History of Early Australian Designed Computers

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Abstract

This paper examines the development of a number of computers designed and built in Australia that really changed everything! Australia designed and built CSIRAC, the fourth stored program computer in the world. Prior to this however, in 1913 the Automatic Totalisator, although not a computer, performed many of the calculations later done by computers. SILLIAC, based on the ILLIAC was built in Australia. UTCOM and WREDAC, although built in the UK, were extensively modified in Australia. In the early microcomputer era the Australian designed and built Microbee computer was used extensively in homes and schools. The paper then discusses the ill-fated project to design and built an Australian Educational Computer. These computers were each designed and built for a purpose and the paper looks at the people, technologies and events that propelled this process. Actor-network theory is used as a lens for understanding the human and non-human elements of these historical developments.

Keywords

Computers, design, manufacture, uses, Australia, history, Actor-Network Theory

Introduction

Although not currently renowned for designing and manufacturing computers, Australia has an important history in this regard. Although not in any way what we would regard as a stored program digital computer, the Automatic Totalisator (1913) used many computing concepts in performing mathematical calculations to determine the betting odds in horse racing. Arguably the world's fourth of fifth stored program digital computer, CSIRAC was designed and built in Australia in the late 1940s. SILLAC (based on the ILLIAC computer), but not an exact copy, was built in Australia and became operational in 1956 as one of the most advanced computers in the world at that time. Although not designed and built locally, UTECOM and WREDAC (1956) were significantly modified for Australian use.

Moving to the 1980s and microcomputers, the Microbee which was designed and built in Australia for both home and education markets sold 70,000 to over 3,000 Australian schools as well as schools in Scandinavia, Asia and Russia. In the mid-1980s an attempt was made by the Commonwealth Government to design an Australian Educational Computer. Initial design work was done but this did not proceed to construction.

In studying the history of technological innovation, in addition to history methodology [1, 2] actor-network theory (ANT) [3-6] can provide a useful lens [7]. ANT was designed to give a socio-technical account in which neither social nor technical positions are privileged, a significant voice is given to technological artefacts, and nothing is purely social or purely technical. Innovation Translation, informed by ANT provides a way to examine the adoption and implementation of these innovations [8]. 'Translation', in this context, can be regarded as a means of obliging some entity to consent to a 'detour' that takes it along a path determined by some other entity. Callon [4] proposes a process of translation with four aspects or 'moments'.

- Problematisation involves defining the nature of the problem in such a way as to be seen by other actors as being the answer [9].
- Interessement involves interesting and attracting an entity by coming between it and some other opposing entity [10].
- Enrolment then occurs through a process of 'coercion, seduction, or consent' [11] and, if all goes well, leads to the establishment of a solid, stable network of alliances (Singleton and Michael, 1993)
- Mobilisation locks in as the proposed solution gains wider acceptance [9] through some actors working to convince others.

The Automatic Totalisator, 1913

By far the most important early development in the history of Australian computing was George Julius's invention of the automatic totalisator as this device used many of the concepts later found in electronic computers [12]. Although far from being a stored program digital computer, this electro-mechanical device performed mathematical calculations to determine the betting odds in horse racing. In totalisator betting systems, also known as

Parimutuel betting systems, all the money wagered on an event is pooled together with dividends being calculated from the weight of money bet on each competitor. The competitor that has attracted the most money will return the smallest dividend, while the least supported horse will return the highest dividend [13, 14].

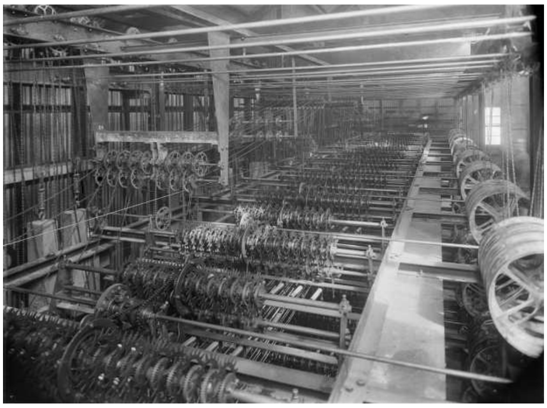

Figure 1: The world's first automatic totalisator (from Conlon, B. (2017). "Totalisator History")

George Julius, who was born in England but migrated to Australia, invented the world's first automatic totalisator. The 'Julius' as it became known, was first used at a racetrack in New Zealand before being adopted in many countries around the world. Julius did not, however, originally conceive the automatic totalisator as a betting machine, but as a mechanical vote-counting machine [15]. Julius reported: "*A friend in the west conceived the idea of getting me to make a machine to register votes, and so to expedite elections by giving the result without any human intervention. I invented one that aroused some interest, and it was submitted to the Commonwealth Government.*" [15]. When the Australian Government rejected the voting machine, Julius adapted it as a racecourse totalisator. Swade [14] described how the Julius totalisator, with its automatic odds machine, was the "*earliest on-line, real-time data processing and computation system*" as other data processing systems of the time "*required operators to prepare batches of punched cards which were then processed en mass*" [14].

