inadvertent omissions from our acknowledgments. Finding suitable photographs has proved unexpectedly difficult and we have not been altogether successful in this quest; we are grateful to those who have helped.

We are particularly grateful to a number of people for reading and correcting our earlier crude efforts. Gordon Rose from Brisbane, and Murray Allen from Sydney, checked the material on the Cirrus project in Chapters 3 and 4, and made valuable suggestions; Kylie Percival and Geoffrey Sauer from the University read an earlier draft manuscript. Above all our thanks go to Nick Capon who has answered many queries and made a significant contribution to Chapter 6 in particular; both he and Bob Culver have carefully read the whole document; we are very appreciative of their helpful suggestions. The authors remain responsible for any inadvertent errors.

We are not trained historians and did not consider it appropriate to give detailed source references, though in the Chapter Notes collected at the end before the appendices we do give a general indication of our sources. Most of the documented sources are in material from the University Archives, or in personal files of University records which have not been preserved by the University; these files will ultimately be deposited in the Archives. A great deal of use has been made of generally available University Calendars, Commemoration records, and other material from the Barr Smith Library. Throughout, the factual account has been supplemented by anecdotal material and by personal recollections of both authors and others; to make a record of this latter material was one of the main aims of the project.

Barbara P. Kidman

CHAPTER 1 IN THE BEGINNING

It's been a long time but it's been fun.

1.1 Introduction

The scope of this history is limited mainly to the early development of machine-assisted data processing for the University[1] administration, to the use by academic staff of the first computers at WRE (Weapons Research Establishment)[2] at Salisbury, near Adelaide, to the formation and early activities of the University's Computing Centre, and to the creation of the Department of Computing Science and the initiation and growth of its academic functions. The history roughly covers the twenty-five year period from 1953 to 1978, with most attention given to the earlier years. It deals quite briefly with early computer hardware research in the Department of Electrical Engineering, which is deserving of a special record, and does not deal with subsequent computing developments in the Engineering, Economics and other Faculties, or in the Barr Smith Library. The authors acknowledge that their close involvement in the early developments has influenced the choice of material. The authors have also chosen to retain throughout this work the name 'computing science' for the new discipline, rather than the later accepted 'computer science', largely because the former was the one originally used at the University.

Computing in Australia has been the subject of two significant histories. The first (Pearcey 1988)[3] gives a comprehensive history of the early use and development of computer hardware, and also gives a necessarily abbreviated account of early computing education and training in Australian Universities, Institutes of Technology, and Colleges of Advanced Education. Dr Trevor Pearcey, who had come from England to Australia in 1945, was responsible for the design and construction of Australia's first computer, the CSIR Mk 1, installed in the Radio Physics Division of CSIRO (Commonwealth Scientific and Industrial Research Organisation). Later, this computer, renamed CSIRAC (CSIRO Automatic Computer), was transferred to the University of Melbourne. Pearcey also describes how, in 1956, the University of Sydney commissioned its first computer SILLIAC, the Sydney version of ILLIAC (University of Illinois Automatic Computer), the NSW University of Technology its computer UTECOM (University of Technology Electronic Computer), and WRE near Adelaide its computer WREDAC (Weapons Research Establishment Digital Automatic Computer). Pearcey's book includes an account of Cirrus, the computer designed and built from 1959 to 1964 in the University's Department of Electrical Engineering. Pearcey only very briefly mentions the formation of the University's Computing Centre in 1960, and subsequently the Department of Computing Science in 1964.

The second history of computing in Australia (Bennett 1994) developed from a proposal for a history of the first twenty-five years of the ACS (Australian Computer Society), but its scope broadened to a collection of contributions from forty authors. It begins with a chapter by Pearcey on 'The Origins of Modern Computers'. The history

[1] Unless otherwise indicated, 'University' in this work refers to 'The University of Adelaide'.
[2] Abbreviations and acronyms are listed in Appendix I.
[3] References are listed after Chapter 10.

acknowledges that the first of the state Compute
formed in 1966, was the one in South Australia

machine language.
awarded in 1958,

Ovenstone presen
WREDAC Aut
Cherry) one o
of the confe
and, in par
are fascir
about
on
Sa
pH.

The early development of computing in
entrepreneurs with vision. Prominent in th
Allen Ovenstone[1]. In 1950 he graduated
class honours B.Sc. degree in mathema
became interested in numerical comput
In 1953 he obtained his Ph.D. de
undertaken in its Mathematical Labor
world's first stored-program com
Automatic Computer), which had been co
1949, under the direction of Dr Maurice Wilkes.
as a Senior Scientific Officer in the Mathematical Servic
the installation, in 1956, of its first digital computer, WRE
1958 he left WRE to work with the Department of Defence, but imp
joined the staff of the University as the first Director of its Computing
the additional title of Professor of Computing Science. By the time of his resigna
at the end of 1970, the computing scene in the University had been advanced enormously. The University owes much to the dynamic leadership of Ovenstone, one of the major pioneers of computing in Australia. Both authors acknowledge his enthusiastic encouragement in fostering their own interests in the field.

used for
t WRE
d the
ity

1.2 The Babbage Connection

Charles Babbage, 1792-1871, the brilliant, but somewhat eccentric genius, and onetime professor of Mathematics at Cambridge University, is acknowledged as the first to have understood some of the underlying principles of the modern computer. One of his sons, Benjamin Herschel Babbage, emigrated to South Australia in 1851, and became engaged in engineering, prospecting, assaying, surveying and exploration work in the colony. For a short time, in 1856, he was a member of the first State Parliament (Tee 1983).

In the 1960s, at the suggestion of Mr Warren Bonython, the authors made contact in Adelaide with Mrs E. Yvonne Clare, the widow of Herschel Deakin Clare, a grandson of B. H. Babbage and, therefore, a great-grandson of Charles Babbage. She possessed a handsome side-table, said to have belonged to Charles Babbage. As a result of this contact, Mrs Clare presented to the University's Barr Smith Library two books which had belonged to B. H. Babbage. One (Babbage 1829) is a copy of a table of logarithms compiled by Charles Babbage. The introductory section gives an indication of how careful he was with the accuracy of his mathematical tables; incidentally the work of calculating such tables lead to his interest in mechanised computing. The second book (Babbage 1869) is an edited collection of papers by Charles Babbage and others concerning his computing machines. It includes a report by the mathematician, Lady Ada Lovelace, in which, in her description of Babbage's design for his so-called Analytical Engine, she clearly explains its structure and use. Ada Lovelace is sometimes designated as the very first computer programmer, and,

[1] Commonly known as JAO.

CHAPTER 1 IN THE BEGINNING

It's been a long time but it's been fun.

1.1 Introduction

The scope of this history is limited mainly to the early development of machine-assisted data processing for the University[1] administration, to the use by academic staff of the first computers at WRE (Weapons Research Establishment)[2] at Salisbury, near Adelaide, to the formation and early activities of the University's Computing Centre, and to the creation of the Department of Computing Science and the initiation and growth of its academic functions. The history roughly covers the twenty-five year period from 1953 to 1978, with most attention given to the earlier years. It deals quite briefly with early computer hardware research in the Department of Electrical Engineering, which is deserving of a special record, and does not deal with subsequent computing developments in the Engineering, Economics and other Faculties, or in the Barr Smith Library. The authors acknowledge that their close involvement in the early developments has influenced the choice of material. The authors have also chosen to retain throughout this work the name 'computing science' for the new discipline, rather than the later accepted 'computer science', largely because the former was the one originally used at the University.

Computing in Australia has been the subject of two significant histories. The first (Pearcey 1988)[3] gives a comprehensive history of the early use and development of computer hardware, and also gives a necessarily abbreviated account of early computing education and training in Australian Universities, Institutes of Technology, and Colleges of Advanced Education. Dr Trevor Pearcey, who had come from England to Australia in 1945, was responsible for the design and construction of Australia's first computer, the CSIR Mk 1, installed in the Radio Physics Division of CSIRO (Commonwealth Scientific and Industrial Research Organisation). Later, this computer, renamed CSIRAC (CSIRO Automatic Computer), was transferred to the University of Melbourne. Pearcey also describes how, in 1956, the University of Sydney commissioned its first computer SILLIAC, the Sydney version of ILLIAC (University of Illinois Automatic Computer), the NSW University of Technology its computer UTECOM (University of Technology Electronic Computer), and WRE near Adelaide its computer WREDAC (Weapons Research Establishment Digital Automatic Computer). Pearcey's book includes an account of Cirrus, the computer designed and built from 1959 to 1964 in the University's Department of Electrical Engineering. Pearcey only very briefly mentions the formation of the University's Computing Centre in 1960, and subsequently the Department of Computing Science in 1964.

The second history of computing in Australia (Bennett 1994) developed from a proposal for a history of the first twenty-five years of the ACS (Australian Computer Society), but its scope broadened to a collection of contributions from forty authors. It begins with a chapter by Pearcey on 'The Origins of Modern Computers'. The history

[1] Unless otherwise indicated, 'University' in this work refers to 'The University of Adelaide'.
[2] Abbreviations and acronyms are listed in Appendix I.
[3] References are listed after Chapter 10.

acknowledges that the first of the state Computer Societies, from which the ACS was formed in 1966, was the one in South Australia established in 1960.

The early development of computing in Australian universities resulted from entrepreneurs with vision. Prominent in the present work will be the name of John Allen Ovenstone[1]. In 1950 he graduated from the University of Sydney with a first class honours B.Sc. degree in mathematical physics. It was at Sydney that he first became interested in numerical computation, under the guidance of lecturer Pearcey. In 1953 he obtained his Ph.D. degree at Cambridge University for research undertaken in its Mathematical Laboratory. It was here that he learnt to use one of the world's first stored-program computers, EDSAC (Electronic Delay Storage Automatic Computer), which had been constructed and become operational in May 1949, under the direction of Dr Maurice Wilkes. Ovenstone joined WRE in 1953 and, as a Senior Scientific Officer in the Mathematical Services Division, was in charge of the installation, in 1956, of its first digital computer, WREDAC (Morton 1989). In 1958 he left WRE to work with the Department of Defence, but importantly, in 1964, joined the staff of the University as the first Director of its Computing Centre, with the additional title of Professor of Computing Science. By the time of his resignation at the end of 1970, the computing scene in the University had been advanced enormously. The University owes much to the dynamic leadership of Ovenstone, one of the major pioneers of computing in Australia. Both authors acknowledge his enthusiastic encouragement in fostering their own interests in the field.

1.2 The Babbage Connection

Charles Babbage, 1792-1871, the brilliant, but somewhat eccentric genius, and onetime professor of Mathematics at Cambridge University, is acknowledged as the first to have understood some of the underlying principles of the modern computer. One of his sons, Benjamin Herschel Babbage, emigrated to South Australia in 1851, and became engaged in engineering, prospecting, assaying, surveying and exploration work in the colony. For a short time, in 1856, he was a member of the first State Parliament (Tee 1983).

In the 1960s, at the suggestion of Mr Warren Bonython, the authors made contact in Adelaide with Mrs E. Yvonne Clare, the widow of Herschel Deakin Clare, a grandson of B. H. Babbage and, therefore, a great-grandson of Charles Babbage. She possessed a handsome side-table, said to have belonged to Charles Babbage. As a result of this contact, Mrs Clare presented to the University's Barr Smith Library two books which had belonged to B. H. Babbage. One (Babbage 1829) is a copy of a table of logarithms compiled by Charles Babbage. The introductory section gives an indication of how careful he was with the accuracy of his mathematical tables; incidentally the work of calculating such tables lead to his interest in mechanised computing. The second book (Babbage 1869) is an edited collection of papers by Charles Babbage and others concerning his computing machines. It includes a report by the mathematician, Lady Ada Lovelace, in which, in her description of Babbage's design for his so-called Analytical Engine, she clearly explains its structure and use. Ada Lovelace is sometimes designated as the very first computer programmer, and,

[1] Commonly known as JAO.

for this reason, a major programming language has been named Ada in her honour. This book is treasured by those interested in the history of computing.

1.3 Visit of John Blatt 1953

Towards the end of 1953, Dr John Blatt, a distinguished mathematical physicist and later computer scientist, passed through Adelaide on his way from the U.S.A. to the University of Sydney, where he was to be involved with the construction in the Department of Physics, of the SILLIAC computer. Its design was based on the ILLIAC computer which Blatt had used at the University of Illinois. At the instigation of Professor Bert Green of the Department of Mathematical Physics, Blatt gave a public lecture in the Kerr Grant Lecture Theatre in the Physics Department. According to Blatt's recollection stated in a letter to the authors from Haifa in 1988, 'The talk was a light-hearted introduction to computers and programming, primarily the latter'. As an example, he discussed the problem of using a computer to determine the maximum of a function computed sequentially at discrete points, and, incidentally, he showed how easy it was to make mistakes in writing a computer program! Two other things about the occasion were well remembered by Blatt and also by Green and the authors who were at the lecture. Firstly the speaker had a heavy cold and delivered his lecture by whispering into a microphone. 'It must have sounded really weird' confessed Blatt in his letter (but in fact it was quite clear). Secondly the speaker produced a long streamer of 5-hole punched paper tape for the audience to see and to handle, not necessarily with great care because, as he explained, one of the holes was in the wrong place![1] The recently retired Professor of Physics, Sir Kerr Grant, asked a question, and Blatt, not knowing the questioner, answered as if he were a complete layman; in fact Blatt playfully wound some paper tape around Kerr Grant, who took the high jinks in good spirit! This all naturally brought the house down as Kerr Grant was very well known in academic circles. For most of the audience, it was a memorable first introduction to the modern computer. In recalling these events in his letter thirty-five years later, Blatt wrote 'It's been a long time but it's been fun'.

[1] At that time, paper tape like this was used for input to computers.

CHAPTER 2 COMPUTING AT WRE 1956-64

...and the average arithmetic instruction execution time was half a millisecond!

2.1 Introduction

It was extremely fortunate for the University to have nearby, at Salisbury, the Commonwealth Department of Supply's Weapons Research Establishment (WRE). Not only was it, and its renamed successors, a major employer of many graduates but it quickly became a leading centre for computing within Australia. WRE's very early interest in computing was recalled by Dr Harry Medlin, a graduate in physics, who, when working at WRE, was sent to Cambridge for a few months at the end of 1949, and was almost at once expected to use EDSAC.

2.2 WREDAC

It became apparent in the 1950s that WRE would have to process and analyse vast amounts of data from guided missile trials, and that a state of the art digital computer would be needed. WREDAC, the first digital computer acquired, was a somewhat modified commercial machine, basically the Elliott 401, but purpose built for WRE. It became operational in September 1956 under the direction of Dr John Ovenstone in the Mathematical Services Division (Morton 1989). In a conference paper (Ovenstone 1957), he describes the computer; the high-speed store held 512 words and the average arithmetic instruction execution time was half a millisecond! The subroutine library was built entirely at WRE in machine language. In the discussion following the presentation of his conference paper, Ovenstone and his group were particularly congratulated on their achievements by Dr S. H. Hollingdale from the Royal Aircraft Establishment in England.

At the end of 1956, one of the authors, Potts, then a Senior Lecturer in the Mathematics Department, was invited and encouraged by Ovenstone to spend the summer vacation learning to use WREDAC. Potts recalls asking his Head of Department, Professor H. W. Sanders, to write to the WRE authorities seeking approval for the arrangement and requesting the security clearance necessary for entering the Establishment.

Beginners taught themselves to write programs for WREDAC from a set of examples with answers. There were then no higher level languages; to develop a computer program, the machine language instructions were first written out as a sequence of mnemonic orders operating on data in the machine store and registers. Punched paper tape for input to the machine was produced from a teletape device; its keys had paper labels with mnemonic codes stuck on them to indicate the various computer orders. The punched paper tape was then read into the computer, which was operated by the programmer, sitting at the console in front of a screen displaying information as execution of the program proceeded. Output results could be produced on paper or magnetic tape. When programming for the computer was mastered, the user was expected to write and thoroughly test some library routines – the pay-back for having been given access to the computer.

To illustrate the unfriendliness of the WREDAC machine language, Figure 2.1 shows part of the program Potts wrote for the library subroutine $x\cot(x)$, with a portion of the input punched paper tape. Potts recalls Ovenstone's surprise when the very first computer run for the $x\cot(x)$ program produced correct results! As programmers had to wait in turn to sit at the console to run their own jobs, it was clearly advantageous to be extra careful to check programs before running them. Potts also remembers continuing to work while missing the start of the computing staff Christmas party – the opportunity to grab the computer when most were partying was just too good to be missed. Machine code programs and paper tape inputs for other library routines, (1/8) $\tan(x)$ and Chebyshev polynomials, written by Potts, have also been preserved.

Of others from the University to be introduced to computing on WREDAC, only those who are mentioned later in this history are cited. John Sanderson graduated with a B.Sc. from the University in 1952[1], with honours in Mathematics. He was employed at WRE over the period 1955 to 1959, first as an Experimental Officer and later as a Scientific Officer. He soon became one of the expert WREDAC programmers; while at WRE he enrolled as an external M.Sc. student in the Mathematics Department at the University under the supervision of Potts. In 1959, Sanderson was appointed to a lectureship in Mathematics at the University, and in 1963 transferred to the Computing Centre as a lecturer.

Nick Capon did Honours Mathematics at the University in 1957, again supervised by Potts; computing on WREDAC was part of his honours project. During the year he helped by managing the computer night shift at WRE. At the end of the year he was awarded a postgraduate scholarship to do a Ph.D. in Cambridge, and until he left Adelaide in August 1958, was employed at WRE. In Cambridge he undertook research in the Cavendish Laboratory but was housed in the Mathematical Laboratory and used the then current EDSAC II computer. Capon returned to Adelaide in September 1961 on his appointment as the first lecturer in the Computing Centre.

Among others with subsequent University association who worked on WREDAC were John Buxton, John Penny, and Andrew Duncan.

2.3 WRE Conference 1957

Ovenstone organised at WRE the notable second Australian Computing Conference held from June 3 to June 8, 1957 (WRE 1957). Of the 150 who attended, several were top computing experts flown out by the RAF from England, including Wilkes from the University of Cambridge, Booth from London, Douglas from Leeds, Hollingdale from the Royal Aircraft Establishment and Wilkinson from the National Physical Laboratory. Sanders, Professor of Mathematics at the University, invited the visitors to tea in the Mathematics Department, and confessed to wondering how to converse on a subject of which he knew nothing! Among those from the University who attended the conference were Bogner, Buxton, Capon, Elford, Ellesworth, Kaneff, Medlin, Pawsey, Potts, Radoslovich, Schubert, Sved and Tomlin. Also present was Frank Hirst from Melbourne, who later was to succeed Ovenstone as Professor of Computing Science at the University.

[1] As in all such references in this work, 1952 refers to the year in which the degree was awarded.

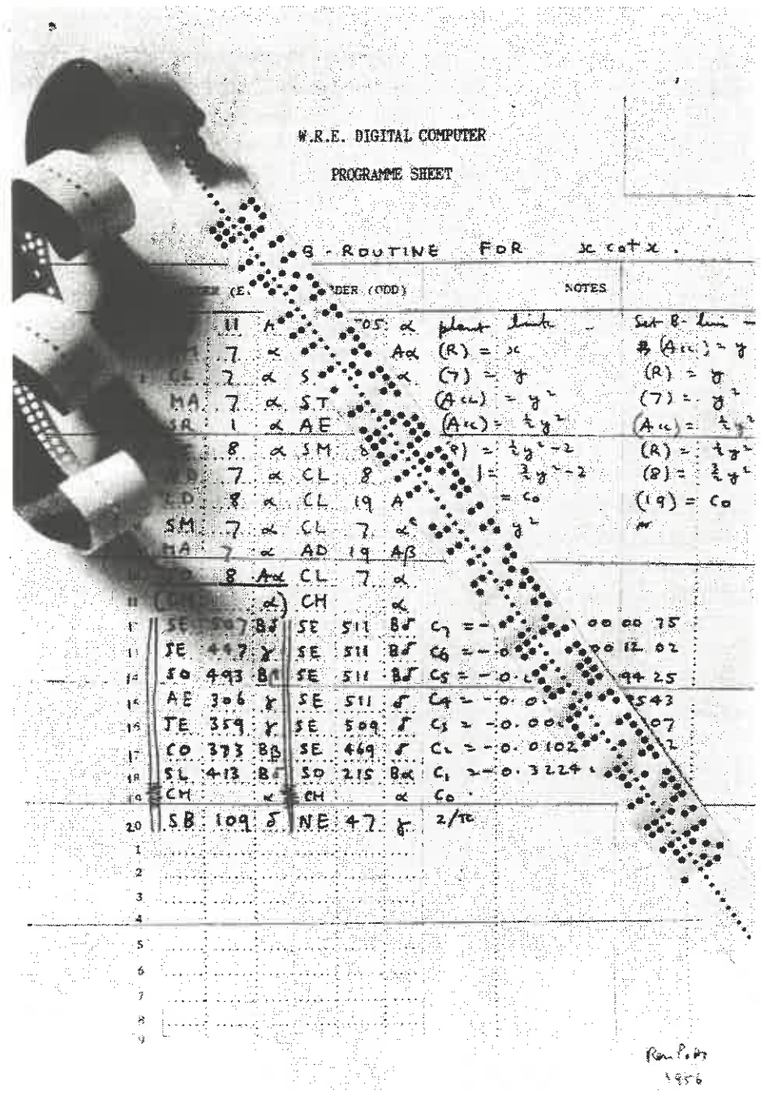


FIGURE 2.1 Part of WREDAC Machine Language Program and Input Punched Paper Tape for Library Subroutine $x\cot(x)$

Ovenstone presented a paper on 'The WREDAC System', Sanderson one on 'The WREDAC Automatic Programming Routine' (Sanderson 1957) and Hirst (with Cherry) one on 'The Machine CSIRAC' (Cherry and Hirst 1957). The three volumes of the conference proceedings (WRE 1957) are interesting in an historical context, and, in particular, details of questions and answers at the end of some of the papers are fascinating. In the discussion following Sanderson's paper, a question was asked about distinguishing 'exp y' from 'e.x.p.y'. Someone answered that in an interpreter on one particular computer, the names 'F1', 'F2' were reserved for functions. Sanderson's comment is really quite profound in the light of later developments – 'I prefer functions written in their normal fashion for convenience of the user'. A little later, another prominent overseas delegate, in commenting about automatic programming routines such as the one described by Sanderson, said 'I feel these things have got a little out of proportion. I am sceptical about how far they will increase the power of the machine ... I find it difficult to see a problem where it would make a major contribution, except from training'. He could not have been more wrong!

The conference proved important in stimulating interest in computing in the University. It was not, perhaps, of great significance internationally, except for a remarkable paper given by C. L. Hamblin from the NSW University of Technology on the subject 'The Addressless Coding Scheme Based on Mathematical Notation' (Hamblin 1957); in this paper he proposed, for the first time, the use of 'reverse Polish' for the machine interpretation of algebraic formulae (Allen 1985). Hirst recalls travelling with Bennett on the return journey to Melbourne, and meeting Hamblin on the Murray Bridge railway platform. Hamblin incorporated the idea in the operating system for UTECOM and subsequently it was taken up in the design of the English Electric machine KDF9 (Pearcey 1988). The Hamblin paper makes the conference proceedings of considerable interest as an historical document. In this regard, Kidman recalls, many years ago, assisting the eminent computer algebraist, Dr Tony Hearn, find the Proceedings in the Barr Smith Library while Hearn, a University of Adelaide graduate, was visiting from overseas.

