The Michael Hewitt Interview

Tom Kilburn

Baby boom

Tom Kilburn built the Baby, the first digital, stored-program computer. Not the size of your average baby, this sixteen feet long by seven feet high mass of wires is being reconstructed in Manchester. Michael Hewitt meets the proud father.

Tom Kilburn, born in 1921, would like everyone to know that he was educated at Dewsbury Grammar School, Yorkshire, and is "proud of it". More so, indeed, than having read mathematics at Cambridge. However, like a good number of people who come from Yorkshire and are proud of it, he upped and left some time ago. Which is perhaps just as well. If he'd helped develop the world's first digital, stored-program computer in somewhere like Barnsley or Pontefract, the world might have taken it a lot less seriously. Fortunately, he did the deed at my old *alma mater*, the University of Manchester, in 1948.

The beast, which is being reconstructed by the British Computer Conservation Society and ICL, resides in the university's Computer Building on Oxford Road. Sixteen feet long, seven feet high and featuring a ton of diodes, valves, metal racks and lethally bare wires, it looks like something you might end up with if you hired Mr Bean to do your electrics. But if *PCW* had been going in the late forties, this would have been its Editor's Choice. The Small Scale Experimental Machine (SSEM), or "Baby" as it became known, set the standard that others followed.

"It was its ability to store and run programs put in by a user that set the Baby apart from earlier, special-purpose machines like the Colossus or ENIAC," explained Kilburn. "These required mechanical intervention to run programs. For example, you had to change wire connections in the much the same way that operators used to transfer calls on old-fashioned telephone exchanges."

Computers weren't exactly in his blood. Kilburn's first love was in fact pure mathematics, which he studied at Cambridge to MA level. Indeed, but for the intervention of the second world war, the two of them might have consummated the relationship. Instead, however, Kilburn was drafted as a science officer and propelled to the Telecommunications Research Establishment, then based in Malvern, to work on some flash-in-the-pan project called RADAR. It was here, in 1942, that he met his future mentor, Freddie Williams, who was then heading a group of circuit designers.

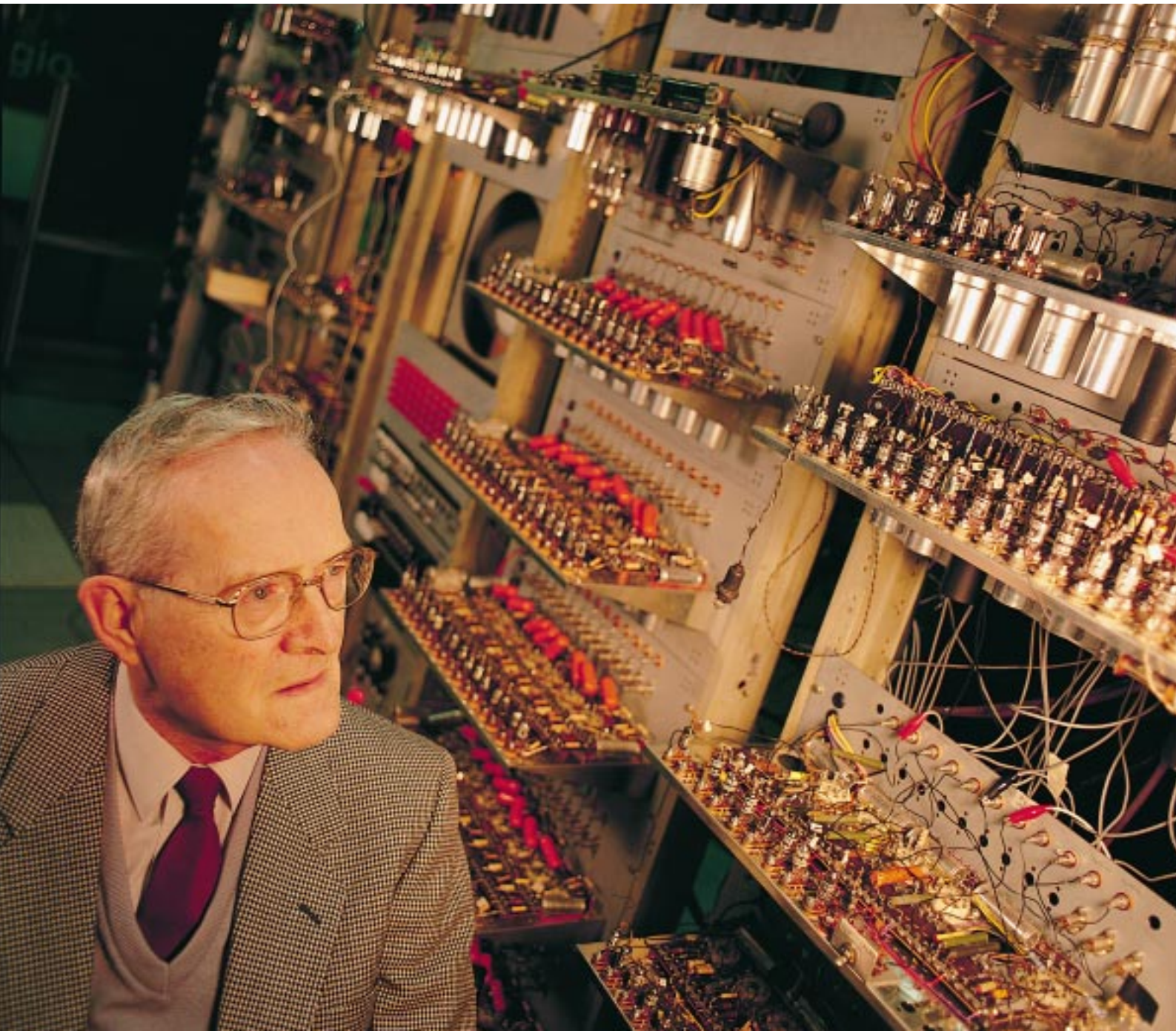
"I was something of a disappointment to him at first. He was expecting a well-qualified electrical engineer, but I was just a mathematician. I didn't know anything. But because our group was so small and because there were so many technical problems to overcome, I was thrown in at the deep end. It didn't take me long to become a reasonable circuit designer, though. I found I actually preferred this hands-on work to the theoretical mathematics I'd been doing before. And, of course, because RADAR was essential to the war effort, you had the feeling you were doing something really useful."