CSIRAC: Australia's Stored-Program Computer, 1949

In the 1940s Australia was well placed to enter the computer age as it had a manufacturing base for the high technology of the day: the vacuum tube [16]. Pearcey [17] describes the transition from analogue type instruments like the slide-rule and the simple desk-calculator, along with books of mathematical tables to the digital computer, and how it was made possible by the prior development of a large scale domestic radio industry during the 1920s and

1930s in this country which was served by a reliable vacuum tube-based radio technology. All that was now missing, technically, was some of the expertise in television and radar (again based on the vacuum tube) developed in Britain during the 1930s and 1940s. The close relationship between Australia and the UK at that time, and the fact that Pearcey and others who were to become involved in computing in Australia had worked on radar in the UK during the war, provided this last technical ingredient [18] [16].

> *"Further, by the end of WW2 the techniques of the early high-definition television developed by EMI and L Baird in the UK during the 1930s and the radar technology which stemmed from it by 1945 provided all the technology needed to create the electronic computer."* [17 :6]

Working at the Radiophysics Laboratory of the Council for Scientific and Industrial Research (now known as the CSIRO[1]), in 1947 Trevor Pearcey and Maston Beard began working on the development of an electronic computer [19]. The CSIR Mk1 (CSIRAC[2]) was built by Pearcey and Beard and became operational in 1949. It was Australia's first stored-program electronic digital computer, and (arguably) the world's fourth or fifth, being used at the CSIRO Division of Radiophysics in the Universities of Sydney

Figure 2: CSIRAC, Museum Victoria in Melbourne (Photo courtesy of Museum Victoria)

[1] Commonwealth Scientific and Industrial Research Organisation (CSIRO)

[2] It was later renamed CSIRAC (Commonwealth Scientific and Industrial Research Organisation Automatic Computer)

and Melbourne until 1964 [17]. It is currently on display in Museum Victoria in Melbourne as the only surviving intact first generation computer [20] [21].

According to Maynard [22], Pearcey got his ideas on computing from two physiologists who had described how they thought the human brain worked. Beard had the technical skills and the knowledge and together they built CSIR Mk1 up from first principles, not greatly influenced by overseas developments [22].

> *"The construction of the CSIR Mk.1 as it was first called was of standard components available from a well-developed radio industry, but no miniaturisation or circuit packaging was then possible. Only the bank of up to 32 sonic delay lines, each five feet long and filled with mercury to carry the stored pulses corresponding to the data and the instructions, together with cabinets and electronic chassis, were fabricated on site. . . The Mk.1 was one of the earliest, truly automatic, stored program computers."*
>
> *[17 :15]*

CSIRAC was what we would now call a first generation computer with over 2,000 thermionic (radio) valves that required a one-hour warm-up period each morning. It was a large and complex machine covering over $40m^2$, consuming around 30kW of power [21]. It required its own maintenance and programming technicians and used mercury delay line storage with a total capacity of 1024 words and an access time of 10 milliseconds [19]. Programs were stored and loaded on wide paper tape and the operator, who was often actually the programmer, commanded a bank of a hundred or so switches which had to be manipulated during program execution. It was essential for efficient operation that the power supply be kept stable, and the story is related that on one occasion the computer was overloaded and crashed when someone turned on an electric jug in a nearby tearoom causing a power fluctuation [21].

Unlike a number of other computing developments around world at the time, CSIR Mk1 was not built for military purposes but as a research machine to perform calculations for agricultural issues such as animal health and plant growth but later extended its interests into manufacturing [23]. Later, the newly formed CSIRO developed new interests in radiophysics, radio-astronomy and industrial chemistry. Australia is a very dry continent and the

Commonwealth Government was, at the time, interested in the possibility of inducing rain over important agricultural areas by cloud seeding. If it could have been achieved this would have revolutionised agricultural production in Australia [20], and CSIRO was thus interested in researching the related physics. (It is interesting to reflect that in retrospect, radio-astronomy in Australia turned out to be highly successful while the rain-making project did not.)