2.4 Sanderson's External M.Sc. Degree 1958

Sanderson's conference paper was the basis of his thesis 'Automatic Programming for Digital Computers' (Sanderson 1958) written as an external M.Sc. student in the Mathematics Department. The topic of investigation was the design and interpretive implementation of a so-called automatic programming system for use on WREDAC. At this time, the term automatic programming referred to the use of algebraic notation and English in place of machine language for programming. Sanderson defines automatic programming as 'a collection of techniques which enable the machine to do part of the work of programming' (i.e. machine language programming). It was then the subject of much research; inevitably the system had to be developed for each particular machine in its own machine language as there were no machine-independent high level languages for writing the translator. The first version of Fortran for the IBM 704 was developed at about this time (Sammet 1969). Sanderson's well-written thesis is now of some historical interest. It uses the spelling computer 'programme' for the modern 'program' and the term 'compiler' with its normal meaning; in his words 'The special function of the compiler routine is to incorporate library subroutines in the programme'. A compiler is now understood to

be a translator from a higher level language program into machine language. Sanderson's M.Sc. degree from the Mathematics Department was awarded in 1958, the University's first research degree in mainstream computing science.

2.5 IBM 7090

Ovenstone left WRE in 1958 and although WREDAC continued to be used for several more years, an IBM 7090, a new transistorised machine, was installed at WRE in February 1961. This was then the largest and fastest computer in Australia, and the University promptly gained access to it. The close interaction between the University and WRE was reinforced by the personal rapport between the Vice-Chancellor, H. Basten, and the WRE Controller, R. W. Boswell. At the instigation of Potts, the Vice-Chancellor wrote to the Controller on April 13, 1960 requesting that consideration be given to the University using the 7090. The Secretary of the Department of Supply finally replied formally on February 9, 1961 giving approval for the University to hire the 7090 for 50 hours during 1961 at the discounted rate of £35/hour. The computer was formally handed over to the Minister of Supply on February 13; the first deck of Fortran cards to be run officially for the University was punched in the University's new Computing Centre on February 14 (see Chapter 3), and the Vice-Chancellor's letter of acceptance of the terms for the hire was dated February 16. While it is evident that the University was officially quick off the mark to make use of the machine, according to rumour, programs had already been run unofficially on the 7090 by University students and staff. The story, hard to confirm, but mentioned independently by two people, is that late every day a research student would somewhat clandestinely meet a member of the WRE staff at a city pub, hand over a deck of cards, and receive back the previous day's output results from the 7090.

Figure 2.2 lists the official arrangements made for University use of the 7090 and Figure 2.3 the first page of the detailed instructions formulated by Ian McCarthy. He was then a Senior Lecturer in Mathematical Physics, and initially in charge of the WRE service. Physically, the decks of cards were collected each morning by a WRE courier stopping on Victoria Drive near the University footbridge and collected at the same place late each afternoon. The daily turn around service seemed very streamlined at the time, but in fact it was quite frustrating for programmers who, inevitably, continually made trivial errors which, in the absence of comprehensive diagnostics, could take days or even weeks to rectify. Culver (from the Civil Engineering Department) thinks that at some stage there was a twice daily collection of jobs from the University. Potts remembers on one occasion the output for a user's program being returned as a thick block of blank paper, with a scathing note from the 7090 operator reporting that the output had been terminated! Culver also recalls the same or a similar incident, caused by failure of one of his colleagues to understand a clumsy feature of Fortran format control.

Liaison with WRE was taken over by Capon when he took up his appointment in September 1961 as a lecturer in the Computing Centre. The University demand for 7090 time increased rapidly and Capon was heavily involved in helping users. The hire rate for 1962 was fixed at £35/hour for the first 50 hours and double that for each succeeding hour. Use of the 7090 continued until 1964 by which time demand had greatly increased and difficulties of access had arisen; at this time the University gained use of the CSIRO machine installed on its own campus.

I B M 7090 C O M P U T I N G A R R A N G E M E N T S.

The Adelaide University Computing Centre is now in a position to offer the following services to the University.

1. LOAD AND GO computing on the 7090.

This system uses 709 Fortran Monitor which is a code that tells the machine how to run the job. The following operations can be performed.

a) Compilation, assembly, and execution of a binary running code using a FORTRAN course program (FAP or a combination of FAP and FORTRAN source programs may also be used). The binary running deck is part of the output together with the print-out.

b) Execution of the binary running code. Once the FORTRAN deck has been used to assemble a successful code, it is filed away and the binary deck is used to run problems.

2. Provision of sub-routines for standard problems.
One of the main features of an IBM system is its universality. Many problems have been coded before and are available in the SHARE library. Before coding a problem it is advisable to check whether use can be made of codes in the library.

FIGURE 2.2 Arrangements for the University's First Computing Service

THE UNIVERSITY OF ADELAIDE

IBM 7090

(1) All programs to be run on the 7090 will be sent to the University Computing Centre.

(2) The University Computing Centre will punch the programs onto cards.

(3) The University Computing Centre will send the decks of cards to W.R.E. for processing and the results will be returned to the University Computing Centre where they can be called for by the user.

(4) Dr. I. E. McCarthy, Mathematical Physics Department, will act as a liaison between the University and W.R.E. and he alone will have direct contact with the personnel at Salisbury.

The system to be followed in preparing programs is explained in the enclosed document prepared by Dr. McCarthy. This system has of course been developed in consultation with W.R.E. as it has to meet with their requirements.

The record of time used on the machine by each program will be kept at the University Computing Centre.

27 February, 1961

FIGURE 2.3 First Page of Document Prepared by McCarthy, February 1961

The University greatly benefited from access to the IBM 7090. It provided research staff and students who needed to run large programs with the best computing facilities in Australia, comparable with the best in the world. The opportunity to use equipment from IBM, undoubtedly at the time the world's greatest computer organisation, had immense advantages.

The high level programming language Fortran was implemented for the 7090 at WRE and, because of its comparative ease of use and because of its wide availability on different machines, was a language important to learn. The machine independence of Fortran was a huge step forward in programming. Library routines which had been developed throughout the world were available to all Fortran users. Though designed and especially suitable for numerical applications, Fortran was also used extensively for data processing and other non-numerical work. The convenience of working in Fortran on the 7090 was well illustrated in the case doctoral research being undertake by Northcote in the Mathematics Department. In Adelaide his computer runs were done on the University's 1620 (see Section 6.3), because of restrictions on use of the WRE 7090. When, in 1962, Potts, his supervisor, went on study leave to the IBM Research Laboratories in U.S.A., he took with him a copy of Northcote's input card deck for a very long Fortran program; this program immediately ran on the 7090 at the IBM Laboratories, enabling expensive runs to be done there.

CHAPTER 3 PUNCH CARD EQUIPMENT USERS COMMITTEE 1960-61

...he hoped that computing within the University 'would not grow'!

3.1 Background

A chance remark made by the University's Assistant Registrar (Academic) Wesley Smith to Potts at a party in early 1960 initiated events which were to result in the formation of a Computing Centre and the provision of computing facilities at the University (Potts 1972). The University already possessed a few items of Powers-Samas 65 column punched card equipment, some purchased from Anti-Cancer funds for processing a survey. This was also being partly used by D. W. Simmons, the Statistics Officer. He had proposed that the University purchase further similar equipment to enable the processing of student enrolments and to meet other administration needs. However, Potts knew that the round hole 65 column cards were soon to be discontinued So not only would such equipment soon be obsolete, but it would not be compatible with commercial computing equipment which the academic departments might wish to use in the future. With the full support of Simmons, Potts immediately went to see Vice-Chancellor Basten who, without delay, sent the following memorandum to the Registrar (with copies to the Assistant Registrars).

> It is of great importance that any equipment, especially punch card equipment, which the Administration may acquire or seek to acquire, should be of such a kind that it will in future years be suitable as peripheral equipment for any computer of which we may have the use. Would you therefore be good enough to make it quite clear to all members of your staff who may be concerned with such equipment now or in the future, that they should not proceed with any plans until they have consulted Professor Potts.
> (Dated March 3, 1960)

Such rapid and decisive action, which was to mark computing developments in the University over the next two years, would be impossible under the bureaucracies of later years. The cooperative relationship between academics and administrators lead to efficient implementation of new proposals. Within one year, the University established a Computing Centre, started providing a service to meet the data processing and computing needs of both the Administration and the academic departments, and had placed an order for its first computer.

3.2 Formation of Punch Card Equipment Users Committee

Following the Vice-Chancellor's directive, the Education Committee[1], at its March 17, 1960 meeting, formed a sub-committee, known as the Punch Card Equipment Users Committee, under the chairmanship of Potts, and with Professors Bennett (Genetics), Cornish (Mathematical Statistics), Green (Mathematical Physics), Mathews (Commerce), Willoughby (Electrical Engineering), Dr Finlay (Waite Institute) and the Registrar as members. The sub-committee was asked to investigate and report on the whole question of punched card and allied equipment and in particular to make recommendations about the need for such equipment, the type and

[1] At the University, what is currently termed the Academic Board was until recently called the Education Committee, a name given to it by the first Professor of Mathematics, Horace Lamb.

extent of equipment required, its location, the integration of the needs of different departments and any other relevant matter.

Despite the narrowness of the committee's title, it was the Chairman's intention to interpret 'allied equipment' broadly as computing equipment, and to press for a Centre which would serve both the Administration and all academic departments. It seemed of political and practical advantage to create a university-wide organisation, akin to the library, rather than to locate equipment in the Administration or in a single department. This concept was strongly supported by Simmons who was to play a significant, supportive role in early future developments.

A hand-written agenda for the Punch Card Committee's first meeting on April 1 listed five items for discussion, namely, computers (WRE, the Electrical Engineering Department's computer, future requirements), punched card equipment in present use, equipment needed, integration of needs of departments, the formation of a university-wide centre, and a questionnaire to Heads of Departments. The brief report of the meeting records two decisions, one to determine whether the equipment belonging to Cornish could be adopted to meet the needs of the Administration, and the other to send a questionnaire to Heads of Departments and others interested, to enable the Punch Card Committee to ascertain the present position. An apology from Wesley Smith suggests he had been co-opted.

A survey form was immediately designed and circulated; replies were received from 35 out of the 49 questionnaires distributed. The results discussed at the second committee meeting on May 13, 1960, indicated that there was already considerable use of 65 column Powers-Samas cards in Cornish's CSIRO Division, the Administration and the Pathology Department. Cornish reported that his equipment could not be easily adapted for use by the Administration. Twenty four departments expressed interest in using punched cards. Simmons, who attended the meeting in place of Wesley Smith, and who was subsequently co-opted to the committee, reported that the manufacturers had confirmed that any system based on the 65 column cards would indeed soon be obsolete. A letter from Willoughby expressed the view that while punched cards were very convenient for specimen or case statistics, they would ultimately be replaced by magnetic tapes and that future machines were likely to do all data processing on tapes, and therefore punched card manipulator equipment 'is likely soon to become obsolete'. At the meeting, he again predicted that magnetic tape would 'soon' replace cards as the standard medium for data processing. This view, differing from that generally held, was a prelude to many lively discussions in the Punch Card Committee and complete consensus was not always reached. The committee discussed the possibility of the formation of a computation centre.

3.3 Computer Users Group

Potts suggested that he convene a meeting of those in the University who were most familiar with computing, and that they be given the task of preparing a detailed proposal for a computer and peripheral equipment to satisfactorily meet the needs of the University. This was agreed to, and Potts invited the following to form the group: Elliott and Sanderson from Mathematics, McCarthy and Reinfelds from Mathematical Physics, Medlin from Physics, Allen and Rose from Electrical Engineering, Culver

from Civil Engineering, Bennett from Commerce, Jones from Geology, Simmons and Meiklejohn from Administration, and Radoslovich and Penny from CSIRO. This specialist sub-committee of the Punch Card Committee, which Potts named the Computer Users Group, wasted no time, producing a comprehensive seven page report, with a complementary one from Willoughby, for the third meeting of its parent committee on June 10, 1960. This report (see Figure 3.1) was prefaced as follows:

> To meet the very urgent needs of computing and data processing in the University, it is proposed that a Computation Centre be formed. In this report an analysis will be given of the equipment and staff required for such a Centre, with a rough estimate of the costs.

The report proposed that the Centre be equipped with a computer and peripheral equipment to be used not only for preparing input for the computer and for printing results, but which would also be capable of meeting data processing requirements of academic departments, the Administration, the Public Examinations Board, and other users. An academic staff of four, plus four technical and clerical staff, was envisaged. The activities of the Centre were to include computing research, teaching, and scientific and statistical computation. A central location for the Centre was suggested.

The report included detailed specifications for the computer, based on requirements to meet various uses, listed as scientific computation, teaching, computer research and administrative work. Two alternative proposals were suggested:

1. that the Cirrus computer should be adopted (a research machine being designed and built in the Electrical Engineering Department)
2. that a machine of comparable capabilities should be bought or rented.

Early on there seemed to be a suggestion that CSIRO might be interested in the Cirrus design for satellite machines (Allen and Rose 1960). However, in supporting Cirrus, the Computer Users Group were well aware that it was an ambitious and experimental project, far from completion. In order to protect the University's interests, their report placed realistic conditions on the acceptability of the machine for the proposed Computing Centre (Figure 3.2), including its adoption by a group of universities or the CSIRO or a manufacturer. They also recommended a director of international repute, and outside contracting of most of the work. This was a hard order to fill, particularly in the early stages of the project.

The complementary report by Willoughby first stressed the importance of access to the IBM 7090 to be installed at WRE in 1961, then supported the development of Cirrus, but he also regarded as essential, the recruitment of two computing staff from CSIRO, Dr Trevor Pearcey and Mr Geoffrey Hill.

As the other alternative, the choice of a suitable commercial machine was discussed. Specifications were also given for the peripheral equipment and it was recommended that IBM equipment for 80 column punched cards should be rented. The report concluded with a positive statement about the 7090, noting that the peripheral equipment would be compatible with it.

PROPOSAL FOR A COMPUTING CENTRE IN THE UNIVERSITY OF ADELAIDE

To meet the very urgent needs of computing and data processing in the University it is proposed that a Computation Centre be formed. In this report an analysis will be given of the equipment and staff required for such a Centre, with a rough estimate of costs.

The section headings in the report are as follows:

--- oOo ---

1. THE COMPUTATION CENTRE

1.1 Equipment

Besides the computer itself a considerable amount of peripheral equipment (punches, sorters, etc.) is required. This equipment would be used to prepare input for the computer and to print results, and in addition would be capable of meeting the simpler data processing requirements of the Departments of the University (including the Administration, Public Examinations Board, etc.) without making use of the computer.

1.2 Staff

It is ~~proposed~~ suggested that there should be an academic staff of four (a Director and three assistants), and also a non-graduate staff of four to carry out routine maintenance, machine operation and clerical work.

FIGURE 3.1 Preface of Report of Computer Users Group

3. PROPOSALS

3.1 The Computer

Two alternatives are suggested:-

(1) That the computer CIRRUS at present under development in the Department of Electrical Engineering should be adopted;

(2) That a machine of comparable capabilities be bought or rented.

(1) It is regarded as urgent that the CIRRUS project should be supported, regardless of whether the machine is adopted for the Centre or not. This work represents advanced research in the field of computer design, foreshadowing the next generation of computers.

Since CIRRUS was designed with the needs of the Australian Universities in mind, it meets all the specifications laid down above. However, if it is adopted for the Centre it must be considered as competing with comparable commercial computers if the users of the centre are to receive an adequate service. That is to say, the machine must be fully operational within a limited time, complete with programme library, and adequate precautions must be taken to prevent the faults and oversights which are common in "one-off" and prototype machines. If this can be done with a computer of this calibre, it will represent a major achievement for the University; but it should not be attempted unless adequate measures are taken to ensure success. The following conditions are considered as necessary:

A. That most of the work of construction be let on contract to a firm capable of meeting rigid deadlines;

B. That a Director of international standing be appointed immediately to co-ordinate the design and programming for the machine;

C. That CIRRUS design is (a) adopted by several Australian Universities, o
(b) adopted by the CSIRO for use in several secondary centres, or
(c) marketed by a firm capable of competing in the computer field.

FIGURE 3.2 Excerpt from Report of Computer Users Group

3.4 A Key Decision – The Go-ahead for a Computing Centre

At its next meeting on June 10, 1960, the Punch Card Committee considered these matters and reported in the following terms to the Education Committee:

- that the University's requirements for punched card and computing equipment could best be met by the establishment of a Computing Centre;
- that the University order the specified IBM punched card equipment (estimated annual rental £3,800);
- that the University underwrite the necessary financial support for the development of Cirrus (estimated cost £5,000 in 1960 and £10,000 in 1961);
- that, on behalf of the University, the Vice-Chancellor and Professor Cornish invite two members of Professor Cornish's Division of CSIRO to accept positions on the staff of the Computing Centre
  (a) one to be Head with status of Professor
  (University to contribute an annual salary of £400),
  (b) one to be an assistant, with the status of Senior Lecturer
  (University to contribute an annual salary of £250).

On June 16, 1960, the Education Committee recommended: firstly to the Equipment Committee that the IBM punched card equipment be ordered; secondly to the University Council that it approve in principle the establishment of a Computing Centre and that the Council give the strongest possible support to efforts of Professor Willoughby to obtain the financial and other assistance necessary for his Department's Cirrus research project, namely the further development of the Cirrus computer; and thirdly to the Development Committee that financial provision be made for supporting the two members of the CSIRO staff to work in the proposed Computing Centre.

Potts recalls that during the intense debate in the Education Committee, one of the Arts Professors said, with some agitation, that he hoped that computing within the University 'would not grow'!

Finally on June 24, 1960 the Council 'approved the report of the Punch Card Committee; the Vice-Chancellor to seek funds to enable the computer project to be proceeded with'. As an advanced commitment, the Equipment Committee approved the hiring from January 1, 1961 of an IBM Printing Card Punch Machine(see Figure 3.3), Verifier, Sorter and Card Counter, but deferred consideration of the Accounting Machine and Collator.

The Computer Users Group, maintaining its initiative, met again on September 12, 1960 to consider recommendations concerning the Computing Centre, the IBM 7090 coming to WRE, the Cirrus computer, and the possible acquisition of an IBM 1620 computer. Culver, from Civil Engineering and a committee member, had good contacts in IBM who kept him up to date on new products. The availability of a punched-card version of the 1620 computer was announced publicly on September 23, 1960. Though a small machine and comparatively slow (about 1/30th the estimated speed of Cirrus), as a computer for the Computing Centre its advantages were suitability for teaching and research, the availability of Fortran and its compatibility with the IBM punched card equipment. It could be used as an independent satellite computer to the IBM 7090 at WRE, with Fortran programs for

the 7090 being checked and tested on the 1620. Another significant attraction was the cost, since IBM offered substantial discounts to educational institutions. For the punched card equipment which the University had already decided upon the discount was 20%; but if the computer were also hired the discount would be a flat 60% both for this equipment and the computer. It was a tempting offer, but not attractive to those supporting the Cirrus project.

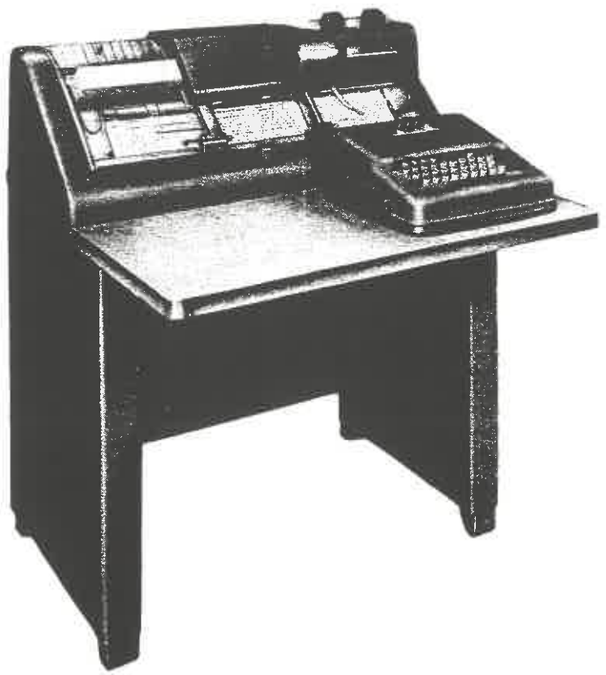
These matters were considered at a meeting of the Punch Card Committee on September 15, 1960, and its decisions passed on directly to the Vice-Chancellor, after deciding it was unnecessary to report to the Education Committee at that stage. The main decisions were to press for the formation of the Computing Centre as from January 1, 1961 (with its location to be considered as a matter of urgency), to express support for financial commitment to the development of Cirrus, and to strongly advocate the hiring of an IBM 1620 for the Centre.

Potts declined the Vice-Chancellor's invitation to be Acting Director of the Centre, but expressed to the Vice-Chancellor his personal view that it would be advantageous to appoint Simmons in charge of punched card equipment and Professor E. S. Barnes as Acting Director of the Centre. As Head of the Mathematics Department, Barnes had direct access to the Equipment and Development Committees; on September 28, 1960, he formally submitted to the Equipment Committee a request for the appointment of two staff, one a Lecturer or Senior Lecturer, and the other an assistant, to run the computer.

These decisions made by the Punch Card Committee, following the considerations of the Computer Users Group, were most opportune because in the same month, September, the Australian Universities Commission requested the University to provide a statement of its 'computer facilities and needs' as part of an Australia wide survey being conducted by the Commonwealth Government. The Vice-Chancellor was able to send a comprehensive response immediately.

The Development Committee met in October and Potts was asked to put the case for staffing the Computing Centre. In December 1960, it was agreed that from 1961 the positions of officer-in-charge and operator be created in the punched card section of the new Computing Centre and a Senior Lecturer for the last quarter of the year in the computing section, it being understood that the punched card version of the IBM 1620 (see Figure 3.3) would not be available before the end of 1961. What exactly happened in regard to the earlier suggestion of co-opting CSIRO staff on a part time basis is not known.[1] What has been verified is that at the beginning of 1962, the staff establishment for the Centre included the unfilled position of Director (see Chapter 5).

[1] Minutes of the Development Committee for 1961-62 were not located.