Exit Mussolini, Hitler and Hirohito stage left. Now fast-forward four years to 1946. Thanks partly to his work at Malvern, Freddie Williams had become the best-known electronics circuit engineer in the world and was appointed professor at Manchester University. As such, he was invited to do regular turns at international electronics circuit engineer bashes. At one of these, in the USA, he came across an experiment aimed at storing analogue data using a cathode ray tube. Williams reckoned it was interesting enough to duplicate back at Malvern. He did so, but advanced the experiment somewhat to the stage where he was able to store a single digit, not in analogue but in binary form, as a charged area on the CRT's screen.

Although it worked, no-one understood quite how. More research was therefore required. It was this stage, round about Christmas of 1946, that the whole project was transferred to Williams' department at Manchester University. Tom Kilburn went with it. Still nominally a serving science officer, he was given the authority to requisition as much kit as he liked and kick as many butts as necessary to get everything up and running.

But to get *what* up and running, exactly? The thing they'd created thus far, while it looked moderately impressive and merited write-ups in technical journals, was still basically just a storage device. It was one project among many that were currently ongoing. Then various lightbulbs started illuminating above various heads: what would happen, these heads asked themselves, if you married this new-fangled CRT storage technology with that of an existing valve-based computing machine? Might you not end up with a machine that could be programmed much, much faster than, say, a Colossus or an ENIAC, and which would therefore be far more practical for multiple computing applications?

PHOTOGRAPH by Mark Rayner



Tom Kilburn among the myriad valves and switches that went to make his Baby. Now retired, his interest in computers has not extended to the rampant web-mania of today

"The only way to find out was to try," said Kilburn.

It was far from a one-horse race. Several groups, both in the UK and the USA, were also trying to build a digital computer. They included researchers at Cambridge University, Welwyn Garden City, and, perhaps the best-known name, Alan Turing at the National Physical Laboratories. Kilburn went to one of the NPL's lectures where Turing described how he was getting along. He left unimpressed. "What Turing was saying wasn't of very great interest to me. This wasn't arrogance on my part. It's just that his work wasn't relevant to what we at Manchester were doing. Turing's group was attempting to use mercury delay lines arranged in series as their storage technology. It could take up to 500 milliseconds just to get a single digit out of a mercury delay line, compared to just five microseconds from a cathode ray tube. So, because it had to be built around a somewhat less efficient storage device, his proposed design of computing machine was totally different to ours."

Over a period of six months, Freddie Williams' CRT storage device was augmented with supplementary store, control and arithmetical units. A high-voltage power supply was laid in. Valves and diodes were ordered by the skip-load. Joints were soldered, screws screwed, and plugs plugged in. Then, finally, before an expectant audience, the machine was turned on. It was not quite the unqualified success they'd all hoped for — at first, anyway. To quote the late Freddie Williams: "A program was laboriously inserted and the start switch pressed. Immediately, the spots on the display tube

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entered a mad dance. In early trials it was a dance of death leading to no useful result and, even worse, without yielding any clue as to what was wrong."