SILLIAC, 1956

Built in 1956 by the University of Sydney as a tool for theoretical physics, SILLAC (**S**ydney version of the **Ill**inois **A**utomatic **C**omputer) was based on the ILLIAC computer, developed at the University of Illinois. It was, however, not an exact copy of ILLIAC. As one of the most advanced computers in the world, SILLIAC was one of the first to be dubbed a 'supercomputer', and was much more powerful than Pearcey's CSIR Mark 1 [12]. SILLIAC was the size of a double-decker bus, contained 2,800 vacuum tubes and was programmed with paper tape [24]. Its chassis and wiring was built by the Australian subsidiary of British company STC but the Government Aeronautical Research Labs was responsible for the project as a whole [12]. SILLIAC became operational in 1956.

Nuclear physics was very important at the time with laboratories around the world producing results. Using SILLIAC, the University of Sydney were the first to synthesise all these experimental results into a theoretical model: into a picture of what a nucleus must look like. The biggest user after the School of Physics itself was the Snowy Mountains Hydro-Electric Authority where it was used in designing the major scheme for hydroelectricity and irrigation in south-east Australia. SILLIAC was used to design dams, tunnels and many other aspects of the project, It considerably reduced the time taken for all the design work. Finally, when spare parts could no longer be found SILLIAC was dismantled in 1968.

UTECOM and WREDAC, 1956

These two early computers were commissioned and used, but not built in Australia. Both were commercial models (highly modified in the case of WREDAC), built in England and shipped to Australia by the manufacturers [12].

UTECOM at the NSW University of Technology

In response to a shortage of scientists and engineers the New South Wales Government established an Institute of Nuclear Engineering at the NSW University of Technology with the intention of examining the use of nuclear power. For this purpose an electronic computer was regarded as essential and the university decided on DEUCE[3], manufactured by British computer company English Electric. The computer was built at the English Electric manufacturing and research facility in Staffordshire where it was tested, disassembled and shipped to Australia where it became UTCOM[4] [25].

WREDAC at the Weapons Research Establishment in South Australia

This computer was unusual for Australia as being the only early computer used for military purposes. It was located in Woomera, a town in South Australia built by the British to develop atomic weapons and with the Woomera Rocket Range to test them. The Weapons Research Establishment (WRE) was populated largely by British scientists, and was incorporated with other Australian Department of Defence research laboratories. Their weapons testing activities involved detailed mathematical calculations and by the early 1950s the WRE became interested in the 'new electronic computers'.

The Elliott 402 looked promising but it was the enhanced Elliott 403 that seemed to satisfy the WRE's requirements. The modified machine was called WREDAC[5] and was special in taking input from locally built analogue to digital conversion of missile range data, processing this with locally written software, and producing off-line performance reports on Australia's first line printer and the world's first digital plotters [26].

The Microbee, 1982

The Microbee computer was designed in Australia by Owen Hill and Matthew Starr from Applied Technology Pty Ltd who, in 1982, developed kit sets for the electronics enthusiasts market, complete with assembly instructions [27]. It was based on a Z80 microprocessor S-100 system. These sold for $399.

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3 **D**igital **E**lectronic **U**niversal **C**omputing **E**ngine (DEUCE) was an improved version of the ACE (Automatic Computing Engine) designed by Alan Turing.

4 **U**niversity of **T**echnology **E**lectronic **Com**puter (UTECOM)

5 **WRE D**igital **A**utomatic **C**omputer (WREDAC)

Fully assembled Microbees with higher specifications soon followed, and by August 1982 almost a thousand computers were being made a month [28].

The Microbee designers were thinking of both home and education markets and it wasn't long before the first Microbee contract was let for New South Wales schools. This was soon followed by Western Australia, South Australia, Queensland and Victoria. Some were also sold in Scandinavia, Asia and Russia [27]. By the mid-1980s more than 70,000 Microbees had been sold and over 3,000 Australian schools, including many secondary schools, were using Microbees. In the later 1980s, however, the rise of Apple and IBM meant that Microbee disappeared from the market.

Figure 3: Microbee advertisement

The Australian Educational Computer, 1986

In 1983 the Australian Government's Commonwealth Schools Commission set up a 'National Advisory Committee on Computers in Schools' (NACCS) to plan the National Computer Education Program [29]. The terms of reference of this committee were to provide advice on professional development, curriculum development, software/courseware, hardware, evaluation and support services [23, 30].

At the time, software from organisations like the Minnesota Educational Computing Consortium was utilised in Australian schools but this software typically had an American outlook, leading to cultural problems. One example of this was the Apple // simulation game 'Lemonade' which was based on making and selling lemonade from a street stall. The only problem was that lemonade stands are almost unknown in Australia. The BBC Computer simulation program 'Suburban Fox' where the student has to take the part of a fox finding its prey and avoiding cars and the fox hunt is another example. The problem was that fox hunting was quite foreign to Australian students [30].