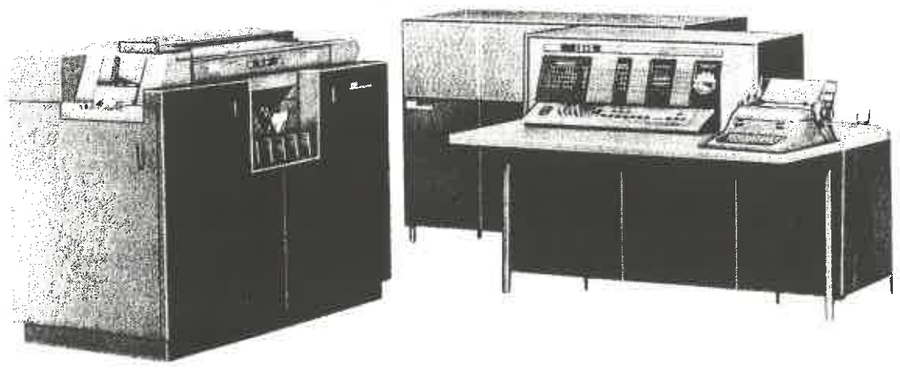


FIGURE 3.3 Top: IBM 026 Printing Card Punch
Bottom: IBM 1620 Computer

Copy for Professor Potts.

VE/BM March 1, 1961.

Dear Sir,

The University wishes to place an order for the hire of a 1620 computer (punched card version) on the terms offered in your recent proposal to the University. Two copies of the signed contract are enclosed.

In order to clarify some details of your proposal, I should like to draw your attention to the following:

1. Educational Allowance.

It is assumed from your proposal that the University qualifies for the 60% Educational Allowance on the 1620 Central Processing Unit, 1622 Card Reader Punch, 026 Printing Card Punch, 056 Verifier, 082 Sorter (with Card Counter), and for the 20% Educational Allowance on the 421 Accounting Machine and the 077 Collator. It is noted that the combined monthly rental for the use of the units qualifying for the 60% Educational Allowance will be based on the following charges:

total normal monthly rental	£1031 4 0
normal hourly rate	5 18 0
minimum monthly charge	412 10 0
additional use rate	2 8 0
number of maximum creditable hours	71 hours.

2. Sales Tax.

The University wishes to support I. B. M. 's application for Sales Tax exemption on the 1620 Computing System.

3. Duty.

The University requests I. B. M. to ascertain as soon as possible the Duty for which the University will be liable.

FIGURE 3.4 Copy of Letter from the University Ordering Its First Computer

2.

4. Delivery Date.

The University will not accept delivery of the 1620 Computer system before December 1, 1961, but requests delivery as soon as possible after that date.

5. Typewriter.

The typewriter desired for the 1620 Central Processing Unit should have a platen of maximum width (9 7/8") and a spacing of 6 lines per inch.

6. Computing Centre Site.

The University Council has allocated portion of the Western end of the Staff Club Building as the site for the University Computing Centre. It would be appreciated if assistance could be given in planning the alterations necessary to prepare this site for the computing equipment.

7. Program - Test Time.

It is anticipated that the University will desire time on a 1620 computer installed elsewhere for the establishment of programs and training of the personnel who will be responsible for running the equipment. It is noted that up to 40 hours can be available for this purpose.

Yours faithfully,

Registrar.

R.C. Ctercteko, Esq.,
I.B.M. Australia Pty. Limited,
408 King William Street,
Adelaide.

FIGURE 3.4 (Continued)

3.5 Ordering the University's First Computer

The matter of the acquisition of the IBM 1620 was not so straightforward. The Vice-Chancellor informed Potts on November 15, 1960 that some outside funding had been obtained for the Cirrus project and that the Department of Electrical Engineering believed that the computer could be made available for the Computing Centre early in 1962. The Vice-Chancellor asked 'Should we proceed with the hiring of the IBM 1620 computer?'

Potts called a special meeting of the Computer Users Group on November 18 at which, after animated discussion, the Vice-Chancellor's question was put to the vote, with 11 in favour, 1 against and 4 abstaining. To the meeting of the Punch Card Committee on November 23, Potts invited Barnes (who was co-opted) and, as an observer, Pearcey from CSIRO, who was involved with the Cirrus project and known to oppose the acquisition of the 1620. The motion 'That this Committee recommends the University proceed with the hiring of the IBM 1620' was passed, 6 for, 1 against, 1 abstention. One member who voted for the motion and the member who abstained wished it be recorded that they hoped the hiring of the 1620 would not hinder the development of Cirrus; in fact, this came across as the general view of the whole committee. However, Cirrus was not yet operational and there was no sign of the machine being adopted by the CSIRO or anyone else; clearly the University could not have gambled on its successful development for teaching and research, particularly without Fortran. As a result of these meetings, the 1620 was eventually ordered for the University with the Cirrus project continuing to be supported (see Chapter 4).

The Computer Users Group was not to meet again. It had certainly performed its *ad hoc* task of supplying detailed computer expertise to the Punch Card Committee in an efficient and most satisfactory manner.

3.6 Nunc Dimittis

The Punch Card Committee also did not meet again. Much of the activity in February 1961 was focused on making arrangements for access to the IBM 7090. The University finally ordered an IBM 1620 on March 1, 1961, with the discounts already mentioned applying (see Figure 3.4). The University requested delivery of the computer not before December 31, 1961; in fact it was not delivered until May 1962.

The objectives of the whole exercise had been realised. The now established Computing Centre was able to take over the role of advising the University on punched card matters (see Chapter 6). On behalf of the Punch Card Committee, Potts submitted a final report, dated March 9, 1961, to the Education Committee, with the expressed wish that the committee now be dissolved, just less than a year after its first meeting. The Vice-Chancellor wrote 'I am sure that the Education Committee will receive your *nunc dimittis* with like gratitude to mine'.

CHAPTER 4 THE CIRRUS PROJECT 1959-71

I was fond of Cirrus.

4.1 Introduction

Cirrus was a research computer designed and built in the Department of Electrical Engineering over the period 1959 to 1962 in collaboration with the CSIRO Division of Mathematical Statistics. The early prototype was developed into a working computer which was utilised in a limited way as a service machine until 1971. As indicated in Chapter 1, it is outside the scope of this history to give a comprehensive technical review of the project, rather it is considered more from the limited viewpoint of the University decision makers. The design and engineering aspects of the computer are covered elsewhere (Allen and Rose 1960, Allen et al 1963, Pearcey 1988).

The Cirrus project is of considerable importance in the early story of computing in the University. It should be clear from the previous chapter that there was a strong lobby group pressing for the University to adopt Cirrus as its main service machine. This did not happen, but the research project, nevertheless, indirectly had a big influence on the development of computing in the University and in Australia.

Rose recalls that the name Cirrus was formed from a selection of letters from CSIRO, WRE, and UA, with the final letter from Satellite. He also suggested an added justification for the name was by association with cirrus clouds, offering the dictionary definition 'a variety of cloud having a thin fleecy or filamented appearance, normally occurring at a great altitude' as an indication that the project was certainly exploratory, and some of the initial concepts were, in a sense, cirrus-like.

4.2 Early Personnel

In 1958, M. W. Allen, an Adelaide engineering graduate with a doctorate from the University of Sydney, was appointed Senior Lecturer in the University's Department of Electrical Engineering headed by Professor E. O. Willoughby. Early in 1959 Allen formed and led a research group to pursue studies in digital techniques and systems. Allen had considerable previous experience with digital computer design, including the design of SNOCOM for the Snowy Mountains Hydroelectric Authority. G. A. Rose, a Senior Lecturer in Electrical Engineering, and J. G. Sanderson, a Lecturer in Mathematics, joined the group which also had close connections with outside personnel, particularly Pearcey and Penny from CSIRO. In fact the essential basis for the design of Cirrus was derived from earlier discussions between Allen and Pearcey (Pearcey 1988).

The CSIRO Division of Mathematical Statistics had for several years been closely cooperating with the University, sharing accommodation on campus and providing the teaching of Statistics courses. The Head of the Division, Dr E. A. Cornish, was an active participant in discussions and decisions concerning computing in the University. In 1960 he was seconded part time from the CSIRO to become the University's first Professor of Mathematical Statistics. He fully supported Pearcey and Penny of his Division in their contribution to the Cirrus project.

Besides the three University lecturing staff who were heavily involved with the project, at least two Electrical Engineering students (I. R. Butcher and M. R. Haskard) obtained research degrees by contributing to the design. Sanderson devised software for processing two languages to be used on the machine, an assembly language called A-code and a compiled language called C-code (Sanderson 1964). Penny from CSIRO obtained his research degrees while developing the operating system/scheduler for the machine (Penny 1961, Penny and Pearcey 1962, Penny 1966).

4.3 The Design Phase of Cirrus

Allen and Rose submitted a report to the University in 1960 outlining the aims and underlying philosophy of the Cirrus design (Allen and Rose 1960). They recognized that there was an urgent need for adequate computing facilities in all universities and in most major divisions of CSIRO; they also expressed concern both about the availability of sufficient funds to meet this need, and the dangers inherent in independent action by individual groups. As a result of a CSIRO survey, it had been proposed that their overall computing needs could best be met by an integrated scheme in which a central installation of large capacity was supplemented by a number of local but independent satellite machines of smaller capacity.

It was considered that there was no suitable small commercial machine available as a satellite machine, and this partly motivated the design of Cirrus, a low-cost microprogrammed, time-sharing computer, which incorporated advances in both logical structure and circuit technique. It was claimed that for the University, this computer would be able to provide a satisfactory service for academic departments, and for administrative and commercial applications. And importantly, it would enable the development in the University of a strong research group on computer hardware. In their 1960 report, Allen and Rose also stated:

> It is hoped that the machine will eventually be adopted by a manufacturer, and negotiations to this end are already under way. The prototype will then be produced by cooperative effort. Given adequate financial support, the prototype could be made ready for evaluation in 1961.

External funds were obtained from the Department of Supply and the PMG (Post Master General's Department), and internally from the URG (University Research Grants scheme), as well as from support provided by postgraduate students. The negotiations referred to concerning the possible external manufacture of the prototype may be related to the 1962 correspondence with TCA (Telecommunications Company of Australia) which has been located. According to Rose, TCA at Hendon, South Australia, under contract, wired the Cirrus mainframe to detailed plans from the Electrical Engineering Department. An application by Rose to the Radio Research Board for support in 1961 was rejected.

Cirrus was tested as a working machine over the period November 1962 to January 1963 (see report by Allen in Section 4.5 below), and the research was published in an international journal in May 1963 (Allen et al 1963). The team then set about building an operating service machine from the prototype.

4.4 Financial Support for the Cirrus Prototype

Specialist University committees dealing with computing matters were invariably supportive of the Cirrus project. As indicated in Chapter 3, in June 1960, on expert advice, the Punch Card Committee recommended to higher University committees that specified sums for the Cirrus research project be underwritten by the University, namely £5,000 in 1960 and £10,000 in 1961. On November 3, 1961, the newly formed Computing Centre Committee (see Chapter 6), with Allen, Capon, Penny and Sanderson attending, considered 'The Future of Cirrus and the Centre'. The committee agreed to recommend that the sum of £24,500 be allocated to the Cirrus project and that the Vice-Chancellor be asked to investigate whether joint ownership of the Cirrus computer with CSIRO was practicable. It is not known what eventuated from the latter recommendation. Rather than trailing the financial recommendations through higher committees, attention is now turned to University records of what was actually spent on the Cirrus project, in so far as this can be traced.

Official University Financial Statements, under the heading 'departmental funds expended' show that £4,500 was spent on equipment for Cirrus research in 1961 and nearly £18,000 in 1962 for equipment and maintenance including £4,500 on research equipment. Over the period 1961-63, external funding totalling over £14,000 was expended for the Cirrus project, coming from the Department of Supply and the PMG. While it has not proved possible to find the precise amounts contributed from URG funds (administered by the University), from old departmental records it appears that URG support amounted to a few hundred pounds in 1959, about £3,600 in 1961 and £4,500 in 1962 (the total departmental grant in 1960 was less than £2,000). It is presumed that these amounts are included in the 'departmental funds expended' quoted above, and that the 'expenditure of grants from outside sources' is separate expenditure, but neither assumption is certain

Allen's early 1963 report (see Section 4.5 below) on the project cites £9,000 from URG and £11,000 from external sources for funding the research. Pearcey (Pearcey 1988) states, without indicating how he arrived at the figures, that the hardware cost £20,000 and development costs were £70,000. Further to the status of the Cirrus development, from the paper in the IEEE Transactions on Computers (Allen et al 1963), it appears that the machine was operating, but operational details are not given; the cost of components excluding peripherals was cited as £15,000. The paper did not estimate overall development costs.

These various cost estimates, while differing, are not really irreconcilable because they account for different aspects of the project costs. It has not been possible to estimate what the University's contribution to the project was or to arrive at an overall figure. However, it should be noted that the sums of money quoted above were quite considerable at the time; for example a professorial annual salary in 1959 was £3,500. Research students working on Cirrus were supported from a number of sources, including the Australian Atomic Energy Commission, CSIRO, PMG and the Commonwealth Postgraduate Award Scheme. In addition the whole project was, of course, led by University staff and supported by University infrastructure.

4.5 Towards a Working Machine

The Computing Centre Committee, at its meeting on April 19, 1963, considered again the development of the Cirrus project for 1963 and 1964, and had before it reports from Professor J. M. Bennett, University of Sydney, and from Allen. In summary, Bennett reported that with an expenditure of about £3,500 for the appointment for one year of an engineer and a technician, Cirrus could be made operational by the end of 1963. For software development he allowed £1,000 and a further £1,000 would be needed for minimal paper tape equipment. Lower priorities were given to magnetic tape units (£35,000) and card input/output (£5,200).

The project clearly was expensive for a small university alone, and at this stage the machine was not operational. While, undoubtedly, components of the system had been tested as they were built, in early 1963 Allen reported as follows:

> CIRRUS was tested as a working machine with a minimum set of slow speed borrowed peripherals and restricted order code in November 1962. These tests were terminated with very satisfactory results in January 1963. The control unit is now dismantled and the final version of control store being installed, which will provide full order code and speed.
> The development of CIRRUS until the end of 1963 has been financed on research merit by grants to the Electrical Engineering Department, from WRE and PMG (£11,000) and URG (£9,000). The costs and recommendations of Professor Bennett provide a basis for the conversion of the machine to a service unit. This aspect has little merit as Electrical Engineering research and cannot be financed on the same basis.
> It is likely that punch card equipment suitable for adaption as input-output units will be offered free of charge to the University. However, this will require design and development of associated electronics to match the machine input requirements.
> It is vital that the proposals for engineering staff and key equipment be implemented immediately or it will be impossible to provide an adequate service with punch card facilities in 1964.

So the Computing Centre Committee finally passed the following, which was then approved for prompt implementation:

(a) the engagement as soon as possible of an engineer and a technical assistant
(b) the expenditure of up to £500 for casual coding
(c) the purchase of peripheral paper tape equipment.

Meanwhile CSIRO had its own plans which did not include Cirrus. The Computing Centre Committee noted that a CSIRO satellite machine would probably be installed in the Engineering Annexe of the University during the first half of 1964 and would be available for University use. Naturally this greatly affected the status of Cirrus within the University, and, as a result, virtually any possibility of Cirrus being fully developed disappeared (see Section 6.2).

4.6 Cirrus as a Specialist Service Machine

The project continued to receive support in the University. The appointment of an engineer and a technical assistant was agreed to and R. J. Potter started working as the project engineer at the beginning of 1964. The exact date when Cirrus came into service has not been unearthed, but according to Allen 'it became operational in 1963'. From a University letter written in August 1962, the anticipated date for the release of the assembly language A-code is stated to be before mid 1963, and for the release of the compiled language C-code is given as late 1963 'under satisfactory conditions'. The manuals specifying the languages are dated July 1963 and May 1964 respectively (Sanderson 1964). Figures 4.1 and 4.2 show photographs of Cirrus and Figure 4.3 shows the list of contents of the C-code manual.

Potter recalls a number of the engineering research students who made use of Cirrus as a service machine. Cooper calculated some Bessel functions with subroutines written in A-code. Igor Hawryskiewzcz also used the machine for his research, while Lees and Sydenham performed experiments involving real time control. There were also research users from other departments. Barter programmed Cirrus in Electrical Engineering undergraduate course work, probably in 1965, while Lewis did her Honours Computing Science project on Cirrus in 1965.

Allen spent a year overseas on study leave in 1964 and left the University at the end of first term 1965; Rose and Penny also moved on. When Ovenstone became Director of the Computing Centre in 1964, he continued to support the use of Cirrus as part of the University's computing facilities, now dominated by the presence of the CDC 3200. When his plans for the CDC 6400 were drawn up in 1965, Cirrus was included as part of the scheme; the block diagram of the Centre's projected new facilities showed Cirrus, with card reader and other equipment, connected to the projected 6400 system (see Figure 6.2). Evidently this caused some consternation to certain Engineering research users of Cirrus, but Ovenstone reassured Willoughby that the machine could be disconnected when necessary! However, like others, Ovenstone's optimistic plans for Cirrus (which still included Fortran at some unspecified future date) were not implemented. Ovenstone's idea of interfacing Cirrus and the CDC 6400 was not practical; also Potter was not successful in developing an interface between CDC peripheral equipment and Cirrus.

Cirrus remained in the Electrical Engineering Department, and, finally, was used for a few specialist applications. Potter, now part of Ovenstone's establishment, continued servicing Cirrus until he left the University at the end of May 1969. He recalls that it was not easy to keep the machine operational. In May 1969, Ovenstone reported that Cirrus needed extensive re-engineering and re-furbishing if it were to remain an effective machine. On July 30, 1969, it was reported to the Computing Science Committee that a 'total' breakdown of Cirrus had occurred – of course what was meant was a major breakdown; attempts to repair the machine were at first unsuccessful. Potter had left the University in May, and his replacement Peter Hawryskiewzcz (whose brother Igor had previously worked on Cirrus), started work in August or September, at which time the machine was still out of action. Cirrus was new to him, whereas Potter had been involved directly or indirectly with the machine from its beginning. Cirrus was well engineered; fortunately one of the technical staff, Werner Dorfl, whose skilful hands had helped build Cirrus, remained working in the

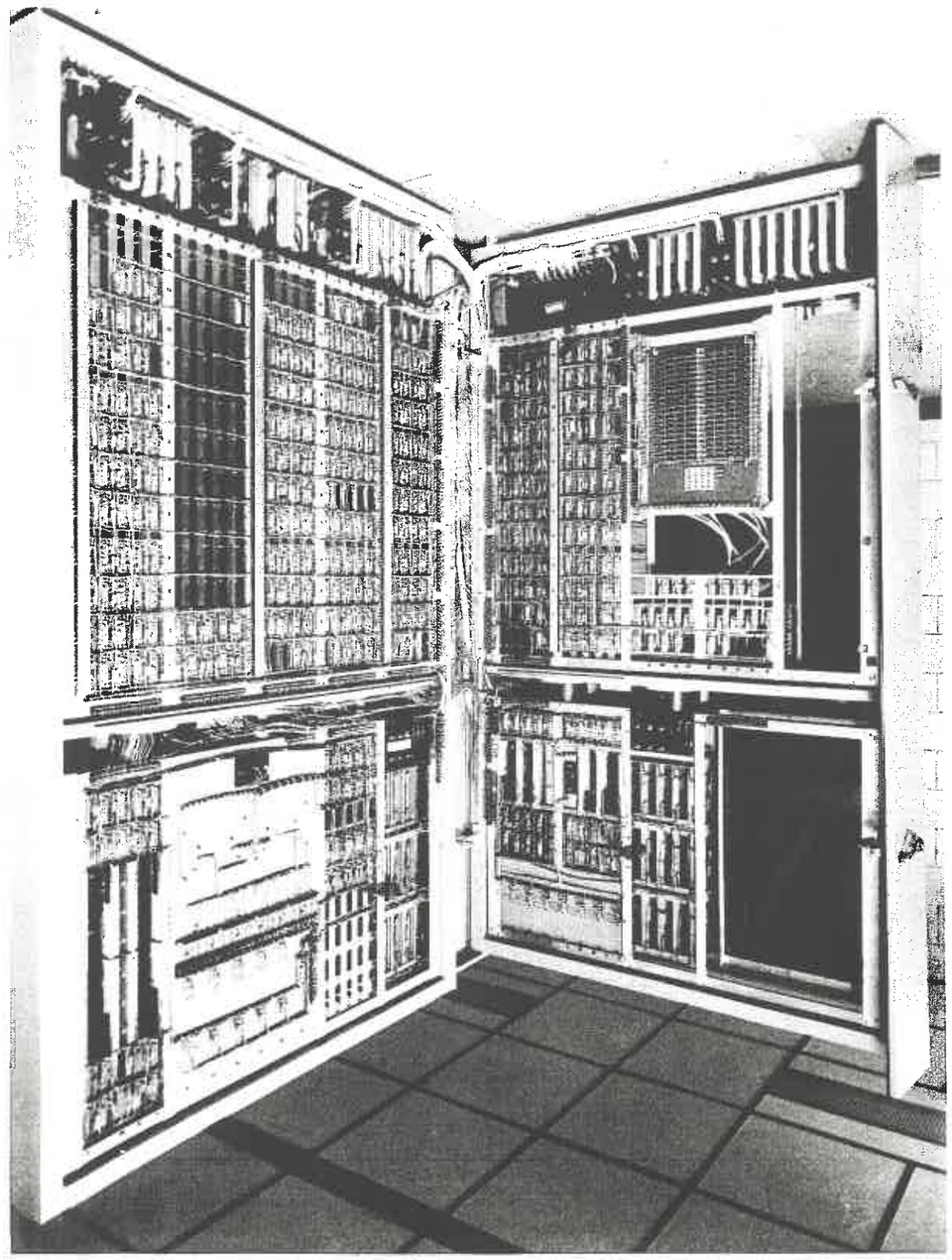


FIGURE 4.1 Inside View of Cirrus Mainframe

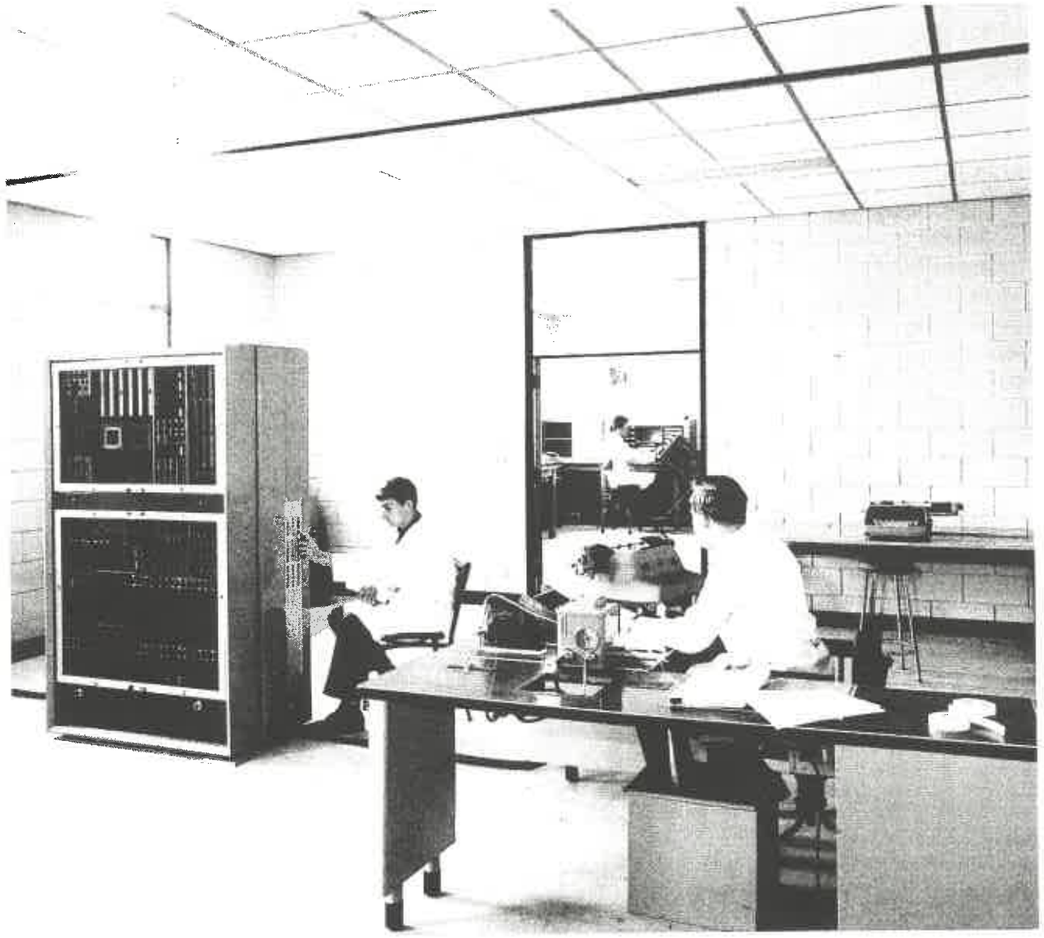


FIGURE 4.2 Cirrus in Operation
In Foreground R. J. Potter; in Back Room W. Dorfl

CIRRUS C-CODE MANUAL

J.G. SANDERSON.

