EXPANDING THE BABY

Once the Baby had been proven, Williams decided to expand it to a full-sized machine, the Manchester Mark 1. Three research students were added to the team, and the basic design was worked out by the end of October. The original design for the Baby was continually modified and expanded and the metamorphosis into the Mark 1 completed by October the following year. In early October 1948 the Chief Scientist of the Ministry of Supply, Sir Ben Lockspieser paid a surprise visit to see the Baby and was so impressed that by the end of the month he sent a letter to Ferranti Ltd. authorizing them to "construct an electronic calculating machine to the instructions of Professor F.C. Williams". So Ferranti were given a grant of around £130,000 (say £4 million in today's money) to build a commercial version of the Manchester Mark 1, even though its basic design had barely been completed! To Kilburn and his team it mattered very little how the machine looked but in order to sell the machine Ferranti had to turn it into a product, work out how to actually build it and put it in desirable cupboards and boxes. With a computer industry to work within, they had to make it all up as they went along.

In terms of actually building the Baby, much of the soldering and ironwork was done by hand by the two technicians Norman Calcroft and Arthur Gledson. [Dai clips][Tom clips]

To Kilburn …

WHY BUILD THE BABY?

The two designers of the _baby_ Freddie Williams and Tom Kilburn had worked at the Telecommunications Research Establishment in Malvern during the war. Here they had worked mainly on radar which involved using cathode ray tubes as well as what were called pulse techniques which we now call digital electronics.

They both moved to Manchester after the war and around this time they worked out how to use Cathode Ray Tubes to make a digital electronic random access memory. Now such a memory was what was needed to turn an electronic calculator into a fully fledged computer. If a program could be stored in an electronic memory it could be obeyed quickly and changed easily. Would it work? The only way to test the memory was to build a computer. So the baby was built just to test this principal.

So even though the goal of the machine was quite modest it was enormously complicated, and hard work. It must have been very exciting as well, particularly when it actually worked!
The storage system worked

HOW THE BABY WAS BUILT?

The baby was built in a fever of practical creativity. The team of Tom Kilburn Geoff Toothill and two technicians essentially worked alone but recieved vital support from Williams and Kilburn_s old employer the Telecommunications Research Establishment who supplied most of the parts and equipment from war surplus. However there was no actual money. So nothing could be sub-contracted. Air conditioning could not be installed in the 7msq room so it was baking hot over 100 degrees. Parts had to be repurposed from other machines. The reuse of buttons from the cockpit of a spitfire fighter plane is just one example. Circuit diagrams were made as work went along. There was no overall plan so problems were solved as they occured.

As all this work was just a means to an end nothing was kept longer than necessary and in any case up until April 1949 the machine was metamorphosing almost constantly. 21st June 1948 when the computer ran its first program is actual just a moment in the growth of the Baby into a relatively sophisticated and powerful machine.

Could it be said that the Baby only existed on that day, that brief moment?

WHAT ELSE WAS GOING ON IN THE WORLD?

There were about eight other teams working on computers in the late forties some based at Universities such as Cambridge and Princeton and some based in Private companies such as IBM and UNIVAC.

Manchester was relatively uninterested in what was going on elsewhere because they were working on a storage mechanism based on Cathode Ray Tubes that was unique. In fact IBM had worked on the same radar problem as Williams during the war and this may have contributed to their adaoption of CRT store in the 700 series besides CRT store was cheaper and easier to build but was seen as less reliable than other types of memory.

The type of memory dictated the structure of the rest of the computer so Manchester_s machine was very different from the other teams who were mostly using mercury delay lines. These do not give the computer user instant access to any piece of data stored, as the delay line sends a pulse of data down a column of mercury as a sound pulse during which time it cannot be accessed. Both systems required innovative means of refreshing the data in order to keep it held in the store. In the end some projects switched to using Williams' Cathode Ray Tube store (including the U.S. flagship project as IAS under von Neumann).

THE CATHODE RAY TUBE

The Cathode Ray Tube (CRT) was invented by the remarkable German physicist Karl Braun in 1897. As a very useful piece of apparatus it came to be used in all kinds of devices such as oscilloscopes and significantly for our story radar displays.

A Cathode ray tube is a sealed glass cylinder with a cone at one end. The air is removed to create a vacuum. At the narrow end is a piece of metal called a cathode which when negatively charged with electrical current emits a beam of electrons. The vacuum means the beam is not dispersed by air molecules. The beam is focused and directed by positively charged deflection plates. At the other end, the fat bit of the cone, is a thin layer of phosphor. Where the electrons strike the phosphorescent surface it glows forming a screen making the electron bem visible. So these cathode ray tubes work like a TV or modern computer screen in essence but the CRTs used as memory are much simpler than those devices.

An array of bits could be stored on the screen by scanning the screen a row at a time and each time it came to a bit position firing a shorter or longer burst of electrons depending on whether a 0 or a 1 was to be stored there. The 1 would glow brighter then the 0. By placing a wire mesh over the screen it was possible to detect at any position whether it was 0 or a 1. However charge on a CRT fades in few seconds. The key to the CRT store was that they were able to refresh the store on a regular basis. As the scanning beam reached each bit position it was possible to detect whether it was a 0 or 1 in time to fire the correct dose of electrons to restore the appropriate charge.

The Cathode Ray Tube Store differs from an oscilloscope in the presence of a mesh over the screen end, an amplifier, a timing and a feedback circuit that enabled the unit to refresh, ie hold the digit in theory indefinately.

