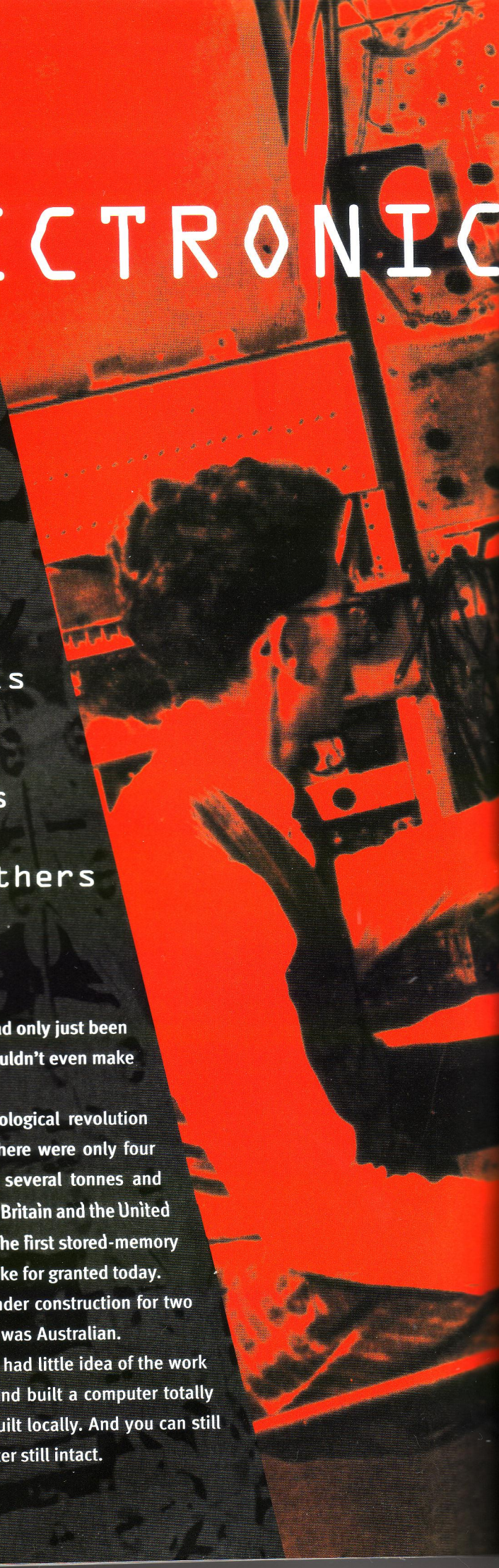
THE ELECTRONIC

by Wilson da Silva

It was one of the world's very first computers and a marvel of its time, but for decades it remained a forgotten relic. Now this little-known piece of world computing history has been restored and is recognised for what it is – one of the grandfathers of modern computers.



