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Electronic Brains

In June 1948, in a drab laboratory in the Gothic surroundings of the Victoria University of Manchester, a small team of electronics engineers observed the success of an experiment they had been working on for months. The object of their interest was an untidy mass of electronics that filled the tall, bookcase-like racks lining the walls of the room. At the centre of this bird's nest of cables, radio valves and other components glowed a small, round display screen that allowed a glimpse into the machine's electronic memory, a novel device sitting off to one side hidden in a metal box. This hotchpotch assembly of electronic bits and bobs was officially known as the Small-Scale Experimental Machine (SSEM), but has become better known as the 'Manchester Baby'. It was the world's first electronic stored program computer, a computer that used an electronic memory to store data and the program that instructed it what to do, the basic architecture still used by most computers today.

Baby's creators, Tom Kilburn, Geoffrey Tootill and Freddy Williams, were all electronics engineers seasoned by years of work developing wartime radar systems under great secrecy and urgency. It took them months of methodical work to complete the computer, building, testing and installing each of the computer's units before moving on to the next. 'The very last thing we could contemplate doing was to design the whole thing, and have it all built, and wire it all up, and then find out why it didn't work,' recalls Geoff Tootill. 'We went on with this process of adding the units and making the whole lot do something together at every stage, until we got to the stage when we'd made a computer.'¹ They began testing the machine, and eventually on the morning of 21 June 1948 Kilburn's first program ran successfully. For 52 minutes, binary

digits danced across the display screen as the computer repeatedly divided numbers as it searched for the highest proper factor of 262,144. By lunchtime it had produced a result, 131,072, displayed as a series of dots glowing on the display screen.

It is nice to imagine Baby's creators pausing to think of how their creation could change the world, the green glow of its small display screen marking the dawn of a new age. In fact it was a low-key moment. No photographs were taken at the time and no press conferences were called. Years later Williams would say that 'nothing was ever the same again',² after the machine completed its first run, but it needs hindsight to appreciate this as a great event. As Tootill recalls it, Baby's first run was an understated moment: 'We congratulated each other and we went to lunch together, which we quite often did anyway.' To those there, this was an experiment that had worked, rather than a world-changing event. At the time, Tootill had thought that computers might be useful for complex calculations in weather forecasting or the development of atomic energy, and that 'there would be scope for another one, or perhaps two big computers in the UK, and three or four in Europe, and probably half a dozen in the US, and that was the eventual scope of our invention'.

In this modest way the world's first modern computer came to life, born in a Victorian laboratory amid the post-war shortages and soot of Manchester. For a short time, Baby placed Britain at the very forefront of computing, before well-financed laboratories in the US and elsewhere raced far ahead. Forty years later a very different Britain once again lead the world in computing, as millions of people purchased their first personal computer, and the country boasted the world's highest level of computer ownership. Between a single experimental machine in post-war Britain and the millions of 1980s personal computers was a story of swift technological development and huge changes in the ways that people thought about computers. This book is a history of how computers entered the homes of 1980s Britain, but to appreciate

the nature of this development it helps to have a little historical context of what computers were like in the decades before they became technologies of everyday life.

Computers before stored program computers

Baby was the world's first electronic stored program computer, able to store its instructions and data electronically. It was the first machine to share the basic architecture of the computer on desks today, but it was far from the first big computing machine, to be built. 'Computer' originally referred not to a machine but to a person who did computations. Organisations that needed mathematical problems solved often employed large numbers of human-computers, and many of them had sought ways to improve the speed and accuracy of calculations. One of the earliest to try was the irascible Victorian polymath Charles Babbage, who became frustrated with errors in human-computed mathematical tables, apocryphally declaring, 'I wish to God these calculations had been executed by steam.' Babbage's solution was to begin development of a giant mechanical calculator, the Difference Engine, but unfortunately Babbage fell out with his funders and the engineer contracted to build his machine, so he never completed it.* In any case, He had become preoccupied with schemes for a more sophisticated successor, the Analytical Engine. This would have been much like a modern computer in concept, albeit realised in brass cogs and Industrial Revolution terminology; instead of information passing through memories and processors, Babbage wrote of 'stores' and 'mills'. Babbage died in 1871 with his engines incomplete, and sadly his ideas had little direct influence on the development of computing afterwards.