List of Contents

FIGURE 4.3 List of Contents of Cirrus C-code Manual dated May 1964

Centre. The engineering team brought Cirrus back into operation, but by 1971 it was only used for 4-5 days a month, and break downs were common. The machine was serviced until August 1971 especially for one or two users. Cirrus was then dismantled and parts divided between the Computing Centre and Engineering. The mainframe and other parts of the machine have been preserved in the Electrical Engineering Department, and a piece of core store continues to be used as demonstration material in the Computer Science Department.

4.7 Conclusion

According to Pearcey (Pearcey 1988) 'the failure to follow up the Cirrus design was probably one of the greatest mistakes in Australian computing'. This lost opportunity to develop a local computing industry has been cited as an example of Australia's inability to capitalise on and develop technological innovations. Pearcey has suggested some of the circumstances which he believed contributed to the lost opportunity for developing a local Australian computing industry from the Cirrus project. He claimed the main factor probably to be insufficient interest by the University in pursuing digital technology, 'the Electrical Engineering Department and its Professor Eric Willoughby being more attuned to the analogue era'. Nevertheless, Potts clearly recalls Willoughby being a passionate advocate for Cirrus in University committees. As outlined in this and the previous chapter, detailed examination of records shows that within the University's limited capacity, the Cirrus project received vigorous and generous support. At that time, both the lack of requisite funds and necessary infrastructure, totally ruled out the University alone developing the project as a commercial venture.

In hindsight, forecasts about the timing of the research always seemed to have been optimistic. The research funding for the prototype machine appeared to meet the recommendations of the specialist Computer Users Group, but it was not until the end of 1962 that this machine was tested. Scant details have become available about the next stage, the full development of the service machine. But again, the University met the minimum financial recommendations of Bennett, who was called in from Sydney during early 1963 as a consultant. According to Allen, in the early stages the development was very experimental, and funding was not really the limiting factor. He also considers that to provide punched card input would have cost as much again as the whole machine.

Early on there appears to have been genuine optimism within the Electrical Engineering Department that the machine would be manufactured from the prototype for use by CSIRO. Whether or not this was ever seriously considered by CSIRO, and whether or not possible commercial manufacturers, other than TCA (see Section 4.3), were approached remain unanswered questions.

The authors have come to the conclusion that Pearcey's criticism of the University's support for the Cirrus project is largely unfounded. He is also critical of the CSIRO both for its discouraging attitude to computer design work, and lack of support for CSIR Mk. 1 and Cirrus. It seems likely that the steps from a working model to a practical general purpose machine were very much greater than originally anticipated by the research workers concerned. In the end time caught up with Cirrus when the CDC machines arrived on the scene.

The main thrusts of this chapter have been firstly, describing the part Cirrus played in early decision making related to providing computing services for the University, and secondly, presenting factual evidence of the University's material support of the project. There is clearly a need for a more detailed historical record of the engineering aspects of Cirrus than provided in the short description in Pearcey's book (Pearcey 1988).

There is a certain magic associated with the Cirrus story among the electrical engineering fraternity who had any association with it – illustrated by one who said he was 'fond of Cirrus'. In retrospect, not only did Cirrus prove to be a highly successful and innovative design as a research computer, but also it was developed into a useful, specialised service machine; its long active life is a credit to those who designed and built it, and to those who maintained it.

The design of Cirrus, according to Pearcey (Pearcey 1988) 'seems to have had some effect upon the evolution of commercial computer design'. In all kinds of ways, from the simple to the significant, the design and building of Cirrus has influenced computing in Australia. For example, a bootstrapping program in a simple hypothetical machine language which was designed for early first year classes, was inspired by an advanced lecture given by Sanderson based on his work on Cirrus. Barter, who succeeded Hirst as Professor of Computing Science in the University, did programming for Cirrus as an undergraduate electrical engineering student. More importantly, the project provided valuable research experience for the team who worked on it, and the five main researchers moved on to positions of academic leadership in computing science. Allen later became Professor of Computer Science at the University of New South Wales, and Rose Professor of Computer Science at the University of Queensland, while Pearcey was Professor at the Chisholm Institute of Technology in Melbourne, Penny Professor at Canterbury University, New Zealand, and Sanderson an influential and much respected Senior Lecturer at the University of Adelaide.

CHAPTER 5 FORMATION OF THE COMPUTER SOCIETY OF SA 1960

Few achievements of modern science are likely to have such a direct and revolutionary effect on so many different spheres of human activity as the electronic computer.

5.1 Introduction

The initiative taken from within the University in the formation of the Computer Society of SA was an important factor in establishing contacts with computer users outside the University and in placing the State in the forefront of computing in Australia. The University provided the common ground for differing computer groups from industry, commerce, WRE, and CSIRO, to meet together to help promote better understanding of computing. Although Victoria and New South Wales were well ahead of South Australia in the early introduction of computers, the Computer Society of SA was the first such society to be established in Australia.

5.2 Preliminary Meeting October 24, 1960

Promoted by a suggestion from Mr Frank Vickress, employed by IBM in Adelaide, it was decided that Potts should arrange a meeting in the University of those in the business, engineering and scientific community interested in computing, in order to consider the formation of an Adelaide Computing Society. The notice circulated widely (reproduced in part in Figure 5.1) reflects the mood of the time.

A Computer Society

Many achievements of modern science have quickly become an accepted part of everyday life. Few, however, are likely to have such a direct and revolutionary effect on so many different spheres of human activity as the electronic computer. The use of electronic data processing equipment in the business, engineering and scientific fields has grown rapidly in Australia in the past few years. In Adelaide, in particular, there are many who now have an interest in electronic computing and data processing and those who have been approached have agreed that the formation of an Adelaide Computer Society is overdue.

It is proposed that the Society should be initiated with the minimum of formality at a meeting to be held in the University in October. At this meeting the guest speaker will be Dr Paul Gygax, who will talk on 'The Automatic Russian-English Language Translator'.

R. B. Potts
Mathematics Department
The University of Adelaide

FIGURE 5.1 Excerpt from Notice for Preliminary Meeting of Computer Society

---

The preliminary meeting was in fact held on October 24, 1960 in the University's Mawson Lecture Theatre, with an enthusiastic audience of over 150. It was decided to form the Society at an inaugural meeting on November 26, 1960; the founding motion was proposed by D. L. Overheu and seconded by R. G. Keats, both from WRE. The elected committee is listed as its composition demonstrates the mix of representatives from the various sectors involved in computing. The president was Potts, with Overheu (WRE) and Powell (Electricity Trust) as vice-presidents, Vickress (IBM) as treasurer and Simmons (University) as secretary; committee members were Dennis (State Public Service), Keats (WRE), Mathews (University Department of Commerce), Rankine (GMH Ltd), Rose (University Department of Electrical Engineering) and Wilson (ICT Aust Ltd).

5.3 Inaugural Meeting November 26, 1960

At the inaugural meeting, held in the Mawson Lecture Theatre, it was decided to name the new organisation the Computer Society of South Australia. The speaker at this meeting was David Elliott, Senior Lecturer in Mathematics in the University, his subject 'A Brief History of Computing'. In the notice for the meeting it was stated that the talk 'will be of general interest and aimed at those who know absolutely nothing about computers and computing'. Some notes about the speaker's early background in computing follow. After graduating from London and Princeton Universities, Elliott's interest in computing began in 1955 while working in the Mathematical Division of the National Physical Laboratory in England, where he gained experience on the English Electric computer DEUCE. He came to Australia in 1957, working for twelve months on the same machine, now termed UTECOM, at the NSW University of Technology. He was appointed a Senior Lecturer in Mathematics at the University of Adelaide in 1958, where he taught courses in numerical analysis. Under the supervision of Potts, he obtained his Ph.D. in 1961, his topic being 'Application of Chebyshev Polynomials in Numerical Analysis'. This was the University's first Ph.D. degree on a subject related to computing science. Elliott subsequently was appointed Professor of Mathematics at the University of Tasmania, a position which he held with distinction for 30 years until his retirement in 1996.

In the Society's first year, eleven meetings were held; among the speakers were Pearcey and Ovenstone.

5.4 Formation of the Australian Computer Society

The formation of the South Australian Computer Society was followed by the Victorian Computer Society (April 1961), the Queensland Computer Society (February 1962), the New South Wales Computer Society (August 1963) and the Canberra Computer Society (March 1965). These five societies were the founding societies of the Australian Computer Society, formed on January 1, 1966 (Bennett 1994).

CHAPTER 6 EARLY YEARS OF THE COMPUTING CENTRE

My most unusual experience by current standards was having to spend the night with the 1620.

6.1 Formation of the Computing Centre in 1961

The Computing Centre came into official being on January 1, 1961 with Barnes as Honorary Director, Simmons as Officer in Charge of Punch Card Equipment and Ms Helen Harris as data processing officer. An IBM printing card punch machine, verifier and card sorter were installed temporarily in the Administration Building on January 9, with a card counter soon to follow. An accounting machine and collator, which had been approved by the Equipment Committee, were ordered for July. Simmons was pleased to report on February 16, 1961, that the Centre had punched and verified over 11,000 cards for processing some 3,000 student enrolments, and that the first Fortran programs had been punched on cards for processing on the WRE IBM 7090. The Centre was up and running and the University's first computing service was operating.

To find a more suitable location for the Centre, the Vice-Chancellor organised the formation of a Computing Centre Site Committee, with the following membership: Potts(chair), Simmons (secretary), Vice-Chancellor, Allen, Barnes, Cornish, Willoughby and the Registrar – certainly a high powered committee. After a meeting on February 7, 1961, when various alternatives were discussed, it was decided to use an area at the western end of the old Staff Club. Previously this location had included a storage room in the Anatomy Department; it was necessary to remove old formalin baths and large overhead hooks before the punched card equipment could be installed. This former use of the area was a source of ghoulish jokes, especially when staff had to operate the equipment overnight.

In the University's 1961 Calendar, the entry for the Centre, including the listing of its staff, was placed adjacent to that for the Library – clearly, right from the beginning, the Centre was seen primarily as a university-wide service provider rather than as an academic unit. However, approval was given for a Lecturer or Senior Lecturer to be appointed to the Centre towards the end of 1961; conveniently at that time I. N. Capon was available after completing his doctorate in Cambridge, and he was duly appointed Lecturer – the University's first academic appointment in computing. Capon commented on his appointment in these words:

> It was ironic in 1961 that the University had hired a card based Fortran processing system, and then appointed somebody trained in the papertape machine-code/autocode culture then prevailing in the UK...I remember having to learn fast.

After Capon arrived from Cambridge in September 1961 to take up his appointment, he assumed responsibility for the computing service and for the Fortran crash courses; he lectured in numerical analysis for the Mathematics Department, but the emphasis of his work in the Computing Centre was on the service side.

6.2 Computing Centre Committee 1961-64

For the administration of the Centre, on the recommendation of the Education Committee, a Computing Centre Committee was formed, with Barnes as Chairman, and Cornish, Potts, Willoughby, McCarthy and the Registrar as members. It first met on November 1, 1961, with Allen, Capon, Simmons and Professor Remmenga, a University visitor from overseas, attending by invitation. The main item discussed was the future relocation of the Centre to the first and second floors of the new Engineering Annexe, to share accommodation with the CSIRO Division of Mathematical Statistics. The committee met again on November 3 to consider 'The Future of Cirrus and the Centre'; this matter has already been discussed in Chapter 4.

Organising support for the Cirrus project appeared to be one of the major tasks of the Committee. It attempted to grapple with the issue of whether or not the project would produce a practical working computer for University use – this was a formidable task for a group of people who really were not in a position to judge, especially before the results of testing the prototype were announced at the beginning of 1963. The Committee always recommended strong financial backing for Cirrus, and the machine remained very much in consideration as the main service provider, until this was pre-empted by an offer from CSIRO. In this regard Barnes tabled an important letter from Pearcey at the meeting on April 10, 1963, about the anticipated installation of a CDC 3200 computer in the Engineering Annexe on campus in 1964. Pearcey pointed out in the letter that the machine would have a fair range of peripheral facilities, and that as CSIRO would not use its full capacity for some time, the machine would be available for University use (see Section 6.3).

Under the chairmanship of Barnes, the Committee continued to meet two or three times a year as required. The Committee's agenda included staffing; among the matters considered was the transfer of Sanderson from a lectureship in Mathematics to one in the Centre in 1963, and the appointment of an engineer, Potter, to the Cirrus project in 1964. Also it was soon necessary to supplement the data processing staff. One important academic matter brought up each year was the possible introduction of a postgraduate diploma course (see Chapter 8).

From the beginning of 1962, the staff establishment of the Centre included a Director, two punch card operators and one junior laboratory attendant as well as the posts filled by Capon and Simmons. Sanderson was to occupy one of two additional scientific positions envisaged in the original scheme. It will be recalled from Chapter 4 that there was much discussion culminating in a recommendation from the Education Committee about the possibility of appointing Pearcey from CSIRO as a part time professor in the Centre (much like the position of Cornish in Statistics). What exactly transpired over this matter is not known, but evidently Pearcey was offered the directorship (with professorial status), for the Computing Centre Committee was informed in April 1963 that an offer to him had been rejected; consequently the immediate advertising of the position was recommended. Potts, who knew Ovenstone well from WREDAC times, drew his attention to the post, and was surprised and delighted when Ovenstone duly applied for the position, and accepted the ensuing offer.

6.3 The University Computing Service 1961-65

Right from its beginning the Computing Centre was responsible for providing the University's computing service. Figure 6.1 lists the computers available for members of the University from 1961-78. The early decision to use IBM compatible equipment (see Chapter 3) was amply justified, as it enabled a broad group of University scholars to have immediate access to IBM computers and the IBM developed high level programming language Fortran. IBM punched card input and Fortran became widely used throughout the computing world and common to many commercial computers, including those of CDC, whose machines the University used for many years.

period	site	computer	notes
1961-64	WRE	IBM 7090	first Univ. service – staff/postgrads (Fortran)
1962-66	C.Centre	IBM 1620	first Univ. machine – staff/postgrads (Fortran)
1964-71	Eng. Dept	Cirrus	Univ. built – staff/postgrads (AC-code)
1964-67	Annexe	CDC 3200	CSIRO machine – general use (Fortran etc)
1966-77	C.Centre	CDC 6400	first large Univ. mc. – general use (Fortran etc)
1977-	C.Centre	CDC Cyber	like 6400 but more powerful (Fortran etc)

FIGURE 6.1 Computers Providing University Service 1961-78

The first computing service for University staff and research students was provided from early in 1961 on the IBM 7090 at WRE (see Section 2.5). The program and data preparation were done in the new Computing Centre; managing the costs and the negotiations with WRE remained a function of the Centre and the Computing Centre Committee. Not surprisingly, usage grew rapidly and the Committee several times had to deal with the problem of asking for extra time, at extra cost. Naturally there were access difficulties, but the 7090 provided valuable service for the University until equivalent or better facilities were available on campus.

The University's first computer was the hired IBM 1620 (see Section 3.5) which was installed in May 1962, firstly in the Computing Centre's quarters on a mezzanine floor in the Staff Club building and later in the Engineering Annexe. Northcote, a student at the time, recalls watching the 1620 being wheeled in to its first quarters. The computer quickly became heavily used for learning to program and for research purposes; in a limited way it was used to debug programs before running them on the 7090, though there were some small differences between Fortran on the two machines. Many large production jobs were run on the 1620; Bob Culver and several of Potts's research students were heavy users. Northcote remembers asking and receiving permission from Barnes, the Honorary Director of the Centre, to purchase a stretcher so that he could sleep at night by the computer when he ran his large jobs. The 1620 was slow; in one particular week Northcote used the machine for 128 hours, that is a week less the 40 hours when it was generally available. A photoelectric device attached to an alarm clock was rigged up so that attention would be drawn to the end of the input of a deck of punched cards – a slow process for Northcote's very large decks! The device was quite independent of the 1620; the photoelectric cell simply detected when a light on the 1620 control panel came on. Culver and Meyler

also made use of the same overnight arrangements when running long programs. Best of all is the comment from Margaret Meyler: 'My most unusual experience by currents standards was having to spend the night with the 1620'. When Kidman came to the Centre as a beginner-programmer in 1966, she tried using the 1620 before it was returned to IBM. What remain as striking memories are firstly, submitting the compiler as a card deck, and secondly, after a Fortran program was compiled, the machine punched the equivalent binary (translated) version as a card deck to be submitted again for executing the program. Later Fortran users may have wondered about SENSE SWITCHES in the language – the 1620 had physical sense switches.

The 1620's life did not end when the University returned it to IBM. In 1967, IBM offered the services of the machine for use in schools to the Education Department; it was installed at Angle Park High School on February 19, 1968, from where it provided secondary schools with a valuable service for a number of years, until the Angle Park Computing Centre acquired an IBM 1130. School students wrote their programs on forms, from which cards were punched at the central Education Department facility and sent to Angle Park for processing. So the 1620 was not only the first computer in service at the University, but also the first computer in South Australian schools.

The service provided by Cirrus has been covered in Chapter 4.

In 1964, CSIRO installed the CDC 3200 in the Engineering Annexe, the building it shared with the University's Computing Centre; this computer, run by the CSIRO staff, provided a readily accessible batch service for University users. For example, to run a Fortran program, the user placed the card deck in an input tray on the counter outside the machine room, from where deck and output could be collected a few hours later after processing. This was, of course, before large classes of undergraduates were involved. In exceptional circumstances, program and data decks were transferred to magnetic tape, for dispatch to the more powerful CDC 3600 at CSIRO in Canberra. Capon was quite involved with the 3600 service, and visited Canberra many times in connection with processing for the PEB (Public Examinations Board). He tells this good story. The 3600 in Canberra was being used to collate PEB results and produce a publication list as soon as possible. As part of the procedure, the program translated from subject code to subject name (for example, from CH to Chemistry). One night at about 3 a.m. there appeared a diagnostic 'unknown code HS'. Capon took what seemed the obvious step of patching in 'History' and reran the program. Fortunately Simmons (next day) realized something was wrong and that 'HS' was 'Home Science' – another rushed trip to Canberra! Next year, the PEB secretary decided to keep an eye on proceedings. After dining well, he arrived at CSIRO at about 11 p.m. or so. As luck would have it there was some fault, leading to delays, so that the job was not completed until 5 a.m.; the secretary was not feeling 100%, but for the operator, on penalty rates, it was a great night's work.

Usage of the CSIRO network within the University grew rapidly; by mid 1966, about 150 staff members and research students were the using the system and nearly every group in the University made some use of the facilities, so that in total the University used two-thirds of a shift daily. This was the main service until the arrival of the CDC 6400 (see Section 6.5). While Fortran programs could be transferred across these three CDC machines with little if any modification, this was not the case if any

assembly language were used; there were also some complications when using magnetic tapes across machines.

The Department of Computing Science purchased its first computer, a PDP 11, in 1973 soon after the arrival of Professor Hirst. It was required for research purposes and to give senior students hands-on contact with a machine. The use of small computers by other departments is outside the scope of this history. The Computing Centre did offer advice, and attempted to regulate and coordinate the departmental purchases.

6.4 Computing Science Committee 1965-67

From 1961 until 1965, the Computing Centre Committee was responsible, among other matters, for staffing and equipment requests for the Centre. After Ovenstone's arrival in mid 1964, when the Department of Computing Science was created outside the usual Faculty structure (see Chapter 7), it became necessary to have a committee through which development in the new department could be channelled. In some documentation this committee was called the Board of Studies in Computing Science. However, it became known as the Computing Science Committee, with a defined membership and charter granted by the University Council; essentially it was intended to deal with the new Department as well as taking over the previous role of the Computing Centre Committee. At the last meeting of the old Computing Centre Committee on June 12, 1964, Ovenstone sought approval for a preliminary plan for academic courses for 1965 (see Chapter 8).

The first meeting of the Computing Science Committee was held in January 1965, and the main topic discussed was the extension of computing facilities. After consideration of six proposals from suppliers, the committee voted in favour of purchasing a Honeywell computer. It was perhaps no accident that Honeywell featured, for that company was the incumbent supplier at the Department of Defence where Ovenstone had been before coming to the University. Meanwhile it is evident that behind the scenes negotiations were proceeding between Ovenstone, CDC and the University. At some stage Vice-Chancellor Basten privately expressed his worries over what was going on to Culver. In the minutes of one of the meetings, it is emphasised that the University required all offers to be in writing – this may have referred to proposals from another company. At the end of January 1965, the Vice-Chancellor presented a report (not seen by the authors) from Ovenstone concerning details of the state of play to the University's Finance Committee, which agreed to Ovenstone visiting the USA. According to Capon, he went to the USA expecting to buy something like a CDC 3200, compatible with the CSIRO machine being used at the University, but was offered a very much larger and newer machine, the CDC 6400, at that time so new that it was unknown in Australia. Ovenstone rang Capon from Minneapolis, the headquarters of CDC, to ask if he had heard of it. Capon suspects that an individual who moved from Honeywell to CDC may have had an influence over what happened. The proposed purchase was carefully considered by the Finance Committee, and, with certain safeguards, was approved. The outcome was reported at the next meeting of the Computing Science Committee in August; by this time a contract had been negotiated for the purchase of a CDC 6400 (see Section 6.5 for further details). A trivial but interesting consequence of the deal was that Culver had to buy Ovenstone a bottle of Scotch, the result of a bet!