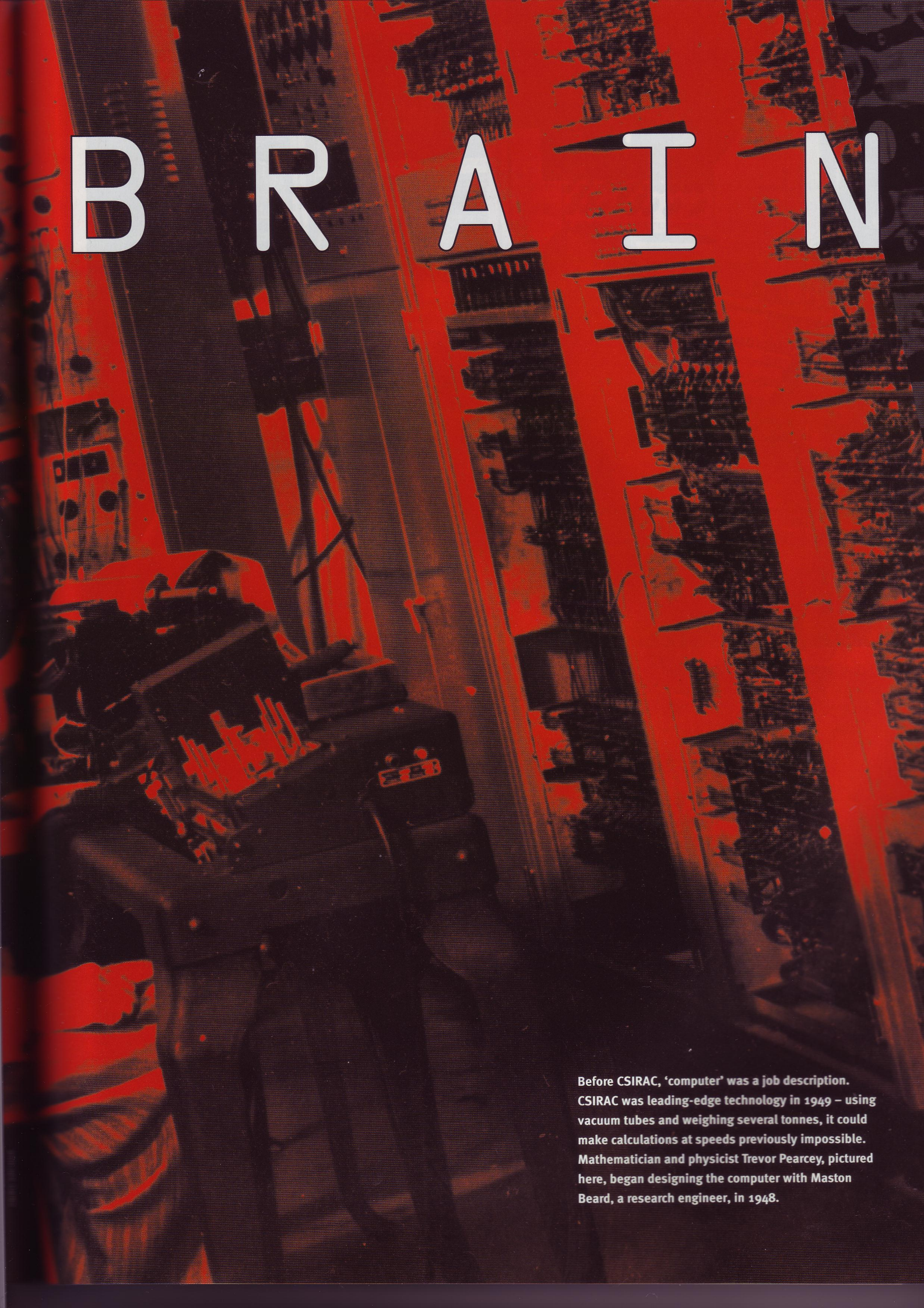
The world was a different place in 1949: vinyl LP records had only just been invented, there was no television in Australia, and you couldn't even make an international phone call.

But behind the scenes, the beginning of a powerful technological revolution was under way. It was the dawn of the computer age, when there were only four computers in the world; large, lumbering machines weighing several tonnes and packed with vacuum tubes and miles of copper wiring. Created in Britain and the United States and only switched on less than a year before, they were the first stored-memory electronic computers – the ancestors of the desktop boxes we take for granted today.