The mesh effectively hides the screen. The fact that data was theoretically visible was a by-product of using CRTs and incidental to its functioning as a store. However it did mean that another CRT could be used as a monitor to look at the stores. The machine could be stopped and all data could be looked at even though it would only appear as zeroes and ones. This practice was called _peeping_ and deemed to be bad practice by mercury delay line users - people from Cambridge - as it slowed the machine down. Originally the only way to output data was by looking at the monitor.

HOW AN EARLY MODERN COMPUTER WORKS

The usual way of describing a computer is by saying that it consists of an input device such as a keyboard which puts data into a store. This data is then manipulated by the _central processing unit_ returned to the store and then outputted to a screen or a printer. This simplicity belies the complexity of actually doing all this and implies that computers should be easy to understand! However we are usually confused not by how a computer works but how it does all the things we now do on it like word processing, drawing and animation. Mercifully the early machines didn't do any of this high level stuff, and so are in a sense easier to grasp.

The store holds a program, a list of instructions, as well as the data to be acted upon. What makes a modern computer different from an old hand calculator [apart from the automatic program!] is that all types of information is stored, not just numbers, and manipulated in all kinds of ways, not just using the basic mathematical operations like add and multiply. However all information still has to be coded in numerical form, e.g. the letters of the alphabet by their position, so E is coded as 5. In turn all numbers are represented in what is called binary notation, not the decimal notation we are used to, using just two basic digits 0 and 1. A binary digit is now called a "bit". This is unpleasant for us to handle, as for example a number with 6 decimal digits translates to a string of 20 binary digits, but it is much easier for the computer.

Users of the Baby had to translate everything into zeroes and ones before putting instructions and numbers into the store. But soon little programs were written so you could input using letters and decimal numbers! [Not true in fact of the Baby, as it ran very few (different) programs.]

The store of a computer can be imagined as a series of pigeon holes, referred to as [locations], each containing a number as a string of bits, called a [word]. Each [location] is designated a unique numerical [address].

There now follows Dr. Brian Napper's corrections to this script

Why Build the Baby
Para. 2
… they worked out how to use cathode ray tubes to make a digital electronic random access memory. Now such a memory was what was needed to turn an electronic calculator into a fully fledged computer. If a program could be stored in an electronic memory it could be obeyed quickly and changed easily. Would …

Where there two technicians working on the Baby? I got the impression from Tom that very little work was done by technicians – in particular they were hardly allowed to touch the Baby in case they upset the electronics. I guess from your naming of the technicians later that you got this information from Dai, and it refers to the time after Dai came (Sept 1948). I could well imagine that with a larger team, in particular two inexperienced research students (Dai & Tommy Thomas), more use was made of technicians, e.g. soldering as well as ironwork (which is all I heard Tom admit to on the Baby!).

How the Baby was built & Expanding the Baby
This is unnecessarily incorrect. A more accurate story can be told with very little extra complication, and even the addition of some "human interest" – the famous letter to Ferranti of October 28th.

The last two paragraphs of BabyBuild are better associated with BabyExpanding The point is well made about continual metamorphosis – but up to October 1949, as the paper-tape & drums were added after April – less so that the Baby existed for only one day!

Expanding para. 1
Once the Baby had been proven, Williams decided to expand it to a full-sized machine, the Manchester Mark 1. Three research students were added to the team, and the basic design was worked out by the end of October. The Baby was continually modified and expanded and the metamorphosis completed by October the following year. In early October 1948 the Chief Scientist of the Ministry of Supply, Sir Ben Lockspieser paid a surprise visit to see the Baby and was so impressed that by the end of the month he sent a letter to Ferranti Ltd. authorizing them to "construct an electronic calculating machine to the instructions of Professor F.C. Williams". So Ferranti were given a grant of around £130,000 (say 4 million in today's money) to build a commercial version of the Manchester Mark 1, even though its basic design had barely been completed! To Kilburn …

We don't like the use of "invent" in the last sentence. In particular not even Tom would claim to have invented computer science, merely facilitated it. Also note that UNIVAC in the US were building the UNIVAC in parallel with Ferranti. Maybe something like Of course there was no computer industry, so Ferranti had to make up how to build one, just as Williams and Kilburn had to make up their own computer science.

What else …
In general fair enough, but suggest :
Para 3: other teams, who were mostly using mercury delay lines.
… as the delay line sends a bit of data down a column of mercury as a sound pulse, during which time …
and add : In the end some projects switched to using Williams' Cathode Ray Tube store. [Notably the US flagship project at IAS under von Neumann.]

CRT
Possibly expand 3rd para & drop 4th, e.g.
An array of bits could be stored on the screen by scanning the screen a row at a time and each time it came to a bit position firing a shorter or longer burst of electrons depending on whether a 0 or a 1 was to be stored there. The 1 would glow brighter then the 0. By placing a wire mesh over the screen it was possible to detect at any position whether it was 0 or a 1. However charge on a CRT fades in few seconds. The key to the CRT store was that they were able to refresh the store on a regular basis. As the scanning beam reached each bit position it was possible to detect whether it was a 0 or 1 in time to fire the correct dose of electrons to restore the appropriate charge.

How computer works
2nd & 3rd paras.
… What makes a modern computer different from an old hand calculator [apart from the automatic program!] is that all types of information is stored, not just numbers, and manipulated in all kinds of ways, not just using the basic mathematical operations like add and multiply. However all information still has to be coded in numerical form, e.g. the letters of the alphabet by their position, so E is coded as 5. In turn all numbers are represented in what is called binary notation, not the decimal notation we are used to, using just two basic digits 0 and 1. A binary digit is now called a “bit”. This is unpleasant for us to handle, as for example a number with 6 decimal digits translates to a string of 20 binary digits, but it is much easier for the computer.

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