This sequence of events suggests that the committee's role was little more than a rubber stamp with regard to the purchase of the 6400. However, at this time Ovenstone put forward his staffing requirements for the next triennium, specifying 4 academic staff and a total of 20 staff at all levels for the Centre – this kind of expansion no doubt left the committee spellbound! Ovenstone always had an answer; for example when asked if 3 of the programmer positions could be omitted, he replied that then it would not be possible for any research work to be undertaken by the Centre on behalf of departments which lacked computing expertise! In the end, after two meetings, the committee voted to forward his staff proposals.

The Computing Science Committee continued to meet several times a year until mid 1968. Teaching and research matters were never considered, the agendas being dominated by submissions for staff (both Centre and academic) and equipment, including two triennial AUC (Australian Universities Commission) submissions. In parallel, the Committee to Allocate Sums for Computing dealt with the allocation of computing resources within the University.

6.5 Acquisition of the CDC 6400

As described in Section 6.4 above, Ovenstone, almost immediately after his appointment in 1964, set about acquiring a larger computer for the University. A major difficulty in formulating a practical plan was that only limited funds were available, and the period 1967-69 constituted a new triennium, for which it was not yet clear whether a large AUC grant would be forthcoming; however, planning at the time assumed there would be a large grant. A contract was signed for the purchase of the CDC 6400 for £480,000, this price representing a 40% discount. A sketch of Ovenstone's proposed computing set up, typically optimistic, is illustrated in Figure 6.2. This was a major step if not a major coup for the University, for the 6400 was of considerably higher speed and capacity than the CSIRO CDC 3600 in Canberra (Pearcey 1988), and it would be the most powerful computer in Australia. On the other hand the sale was to be enormously beneficial to CDC too, because this was the initial step towards its dominance of the Australian computing scene for some years.

The 6400 duly arrived and was installed on the ground floor of the Engineering Annexe in mid 1966; with the machine came ancilliary equipment, including card punches, and a large contingent of staff with various qualifications. Just how large the operation became is illustrated in the staff profiles given in the following section. For the 1968-72 period Ovenstone submitted applications for 42 additional staff for the whole organisation (including academic positions), claiming to have foreshadowed this need in 1964.

The acquisition of the 6400 was extremely good for University computing, but was almost beyond the capacity of the University to finance. Naturally, right from the start, even before the arrival of the machine, it was essential for Ovenstone to have extra staff to prepare to run the new computer. The University was asked to underwrite staff appointments for 1966, with the expectation of ultimately paying the deficit from anticipated staff development. After the AUC provided less money than had been assumed, the Computing Centre virtually became a commercial operation, with computing time and services sold to other universities, government institutions and private organisations; in addition to computer time, consulting and programming

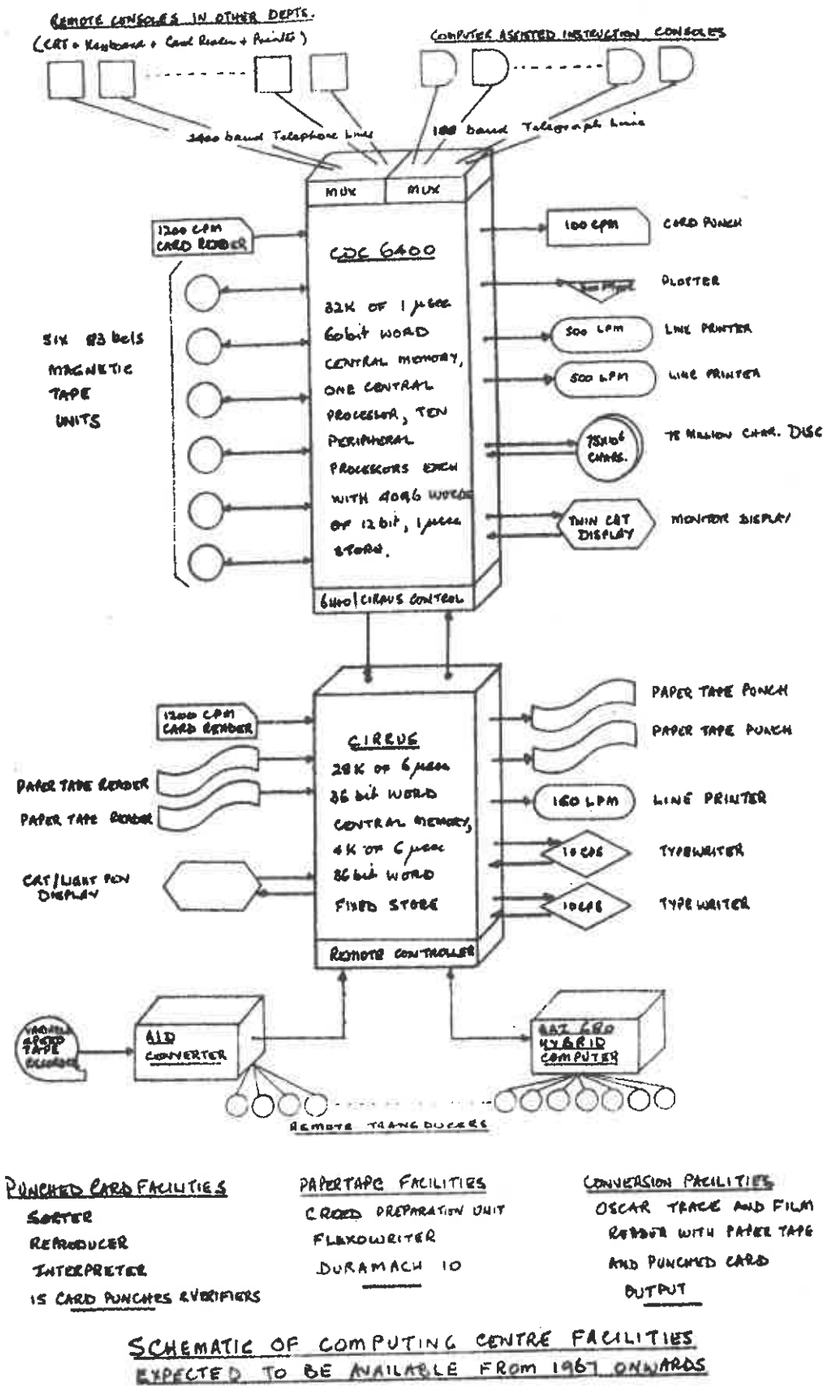


FIGURE 6.2 Ovenstone's Block Diagram of the Planned 6400 System, 1965

services were provided and used to capacity. While computing time for undergraduate use was at first free, postgraduate research was expected to be paid for from URG or other sources; departments were rationed, and there were continued applications for extra time – the story of computing! Committee minutes and Centre submissions abound with estimates of the large sums which needed to be earned annually. Overall the impression gained from the minutes is that estimates were constantly being revised, and that Ovenstone was often requesting more equipment and more staff so that the Centre could earn more money!

The pattern of paying some staff salaries from computer income, which began before the 6400 was installed, continued for many years. In the documentation of the early Ovenstone period, a fund called the suspense account was used, for a time, as an accounting device to describe this source for the payment of salaries.

It is apparent that Ovenstone avoided dealing with University academic committees if at all possible, and appeared, sometimes, to be a law unto himself. When he did deal with a committee, he inundated it with voluminous reports and recommendations, full of tables and graphs. It is of interest to quote from a written submission (unsigned but believed to be from the Professor of Commerce) to the 'Special Computing Sub-Committee' (the Computing Science Committee ?), concerning the need to make cuts in support for the Centre:

> The charter under which Professor Ovenstone operates apparently gives him the freedom to hire and spend, places upon him the responsibility for meeting the greater part of the purchase price of the computer, and gives him the right to purchase additional equipment with any surplus…The Computing Centre is thus a virtually autonomous semi-commercial operation not under the direct financial control of the University.

In fact, of course, this was not true, though at times it may have seemed so. The Finance Committee controlled University finances, and the Bursar, Meiklejohn, carefully kept the University accounts; at the end of 1969 the Bursar was appointed to the Computing Centre Committee.

It is, perhaps, of some interest from an historical perspective, to examine, in a superficial way, how the University met the purchase price of nearly a million dollars for the 6400.[1] Folklore suggests it was largely paid for from Computing Centre earnings. In Ovenstone's report of October 1966, he counted on some $360,000 from the AUC (with the hope of more in 1970 – which did not eventuate) and on an annual contribution from the University, and planned to earn the balance. He did not account for staff salaries, perhaps expecting the University or the AUC to meet this cost which did not happen. Consequently, a considerable sum had to be subtracted from annual earnings before any profit could be directed to debt reduction. In a financial statement of the affairs of the Computing Centre at the end of 1968, the Bursar stated that the debts could be liquidated by early 1972, providing earnings continued as predicted. A year later, the Centre's debt to the University remained at about $200,000, despite earnings of some $675,000 (enough to cover the initial debt) over the three years of operations.

[1] Decimal currency was introduced in 1966.

The prime function of the 6400 was to provide a computing service to the University; at the time of installation, its capacity was more than that needed by the University, but internal use of the machine rapidly escalated; at some stage the Council decreed that one shift was for internal use. The University provided three quarters of the 6400 load at the end of 1971. However, according to documentation, the annual cost of running a one-shift operation was considerably greater than the University's financial input to the computing service at this time. So, in effect, the Centre's earnings were used to pay for part of the University's computing service as well as to amortize debt – to quote from the Centre's Annual Report for 1976 when these arrangements ended:

> For a number of years, the Centre's finances have been dominated by the necessity to earn both recurrent and capital funds to meet part of the costs of its major equipment, its staff and consumables. In 1975, after many representations on the matter, the Finance Committee recommended that all staff paid from earnings (some 15 posts) be taken over by the University.

In 1976, the final payment for the 6400 was made, and from that time, the University received an income from the Centre.

It may be of interest to mention some of the outside projects undertaken by the Centre. In this regard, Capon has indicated that it was always agreed policy that the University was not in competition with commercial service bureaux. The Centre only undertook a job if there was an element of research involved, or if the project could not be undertaken on a smaller machine. In Ovenstone's words (Ovenstone 1969):

> A list of applications and problems dealt with by the computing group over the last three years would require more space than is available for this article but a few that can be mentioned are production scheduling for mining and building corporations, allocation scheduling for oil refineries and public works, data bank development and implementation for government and industry, and a mass of large-scale critical path analyses.

The largest project was certainly the 'Northern Territory' job, a huge undertaking for the Territory's Government; this included payroll processing, statistics and systems for the Road Commission and Forests. Other external work was done for Amdel, ETSA, Flinders University, IMVS, NZ Apple and Pear Board, PEB, Telecom, WRE and many other organisations. Kidman was employed as a half time programmer for part of the period 1966-70; examples of the jobs she worked on include a numerical application for the Botany Department, an analysis of frequency ratios in aboriginal music for the Music Department, processing an Airline Passenger Survey for P. G. Pak Poy and Associates, developing a general conference package (used by ANZAAS and a Libraries conference) and ongoing enhancement and optimisation of numerical programs for a group at WRE. When Ovenstone left at the end of 1970, the prospects for external earnings still looked very rosy but only for two or three more years. In 1968-69 gross income from external customers was about a quarter of a million dollars, and Ovenstone predicted considerable growth if the 6400 were expanded; however, by 1972 earnings started to decline, naturally enough, because other big computer systems were being installed elsewhere. University demand for computing services remained insatiable.

6.6 Staffing Profiles of the Computing Centre 1967 and 1969

At the time Ovenstone took up his appointment as Director in 1964, the Computing Centre was a modest institution, with two lecturers, an engineer, an officer in charge of punched card equipment and two or three card punch operators. Kidman started working in the Centre in 1966; by the time the 6400 was installed during the year, the place seemed full of card punch machines and operators; there were several programmers, a large number of postgraduate students, and five academic staff; it seemed a large busy centre. This is confirmed by Ovenstone's report to the Computing Science Committee in October 1967, which lists 6 academic staff, a secretary, a professional officer, an engineer and 8 technical staff on the University payroll, two technicians funded by research grants, and 7 programmers as well as 7 technical staff paid from computing income, a total of 33 on the staff, besides some others paid by CDC. A report to the Computing Centre Committee dated October 4, 1969 includes a detailed list of the non-academic staff which provides a concrete picture of how the Centre continued to grow. In addition to the academic staff, there were in the Centre some 45 staff positions, including 19 programmers, 7 computer operators and 12 data processing operators.

While the senior Centre staff were always male, and the data processing operators almost always female, Ovenstone's programmers included a number of women. It was in this environment that Kidman began her computing career as a programmer. The programmers were a supportive group, and she particular recalls Robyn Lewis (one of the first Computing Science Honours graduates), Sally Jantzow (a local graduate), Vera Fris (a mathematician from Czechoslovakia), Phil Burke, Bill Pearce and David Haycraft, the latter remembered as an uncommonly approachable systems programmer.

6.7 The Computing Centre and Computing Committees from 1968

By 1968, the first academic courses were firmly established, and, at the same time, the Computing Centre was delivering computing services within and outside the University. After March 1968, at Ovenstone's suggestion, requests for staff and equipment for the Department of Computing Science were to be made in the more usual way through the Faculty of Science, while a newly constituted Computing Centre Committee was to deal with requests from the Director relating to computing services, including staff and equipment. This committee was also to advise the University on all matters related to computing. (From 1974, the committee became known officially as the Computing Committee.) The existence of the Computing Centre as a separate facility is usually dated from the beginning of 1969 – as a consequence of implementing these changes.

Minutes of the new Computing Centre Committee are dominated by financial considerations, by staffing and equipment needs, by complaints from departments about service difficulties and by requests from departments for extra services. In 1970-71 much time was devoted to preparing submissions to the Commonwealth Government, firstly for a proposed regional computing network, and secondly for a joint Adelaide/Flinders University facility, to be centred in the University; neither of the proposals eventuated, although Flinders subsequently made use of the 6400 service.

Job turn around time was always a controversial topic, and it must have been difficult to manage conflicting interests. One example comes to mind. As Computing Science course enrolments increased, student class exercises had sporadic effects on turnaround times. This did not please certain research users. On one occasion, the Faculty of Science representative recommended to the Committee that a small 'minicomputer' system linked to a number of teletypes be purchased for use by the Computing Science undergraduate classes. Such a system could provide a simple interactive version of the language Basic. The matter was referred to the Faculty of Mathematical Sciences, which rejected it, both on academic grounds and because its use would be quite limited, and, anyway, would not have had a significant effect on 6400 throughput.

6.8 The CDC 6400 in Service

The CDC 6400 was introduced for general use on August 29, 1966, processing 185 jobs on the first day (for comparison, in 1972 over 1200 jobs a day were run). At first, staff, programmers and research students freely used the operations and control rooms, feeding their own card decks into the machine and collecting the output – at the time this seemed natural, but in fact it was an unusual experience. Machines like the 6400 were closed to users, jobs being handled by the operator. In due course that is what happened in the Computing Centre, to the annoyance of programmers.

Figure 6.3 is a view of the 6400 computer room in 1972. The photograph shows a number of magnetic tape units; at this time, magnetic tapes were used for back up and for the transfer of large amounts of data or programs between machines. Punched cards were usual for program input.

The CDC 6400 was a very new machine in 1966, and the particular machine installed in Adelaide was only the fifth built; as a consequence, the software was not troublefree. For example, in the Newsletter of October 21 it is noted that in Fortran 'Complicated arithmetic statements with indexing may fail if the statement is labelled', producing one of the dreaded mode errors (which often required looking at binary store dumps). At first the machine operated under the Chippewa Operating System with a version of Fortran termed Chippewa Fortran available. In January 1967 the Scope Operating System was installed together with a wider range of software; on this occasion users were treated kindly, and those reluctant to change over were accommodated for a few weeks.

This was to be the first of many Scope operating system changes, some of which created significant difficulties for users. There were major changes such as from Scope 2 to Scope 3 (1968) and then 3.1, 3.2, 3.3, 3.4.1, 3.4.2, 3.4.3, and 3.4.4 (renamed Nos/BE)! Users were normally given the opportunity to test programs before a new system was introduced, and, on occasion, a stage was not installed by the Centre. Sometimes the changeover introduced new software faults; for example, there was an error in Fortran DO loops introduced with Scope 3.4 early in 1973. However, much as they were dreaded by conservative users, new operating systems lead to improvements in performance or enhanced features or both. The Director was continually faced with timing problems when making major changes; for example, the

FIGURE 6.3 View of the Computer Room, 1972, showing the CDC 6400 System

teaching departments preferred changes to be introduced in vacations, but during the long vacation, examination and enrolment processing were given priority. Often the Centre had just one system programmer, which limited the system support which could be provided; moreover, throughout the period there was a serious shortage of experienced personnel.

The 6400 system provided a wide range of software, including application packages and many programming languages, such as Basic, Fortran, Cobol, Algol, Algol 68 and others. Pascal was obtained privately in 1973.

Although software faults occurred from time to time, from the user's point of view, at least, hardware faults were fairly rare on the 6400. According to Capon, the machine required regular and expensive maintenance to keep it in operation. There were just two occasions when hardware faults caused errors for users (as reported in Newsletters), once in 1969 and again in 1973. The machine was out of action as the result of a switchboard fire in September 1972, and of course, upon occasion, when it was moved or for the installation of hardware upgrades.

In the days of punched cards, the heavy, desk-sized card punches or key punches (see Figure 3.3), used for punching cards, were essential equipment. At the end of 1967 the Centre had 20 key punches; at this time an area in the Fisher Undercroft opened for student use. C. R. Jones, who was appointed to take charge of the card punching operations in 1969, remembers that there were four rows of four key punches in the main room with sixteen operators – a large operation! Although the Centre provided a card punching service, students generally preferred or were expected to do their own punching. This created a huge bottleneck for students. In those days, most University students were unfamiliar with the standard keyboard and totally lacked keyboard skills, so consequently they were very slow at punching cards. Before a class exercise deadline, there would be a circle of students queuing to punch a few cards on the punches designated with say a 5 card limit; an individual would punch 5 cards and then rejoin the queue. On more than one occasion either the Director was approached or the problem raised on University committees. Of course hiring punches was expensive, and the problem was not easy to solve, although various ideas were investigated; it was alleviated somewhat by extending the hours when punches were available and by the provision of some departmental punches.

The following description is given for the benefit of those not familiar with the interface between the user and a computer such as the CDC 6400. For processing ordinary programs, users submitted their programs punched on cards (perhaps along with data decks), which together with the necessary control cards, were assembled as decks of cards. Each deck, held together with rubber bands, had a coloured 'job' card on top and a green 'end of file' card on the bottom. It was placed in an input tray on a counter at the central site (later, perhaps, submitted at a remote terminal) for an operator to collect for reading into the machine. The coloured cards enabled the operator to separate decks after processing. At best in an hour or so, the deck and resulting printed output paper could be collected from designated pigeon-holes or tables. The operator was the user's most direct contact with the machine.

The Centre was busy in 1967 preparing to provide the interface for remote input/output to the 6400. Figure 6.4 shows the Centre's first terminal in use. Campus

FIGURE 6.4 I. N. Capon with Student P. G. Perry at the First 6400 Terminal

wiring was undertaken by Engineering staff, and departments submitted applications for purchasing remote terminals. Before long there was a remote input/output terminal for student and general use (at first in the Undercroft), as well as others in some departments and at the Waite Institute.

The 6400 was a multiprocessing machine really designed for user batch processing. However, facilities for interactive computing gradually became available (at the expense of batch processing); the limited access to this facility on the 6400 and its successor, the Cyber, whetted the appetite of users for more. An essential part of using interactive facilities to develop and process programs is a text editor. Chris Keen, a talented Computing Science research student, developed an excellent editor (in Pascal) which he named Edna. It proved much better than the system editor and was adopted by the Centre around 1977.

6.9 Newsletters and Other Publications

Capon wrote a fairly comprehensive and helpful set of Fortran notes in the early 1960s, giving detailed information on both 1620 and 7090 Fortran. Besides serving as a Fortran manual, the document included some general introductory explanations as well as processing instructions. Also a series of Memos relating to Fortran on the 1620 were produced before 1964.

After the installation of the 6400, regular Newsletters were issued, at first under the banner of the Department of Computing Science. Newsletter No. 1, issued on August 12, 1966 (see Figure 6.5), announced the expected date for 6400 Fortran to be available, and Newsletter No. 2 reported that, indeed, 185 jobs were processed on that day. No. 3 was concerned with charging for services; only computing for undergraduate and honours students would continue to be without charge. Quite reasonably restrictions were placed on the accessibility of the new machine to visitors. No. 4 was technical, on execution time mode errors, and No. 5 dealt with relative execution speeds – the 6400 *was* faster than the 3200/3600 machines. Next more Fortran errors had been discovered, and No. 7 dealt with conversions of magnetic tapes from the 3200/3600 system to the 6400, complicated because of different internal character codes, different word lengths and different tape formats! And so the newsletters continued; No. 13 was the last for 1966. No.15, issued on January 18, 1967, reported that Scope 2 along with Fortran 2 was introduced on January 16 as planned. After the first 50 issues, late in 1971, the Newsletter was divided into series A and series B, continuing regular publication, disseminating news and technical information.

6.10 Overview

Largely as a result of the efforts of the Punch Card Users Committee (Chapter 3), the Centre was formed in 1961 with Barnes as Honorary Director. Towards the end of that year, Capon arrived from Cambridge, effectively running the fledging Centre on a day to day basis, along with Simmons, until Ovenstone's appointment in 1964. With Ovenstone came a very rapid expansion after the purchase of the CDC 6400; this machine (and a similar successor, the Cyber) and its 'culture' dominated the University computing service throughout the remainder of the period under consideration. Simmons, who had originally been in charge of punch card operations,

DEPARTMENT OF COMPUTING SCIENCE

Newsletter No. 1.

(1) Circulation Policy

The Department of Computing Science has allocated a 2-character code to each department, to which the head of the department after consultation with Department of Computing Science attaches a third character denoting a member of his staff. These 3 characters will become the first three characters of the name of any job run under the supervision of that staff member, and will also form the basis of newsletter circulation.

The departmental codes will be circulated to heads of departments within a few days. Staff members who wish to receive Newsletter No. 2 must obtain their 3 character code and forward it to the Secretary of the Department of Computing Science, together with their name and departmental address before 1st September.

Future issues of this newsletter will contain, inter alia, lists of issued manual supplements, subroutine write-ups etc., which have become available since the previous issue. These documents will not be circulated, but will be obtainable from the Department of Computing Science on request.

(2) 6400 Availability

The 6400 Fortran system is expected to become operational on Monday 29th August. Jobs will be accepted from users as from that day. However, no guarantee can yet be given as to the accuracy of the various manuals, and all jobs will be run at the user's risk.

(3) Manuals

6400 manuals are on order by the W.E.A. Intending users should order a 6400 Fortran reference manual, and advanced users should also obtain copies of "Chippewa Operating System Reference manual".

3200 users will find the duplicated document "Chippewa Fortran IV - version 2" (available from Department of Computing Science) useful.

The first set of corrections to the 6400 Fortran manual will be issued on 22nd August, and will be available from the Department of Computing Science.