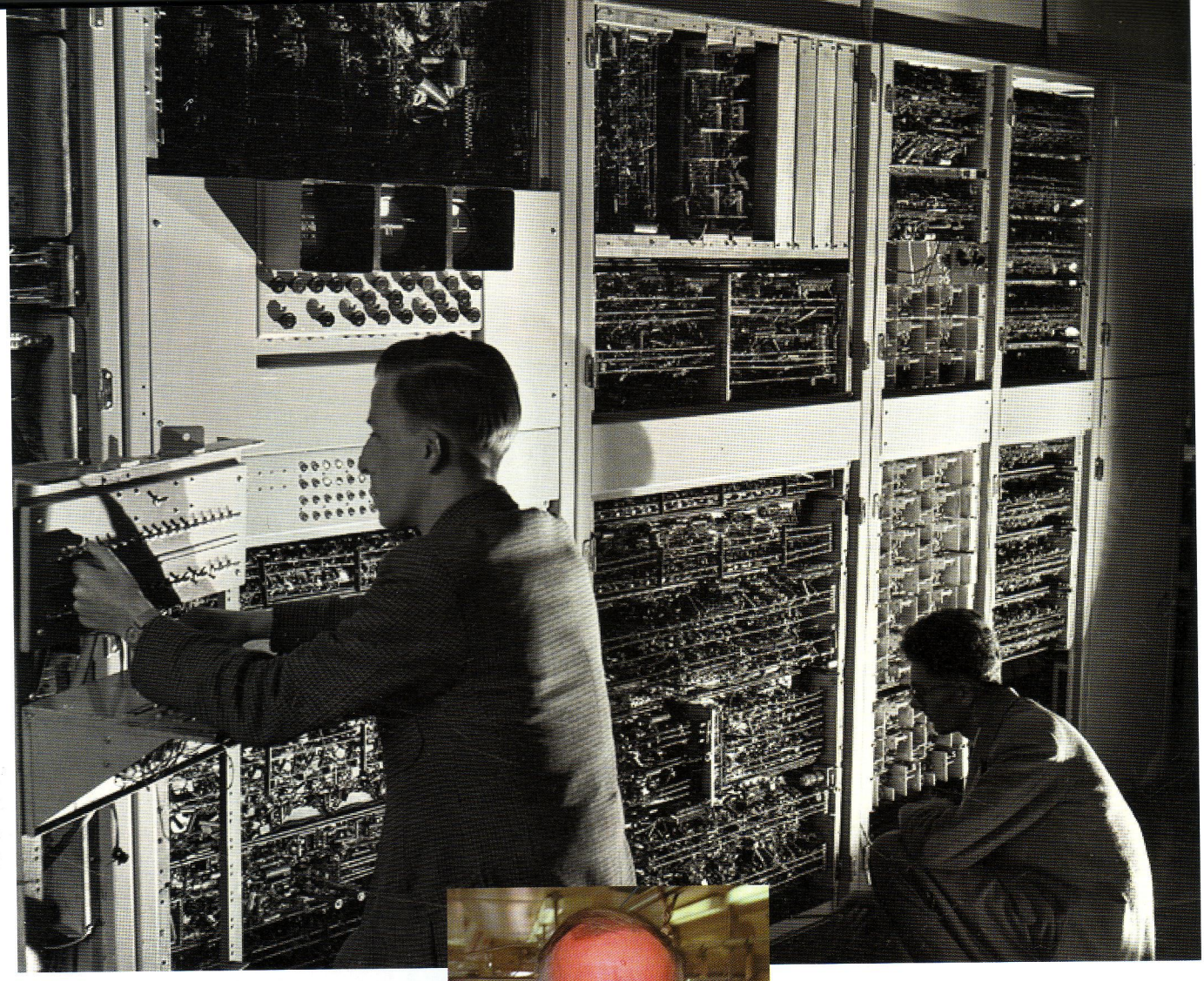
In November 1949, the fifth of these electronic marvels – under construction for two years – finally ran its first program. Its name was CSIRAC. And it was Australian.

What's amazing about CSIRAC is that the people who built it had little idea of the work going on elsewhere in the world. They conceived, developed and built a computer totally independently. All of the parts, hardware and software, were built locally. And you can still see it today, because CSIRAC is the only first-generation computer still intact.

BRAIN



Before CSIRAC, 'computer' was a job description. CSIRAC was leading-edge technology in 1949 – using vacuum tubes and weighing several tonnes, it could make calculations at speeds previously impossible. Mathematician and physicist Trevor Pearcey, pictured here, began designing the computer with Maston Beard, a research engineer, in 1948.