One problem was that "noise" from all the valves was causing interference in the CRT storage device. As was some idiot on an unsupressed motorcycle who insisted on riding up the road at the back whenever the machine was turned on. In the good old days back at Malvern, Kilburn could probably have ordered an NCO to go outside and take him out with a high-powered rifle. But in the late forties, with a new people-friendly Labour government in power, this might have been frowned upon. Instead, Kilburn and his team had to put heavy metal shields round the CRT units to protect them. This, together with a certain amount of taking things apart and putting them back together again, eventually did the trick.

On 21st June, 1948: "I'd drawn up a 17-instruction program on a sheet of paper that was intended to find a number's highest factor. It all fitted into a 32 x 32 array, which was the capacity of the CRT. Then I entered this program into the machine via the keyboard. It was a fairly lengthy procedure that took about ten minutes. When I'd finished, I flicked a switch and waited. Suddenly, there on the screen, was the correct answer. It had worked. We all cheered like mad."

But the machine, although it had worked to spec, was "horribly unreliable". If you got an hour's work out of it without a valve blowing or a lab assistant electrocuting himself, it was a good day. But this was history in the making. "There was great excitement," said Kilburn. "Bear in mind that existing mechanical calculating machines could process, at a maximum, maybe one instruction every two seconds. Ours could process a thousand a second. So it was a thousand times more powerful than anything else around at the time."

By today's standards, the Baby is slow and bulky. To give you a for-instance: it's 15 million times less powerful than the latest ICL Trimetra computer, which is itself a distant grandchild of the Baby. Something of similar processing power and memory of the Baby would now fit on to a silicon chip the size of a pinhead. That said, in 50 years' time, our own super-fast Pentiums will doubtless provide a similar source of mirth. Such is progress.

Competition: write a program for the SSEM

To celebrate the 50th anniversary of the Baby, ICL and the British Computer Conservation Society are running a competition where programmers, both experts and novices, are invited to write a software program for the SSEM. Entries must be in by 31st March 1998. A panel chaired by Tom Kilburn will judge the entries. The winner will be invited to run his or her program on the SSEM when it goes live on 21st June. Information on how to program the SSEM, the competition rules, and a simulator written by the University of Manchester, can be downloaded to a Windows-equipped PC from www.cs.man.ac.uk/prog98/

Anyhow, news of the Baby's success travelled fast. American engineers, familiar with much of Williams' work, immediately christened the Williams and Kilburn CRT store the "Williams Tube". This terminology soon became the generic term for the invention. In 1951, Ferranti rebuilt the Baby as the Ferranti Mark I commercial computer. In the States, the CRT store formed the basis of the first IBM computers, the 701 and 702, in 1953. Indeed, the technology was still going strong into the early sixties, before eventually being superseded by the invention of magnetic core storage and, of course, transistors.

"I count transistors as being one of the most significant developments during my time with computers. But of much more lasting importance than that was the invention of the index register, just two weeks after the Baby first performed to order. This allowed you to have subroutines in programs. And from this stemmed the concept of virtual memory, a term which first came to use, again in Manchester, with the creation of a machine called the Atlas. I believe virtual memory will exist as long as computers exist."

In 1948, Kilburn was awarded a PhD for his work on the CRT store. In 1953, Manchester University awarded him a Doctor of Science degree. He stayed on as lecturer in the Electrical Engineering Department, before going on to found the Computer Science Department, of which he became the first professor. This department went on to design many machine architectures which have had their own impact on the development of computing. Tom Kilburn retired in 1981, but he still pops in to see how things are going and to keep his hand in. But perhaps curiously, he isn't particularly interested in modern computer offshoots such as the internet. How come?

"My interest in technology has always been in looking at ways to make it more efficient. When we finished the Mark 1, for example, I could, I suppose, have just spent the next few years writing programs for it. However, I saw that there was a lot of scope for improvement. So I set about building a machine called the Mercury, which was 30 times more powerful than the Mark 1. And having built the Mercury, I could then see how I could build a machine 80 times more powerful even than that. All my life, I've concentrated on thinking about how things could be improved. The present stopping point is the internet. If I were young again, I wouldn't be wasting my time netsurfing. I'd be trying to imagine what was coming after the internet, and planning for it."

After his work in RADAR, his associations with Freddie Williams and his contribution to computing milestones, when Kilburn sees these pimply youths playing Tomb Raider and downloading naughty gifs, does he wonder why he bothered? He smiled and shook his head. "It's a different world," he said. "Every man to his own.. every man to his own." ■