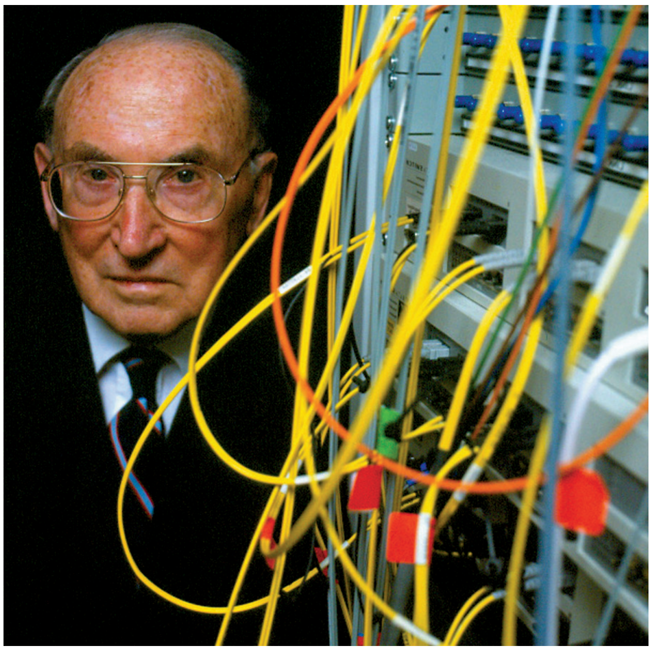
Machine that changed the world

The world's first operational programmable computer went live at Cambridge in 1949. Clive Akass talks to Sir Maurice Wilkes, the former wartime boffin who built it

Even today, if you have a sense of history, you can get a shiver down your spine running the first code of the world's first operational general-purpose computer (see box below). Any novice programmer knows the thrill of getting code to run for the first time. The team who built the Electronic Delay Storage Automatic Calculator (Edsac) at Cambridge University had been doing nothing so simple as tweaking a few lines of code: they had spent more than three years building the computer and learning to program it from scratch. Suddenly, after months of debugging, it worked: a teleprinter began printing out a table of squares. It was 6 May 1949, and you could see it as the beginning of the modern world.

The Edsac kept going for nearly 10 years, but the man responsible for it is still going, rather more strongly than you would expect at the age of 89. Sir Maurice Wilkes drives daily to the Cambridge Computer Laboratory, where he has an office as emeritus professor, and his mind is as agile as ever.



Picture: Jason Bell

Sir Maurice Wilkes ... still going strong at Cambridge Computer Laboratory

There are of course other people and other times with a claim to having given birth to computing. There was the Victorian engineer Charles Babbage, who described and tried to build programmable computing machines a century before the technology had matured enough to make them practical.

But his work had been largely forgotten by 1937, when young Wilkes began work at the Computer Lab, then known as the Mathematical Lab, under Sir John Lennard-Jones, a structural chemist who was interested in using machines to solve differential equations.

A year earlier, Alan Turing had published his classic paper, *On Computable Numbers*, outlining a universal computing machine. But Wilkes recalls: 'It was purely theoretical. There is no hint in that paper of there being any practical applications. No hint whatsoever. I think he [Turing] made that connection afterwards.'

Computing at the lab involved mechanical desk calculators and analogue computers that solved mathematical problems by modelling them mechanically – just as an analogue clock 'computes' the time by modelling the rotation of the earth. There was nothing that is generally thought of as a computer today. 'No-one had thought of digital computers. That was all in the future,' said Wilkes.

So, as it turned out, was his work on computing. Wilkes, who had done his doctorate on radio waves in 1934, became a wartime boffin, pulled from the lab to work on radar even before hostilities started. When he returned to Cambridge after the Second World War, he found himself in charge of the laboratory.