THE AGE

Above, from left: **Geoff Hill and Trevor Pearcey with CSIRAC in 1952.** ***Left:*** **Peter Thorne, now head of computing science at the University of Melbourne, recalls using CSIRAC in the '60s.**

CSIRAC's remarkable story began in Sydney in 1947, at the Radiophysics Laboratory of the CSIR (or the Council for Scientific and Industrial Research, the forerunner of today's CSIRO). The laboratory, in those days based at the University of Sydney, had been looking at new means of carrying out large-scale mathematical calculations using electronic components and equipment developed for use in World War II. Converting radar from its wartime application to everyday civilian use required a level of electronic sophistication and complex calculation that was too laborious to do by hand. Even the mechanical calculators used at the time were too slow. So engineers began to build large-scale electronic calculators that could be pre-programmed to handle large computational tasks.

So began the grand endeavour to build a massive electronic calculator. Maston Beard, a research engineer at the laboratory, teamed with Trevor Pearcey, a physicist and mathematician who had worked in Britain for many years on the development of shortwave and microwave radar. During 1946, Pearcey began to design a large electronic computation device with a stored memory, something he described as an 'Automatic Computor'. Each circuit, each switch, each connection was painstakingly hand-drawn by pencil on large-format plans that later became the machine's blueprints – reams and reams of them. Finally, in early 1948, construction began, with Beard in charge of engineering and Pearcey the design.

The moment of truth came in November 1949, when the first test program was run: a long multiplication routine. It worked. The finished computer was able to operate more than 1000 times faster than the best mechanical calculators. It was a marvel of its day. The engineers called their metal creation the CSIR Mark 1 (which was later renamed CSIRAC, for 'CSIR Automatic Computer'). When fired up, it covered 40 square metres of floorspace, weighed two tonnes and consumed 30 kilowatts of power.

"We knew we were in at the beginning of something wonderful," recalls Professor Peter Thorne, one of the young engineers who worked on CSIRAC before it was retired in the 1960s. "The scale of the machine was impressive. It had a noise and a buzz about it – it even had a special smell about it. CSIRAC used a lot of power, and that meant that the computer room was always warm, even in winter."

Before CSIRAC, a 'computer' was really a job description – someone who would sit for hours tapping figures into a mechanical calculator. Complex calculations, such as those needed for the emerging field of radioastronomy, had first to be broken down into many smaller calculations and distributed to individual 'computor assistants', row after row of maths graduates

(mostly women) who would sit in front of calculating machines tapping keys, often for hours or days. "CSIRAC was 1000 times faster than that, so it was really like a 'super computor' in its day," recalls Thorne.

By today's standards, CSIRAC was a weakling. Its main memory, what we would call today its RAM (random access memory), was just 2k, or a paltry 2000 bytes. Its long-term data storage – what we might call today its 'hard disk' – held just 5000 bytes. And its clock speed, or speed at which it conducted calculations, was just 0.001 megahertz.

Nevertheless, CSIRAC was a wonder of the age. Twenty years before computer monitors were invented, CSIRAC was using cathode-ray tubes – mini television terminals – to display the internal workings of the machine. It had neither mouse nor floppy disks: instructions were written on punched paper tape, and then fed into the computer via a little feeder wheel. A photoelectric detector would read each line of 12 holes on the spool of paper tape, row by row. An operator would sit behind a ponderous grey metal console covered with toggles, switches and meters and lights.

Once the hour-long testing procedure had been completed, and the paper 'software' loaded, CSIRAC would fire up with the flick of a series of switches. Its row after row of grey metal cabinets covered with dials and switches and gauges would come alive. Coloured lights dotted in rows along its panels would blink on and off as it processed its task. Inside the cabinets, a jumble of thick wiring, mercury switches and vacuum tubes would do their job. When it was fully operational, CSIRAC had 2000 vacuum tubes in its innards – the glass-enclosed valves you find inside old radios.