Two decades later, the American Herman Hollerith was more fortunate in his development of punched card tabulators. Tabulators were not computers as we would understand them

*Although Babbage did not complete his engines, his schemes were validated in 1991 when the Science Museum in London built a working Difference Engine to his plans.

today, but machines for swiftly processing stacks of punched cards. The holes punched in different locations on the cards represented different types of data, which could be read by the tabulator and the results recorded as the cards whisked through the machines at a rate of over a hundred a minute. The tabulators were first used on a large scale in the 1890 US census, processing the data in a single year, whereas with traditional methods the 1880 census took seven years. Hollerith's Tabulating Machine Company eventually merged with other office-equipment firms to form International Business Machines, IBM, in 1924. Following Hollerith's example, other companies were soon building comparable equipment, which proliferated through the statistics and accountancy departments of governments and businesses. As well as the general-purpose tabulators, other machines were built for specialist scientific work, such as the mechanical differential analysers built for several universities and research centres in the 1930s to solve differential equations.

By the end of the Second World War, mechanised information processing had reached new levels of sophistication. Some of these machines were electromechanical, with the logic that did the 'thinking' built of a mix of electronic and mechanical components. Best known today, though ultra-top secret at the time, were the Bombe code-breaking machines of Bletchley Park. Designed principally by mathematicians Alan Turing and Gordon Welchman, and building on earlier work in Poland, the Bombe were invaluable in the deciphering of secret messages encoded by German Enigma machines. Over in the US, the physicist Howard Aiken and IBM developed the Harvard Mark 1, a 50-foot long electromechanical calculator used for a variety of purposes, including calculations for the development of the atom bomb.* In Germany, an engineer named Konrad Zuse had

*Howard Aiken was perhaps the only computing pioneer directly influenced by Charles Babbage, after discovering part of the Difference Engine while scheming a calculating machine of his own in the 1930s.

been building electromechanical and mechanical computing machines since the 1930s. Zuse's Z3 was used in aeronautical research, but with little support from the Nazi government, and with two of his machines destroyed in air raids, his work had little impact on the war. The principle problem with electromechanical computers such as these was speed. The Bombe, for example, had mechanical rotors, which physically rotated as they tested different possible Engima settings. Zuse's machines were mostly built with relays, small switches that flicked on and off as data clicked through the logic. Because their parts had to physically move, electromechanical computers were far slower than purely electronic machines could be.

Electronics in the 1940s did not mean microchips or integrated circuits, but bulky radio valves, each about the size and appearance of a light bulb, and used as the basic building blocks of everything from wireless and radar sets to the logic circuitry for computing machines. The first machine to be entirely electronic was Colossus, another of Bletchley Park's code-breaking machines, designed by Post Office engineer Tommy Flowers to crack the Lorenz code. Capable of faster operations than any machine before, there were ten Colossus machines at work at Bletchley Park by the end of the war. In 1945 most were broken up on the orders of Winston Churchill to preserve their secrets, which did not come to public notice until the 1970s.*

Most technically impressive of all the wartime efforts was the Electronic Numerical Integrator And Computer, or ENIAC. Developed in an American project led by J. Presper Eckert and John Mauchly, ENIAC was a monstrous 30-ton computer built from over 17,000 electronic valves. Initially developed for solving ballistic calculations, it could actually be used for all sorts of different problems, making it the first

*Although their logic circuits were entirely electronic, the Colossus machines relied on punched paper tape to feed data into them. At least two of the machines survived the war and were used in secret at GCHQ until about 1960.