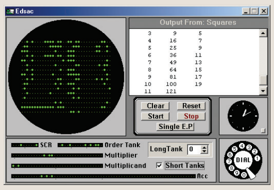
'It was wonderful. I'd had six full years involved in radar and I got away as soon as I could and said to myself: "Let's do something constructive." There was a wonderful feeling of reconstruction in the world. Everyone felt this excitement of establishing peacetime values.'

Considerable steps had been made in computing during the war. A team under mathematician Max Newman built a proto-computer called Colossus at Bletchley in 1943 to help decrypt signals; Turing, of course, also worked there. Colossus could perform logical operations but no arithmetic, and the fact that Britain insisted on keeping it secret for 30 years limited its influence.

Much more important to Wilkes was the 18,000-valve Electronic Numerical Integrator and Automatic Computer (Eniac) completed in 1945 in the US by a team led by Presper Eckert and John Mauchly, initially to perform artillery calculations. It was decimal rather than binary, it was very cumbersome to program, and the processor was not separated from the memory. But a lot of lessons were learned building it.

Out of the blue in 1946 Wilkes got an invitation to attend a series of lectures at Philadelphia's Moore School involving the Eniac team leaders. 'It was very difficult to cross the Atlantic at the time. Shipping was very scarce. But I did get there for the latter part of the course and I got the whole story – all these new

How you can replay IT history



Programs with the Edsac emulator on this month's cover disc show how fast computing developed even in its early days. Note the folder to which it unpacks from the disc and be sure to switch on your sound to catch the buzz of the teleprinter.

Start the emulator and click the Edsac menu to ensure 'Initial Orders 1' is selected. Go to the File menu and open Squares.txt from the Demonstration Programs subfolder in the Edsac folder.

A text box will appear giving the program listing. Press the Start button and the squares will appear.

OXO.txt, which we believe to be the world's first computer game, is in the same folder. It dates from 1952 – so within the space of three years the interface had become interactive and the computer could beat humans at their own game.

There's a lot more about Edsac in the folder – all comes courtesy of Dr Martin Cambell-Kelly of Warwick University. His site is at www.dcs.warwick.ac.uk/people/academic/Martin.Campbell-Kelly.

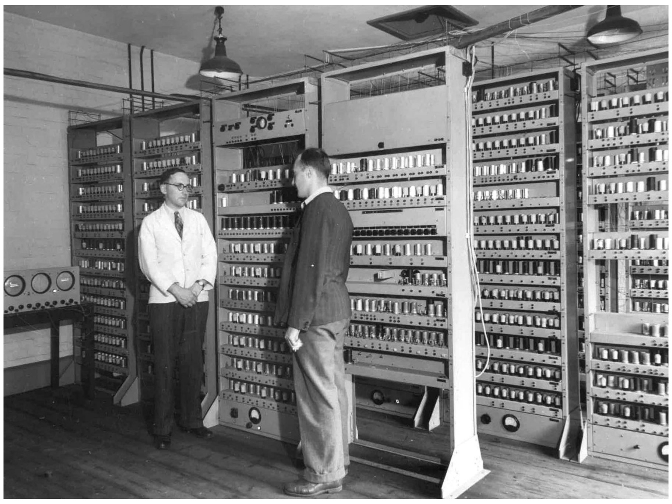
ideas. As far as I am concerned that is where they all came from,' Wilkes said.

'They were quite revolutionary. The idea that everything could be contained in memory: numbers, any mathematical tables that you needed, and indeed the program itself. All contained in one big memory. No setting up the machine. You walked up to it, you fed your program in, and then you were in business. You didn't have to set a lot of switches, or knobs, or things of that sort. In fact it was the idea of the modern computer.'

In contrast to the secrecy surrounding Colossus there was a 'very free exchange of information'. Wilkes recalled: 'I came back from that course feeling that I knew everything there was to know. Some of the people on the course, and some others, set about building computers. The Edsac was one of these [projects].'