"It is a marvel of engineering," says Thorne, now head of computing science at the University of Melbourne. As an 18-year-old

LADY COMPUTORS

In the early 1940s, Kay McNulty, an American mathematics graduate, was employed along with about 75 other young female mathematicians as a 'computor assistant' at the University of Pennsylvania's Moore School of Engineering. They were responsible for making calculations for tables of artillery and bombing trajectories during World War II.

She recalls computing in 1946: "We did have desk calculators at that time, mechanical and driven with electric motors, that could do simple arithmetic. You'd do a multiplication and when the answer appeared, you had to write it down to re-enter it into the machine for the next calculation. We were preparing a firing table for each gun, with maybe 1800 simple trajectories. To hand-compute just one of these trajectories took 30 or 40 hours of sitting at a desk with paper and a calculator. As you can imagine, they were soon running out of young women to do the calculations. Actually, my title working for the ballistics project was 'computor'. The idea was that I not only did arithmetic, but also made the decision on what to do next."

She was eventually replaced by a first-generation valve computer called ENIAC.

Down through the generations. The woman on the left holds a valved board from ENIAC, the computer that replaced dozens of young female 'computors'. The board on the far right is from BRLESC-1, a second-generation transistorised U.S. army computer from 1961.

U.S. ARMY PHOTO

student in the 1950s, he started his career in electronics tending to the machine on weekends. "It was designed and built in Australia - the transformers, the meters on the panels, everything. It's very probably the most completely Australian-made computer that's ever been!"

It seems hard to believe, but this archaic marvel of 1940s technology nevertheless allowed scientists to tackle problems that had hitherto been considered too difficult or too laborious. Unlike today, computer memory was precious, so the early computing pioneers could not afford to write software with millions of lines of repetitive computer code, as software programmers do today. They whittled down their instructions to the barest minimum, often competing with each other to see who could write the shortest instruction set.

And what achievements: CSIRAC was used to develop designs for the construction of buildings, such as the Reserve Bank Building in Sydney, and ICI House in Nicholson Street, Melbourne, today considered an architectural icon of the 1950s. Early numerical weather forecasting was attempted - although meteorologists soon discovered that a lot more computing power was needed (and still is) for such complex interactions. In their quieter moments, engineers also created computer games, calculated their mortgages and even tried their hand at a little computer music.

This was in 1951 and, as it now turns out, a historic moment. CSIRAC's very first programmers were Geoffrey Hill and its designer, Trevor Pearcey. Hill came from a musical family and had 'perfect pitch', the ability to identify by ear any note and sing a specified musical note at will. It was his musical interest that to led him to wonder if he could program CSIRAC to play a musical melody.

CSIRAC already had a rudimentary speaker, or 'hooter' as it was known, that would warn operators when a task had been completed. To program this very basic instrument to play music required more than a little effort: pulses needed to be sent to the speaker with a regular and predictable period, in order to achieve a steady and continuous tone. This seemingly simple task was complicated by the fact that CSIRAC had delay-line memory, and each memory tube had a different access timing. Along with a 1kHz main frequency and a memory limitation of

COMPUTER CHRONOLOGY

Until now, the difficulty in establishing a definitive history of computers is agreeing on just what a computer is. Many groups claim the title, and there are some early electromechanical calculators that did large-scale calculations as far back as 1941.

However, applying today's definition of a digital computer – an all-electronic machine capable of calculating operations, where the data and instructions are held in rewritable memory – then the chronology of the first computers to go 'live' is this:

June 1948: The Mark I, built at Manchester University in Britain, goes online and runs its first stored program.

May 1949: EDSAC, built at the University of Cambridge in Britain, goes live and runs its first stored program.

August 1949: BINAC, built by the Electronic Control Company of the United States (consisting of ex-University of Pennsylvania engineers), runs its first stored program.

September 1949: The Harvard Mark III, designed and built at Harvard University in the United States, runs its first stored program.

November 1949: CSIRAC, built at the Radiophysics Laboratories of the predecessor to the CSIRO, goes live, running its first program – a long multiplication routine.