(4) Queries

On and after August 29th, queries must be directed to the duty programmer. The name and location of this individual will be found in the computer room foyer.

INC/EMP
12/8/66.

FIGURE 6.5 First Newsletter August 12, 1966

was put in charge of computing services in July 1967. He had throughout supported the introduction and expansion of computing in the University. Although not technically a programmer, he exhibited some appreciation of what was involved.

How the computer facilities at the University in 1966 compared with those in other Australian universities is detailed in a report (AVCC 1967) of a sub-committee of the AVCC (Australian Vice-Chancellors' Committee). The sub-committee's terms of reference were to report on the long range planning of computing facilities in Australian universities and as a first step a survey of university computing activities was carried out. Adelaide was the only university to report that it presently (1966) had adequate computer equipment and that it would not reach saturation at the end of 1968; Adelaide and Monash reported having many more peripheral devices than other universities. The survey revealed the inadequacy of the financial support for university computers and noted that outstanding debts applied in three universities: Adelaide (40% of the purchase price), Sydney (33%) and Monash (10%).

Big changes came at the end of 1970; the Department was then completely separated from the Centre; in July 1970 Simmons was elected to Parliament; at the end of the year Ovenstone resigned, and at about the same time Sanderson resigned to work in Oxford. A new era started for the Computing Centre; in 1971 Capon was appointed Acting Director and subsequently Director, of a Computing Centre now divorced from academic computing science teaching and research. In mid 1971, both the Centre and the Department moved to new quarters in the Horace Lamb Building – another big upheaval. The Centre started operations in the new quarters on August 23. The new Director, while welcoming incidental income, advocated a policy which emphasized the service functions of the Centre. It took some years to effect all of the required changes. A detailed account of the later years of the Computing Centre remains to be given.

In 1977 the 6400, then an old machine, was replaced with an upgraded but similar machine, the Cyber 173, which, while logically the same, was physically much smaller and somewhat faster. Peripheral parts of the old machine remained in the Centre, some as part of the new system. T. J. Fanning, the manager at that time, recalls that the mainframe went back to CDC, and various other unwanted parts were given away or souvenired.

CHAPTER 7 THE DEPARTMENT OF COMPUTING SCIENCE

He personally preferred 'computing' to the more American 'computer' science.

7.1 Formation of the Department of Computing Science

Ovenstone came to the University during 1964 as the first Director of the Computing Centre with an entrepreneurial reputation but without academic experience. He immediately showed an interest in matters academic and a determination to make computing science an academic discipline in the University. He was officially designated Professor of Computing Science, the Department was created, and the academic staff, who had been appointed to the Computing Centre, were listed in the 1965 University Calendar as staff of the Department of Computing Science.

Potts recalls a discussion with Ovenstone about the name 'computing science' chosen for the new discipline; the alternative 'information science' did not seem focused enough to Ovenstone, and he personally preferred 'computing' to the more American 'computer' science. Sometime later he admitted to having backed the wrong horse in this regard.

In the beginning, the Centre and Department were closely associated, and did not fit into the usual University structures. In contrast to the situation with other University departments, for the first few years requests for resources for the Department were dealt with along with those for the Centre (see Section 6.7). However, right from the beginning in 1965, the Honours and Diploma courses were described in the Calendar under the banner of the Faculty of Science.

While the Department certainly began in 1965, it was not on a par with other departments in the Faculty of Science until 1969, when it was separated from the Centre. Even then, the Department and the Centre were housed together in the Engineering Annexe, and the Head of the Department was Director of the Centre. In mid 1971 the Department moved to new quarters in the Horace Lamb Building, a floor above the Centre. Later in the year, Macaskill was appointed as Acting Head of Department (see Section 7.2).

There is no indication in University records of any thought of placing Computing Science anywhere but in the Faculty of Science in the first instance. When the Faculty of Mathematical Sciences split off from Science in 1973, Computing Science, with its origins in Applied Mathematics, did not hesitate to move into the new Faculty. Much later, after Dr C. J. Barter, himself an engineering graduate, had been appointed as Professor, discussion arose in Departmental meetings about the possibility of the Department being part of the Faculty of Engineering; this came to pass in 1992.

7.2 Academic Staff

Academic staff appointed up to 1978 are listed in Appendix II. The first academic courses were launched over the years 1965 to 1976 (see Chapter 8) by a small but committed academic staff. Obviously the early lecturing staff had no formal computing science degrees, but in one way or another had acquired expertise and interest in the field. As already described, both Capon and Sanderson, who were

mathematics graduates, had worked under Ovenstone at WRE, after which Capon did a Ph.D. degree in Cambridge while Sanderson obtained an M.Sc. from research at WRE; Duncan and Buxton had worked on computers overseas, and Weadon in the Department of Defence. Macaskill, with a strong research background and some programming experience, came to the University from an engineering firm; Kidman, a physics graduate with a research background in biophysics, had worked in the Centre as a programmer. Elhay was a mathematics graduate from the first Honours Computing Science class, and subsequently obtained a Ph.D. in numerical analysis. Barter was a local graduate in electrical engineering, a course which had included some material on computers; he subsequently obtained a Ph.D. in the field of artificial intelligence at the University of NSW. Beaumont was a local diploma graduate who, while a programmer in the Department, obtained a Ph.D. It was not until 1984 that the first lecturer (C. D. Marlin) was appointed with undergraduate, honours and postgraduate qualifications in computing science. In the main, the tutors appointed in the period 1971-1978 were Honours Computing Science graduates, at least one coming from interstate; two of the tutors had postgraduate diplomas.

The dominant characteristic of these early years was a chronic acute shortage of staff. In 1965 when the Department's courses started, Ovenstone had five lecturing staff, the most favourable staffing position for the Department over the years covered in this history. Duncan, who held a lectureship for the year 1965, taught just one subject for one term. In later years it was not uncommon for a staff member to give five such courses in a year. When Professor Hirst arrived, there was the same number of lecturing staff as in 1965, but many more lectures to deliver. Not only was the staff establishment low, but there were often vacancies because of a worldwide shortage of qualified computing academics. On some occasions it was necessary to use outsiders as casual lecturers. For example, in the 1971 crisis, when the Department found itself with only three lecturing staff available, Capon continued to give lectures, and Northcote was called on to give an Honours unit.

Ovenstone resigned in 1970 somewhat unexpectedly, though Elhay recalls him earlier suggesting that he would move on when he had achieved his primary goals. As a consequence, when separate positions were created for the Director and Professor in 1971, the professorship became vacant; Capon reluctantly accepted appointment both as Acting Director of the Centre and as Acting Head of Department, although he had expressed objections to taking on the dual roles. Later in 1971, after Capon's appointment as Director, perceived or imagined difficulties arose in the Department over conflicts of interests which lead to Vice-Chancellor Badger being approached to appoint Dr John Macaskill as Acting Head. After consultation with other staff, and much to Capon's relief, Macaskill was duly appointed, pending the arrival of Hirst in 1972 as the new Professor.

Dr Frank Hirst, originally a physics graduate, came from the University of Melbourne with an academic background and years of experience in the computing field, dating from the time of CSIRAC. He served the University as the Professor of Computing Science from 1972 until his retirement in 1984; this period spanned the introduction of second year subjects (see Chapter 8) and the consolidation of a solid academic teaching programme as well as the establishment of a great deal of research activity (see Chapter 9). Hirst adopted many of the practices of departmental government; he was chairman except when on study leave, held regular departmental meetings, and

sought advice and support from academic staff on many aspects of departmental administration. The considerable advances made during the period were made in the face of very great difficulties.

Besides heavy lecturing loads, extra burdens faced by the academic staff in the seventies included a constant stream of new and evolving courses, requiring new lectures and new practical programming exercises, all of this superimposed on a rapidly changing and developing discipline. On a mundane level, there were new programming languages and new styles of programming to learn and use; there were new machines and frequent changes of operating systems to contend with, and later there was the changeover from batch to interactive computing. At the same time the discipline was developing on a more theoretical level.

In many if not most computing science courses, practical programming work is crucial; as computing was done in batch mode in these early years it was not possible to arrange class work in a laboratory situation. One of the difficulties this created was that a significant number of students copied work from others. Thus there was a delicate balance to find between awarding real marks for programming work in recognition of achievement and to encourage completion, and avoiding real marks on account of the copying. Designing good practical exercises was a time consuming task for teaching staff. The difficulties mentioned above were exacerbated if the same practicals were set for more than one year. Students undertaking practical programming exercises outside of a class situation required a lot of support; long queues outside the tutor's office were a familiar sight. In applying for staff funding, the Department was never really successful in making a special case for its consultation requirement, a unique characteristic of computing science at this time.

Enrolments in Computing Science subjects were high from the start. Having large student numbers and small staff numbers meant that virtually each member of staff carried a significant to heavy administrative load; to this was added the need to prepare cases at Faculty level for new and changing courses. Supervision of Diploma as well as Honours projects was an added task.

7.3 Report of 1966 AVCC Survey

The Report of the AVCC survey of computing activities in Australian universities (AVCC 1967) raised the issue then being debated of the optimal relationship of a computing science department to the computer utility. It noted that as computer science was widely accepted as a separate discipline, in order to attract and hold academic staff of suitable calibre it was important to have a separated academic department with conventional promotional opportunities up to the rank of professor – only in Adelaide and Melbourne did this situation apply at the time. Although at Adelaide the Department was not to separate formally from the Centre until 1969, the progress it had made towards this was ahead of other Australian universities.

Adelaide's difficulties with acute staff shortages were similar to those experienced elsewhere. The University of New South Wales reported that two senior computing personnel took jobs in industry and the ensuing vacancies were unfilled for nearly five years, and Sydney took two years to replace one of its three staff.

The report of the survey concluded (p. 61):

> The effect of long delays in providing funds for university computing installations has been to interfere seriously with the retention and recruiting of staff for teaching computer science and electronic data processing subjects. There is an acute shortage of graduates with training in this field.

CHAPTER 8 TEACHING: COURSE DEVELOPMENT 1960-76

'...Computing Science I was not of sufficient intellectual content to qualify as a first year subject'

8.1 Introduction

In 1960 the Punch Card Committee specifically included teaching among the activities proposed for the new Computing Centre in the following terms:

> The Centre should provide (or assist in providing) courses in numerical analysis, business applications and programming (for example short courses on simplified programming techniques such as Fortran) and students of programming should be given an opportunity to use the equipment at the Centre.

Mathematicians, engineers and physicists were in the forefront of the movement for the development of computing facilities and courses at the University; initially their interest was largely in numerical applications, so consequently Fortran programming and numerical analysis courses were the first topics taught. Numerical methods and numerical analysis had been part of applied mathematics courses for some years before computing science courses began. Prior to being employed as a programmer in the Computing Centre in 1966, Kidman recalls that in the interview Ovenstone asked 'How is your numerical analysis?' It was a topic sometimes included under the computing science banner and sometimes not.

It is probably fair to say that University computing scientists over the period of this history were neither qualified nor interested in teaching business data processing; even Cobol programming was not introduced for some years. The general field was felt to be more properly the domain of SAIT (South Australian Institute of Technology) which provided a range of well received computing courses. University computing science graduates were given a general academic background in the field (including substantial programming practice), eminently suiting them to work in most areas. In the late 1960s there was a degree course, the Bachelor of Applied Science in Data Processing, jointly run by SAIT and the University; it appears that for two or three years, the Department contributed to the teaching in the final year of this course before it was completely taken over by SAIT.

8.2 Fortran Crash Courses

Fortran became available on IBM computers in the late 1950s. IBM soon began offering free short programming courses on the University campus, the first of which seems to have been held in February 1959. While overseas on study leave, Culver became convinced of the importance of computing. Consequently, when he returned to Adelaide, he was active in promoting the short Fortran courses, possibly including this first course. The course was given over five morning sessions, the main topic being a new programming language called Fortransit, a version of Fortran available on the IBM 650, an early computer which was in operation at IBM in Sydney. It is certain that Culver and Brooks from Civil Engineering were among those who attended that particular course with others from Mathematics; the lectures were held

in Room 2 of the Arts Building[1] and were taken by Dr F. Barr-David from IBM. A longer ten day full time course on the 'Basic 650' was scheduled for May 1959, and attended by some engineering students – this seems to have been the 'Machine language programming' course referred to by Culver in subsequent correspondence with IBM.

Culver's initiatives lead to IBM agreeing to teach two Fortransit courses at the University in 1960. Although they were planned initially for final year engineering students, Culver wrote to a number of University departments and other groups about the courses, and almost 80 students and staff registered for them. An amusing sidelight, in view of the later extensive computer processing of exam results (see Sections 6.3, 6.5), was the polite negative response from the PEB, the final sentence reading:

> It is, of course, very doubtful that this office will need to use any calculating equipment which the University may acquire, except for simple classification and printing requirements in the card system.

Mr Max White from IBM took the 1960 classes which were held in the May and August vacations in the Mathematics Building; about 60 attended each course. In the May course, three Sveds (George, Marta and John), Potts, Tuck, Culver and Sanderson were among those who attended. Tuck, then a third year mathematics student, has kept his course notes including a sample program under the heading 'Mrs Sved's solution' and also a copy of his own program for 'The evaluation of a determinant using the method of pivotal condensation' (see Figures 8.1 and 8.2). Culver also kept Fortransit notes and a copy of the manual. Certainly students in these classes did pencil and paper practice exercises; dim personal recollections suggest that at the end of the course, there may have been the opportunity to present program code, written on an IBM coding form (as shown in Figure 8.2), for sending to Sydney to be punched and submitted to the IBM 650 machine operating there.

Culver always found the local IBM manager, R. C. Ctercteko, very supportive, and he arranged for IBM to repeat the short courses in 1961. With the WRE IBM 7090 (and Fortran) becoming available this year to University users, the courses were very timely. The newly formed Computing Centre issued an announcement that Mr Frank Vickress from IBM would be offering a week-long Fortran course in the Mathematics Department starting February 20, 1961. R. S. Northcote arrived in the Department that very morning. He had come from New Zealand to do a Ph.D. with Potts, who immediately rushed him into the course. It was to be the start of Northcote's distinguished career in computing, culminating with a professorship at the University of South Australia. While a Ph.D. student he took over most of the teaching of crash courses, giving seven in all! When Capon arrived from Cambridge in mid 1961, the computing culture based on Fortran and punched cards was new to him but he soon learnt. He recalls his answer to an exercise set in one of the Fortran courses. The problem was 'The number in some cell is either 3 or 4; whichever it is, replace it by the other'. Capon showed he understood exactly what it was all about by submitting the answer 'X=7-X'.

[1] Later called the Mathematics Building.

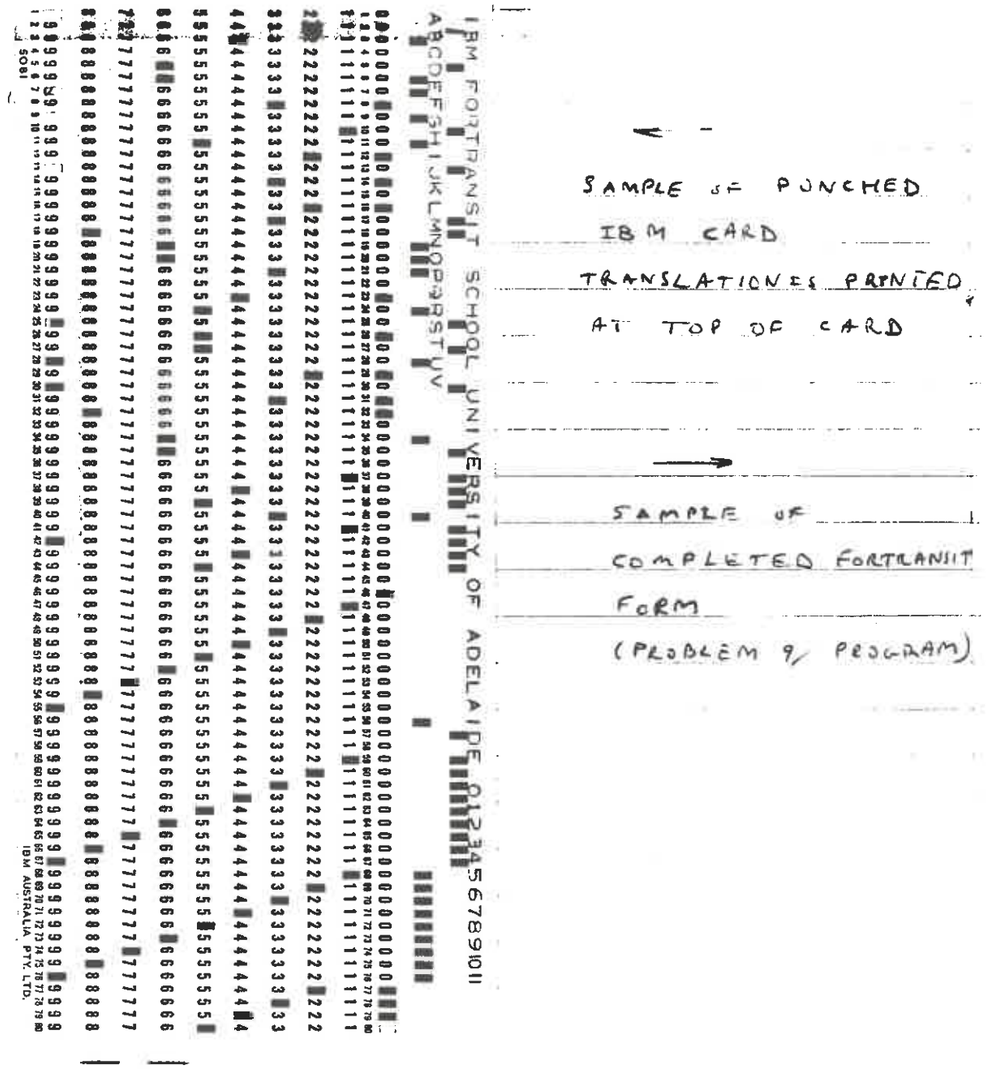


FIGURE 8.1 Punched Card and Notes from 1960 Fortran Crash Course

IBM AUSTRALIA

FORTRAN CODING FORM

PROBLEM

CODER

C ← FOR COMMENT / STATEMENT NUMBER (1–5)	CONTINUATION (6)	FORTRAN STATEMENT (7)
C		PROBLEM 9
		DIMENSION A(20,20)
4		READ, N, IDENT
		READ, A
		VALUE = A(1,1)
		DO 1 K = 2, N
		DO 2 I = K, N
		DO 2 J = K, N
2		A(I, J) = A(I, J) - A(K-1, J) *
	1	A(I, K-1) / A(K-1, K-1)
1		VALUE = VALUE * A(K, K)
3		PUNCH, VALUE, IDENT
		GO TO 4
		END

FORM Y40-0

FIGURE 8.2 Fortransit Program from Tuck's 1960 Crash Course Notes

The responsibility for giving the crash courses was soon taken over from IBM by the Computing Centre as indicated above. Early in 1966 Kidman attended a course taken by Capon; later she herself was among programmers assigned to do the teaching. Typically the later Fortran crash courses spanned one or two vacation weeks, and consisted of lectures interspersed with tutorials, and later, when fast turnaround was available, some practice programming exercises. Although many (including both authors) were introduced to elementary Fortran in these short courses, it was not felt that this approach, without a great deal of reinforcement from self study and practice, was an effective way for students to learn to program. Most computing science academics and others favoured a regular lecture course for teaching computer programming, spread over a term or more, so that students had adequate time gradually to learn programming skills by practice; short intensive courses tend to emphasise the language rather than the program development.

After 1971, undergraduates had the opportunity to learn programming by enrolling in Computing IH, but the Centre continued to hold open Fortran crash courses in 1971 and 1972. It was then decided by agreement between the Centre and the Department that it was inappropriate for undergraduates to attend future courses offered from the Centre. In February 1973 the Department gave the last short Fortran course open to undergraduates. From this time on, for a number of years, the Department of Applied Mathematics gave its own Fortran crash course (it was required for second year Applied Mathematics), and from about 1976, used a carefully prepared and quite professional video course from the Computer Laboratory in Cambridge. Kidman had purchased (at nominal cost) the video from its author Dr Frank King while on study leave in Cambridge in 1975.

The Computing Centre continued to offer regular short Fortran courses at different levels, two or three times a year. These courses were free for postgraduate students and staff, but external attendees were charged. After the appointment of Tony Kiek as the Computing Centre's Education Officer, a wide selection of short courses were given from the Centre, on various programming languages, the operating system and application packages.

8.3 Early Proposals for a Postgraduate Diploma

An ad hoc committee chaired by Potts was formed in 1961 to initiate the introduction of an academic computing course. The group (Potts, Remmenga, Allen, Capon, McCarthy, Northcote, Penny, Rose, Sanderson) produced a proposal dated October 16, 1961, for a Postgraduate Diploma in Automatic Computing. The proposed course was to be one year full time (or longer part time) with two streams, one scientifically oriented and the other commercially oriented. It was suggested that the topics to be covered would include machine methods, logical design and the theory of programming, together with extensive practical programming problems. At the time there was a postgraduate diploma in Cambridge and one had begun in 1959 at the University of Sydney (Bennett 1994). Both the Sydney and proposed Adelaide courses were influenced by that in Cambridge and, to a lesser extent, by the Public Service 'Programmer in Training' classes. The Diploma proposal was adopted by the Computing Centre Committee in February 1962.

The original plan was that the course for the scientific group would commence in 1963, but the alternative stream would not start until it was possible to provide appropriate courses in commercial data processing. Late in 1962, the start of the Diploma was postponed until 1964, and again in 1963 it was put off until 1965, apparently because of lack of academic staff.

8.4 Ovenstone's Arrival, and the Start of the Diploma 1965

After Ovenstone's arrival during 1964, staffing and bureaucratic difficulties were overcome quickly, and in 1965 both the postgraduate diploma course and an ambitious honours course in computing science were offered, these being the University's first computing courses for academic credit.[1] There were now five lecturing staff, with the appointments of J. B. Buxton, who had been working at Leeds with Professor A. S Douglas, and A. K. Duncan, who stayed for one year only and later took up lecturing duties at SAIT.

The Diploma was, at first, structured as originally envisaged in two streams, one more scientific and requiring a significant mathematics background (Diploma A), the other with emphasis on data processing (Diploma B). Right from the beginning a considerable amount of practical programming was required, and a programming project counted as a quarter of the course. Both streams immediately attracted enrolments, at first mainly on a part time basis. The first diplomate was R. E. Schoff who, after graduating in 1965 as a Bachelor of Applied Sciences, did the Diploma full time in 1966. A list of diploma graduates in the first few years is given in Appendix III. There were three graduates in 1967, five or six in each of the years 1968-71, and in 1972 and most years thereafter, ten or more. After 1968, the two-stream structure was abandoned; by this time SAIT had introduced courses specifically covering commercial applications.