A major technical problem was how to implement fast memory. At Manchester University, FC Williams and Tom Kilburn solved the problem by using a cathode ray tube (see Kilburn interview on our website). Their 'Baby' was working before Edsac but it was a short-lived pilot project; Wilkes had to build a computer that could be used in earnest. At Eckert's suggestion he used magnetic delay lines as memory (see box below).

Building a computer was a 'very large-scale engineering problem' requiring unprecedented build and component quality. 'There was a period of some months when all the hardware was there and we were making it work. We had to make modifications where we had not matched up to these high standards. You see in a computing machine the numbers change very rapidly and when a change takes place you mustn't lose any pulses and you can't have any intrusive pulses.'



Wilkes (left) with the Edsac. Its three monitors are visible on the left

How did he feel when it finally worked? 'We all made a beeline for the pub and celebrated.'

Success for Wilkes meant moving to a second phase. 'The Edsac project was two things. It was to build a computer that was workmanlike – not necessarily the best that might with more time be done with the technology of the day – so that we could get on with running some problems and getting experience of its use... we began to turn our attention to the development of what is now calling programming methodology.'

Wilkes is self-effacing about the fact that his team beat the Americans in building the first stored-program computer to go into service. There was not a race, he said. Or if there was, it was one in which the competitors each had a different winning post. 'Eckert and Mauchly, the Eniac engineers, set up a company to produce a computer they could sell for business purposes. Clearly, they had to achieve a higher degree of technical perfection than ours. We cut a lot of corners to get things going.'

There was a sense among all people working in the field at the time that computing would have 'very, very wide applications'. But, with early machines breaking down several times a day, what was not foreseen was that computers would get reliable, Wilkes said. Valves 'weren't particularly unreliable' but resistors tended to drift in value and soldered joints would give a lot of trouble.

'Of all the advantages of integrated circuits – low cost, high speed and all that – the most important thing it seems to me is reliability. The idea that you can have a computer of your own and that it will work for months or years without going wrong.'

The press got hold of the Edsac story and had a field day, with much talk of a 'mechanical brain' – which was curious, considering that mechanical computers were precisely what electronic ones were superseding. Also curious was the fact that Alan Turing, the only UK computer pioneer of the time to be famous today, was unknown outside academic circles. Wilkes, who was the same age as Turing and went up to Cambridge with him in the same year, recalled: 'I liked him. He was a quiet man who kept himself to himself.'

But he said Turing's post-war work at the National Physical Laboratory, and later at Manchester University, met little success in practical terms. 'He wasn't a man of action. He didn't know how to get a project going. I don't think he was very interested in the user side of a computer. He was more interested in ideas... His record of achievement is really very slight.'

The old way... Wilkes (right) and colleagues in the 1930s with a mechanical analogue computer that was designed to solve differential equations. Analogue computers can also be electrical and may still be used for some purposes

Wilkes headed the Computer Lab until 1980, and the spent five and a half years with Digital Equipment in Massachusetts before returning to Cambridge.

'The extraordinary thing is that progress was enormously fast in those first 10 to 15 years and in the last 15 years it has been as fast or even faster. People were always saying that the computer field will settle down and it will become like the motor car industry or something. But it hasn't. It has retained its excitement.'

● Sir Maurice Wilkes' 1985 book *Memoirs of a Computer Pioneer* (MIT Press ISBN 0-262231-22-0) is still in print and costs £23.50 from John Wiley distribution (01243 779 777).

Mercurial memory down the tube

Sir Maurice Wilkes in Edsac days with a bank of mercury delay lines. These consisted of a tube of mercury with a quartz crystal at either end; one crystal sent a pulse that was picked up a millisecond later by the other one, which translated it back into an electrical pulse.

This was amplified, cleaned up, and looped back. A train of 500 to 600 pulses could be kept circulating indefinitely, and they could be counted off and read when required.

Each tube was called a tank, to avoid confusion with 'vacuum tubes', and the Edsac had 32, giving a total of some 2KB of memory.