



## The Manchester 'Baby' Milestone

IEEE MILESTONE

Manchester University "Baby" Computer and its Derivatives, 1948-1951

At this site on 21 June 1948 the "Baby" became the first computer to execute a program stored in addressable read-write electronic memory. "Baby" validated Williams-Kilburn Tube random-access memories, later widely used, and led to the 1949 Manchester Mark I which pioneered index registers. In February 1951, Ferranti Ltd's commercial derivative became the first electronic computer marketed as a standard product delivered to a customer.

June 2022

In 1946 F.C. (Freddie) Williams and Tom Kilburn started researching a novel computer memory system based on electrostatic charge storage. By the autumn of 1947 they had successfully demonstrated their random-access memory system – later called Williams-Kilburn Tubes. But was their system robust enough for sustained use in a high-speed computer? The only way to prove this was to build a computer using Williams-Kilburn Tubes and to run programs on it.

The proof was the Baby, a small-scale experimental computer that first ran a program in the Department of Electrical Engineering at Manchester University on 21st June 1948. Its historical importance was twofold: it contained the





Manchester Mark I 1949



first cost-effective random-access memory system and it demonstrated for the first time a stored program running on a general-purpose computer.

The Baby computer was of immediate interest to the mathematicians at Manchester University. Williams' engineering team added to the Baby's facilities so that, by April 1949, the mathematicians could use the enlarged computer, now known as the Manchester Mark I, for more ambitious mathematical investigations. Amongst its new facilities, the Manchester Mark I introduced modifier, or index, registers – a feature seen on practically all modern computers.



Under a contract from the Ministry of Supply (forerunner of the MOD) the Manchester company Ferranti Ltd produced a re-engineered production version of the university's computer called the Ferranti Mark I, which was sold on the open market. The first Ferranti Mark I was delivered to the University of Manchester in February 1951. One more Ferranti Mark I and seven Ferranti Mark I\* computers were delivered, three of them being shipped abroad (to Canada, Holland and Italy).

#### **IEEE HISTORY MILESTONES**

# Manchester Computers

### Tuesday 21 June 2022

Science and Industry Museum Liverpool Road, Manchester M3 4FP

10.30 & 11.15 am Replica 'Baby' demonstrations

Kilburn Building, University of Manchester Oxford Road, Manchester M13 9PL

## 2.00 pm

Welcome and introduction Jim Miles, University of Manchester Steve Welby, IEEE COO José M.F. Moura, IEEE Former President Brian Berg, IEEE History Committee Richard Jones, University of Manchester, VP for Regional Innovation and Civic Engagement

2.40 pm Unveiling of the plaques

2.50 pm Refreshments

**3.20 pm Technical seminar** Simon Lavington: *The Manchest* 

Simon Lavington: *The Manchester 'Baby' and its derivatives* Roland Ibbett: *Atlas* Peter Denning: *Virtual memory today* Steve Furber: *Current computer science research at Manchester* 

#### 4.40 pm

Closing remarks Izzet Kale, *Chair, IEEE UK & Ireland Section* Roderick Muttram, *Meeting chair, IEEE UK & Ireland Section* 

5.00 pm Reception



# The Manchester Atlas Milestone

#### IEEE MILESTONE

Atlas Computer and the Invention of Virtual Memory, 1957-1962

The Atlas computer was designed and built in this building by Tom Kilburn and a joint team of the University of Manchester and Ferranti Ltd. The most significant new feature of Atlas was the invention of virtual memory, allowing memories of different speeds and capacities to act as a single large fast memory separately available to multiple users. Virtual memory became a standard feature of general-purpose computers.



The Atlas project, led by Tom Kilburn, was a joint venture between the University of Manchester and Ferranti Ltd. Atlas incorporated many novel features that together made it the most powerful computer in the world: asynchronous pipelined operation, a high-speed parallel arithmetic unit, extracodes, interleaved main core store, simultaneous operation of many types of input/output device and, most significantly, virtual memory. The whole system ran under the control of the Atlas Supervisor, the first multi-tasking, multi-user operating system. The first production version of Atlas was officially inaugurated at the University of Manchester in December 1962.

The Supervisor and virtual memory enabled Atlas to switch rapidly to a different program whenever the current program was held up, e.g. by an input/output transfer. Several programs could be co-resident in the store but none of them could be allowed to know which physical store locations were available to them rather than to others. This fundamental concept underpins much of modern computer security. Originally called 'One-level Storage', the Atlas virtual memory also provided each user with a very large virtual memory space without the need to know how or where the program would be located in physical memory.

When a program required a new word from memory, if it was

in the core store it was accessed immediately. If it wasn't, the Supervisor determined the location of the required page in the drum store, transferred it from the drum into an empty page in the core store and created a new empty page by transferring an old page back to the drum.

To make the whole system run as fast as possible it was necessary to choose the page of the core store least likely to be required again, for which a "learning program" in the Supervisor was invented. Because transfers of code and data between the small fast core store and the large, slower, magnetic drum were effected by the Supervisor, each user had the illusion of operating in a very large, fast memory.

Virtual memory was soon incorporated into the design of a number of major academic and commercial computers. It has become so commonly used that the only computers today without virtual memory are a few supercomputers, embedded processors and some vintage personal computers.

In all, three Atlas 1 and three smaller Atlas 2 computers were delivered by Ferranti. The largest Atlas 1 was able to run 2,500 jobs in a typical week, thanks to the close integration of its high-speed processor and Supervisor.



Tom Kilburn (right) with Nobel Prize winner (Physics, 1951) and Director of the UK Atomic Energy Authority Sir John Cockcroft (seated) and Sebastian de Ferranti, Chairman of Ferranti Ltd, at the inauguration of the Manchester Atlas, 7 December 1962.

The IEEE History Milestone program has commemorated over 200 notable achievements in electro-technology around the world. Sixteen of these are located in various parts of the United Kingdom and Ireland, including Bletchley Park (Code breaking), Cornwall (Transatlantic radio signals) and Glasgow (Standardisation of the Ohm).

The Milestone program is organised by the IEEE History Center, based at the IEEE Operations Center in Piscataway, New Jersey. Nominations for the award of a Milestone plaque are reviewed for approval by the IEEE History Committee. The subject of the nomination must relate to work done at least 25 years ago. Further Details about the program and a full list of Milestones can be found on the IEEE History Centre website at:

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#### ethw.org/Milestones:IEEE\_Milestones\_Program

More details about the Milestones being unveiled in Manchester today can be found at:



#### ethw.org/Milestones:

**Small Scale Experimental Machine** 



ethw.org/Milestones: Atlas Computer

The unveiling ceremony and technical symposium are being sponsored by the Committee of the UK & Ireland Life Members Affinity Group (funded by donations from IEEE members to the IEEE Life Member Fund and the IEEE



Foundation), ARM Limited, the University of Manchester Department of Computer Science and the Computer Conservation Society.