It is of interest to hear of the experiences of an early diplomate, Les Howard, who enrolled in Course B on a half time basis in1966, graduating in 1968; at the same time he was working in the Barr Smith Library and recognized the relevance of automatic data processing in this field. Howard recalls, in particular, the digital logic course, the excellent introductory mathematics lectures given by Buxton, and the systems analysis course taken by Ovenstone. Previously Howard had become interested in computing when working in the Psychology Department, and while there, had been sent to the Basser Laboratory, University of Sydney, to do courses on SILLIAC during 1958-60.

As more computing science undergraduate courses were introduced and as computers were used more in the workplace, inevitably some diploma applicants had considerable computing experience while others had none. Meanwhile staffing pressures within the Department lead to a Diploma course composed largely from undergraduate and, in special cases, Honours units. Consequently, after a few years, the arrangements for the Diploma became complicated both administratively and academically, with the result that each student virtually took a different course. A further complication arose from the constantly changing character of the undergraduate courses especially when spanning the years a part time student was

[1] From about 1960, there was a component on digital computers in one of the Electrical Engineering subjects.

studying. For some years the Department reluctantly ran a programming crash course for certain diploma students. Eventually it became necessary to restrict the full time diploma course to those who were experienced programmers, as it was just not possible for a student, starting from scratch, to attain the required standard in one year.

Initially diploma students were given an individually supervised large practical programming project either on a topic of the student's choice or on one suggested by the supervisor. Eventually the supervision work load this imposed on staff forced the replacement of the individual projects by a common Cobol project, designed so that each student's program was somewhat different from others (devised by W. P. Beaumont).

In these early years of computing, the postgraduate Diploma provided an opportunity for graduates to learn, understand, and practise computing science. The course remained popular, overall attracting a wide variety of students including some from overseas, students with and without computing and programming experience, students with and without a formal computing science background, students with and without much mathematics and some students with doctorates. A number of diplomates have had remarkably successful careers, especially in the public sector. In 1967, the authors of the AVCC Report on Computing in Australian Universities (AVCC 1967) saw postgraduate diploma courses as a stop gap measure until full degree courses were built up. The diploma course is still available at the University in 1999.

8.5 The First Honours Course 1965

Although not envisaged by Ovenstone in 1964, an Honours course was mounted in 1965, a year ahead of earlier plans, and made possible by cooperation with Mathematics. The Honours students were required to have a background in third year mathematics, and while there were no undergraduate computing science subjects, there was a component of numerical analysis in third year Applied Mathematics, given by Capon. A picture of the course content in this first year of the Honours course emerges from consultation with some of the students from the class of four. Robyn Lewis and Sylvan Elhay recall subjects given by Sanderson (programming languages), Capon (Numerical Analysis), Weadon, Ovenstone (Data Processing), Buxton and an engineer (Digital Logic), in addition to the mathematics component. Lewis worked on two projects, the first short one amounted to a programming exercise in Fortran – the task was to write a program to determine the date of Easter in any year, the second year-long project was a substantial mathematical application, which was to be developed on Cirrus. She recalls particularly the nuisance of the paper tape input, so prone to tearing. Elhay's project was to write a matrix processing system, with a Fortran-like language as the user interface; the program was written for the CDC 3200 in assembler. The standard of both projects sounds impressively demanding.

With no undergraduate computing science courses, what lead those first four Honours students to take this great leap into an almost unknown field? Lewis had taken a Fortran crash course because it was recommended for Capon's third year numerical analysis. In the long vacation she obtained a job working for Sanderson on the Cirrus

project. Elhay does not know how he learned to program! But as an undergraduate he had a spare time job programming for Glow in the Psychology Department; this work he obtained by a chance contact while 'hanging around' the IBM 1620, obviously fascinated. Again, he did numerical analysis in third year, and so proceeded to Honours. Malcolm Gray, who did the Honours course in 1966, also 'discovered' programming in the numerical analysis component of Applied Mathematics III.

8.6 Startup of Third Year Computing Science

At the time of Ovenstone's appointment in 1964, there was no specifically designed formal academic teaching of computing science, but, as already indicated, numerical analysis had been part and parcel of Applied Mathematics courses for some years; meantime Fortran crash course were introduced and soon became entrenched. When Capon began teaching numerical analysis within Applied Mathematics in 1963 or 1964, he required third year students to learn Fortran. In 1965 and 1966, there was a component in Applied Mathematics III termed computing science; this was possibly taught by Sanderson. In 1967-68, selected topics from computing science were included in the third year subject Honours Mathematics III, designed to prepare students for Honours.

The introduction, in 1968, of the third year unit system by the Faculty of Science, gave students choice in topic selection within subjects, and in so doing, facilitated the introduction of the third year subject Computing Science IIIM. The prerequisites were Applied Mathematics II and Fortran, and the content appears to have been about half computing. Several Computing Science third year subjects appeared over 1969-70; Computing Science IIIA required students to take five computing units and one mathematics unit, while other subjects had a lesser computing content; by 1972 the Department was able to offer enough units for a full Computing Science third year subject.

Thus, over the period 1968 to 1972, with the cooperation of Mathematics, third year Computing Science subjects were introduced gradually into the curriculum of the Faculty of Science without evidence of any dissension. On one occasion there was a brief Faculty minute indicating that Professors Ovenstone and Potts had worked out privately a resolution to a problem of overlap between their respective third year subjects (both of which included numerical analysis and mathematical programming).

8.7 Negotiations Over Introducing a First Year Subject 1968-70

In April 1968 Ovenstone first submitted a proposal for a first year subject to Faculty, which referred the matter to its Curriculum Committee. That committee reported back to Faculty that it was 'of the opinion that Computing Science I was not of sufficient intellectual content to qualify as a first year subject'! On the other hand 'it was important for students to be introduced to a computer language and procedures as early as possible in their course and that an appropriate course of half a year or a term be introduced'. In the 1940s the Faculty of Science required all students to do Physics I and Chemistry I; later this was changed to two out of the three first year Physics, Chemistry and Mathematics. This scheme, of course, was not attractive to the Biology and Geology Departments, so naturally another first year subject was not a welcome addition on top of existing arrangements. Given this background, it is not

surprising that at its May 1968 meeting the Faculty rejected the proposal for a full first year computing subject and charged the Department with the task of formulating a way of incorporating a half subject into the curriculum. Ovenstone was quick to respond; at the July 1968 Faculty meeting, he introduced a document concerning the teaching of elementary computing science in which a subject composed of half computing and half statistics was proposed. This was supported by Professor James from Statistics. This compromise proposal was next referred to the Heads of Departments Committee.

The saga continued through 1969 with constant deferrals of a decision; the question of half subjects was discussed by the Structure of Degree Committee, who referred the matter to departments. In July 1969 the Curriculum Committee deliberated on the matter again, and then it was sent back to the Structure of Degree Committee in August, and so on; departments were given until March 1970 to make submissions. Faculty was reminded that there was an outstanding proposal dated early 1968 from Computing Science and Statistics. But the matter continued to be deferred, in March 1970 to April and then to May – by this time there were additional proposals for half subjects in Mathematics, Genetics, and Biology for 1971. Even then some further matters were referred to the Structure of Degree Committee. Eventually, the half subjects Computing IH and Statistics IH were accepted by a vote of 21 to 12, just two years after the first proposal was submitted to Faculty!

8.8 Launch of Computing IH 1971

Soon after her appointment as a lecturer to replace Buxton, Kidman was given the job of organising and lecturing the new half subject, which was to be an introduction to computing science as well as an introductory programming course. The Department approved an ambitious syllabus; although there were a number of programming text books, only one or two elementary computing science texts had appeared at this time and none were appropriate for the half subject.

Predictably, as it was popular to equate elementary computing science and programming with programming language, there was much discussion about choice of the programming language for Computing IH; in practice only two possible languages, Fortran and Basic, were available, neither ideal. That year the Department did not succumb to outside pressures for Fortran, but idealistically selected Basic on account of its simplicity (this was before Basic became popular as an interactive language). Fortunately there was an excellent Basic text available, and a suitable batch mode Basic compiler (translator) on the CDC 6400 (interactive facilities were not then available). As it had scarcely been used at the University, this compiler had to be thoroughly checked out before submitting it to student use, and just as well, for there were several faults to correct. The compiler was coded in assembler, but was fortunately well structured and documented. This is mentioned to illustrate how often system software bugs were encountered in those times.

Computing IH was given for the first time in 1971. Capon, by then the Director of the Centre and Acting Head of the Department, had arranged for a quota of 120, which was not invoked as the enrolment was 104. Everyone, students and staff, tackled the new subject enthusiastically. As far as possible, computing was used in both the teaching and the administration of the course, at a time when this was not the usual

practice; for example, class and tutorial lists, exam and exercise marks, were kept on the computer. All demonstration programs and class exercise problems were presented as actual listings from computer runs and students were provided with a simulated simple machine for working with machine languages. One of the main hitches was a bottleneck at the card punches near programming exercise deadlines (see Section 6.8). There were complaints over the student workload, in reality largely caused by inadequate resources for students to prepare their punched card decks.

Although Basic proved to be an admirable language for the course, it was not acceptable for Applied Mathematics, Physics and more advanced Computing Science courses; so in the following year students began with Basic as the programming language, and later in the year transferred to Fortran. The disadvantage of this approach was that the subject became dominated by elementary programming. Consequently, for pragmatic reasons, Fortran alone was the programming vehicle in first year from 1973 until 1976, by which time a much better language, Pascal, had become available (a limited introduction to Pascal was tried in third year in 1974).

The first year half-subject immediately proved popular, with enrolments growing from 104 in 1971 to 206 in 1974 and to 295 in 1978; when, by 1980, enrolments were over 350, the class could not be accommodated in the University's largest lecture theatre, so both day and evening lectures were given. The half subject was required for Computing Science II when that started in 1976, and became part of the first year Mechanical Engineering course in 1983.

8.9 Introducing Second Year Subjects 1974-76

The Department of Computing Science, along with the two mathematics departments and Statistics and Mathematical Physics, became part of the new Faculty of Mathematical Sciences in 1973. With only a half subject in first year and one third year subject, it was not possible to provide a comprehensive and internationally acceptable undergraduate degree in Computing Science. So early in 1974, allowing plenty of time for full consultation, the Department submitted proposals to the new Faculty for the introduction of Computing Science II in 1976. In essence the proposal was for two subjects, both with a first year mathematics subject as a prerequisite, but the mainstream computing science also requiring Computing IH. A great deal of concern was expressed in Faculty over the growth in second year subjects. At this time there were three second year subjects (Applied and Pure Mathematics, Statistics), but five third year subjects (with Computing Science and Mathematical Physics added). The argument from some quarters against the introduction of Computing Science II was that it would force students to make decisions about third year at the beginning of second year. This, in fact, already happened because Mathematical Physics III required Physics II, so that students needed to omit one of the Faculty subjects in second year in order to take Mathematical Physics in third year. Possibly the opposition to the Department of Computing Science proposals was partly motivated by concern about losing students.

The matter was first referred to the Curriculum Committee and then to a special subcommittee, which eventually came up with a counter proposal for 'mixed' second year subjects, composed equally from two disciplines. In order to expedite acceptance of its main second year proposals, the Department reluctantly accepted the mixed

subject proposal although it seemed of doubtful academic merit. Moreover, it greatly complicated the second year to third year prerequisite structure and imposed sequencing constraints within second year Computing Science. More committee considerations were required to decide on such matters as names for the mixed subjects, and on how they would be administered.

At this time the second year subjects were formulated with an unofficial unit structure, and the Department did its best to implement the whole complicated scheme of second year subjects. Computing Science II, Computing Science IIC and the mixed subjects were launched in 1976. By this time it was fortunate that the Pascal programming language became available; it was a simple, attractive but powerful language designed for the new 'structured programming'. After Pascal was adopted in first year, one second year computing science stream started from scratch with Pascal, while the other, from Computing IH, learnt advanced Fortran. The second year subjects were in depth computing science courses, with plenty of nontrivial programming, a unit of numerical methods, as well as a hardware unit and material on operating systems. Computing Science II became the mainstream Mathematical Sciences computing subject; Computing Science IIC (which did not require Computing IH), was adopted from the beginning as a subject in the third year Electrical Engineering course, and it also became part of the postgraduate diploma course. The new computing science subjects were very well received from the beginning with enrolments of almost 150 in the first year; as for the infamous mixed subjects, they were abandoned by Faculty after only one or two years because of extremely low enrolments.

8.10 Some Comparisons with Developments in Other Universities

The report of the AVCC survey of computing activities in Australian universities (AVCC 1967) details non-credit and credit courses. Most universities were giving short coding courses on Fortran, and a few on other languages – in 1966 Adelaide reported the largest number of students. In listing credit courses, Adelaide reported 'Hoped for expansion now impossible because of staff shortage'; Sydney reported 'Two courses cancelled because of staff shortage'.

Academic teaching at Adelaide began with the more advanced courses; this pattern seems to be typical of what occurred interstate. At the University of Sydney, Professor J. M. Bennett was the first to teach an academic computing course in Australia, a postgraduate Diploma being offered there from 1959 (Bennett 1994). Adelaide's diploma course was proposed in 1961 (see Chapter 6) but did not eventuate until 1965. However, the Honours course was also started in the same year, and, according to the results of the AVCC survey, was the first to be given in Australia; the University of Sydney reported that it was introducing an Honours course in 1967, although a computing science option in Honours Physics began round about 1960 (Bennett 1999). Apparently, similar difficulties of fitting computing science courses into the existing academic structures were encountered elsewhere. It was not until 1975 that Adelaide and Sydney were able to introduce their second year courses.

The report of the AVCC survey made this significant comment on the 1966 Australian computing scene (AVCC 1967 p. 18):

> The effect of staff shortages in slowing down the introduction of computer science courses should be noted....until undergraduate credit courses are conducted on the same basis as courses offered in other disciplines, universities are unlikely to produce their share of computing professionals. Post-graduate diplomas are at best a stop-gap measure.

CHAPTER 9 RESEARCH

...up to 1987 not one (female student) completed a research degree.

9.1 Introduction

When it comes to considering the beginnings of computing science research at the University, it is difficult to decided what to include because of somewhat fuzzy boundaries between departments and disciplines. Firstly, applied mathematicians were active in numerical analysis some years before the Computing Centre was established; Elliott's doctorate has been mentioned in Section 5.3. Secondly, before Ovenstone's arrival, some of the early research work in computing by postgraduate students was supervised by academic staff in the Mathematics Department.[1] Thirdly, Macaskill, while a lecturer in Computing Science, undertook research for his Ph.D. in operations research under the supervision of Potts in applied mathematics, and Elhay, one of the first Honours Computing Science graduates, before being appointed Lecturer in Computing Science, undertook numerical analysis research for his Ph.D. effectively under the supervision of Kautsky, an applied mathematics lecturer. What seems relevant or interesting from the early years has therefore been included without regard to departmental boundaries.

The Cirrus project, which began in 1959 and is discussed in Chapter 4, was the first major research undertaken in the University directly relating to computers and computing. The research was carried out in the Department of Electrical Engineering and was primarily engineering research (Allen et al 1963). Nevertheless, software had to be developed for the new machine being designed and built, and two mathematics graduates, Sanderson and Penny, worked in this area, Sanderson on the languages and Penny on the operating system. Their research work on the Cirrus project certainly falls into mainstream computing science. Sanderson had served his apprenticeship at WRE, and, as mentioned in Section 2.4, the work he did there was the basis for an external M.Sc. and the foundation for other research he did as part of the Cirrus project (Sanderson 1964, Allen et al 1963). Penny, working for CSIRO under Pearcey, was awarded both an M.Sc. and Ph.D. for his work on Cirrus (Penny 1961, Penny and Pearcey 1962, Penny 1966).

9.2 The Ovenstone Era

When appointed, Ovenstone appeared determined to establish the academic functions of the Department, both teaching and research, as well as expanding the computing service as already covered in Chapter 6. Teaching and course development have been described in Chapter 8. While it is more difficult to be precise about research activity, there is no doubt that Ovenstone also supported research and undertook some limited original work himself. Enrolment statistics suggest that he strongly encouraged students to enrol for research degrees (see Section 9.3). In a report dated October 1967, Ovenstone writes about the variety of research being done in the Department and lists thirteen publications (Figure 9.1). These include two journal articles and one conference paper by Sanderson on language and programming theory and two international journal articles, a conference paper and two short notes by a research student working on the automatic planning of radiotherapy treatment.

[1] Pure and Applied Mathematics became separate Departments in 1971.

1. R. E. M. Cooper: "Applications of Computers in Radiotherapy", Australian Newsletter of Medical Physics, September 1966.

2. J. A. Ovenstone: "Computer-Assisted Instruction in Undergraduate and Postgraduate Medicine", Med. Journal of Aust., 2, 11, 1966.

3. R. J. Potter: "Some Problems in the Design of Compatible Computers", Proc. Third Aust. Comp. Conf., May 1966.

4. J. G. Sanderson: "On Simple Low-Redundancy Languages", Comm. A. C. M., 8, 10, 1965.

5. J. G. Sanderson: "On a Theory of Programming", Proc. Third Aust. Comp. Conf., May 1966.

6. R. E. M. Cooper & B. W. Worthley: "Computer-based External Radiotherapy Planning, Pt I", Phys. Med. Biol. 1967, 12, No. 2, 229.

7. R. E. M. Cooper & B. W. Worthley: "Computer-based External Radiotherapy Planning, Pt II", Phys. Med. Biol. 1967, 12, No. 2, 241.

8. J. G. Sanderson: "A Basis for a Theory of Programming Languages", Aust. Comp. Journ. 1967, 1, No. 1.

9. E. A. Fanning, T. Gotjamanos, N. J Vowles, K. M. Cellier and D. W. Simmons: "The use of Fluoride Dentifrices in the Control of Dental Caries", Med. Journ. Aust. 1967, No. 1, 383.

10. M. J. Barrett, T. Brown and D. W. Simmons: "Computers in Dental Research", Aust. Dent. Journ. 11, No. 5, 329.

11. R. E. M. Cooper: "The Computer in Radiotherapy, Cytology and Biochemistry Departments", Presented at Conference on Computers in Hospital and Medical Systems, to be published later this year.

12. R. E. M. Cooper: "Applications of the Computer to the Radiotherapy Department", Australasian Bulletin of Medical Physics and Bio-physics No. 31, February 1967, p.4.

13. D. M. Haycraft: "Computers in Medicine", Aust. Health Educ. Advisory Digest, to be published Nov. 1967.

FIGURE 9.1 Departmental Research Bibliography 1967

As discussed in Section 6.5, after the acquisition of the CDC 6400, the Centre was heavily involved, in one way or another, in doing outside work. Systems work and programming were, in many cases, undertaken by professional or academic staff. Members of staff also were involved in assisting with research in other disciplines, work which in a number of instances lead to research publications. Computing Centre programmers, as opposed to academic staff, seldom had their names included among the authors. Publications listed in the University's Annual Report also include a number of review or general articles on applications of computing. The contribution listed in the 1965-70 Reports in these two categories from Ovenstone, Haycraft and Capon probably are but a sample of the activity actually taking place.

9.3 Research Students

In the earlier years, there was a surprisingly large number of students enrolled for higher degrees; in 1969, 11 M.Sc. and 13 Ph.D. students, in 1970, 12 of each, in 1971, 15 and 10, in 1974, 8 and 14 and in 1975, 8 and 6 students respectively. For the next few years the numbers were 4-6 M.Sc. and 6-8 Ph.D. students. Appendix III lists Computing Science Honours, M.Sc. and Ph.D. graduates for the period covered in this history. Even allowing for the span of years required to complete a Ph.D., it is apparent that there were a number of students enrolled for higher degrees who did not graduate, particularly early on. After 1971, a number of female students were among those who enrolled for higher degrees, but up to 1987, not one completed a postgraduate degree.

There were probably a variety of reasons why postgraduate students did not complete their degrees, the most important being the many tempting employment opportunities for those with skills in the computing area. Another factor may have been that virtually all of the early academic staff lacked experience in advising and supervising postgraduate research – two of the successful research students from this time have indicated to the authors that they found Ovenstone unhelpful as a supervisor; in the beginning those who obtained research degrees in the main had external supervisors. However, with the appointment of Macaskill as Lecturer (later Senior Lecturer and then Reader) in 1968, the situation changed radically; within two years he, himself, was awarded a doctorate in the operations research area, and from then on, he successfully supervised a succession of Ph.D. students. Besides students who started, at his instigation, on computer oriented operations research projects, he also took over the supervision of a number of students who were stranded without a supervisor. From 1974 to 1982, six of the eight students who graduated with doctorates did so under Macaskill's supervision, a notable achievement. In the seventies, the employment situation remained buoyant and few Honours graduates were attracted to continuing immediately with research. As a result other academics seldom had the opportunity to take on the supervision of a research student.

For anyone interested in an academic career, a Ph.D. in computing science ensured a tenured position. Of the fourteen Ph.D. graduates between 1966 and 1982, half continued with academic careers. A number of honours students, with no higher degree, obtained lectureships, such was the shortage of qualified people in Australia and worldwide.

9.4 Conferences

In the early years, as the discipline of computing science was being recognised in Australian Universities, there was little contact between academics from different institutions within Australia. Attendance at national conferences made an important contribution in promoting computing science research.

Five computing conferences were held in Australia before 1969, the second of which was the important 1957 meeting held at WRE (see Section 2.3). Further details about the early conferences are given in the two computing histories cited in Section 1.1; they served an important function both in promoting research and in disseminating information about developments in the field within Australia and from overseas. The programme for the 1960 ANCCAC (Australian National Committee on Computing and Automatic Control) conference lists papers presented by Allen and Rose, Butcher, Hirst, Ovenstone and Thacker (later in the Commerce Department). From 1969 the ACS organised an annual conference, and, at first, these conferences provided an appropriate venue for presenting academic research papers. The first such conference held in Adelaide was large and successful; Capon assisted with the organisation. Northcote remembers coming from America to present a paper, and Macaskill, by then lecturing in the Department, also gave a presentation. However, as the Australian computing industry grew, the ACS conferences became very large; academic research papers seemed swamped by large numbers of other reports and other papers. A small academic meeting hosted at Monash University in the early seventies was one of the first venues at which some of the Department's academics had the opportunity to meet interstate counterparts. Following this there were opportunities to attend one or more specialist conferences or summer schools. The initiative taken by Professors Reinfelds and Sale lead to the organising of an Annual Australian Computer Science Conference starting in 1978 (Bennett 1994); these meetings played an important role in fostering academic research in the new discipline. Papers submitted were refereed, and the proceedings published.

9.5 Departmental Research in the Seventies

In the seventies, four masters and three doctoral students from the Ovenstone period successfully completed their degrees. There were also a small number of publications from the Department cited in the University Annual Reports. In 1972 there were two papers, in 1973-76 three or four papers each year, in 1977 there were eight papers and in 1979 ten papers. As described in Chapter 8, throughout this period there was a great deal of pressure on staff as the teaching of computing science was incorporated into the academic life of the University. However, after the mid seventies, there is evidence that the Department, in general, became more active and more successful in its research activities. Undoubtedly, conference attendance, periods of overseas study leave, and the fact that a number of staff members were supervising research students all contributed. While some of the publications cited were unrefereed, many were conference or journal articles. By the end of the period described in this history, the Department had moved on from the stage where teaching was its dominant consideration, to an intermediate stage in its development, with research activities becoming equally significant.