Despite its success, CSIRAC was decommissioned after only six years of operation – a victim of the irresistible march of progress that saw the vacuum tube, or valve, replaced by transistors.

CSIRO ARCHIVE

CSIRO ARCHIVE

CSIRAC was used to make calculations for building projects. This image shows a CSIRO Division of Building Research team. There was no keypad – instructions were fed into the machine on punched cards.

CSIRAC and the modern PC

The table below compares CSIRAC to a modern PC

Disk space	5000 bytes	5,000,000,000 bytes
Main memory (RAM)	2000 bytes	128,000,000 bytes
Number of processors	2000 valves	Microchips equivalent to tens of millions of valves
Power rating	30 kW	0.1 kW
Size	40 m^2 floor area	0.2m^2 desk space
Speed	500 operations per second	Up to 300,000,000 operations per second

just 768 words, CSIRAC made the task of playing even the simplest tune extremely difficult. Even so, Hill realised that with a little effort, rudimentary music could still be played.

And so it was. At the computer's first public exhibition on 7 August 1951, during the inaugural Conference of Automatic Computing Machines in Sydney, CSIRAC played 'Colonel Bogey's March', a popular marching tune from World War II. Hill went on to program CSIRAC to perform other musical melodies, mostly from popular songs of the day, including 'Bonnie Banks' and 'The Girl with Flaxen Hair'.

It's only recently been discovered that this light-hearted musical foray made CSIRAC the first computer in the world to play music, according to Paul Doornbusch, a composer at the University of Melbourne who specialises in electronic music and has been researching CSIRAC's past. "The pieces were not as musically inspiring as they might have been if composers had been involved," says Doornbusch. "The achievement was in conceiving of using a computer to make music, and in the ingenuity required to produce reliable sounds. It's difficult to appreciate today just how skilful these people were; only two of the best programmers ever managed to program CSIRAC to play music."

By June 1955, only six years after it first went live, CSIRAC was dismantled. Demand for computational power for scientific research was outstripping its capability. The development of transistors during the 1950s meant that CSIRAC's vacuum-tube architecture would soon be obsolete, and so engineers at the Radiophysics Laboratory began to construct the more powerful SILLIAC, at the University of Sydney. Meanwhile, an American company known for its high-quality electric calculators was starting to sell its first stored-program computer, the IBM 701. Within a few years, it was shipping fully transistorised – or second-generation – computers ... the rest is history.

CSIRAC, still the only computer in Australia, was packed up and moved to the University of Melbourne, where it went live on 14 June 1956 and continued to do valuable work for research and civilian projects. During the eight years it operated at Melbourne, CSIRAC computed some 700 projects. It tackled everyday problems such as insurance risk analysis, calculating government drought-relief programs, simulating the operation of Victoria's power supply, estimating the growth rate of pine trees for forestry, producing solar position and radiation tables for all Australian capital cities – and was even pressed into service to calculate housing loan repayment plans for university staff.

Newspapers of the period lauded CSIRAC as 'The Electronic Brain' and a wonder to behold – although the now-defunct *Melbourne Herald* described the computer's rendition of the university's anthem as "sounding like a refrigerator defrosting in tune". But, it went on to admit, "as Professor Cherry said yesterday, 'This machine plays better music than a Wurlitzer can calculate a mathematical problem ...'."

CSIRAC was decommissioned in November 1964, finally succumbing to the power of the transistor. By then, IBM was already making more than US$1 billion a year selling its mainframe second-generation computers powered by transistors, and computing power was doubling every two years.

It was donated to the Museum of Victoria, and sat in a dusty corner of a Melbourne warehouse for 35 years. In 1999, it was dusted off and restored, and is now the centrepiece of the technology gallery in the new Melbourne Museum.

It's the only first-generation computer still in existence anywhere in the world. A reminder of an era long past, an era when the idea that one day anyone could have their own personal computer would have surely seemed preposterous. ●