A number of other countries had developed their own educational computers: Acorn BBC Computer (UK), Compis (Sweden), ICON (Canada) and Poly

(New Zealand). NACS thus saw an opportunity for Australia to develop an educational computer system of its own. It was also recognised that this project would have had the added advantage of the new computer being built in Australia by an Australian company.

The idea was that the Commonwealth Schools Commission be responsible for the production of an **Educational User Requirement** and an **Educational Technical Requirement**, while the Department of Science and Technology would take charge of a **Systems Concept Study**. If no existing computers were to satisfy this then the they would draw up an **Australian Design Specifications** and arrange for the manufacture of pilot and prototype systems [29].

An Educational User Requirement Working Party was appointed early in 1985, consisting of educators at all levels from around Australia and produced a report [31] outlining the many and varied potential educational needs of computer users in schools, and the need for integration of information technology concepts into the curriculum. In summary, its report highlighted several critical user requirement issues to be taken into consideration by the Educational Technical Requirement working party:

- The needs of various different types of users at both primary and secondary schools.
- The nature of the physical, school and classroom environment.
- The variety of applications.
- A consideration of modularity, expandability, entry cost, user interface, robustness, reliability, portability, compatibility and adoption of current recognised standards.

The Technical Requirements Working Party was set up later in 1985 as an 'expert' committee with membership reflecting the range of relevant groups and interests from each Australian educational sector, state and territory[6]. Its report was published in March 1986 and contained two main sections [32]:

- A Technical Requirement, which gave detailed coverage to: user interface, input devices, output devices, processing resources, networks, telecommunications and system requirements.

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[6] Arthur Tatnall was a member of this committee.

- A section dealing with possible implementations of these requirements to satisfy at least three envisaged types of use: Personal Systems, Classroom Systems and School Network Systems.

The next steps should have been setting up a System Concept Study to be followed by a Development Proposal, but at this stage the project stopped [23, 30]. The three year Government initiative for the National Computer Education Project was at an end and so was its funding. Further development funds from the Department of Science and Technology were not made available and so work on the Australian Educational Computer ceased [33]. Although this was disappointing at the time, in the light of later developments it was perhaps a relief not to have created a white elephant like the ICON in Canada, as within a few years the Apple Macintosh and MS-DOS (- later Windows) PC had become dominant.

Conclusion

Any study of these matters needs to be a socio-technical one and actor-network theory is thus a useful way to frame this.

The initial idea for building CSIR Mk1 came from a need to provide the computing power for calculations related to research work in radio-astronomy and rain-physics, and the Commonwealth Government's goal of assisting Australian agriculture by cloud seeding to produce rain. The problematisation [4] proposed was thus to find a means to assist with the huge number of complex calculations required for these purposes. The actors that contributed to the conception, design and construction of CSIRAC included: Pearcey, Beard, radar technology, the Australian radio industry, radio-physics, rain-physics, the Commonwealth Government, Australian agriculture and the CSIRO [23]. The mobilisation [4] resulting from this led to the subsequent building in Australia of several other first generation computers: SILLIAC at Sydney University, UTECOM at the University of NSW and WREDAC at the Weapons Research Establishment. With SILLIAC, UTECOM and WREDAC a variety of human actors, governments, universities, overseas computer companies, technologies and applications were involved. Understanding the development and use of these computers needs an understanding of the interactions of all these actors.

When CSIRAC's useful life at CSIRO and universities came to an end, new actors began to enter the picture with its final translation involving display in Museum Victoria. With another set of human actors and a new physical location CSIRAC took on a new role as a means of showing school children and the public Australia's first computer, how it worked and also how much computers have changed over the 70 year lifespan of the stored-program electronic digital computer.

Development of the Microbee required advent of the microprocessor, Microbee's human designers, absence of any dominating microcomputer competitors at the time and the desire by many homes and schools to have their own low price computers.

The project to build the Australian Educational Computer involved the Commonwealth Government, State and Territory Governments, Commonwealth Schools Commission, Department of Science and Technology, other State and Commonwealth education authorities, committee members, reports, specifications documents, the computer industry and changes in funding priorities. Various interactions between these actors led to the development of the specifications for this computer, but not to its construction [30]. Getting a technological innovation adopted, or in this case even manufactured, involves convincing people of its value, of interessement. Convincing people was almost impossible in this case as outside the committees and the government very few people knew about it. Perhaps this was a factor in its demise.

In considering the history of the design of early computers in Australia it is necessary to look at the purpose for which they were built, the people involved, current culture and not just characteristics of the technology itself. This involves understanding both the human and non-human elements of these historical developments.

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