CHAPTER 10 CONCLUSIONS

The Mathematics and Engineering Departments deserve particular accolades...

The technological revolution, dating from the 1940s, rapidly and widely permeated advanced societies. The basic concepts of the modern computer had been first formulated by Charles Babbage in the early nineteenth century, extended by Alan Turing in the 1930s, and given practical impetus by John von Neumann in 1945. Some universities in the USA and England were at the forefront of the revolution, but sharing the creative developments were government establishments, like the National Physical Laboratory in England, and commercial organisations, such as the International Business Machines Corporation in the USA. How did the University of Adelaide cope with this revolution which resulted in digital computation forming an essential service for the Administration and many academic departments, and computing science becoming a new basic scientific and mathematical discipline? This history has attempted to answer that question, as well as to record information before it is lost with the passage of time.

Although this history deals with a period only decades in the past, the pace of technological advance since that time has been extraordinary and hard to foresee. Fortunately there were some academics in the University who early on recognised the importance of computing; an account has been given of the roles they played in initiating, promoting and supporting the development of computing services and sciences in the University. The Mathematics and Engineering Departments deserve particular accolades in this regard.

In Australia, among those who were foremost in leading the computing revolution, there are three leaders all of whom are at least mentioned in this history – Bennett at the University of Sydney, Pearcey at CSIRO and, most importantly for present purposes, Ovenstone at the Department of Defence and then at the University of Adelaide. Adelaide was at first well behind Melbourne and Sydney, but benefited from its close proximity to WRE where Ovenstone was responsible for the installation of WREDAC in 1956. When this computer was replaced by an IBM 7090 in 1961, University staff and research students gained limited access to the best computer in Australia.

But how was the University to acquire its own computer and introduce the teaching of computing science? Once the bureaucratic wheels started to turn in early 1960, they turned rapidly. The Vice-Chancellor, Henry Basten, was decisive at a period when Vice-Chancellors could be decisive, and with his support, a Computing Centre was established and a computer ordered in less than a year. The decision to form a university-wide centre to serve both the data processing needs of administration as well as the computing requirements of the academics was pivotal, and avoided difficulties encountered in some other universities where computers were attached to single departments.

To decide which computer to acquire to best meet the needs of the University was complicated by the presence in the Electrical Engineering Department of an active research group engaged in designing and building a small digital computer named Cirrus. There was no similar project in Australia at the time, and some commentators

consider that it presented an opportunity for the establishment of a national computer hardware industry. This was not to eventuate, and reasons for the lost opportunity have been advanced. It is the authors' view that the University gave as much support to the project as could be expected, and that it was not itself in a position to develop Cirrus as a commercial proposition. The authors believe the University's 1961 decision to order an IBM 1620 as its first service computer was correct and, moreover, had little if any material effect on the Cirrus project.

Ovenstone's subsequent appointment in 1964 to the University's staff as Director of the Computing Centre and the inaugural Professor of Computing Science sparked an explosion in the University. Within two years he replaced the now inadequate IBM 1620 computer with a state-of-the-art CDC 6400 computer, and soon the Computing Centre became a large, exciting organisation with staff numbers approaching fifty. How did Ovenstone achieve support for this grandiose scheme? By force of circumstances, the Centre became a semi-commercial operation, which not only had to earn funds to pay part of the cost of the machine, but also to pay staff. This was still the situation when Capon took over the Directorship from Ovenstone, even though the Centre's external operations had been very successful, and a large proportion of the 6400 debt had been paid. Of necessity, management of the Centre was dominated by the need for external earnings over the period under consideration. Although this situation was unusual at that time and difficult to manage, it has turned out to be a portent of things to come at universities.

After the arrival of the 6400, the University developed an insatiable appetite for computing, and its use of the services of the new machine expanded rapidly and without abating. The University was not so quick to recognise that the provision of computing services was essential in a modern university and, as such, had to be paid for. In effect, the internal University computing service was being partly supported by external earnings right up until 1976 when the University took over all of the salary payments.

The University was prepared to support the potential of computing as a tool, but how does a new discipline, computing science, and a new department, start up in competition with those already entrenched? Because there is real competition within a university for students, staff and funds, the appearance of a new discipline was not altogether welcome. Short programming service courses were encouraged; they did not take students from other courses and cost other departments nothing. But introducing some of the new undergraduate computing science subjects proved another matter.

However, Ovenstone's initial achievements on the academic front are impressive – immediately he was able to launch the postgraduate diploma and Honours courses, with support from Mathematics and his own academic staff. His entrepreneurial methods were not so successful when he tried to introduce a broader teaching programme for the new Department. The established departments obstructed his moves, some not convinced of the academic quality of the new discipline, but others perhaps selfishly unhappy with potential competition for staff and students. Ovenstone's negotiations to introduce firstly a full first year subject, and then a half subject, took two years to gain Faculty approval; at least Ovenstone had the satisfaction of knowing, when he resigned at the end of 1970, that a new half subject

was to be taught the following year. Similarly, in the seventies, proposals to introduce second year subjects were not exactly welcomed by other departments in Faculty. However, by 1976, under Hirst, Ovenstone's successor, the Department was teaching a full programme of first, second and third year undergraduate courses, an Honours course and a diploma course, as well as supporting postgraduate research by M.Sc. and Ph.D. students. Large student classes, small numbers of hardworked staff, and shortages of qualified staff were difficulties faced by the new department. Other Australian universities experienced similar problems.

How did the University cope with the digital technology revolution? This account of the period 1953 to about 1978 shows that the University coped quite well. From the beginning, the University was involved in fundamental computing research, and researchers in other disciplines embraced the new tool enthusiastically. Despite a slow start, a new computing infrastructure was gradually established – a Computing Centre servicing the needs of the Administration and academic departments, and an academic Department of Computing Science with a full teaching and research programme.

At the end of the period covered in this historical report, computing was accepted as an essential requirement throughout the University. However, the world of computing was, as always, changing; computers were becoming less expensive, smaller and more powerful and, for most academic purposes, the large central facility provided by the Computing Centre was no longer essential. Within the University, departments wanted to control their own machines, and there was a rapidly rising demand for better interactive facilities. Arrangements were finalised in 1978 to purchase multiple VAX 11/780 systems from Digital Equipment Corporation in 1979, to be available for teaching in 1980. But that is another story. The use of punched cards in computing was coming to an end. A few years later the Centre literally scrapped its remaining key punches[1]; the only use, then, for any remaining IBM cards was for writing notes and messages.

[1] Personal communication from Terry Fanning.

CHAPTER NOTES

Ch 1 In the Beginning
Some of the material in this chapter has been taken from the two histories referenced. The paper by Dr Garry Tee gives a fascinating account of the heritage of Charles Babbage. Most of the material in 1.3 comes from files, notes and recollections of the authors, supplemented by discussions with Culver and Green, and correspondence with Blatt.

Ch 2 Computing at WRE 1956-64
The main sources for this chapter are the files and personal recollections of the authors as well as the WRE conference proceedings. Capon, Culver, Duncan, Hirst and Penny filled in details from their recollections. Factual material was checked in Morton's book.

Ch 3 Punch Card Equipment Users Committee 1960-61
The principal sources for the detailed account given in this chapter are the personal files of Potts; the minutes of the special sub-committees do not appear to have been preserved in the University. Also consulted were University records of meetings of the Education Committee, the Staff Development Committee and the Council, as well as Culver's records of his correspondence with IBM regarding the 1620. The documentation has been supplemented by personal recollections.

Ch 4 The Cirrus Project 1959-71
The material in this chapter is based on personal files and recollections of Potts, the records of University meetings, University correspondence, University Annual Financial Statements, the book by Pearcey, research papers by Allen and others, the Manual by Sanderson, notes from Rose, and discussions with Allen, Barter, Dorfl, Hawryszkiewzcz, Lewis, Penny, Potter and Rose.

Ch 5 Formation of the Computer Society of SA 1960
The material in this chapter is based on filed material preserved by Potts, supplemented by personal recollections, and on the book edited by Bennett.

Ch 6 Early Years of the Computing Centre
The sources for material in this chapter are minutes of Computing Centre and Computing Committee meetings and other meetings, Computing Centre Newsletters, University Calendars, the 1967 AVCC Report, notes from Capon, discussions particularly with Capon, but also with Culver, Fanning, Howard, Jones, Northcote, Lewis, Meyler and others, all again supplemented by personal recollections.

Ch 7 The Department of Computing Science
Material in this chapter is derived from Faculty minutes, University Calendars, the book edited by Bennett, the 1967 AVCC Report, discussions and correspondence with Barter, Bennett, Capon, Duncan, Elhay, Hirst, Macaskill and Weadon, and from personal recollections.

Ch 8 Teaching: Course Development 1960-76
The material in this chapter is based on University Calendars, Faculty and Faculty subcommittee minutes, University enrolment statistics, Punch Card Committee minutes, Computing Centre Newsletters, the 1967 AVCC Report, course notes provided by Tuck, course notes, a correspondence file and other material from Culver, supplemented by personal recollections.

Ch 9 Research
Material for this chapter is based on University Calendars and Annual Reports, graduation ceremony programmes, Computing Centre Committee minutes, discussions or correspondence with Elhay, Gray, Macaskill and others, and personal files and recollections of the authors.

Photographs
Most photographs were supplied by the person or family concerned. The photographs of Cirrus were supplied by Rose. The photograph of the CDC 6400 was printed from a negative kept in the photographic collection at the Waite Institute. The photograph of Ovenstone came from the Advertiser and a newspaper clipping from the Special Collection of the Barr Smith Library.

REFERENCES

(Numbers in brackets refer to the Section where the reference is first made)

Allen M. W. and Rose G. A., (1960): 'University Computation', Occasional paper. (3.3)

Allen M. W., Pearcey T., Penny J. P., Rose G. A. and Sanderson J. G., (1963): 'Cirrus, an Economical Multiprogram Computer with Microprogram Control', IEEE Trans. on Computers, vol. EC12, p663. (4.1)

Allen M. W., (1985): 'Charles Hamblin (1922-1985)', Australian Computer Journal, 17, p192. (2.3)

AVCC, (1967) 'Report of a Survey of University Computing Facilities', C67/9. (6.10)

Babbage C., (1829): 'Table of logarithms of natural numbers from 1 to 108,000', London, B. Fellowes. (inscribed B. H. Babbage). (1.2)

Babbage H. P. (ed), (1869): 'Babbage's Calculating Engines, Being a Collection of Papers Relating to Them: Their History and Construction', London, E. & F. Spon. (1.2)

Bennett J. M. (ed), (1994): 'Computing in Australia: The Development of a Profession', Sydney, Australian Computer Society, Hale & Iremonger. (1.1)

Bennett J. M., (1999): Personal communication. (7.3)

Cherry T. M. and Hirst F., (1957): 'The Machine CSIRAC', Proc. WRE Computing Conf. vol.1. (2.3)

Hamblin C. L., (1957): 'An Addressless Coding System Based on Mathematical Notation', Proc. WRE Computing Conf. vol.1. (2.3)

Morton P., (1989): 'Fire Across the Desert', AGPS Press, Canberra. (1.1)

Ovenstone J. A., (1957): 'The WREDAC System', Proc. WRE Computing Conf. vol.1. (2.2)

Ovenstone J. A., (1969): 'Occasional Paper'. (6.5)

Pearcey T., (1988): 'History of Australian Computing', Victoria, Australia, Chisholm Institute of Technology. (1.1)

Penny J. P., (1961): 'Application of the Principles of Time-Sharing in the Design of a Multiprogramme Digital Computer', M.Sc. thesis, The University of Adelaide. (4.3)

Penny J. P. and Pearcey T., (1962): 'Use of Multiprogramming in the Design of a Low Cost Digital Computer', Communications of the ACM, vol.5. (4.3)

Penny J. P., (1966): 'Multiprogramming for a Small Scale Scientific System', Ph.D. thesis, The University of Adelaide. (4.3)

Potts R. B., (1972): 'Computing Facilities at the University of Adelaide', Occasional paper. (3.1)

Sammet J. E., (1969): 'Programming Languages History and Fundamentals', Prentice-Hall. (2.4)

Sanderson J G., (1957): 'The WREDAC Automatic Programming Routine', Proc. WRE Computing Conf. vol.1. (2.3)

Sanderson J. G., (1958): 'Automatic Programming for Digital Computers', M.Sc. thesis, The University of Adelaide. (2.4)

Sanderson J. G., (1964): 'Cirrus C-code Manual'. (4.3)

Tee G. J., (1983): 'The Heritage of Charles Babbage in Australasia', Ann. Hist. of Computing, vol.5, p.45. (1.2)

WRE Computing Conference, (1957): 'Data Processing & Automatic Computing Machines', Proceedings vol.1. (2.3)

APPENDIX I ABBREVIATIONS AND ACRONYMS

(Numbers in brackets refer to the Section where first used)

ACS	Australian Computer Society (1.1)
AUC	Australian Universities Commission (6.4)
AVCC	Australian Vice-Chancellors' Committee (6.10)
CDC	Control Data Corporation (4.6)
CSIRAC	CSIRO Automatic Computer (1.1)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (1.1)
EDSAC	Electronic Delay Storage Automatic Computer (1.1)
Fortran	FORmula TRANslation programming language (2.4)
IBM	International Business Machines (2.5)
ILLIAC	University of Illinois Automatic Computer (1.1)
PEB	Public Examinations Board (6.3)
PMG	Post Master General's Department (4.2)
SAIT	South Australian Institute of Technology (8.1)
SILLIAC	Sydney version of ILLIAC (1.2)
TCA	Telecommunications Company of Australia (4.3)
URG	University Research Grants Scheme (4.2)
UTECOM	NSW University of Technology Electronic Computer (1.1)
WRE	Weapons Research Establishment (1.1)
WREDAC	WRE Digital Automatic Computer (1.1)

APPENDIX II ACADEMIC STAFF 1961-78
Department of Computing Science

Lecturing Staff

1961-71	Capon, Ian Nicholas	Lecturer, Senior Lecturer
1963-71	Sanderson, John Gavin	Lecturer, Senior Lecturer
1964-70	Ovenstone, John Allen	Professor
1965	Duncan, Andrew Kenneth	Lecturer
1965-86	Weadon, John Noel	Senior Lecturer
1966-70	Buxton, John Balfour	Lecturer
1968-82	Macaskill, John Leonard Cameron	Lecturer, Senior Lecturer, Reader
1970-87	Kidman, Barbara Phyllis	Lecturer, Senior Lecturer
1972-	Elhay, Sylvan	Lecturer, Senior Lecturer
1972-84	Hirst, Frank	Professor
1972-	Barter, Christopher John	Lecturer, Senior Lecturer, Professor
1974-84	Sanderson, John Gavin	Lecturer, Senior Lecturer
1976-90	Beaumont, William Paul	Lecturer

Tutors

1971-72	Thamm, Helen Mary
1973-77	Colquhoun, Daryl George
1975-76	Nicolle, Kelvin Brian
1977-79	Cox, Catherine Elizabeth
1977-83	Verbyla, Janet Louise
1978-82	Choi Young Ju
1978-82	Southcott, James Bruce

APPENDIX III HIGHER DEGREE GRADUATES AND DIPLOMATES
(Prior to 1973, degrees awarded in the Faculty of Science, subsequently in the Faculty of Mathematical Sciences)

Honours Degree of Bachelor of Science 1966-78[1]

1966	Elhay, Sylvan
	Foss, David Anthony Berthold
	Gascoine, Christopher Eric
	Lewis, Robyn
1967	Courtney, Peter Graham
	Gray, Malcolm
	Lee Kim Cheng
	Perry, Peter Grant
1968	Doble, Peter Gordon
	Knuckey, Michael Henry
	Risticz, Alexander
	Russo, Eugene
1969	Cleave, Geoffrey Alan
	Hemmerling, Malcolm Brian
	Hetherington, Robert Roy
	Jennings, Leslie Stephen
	Johnson, Sydney Gordon
	Rattley, Robert Campbell
	Ryan, Douglas Martin
	Vawser, Keith Derwent
1970	Cooper, Dale Francis
	Hadley, James Richard
	Johnson, Terence Sydney
	Reilly, Peter Fergus Alexander
	Ryan, Peter Martin
	Tildesley, Paul Clive
1971	Bryant, Antony David
	Gabb, Andrew Paul
	Malcolm, Philip James
	Thamm, Helen Mary
1972	Aitken, Alister James
	Bishop, Christopher Ashwick
	Briffa, Charles Anthony
	Cumming, Bruce Gordon
	Cumpston, Stuart William
	Davis, Robert James
	Dawes, John Patrick
	Gwatking, Jeffrey Clude
	Hall, Geoffrey Bidgood
	Morcom, Richard Hewer
1973	Chatfield, David Martin
	Colquhoun, Daryl George
	Kapust, Barbara Dorothea
	Kowalik, Ian John
	Smith, Glen Alexander
	Wendelborn, Andrew Lawrence
1974	Barton, Alan Reginald
	Cox, Catherine Elizabeth
	Crompton, Robert Philip
	Golding, Stephen Maxwell
	Keen, Christopher David
	Laslett, John Victor
	Marlin, Christopher David
	Ngo Get Sen
	Parkinson, Michael John Austin
	Roberts, Peter Malcolm
1975	Barber, John Andrew
	Blavins, Ian Neville
	Fiddaman, Graham
	Fisher, Peter Donald
	Nicolle, Kelvin Brian
	Orum, Peter Janus
1976	Azizi bin Ngah Tasir
	Davison, Stephen
	Mavromatis, Danny
1977	Harmer, Jon Deon
	Hodson, David Andrew
	Rowlands, John
	Teo Chae Gim
	Ho Xuan Thu
1978	Chick, Alan John
	Craig, Gregory Thomas
	Crawley, Stephen Christopher
	Hendrick, Geoffrey Thomas
	Pallotta, Dino Carmine
	Smith, Neill Richard Moffatt
	Vu Cong Hieu

[1] The listed year is that in which the degree was awarded

Degree of Master of Science 1958-78

1958 Sanderson, John Gavin
'Automatic programming for digital computers.'
1961 Penny, John Philip
'Application of the principles of time sharing in the design of a multi-programme digital computer.'
1971 Gray, Malcolm
'Machine recognition of Thai text.'
1973 Courtney, Peter Graham
'The numerical solution of the laminar boundary layer equation of a compressible fluid.'
1975 Perry, Peter Grant
'Computer aided instruction.'
1976 Wiley, George Richard
'An experiment in multiprocessing compilation.'

Degree of Doctor of Philosophy 1966-82

1966 Penny, John Philip
'Multiprogramming for a small scale scientific computer system.'
1967 Sanderson, John Gavin
'A contribution to the theory of programming languages.'
1970 Macaskill, John Leonard Cameron
'The application of computers to the balancing and sequencing of assembly lines.'
1971 Cooper, Richard Edward Mounteney
'Optimal radiotherapy using digital computers.'
1972 Elhay, Sylvan
'Optimal quadrature formulae for certain classes of Hilbert spaces.'
1972 Lee Kim Cheng
'Supervision of trigonometric proofs for computer aided instruction.'
1974 Hemmerling, Malcolm Brian
'The generation by computers of timetables for South Australian secondary schools.'
1974 Risticz, Alexander
'An investigation of the game of poker by computer based analysis.'
1975 Cooper, Dale Francis
'An experimental investigation of some heuristics for scheduling constrained projects.'
1976 Beaumont, William Paul
'Models for computer simulation with application to a CDC 6400 system.'
1977 Malcolm, Philip James
'Rules of mathematical and computational techniques in assisting the understanding of complicated phenomena.'
1979 Keen, Christopher David
'Design and evaluation of database access paths.'
1980 Marlin, Christopher David
'Coroutines: a programming methodology, a language design, and an implementation.'
1982 Lester, Lewis Neale
'Evaluation by simulation of queuing network models of multiprogrammed computer systems.'

Diploma in Computing Science 1966-72

1966 Schoff, Richard Frederick
1967 Burke, Philip Damien
Hercus, Robert William
Robertson, Robert James
1968 Howard, Leslie Frank
Porter, David Rodney
Rainsford, Brett Geoffrey
Riceman, Mary Stirling
Seidel, Ronald Desmond
1969 Duncan, Bruce McLean
Henshaw, Ian Ferguson
Kelly, Graham Ross
Low Kim Huat
Roper, John McEwen
1970 Beaumont, William Paul
Mathers, Roger Barry
Nissen, Peter Laurence
Smith, Robert John
Spencer, Brian James
Swanson, Gary John
1971 Burgess, Noel Keith
Chong Kuan Fong
Goh Teck Soon
Langhans, Peter Richard
Sharper, Michael Whitfield
1972 Andersen, Ronald Eric
Cookson, Gathorne George
Deeming, Lawrence Wayne
Marsh, Gregory John
Medd, Ruth Elizabeth
Reid, John James MacFarlane
Seidl, Gunther Hermann
Steen, Gregory Ray
Thompson, James Edward
Whellum, Emily Joy

CHRONOLOGY

(Numbers in brackets refer to the relevant Section)

1953 Blatt's visit (1.3)
1956 Ovenstone in charge of installation of WREDAC at WRE (2.2)
Capon, Penny, Potts, Sanderson worked with WREDAC (2.2)
1957 WRE conference (2.3)
1958 Sanderson's external M.Sc. thesis submitted and approved (2.4)
1959 Cirrus project began under direction of Allen (4.1)
First of a series of Fortransit courses given by IBM (8.2)
1960 Formation of Punch Card Users Committee (3.2)
Formation of Computer Society of South Australia (5.3)
1961 Computing Centre established in Old Anatomy Building (6.1)
Simmons appointed Punch Card Equipment Officer (6.1)
University hired time on IBM 7090 at WRE (2.5)
University ordered IBM 1620 (3.5)
Capon appointed Lecturer in Computing Centre (2.2, 6.1)
Fortran courses taken over by University (8.2)
1962 IBM 1620 installed (6.3)
1963 Sanderson transferred to Computing Centre (6.2)
Cirrus in operation (4.6)
Computing Centre moved to Engineering Annexe (6.2)
1964 Ovenstone appointed Director of Computing Centre
and Professor of Computing Science (6.2)
CSIRO CDC 3200 in service at University (6.3)
1965 Postgraduate diploma and Honours courses started (8.4, 8.5)
Contract for CDC 6400 negotiated (6.6)
1966 IBM 1620 decommissioned (6.3)
CDC 6400 installed (6.5)
1968 Computing Science IIIM started (8.6)
1969 Administrative Separation of Department from Centre (6.4, 7.1)
1970 Ovenstone, Sanderson, Simmons resigned (6.10)
1971 Capon appointed Director of Centre (6.10)
Computing IH started (8.8)
Cirrus service discontinued (4.6)
Centre and Department moved to Horace Lamb Building (6.10)
Macaskill appointed Acting Head of Department (7.2)
1972 Hirst appointed Professor of Computing Science (7.2)
1976 Computing Science II and IIC started (8.9)
1977 CDC 6400 decommissioned, replaced by CDC Cyber (6.10)

INDEX OF SELECTED NAMES