THE MANCHESTER MARK I: THE TURING-RICHARDS ERA

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Alan Turing, born 23rd June 1912 in London, and educated at King's College Cambridge, went to the UK Government's Code and Cypher Unit at Bletchley Park on 4th September 1939,the day after the UK entered the Second World War. There, he was the brains behind the building of the Colossus code-breaking computer which was used to decipher enemy messages. The Unit was so successful, thanks to Turing's genius, that some say it was the deciding factor in helping Britain to win the war. [The Colossus was scrapped at the end of the war but a replica has since been rebuilt by Tony Sale in the original surroundings at Bletchley Park with support from members of the British Computer Society's Computer Conservation Society and is on view to the public].

After the War, Turing went to the UK National Physical Laboratory at Teddington to put into practice his ideas about the design of the "Universal Computer". So began work on the Pilot ACE Computer.

On 29th September 1948, Turing went north to Manchester to join a fellow mathematician, Professor Max Newman, and engineers Professors Freddie Williams and Tom Kilburn in the design of the Manchester mark I Prototype. This combined effort resulted in the invention of a Random Access Store (RAM) and the building of a computer to prove its capabilities. So, on 21st June 1948, the world's first computer program to run in RAM worked. [That machine, the Mark I prototype has since been named "The Baby" and an exact replica has been rebuilt by Chris Burton, again under the auspices of the Computer Conservation Society, and is on view in the Manchester Museum of Science and Industry]. The team at Cambridge, led by Professor Maurice Wilkes, were about to run programs on their delay-line machine in the Autumn of 1948. A description of the Manchester machine was published in Nature in September 1948 in a paper by Williams and Kilburn [1] In June 1998, a big celebration was held in Manchester to commemorate the 50th Anniversary of the 21st June 1948 event.

Having seen the computer working, Alan Turing set to on the second love of his life, Morphogenesis, his first being the Universal Computing Machine. His first paper on this topic was "The Chemical Basis of Morphogenesis" published in 1952[2]. In it he postulated that chemical substances, called morphogenes, could explain the tentacle patterns on the Hydra and whorled leaves. He also suggested that his theory could explain the phenomenon of Phyllotaxis. In that paper he also expressed the idea that the theory would explain the growth in spherical organisms. However he did not exploit these latter ideas until he was joined by Bernard Richards in 1953.

Meanwhile the Mark I Prototype - The Baby - had been replaced by a production version known as the "Ferranti Mark I" in recognition of its creation through the collaboration between the Manchester University Team and the Ferranti brothers at their factory in Manchester. The Ferranti Mark I was the world's first commercially available (ie factory-built) computer. The Ferranti Mark I was delivered to the University in February 1951 and housed in a purpose built Laboratory and performed well during the Inaugural Conference in July 1951 [3]. The specification was (i) A Main Store (RAM) of 256 40-bit words (ie 1280 bytes), (ii) A drum backing store of 3.75k words, (iii) add-time 102 msecs, (iv) multiply time 2.16 msecs. For more details see Lavington's book [4]

Turing was the master-mind behind the first input-operating-system, INPUT SCHEME A, for this machine. Although a later version was produced, INPUT SCHEME B, Turing never used it, preferring to remain with SCHEME A which he knew so well. However, its drawback was that it mandated that all input must be in binary and so numeric data had to be converted from decimal to binary before input. (SCHEME B had a decimal input routine).

Turing had already produced a paper to explain the dappling on cows - which was published by the Royal Society, but he returned to plant life and more theories of phyllotaxis.

In the Turing-Richards collaboration, the theme was to explain the specific growth in the minute sea creature, the species Radiolaria. Turing postulated that the growth of these unicellular organisms was influenced by sea-water (saline) diffusing into a spherical cell and causing growth in preferred directions. Richards took over from the point of the diffusion equation and completely solved the problem. See Thesis [5]. The Turing-Richards Theory explains the growth of “spines” protruding like gigantic flag poles on the surface of the sphere. These occur in 6 spine, 8 spine, 12 spine, and 20 spine versions. The full mathematics is published in the Thesis [5] and in the Saunder’s Book [6].

The thesis [5] describes how the Turing diffusion equation was solved by Richards using the Mark 1 Computer. Solutions involving the Legendre Polynomials were sought using the computer and spherical surface maps were produced to depict each of the solutions. The solutions obtained were those easily mapped on to specimens found by HMS Challenger in its Pacific voyage of the last century. By a suitable choice of scale-factor it was possible to map the computer solution on to the biological specimen and to find that the length of the computer spines matched exactly the lengths of the biological spines. This work of Richards seemed to vindicate the theory of Turing.

There is no doubt that Turing was still producing new ideas and using the computer to test his new theories right up to his tragic death. We had planned a meeting a few days ahead of that date but alas it never transpired. So he will be remembered for four things (i) being a son very much loved by his mother who told me much [7], (ii) being the genius behind the Colossus Computer that helped to win the War, (iii) for his ideas on the Universal Computing Engine, and (iv) for his pioneering work on Morphogenesis. I am glad to have worked with him.

1. Williams F.C., Kilburn T, Electronic Digital Computers. Nature Vol 162 pg 487, Sept 1948
2. Turing A (1952) “The Chemical Basis of Morphogenesis”
3. Philosophical Translations of the Royal Society, London
4. Williams F C and Kilburn T. The University of Manchester Computing Machine: Inagural Conference of the Manchester University Computer, July 1951 (pg 5-11) Manchester University Press 1951
5. Lavington, S (1988). The History of Manchester Computers. 2nd Edition, British Computer Society, Swindon 1998
6. Richards B. “Morphogenesis of Radiolaria” MSc Thesis Manchester University, 1954
7. Saunders P.T. “Morphogenesis”, North Holland, Amsterdam 1992
8. Turing Sara (1959) “Alan Turing” Heffer, Cambridge, 1959