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THE MANCHESTER MARK I: THE TURING-RICHARDS ERA

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1. Introduction

The title of this paper is as given above. The partnership which is the subject of this paper justifies the inclusion of the two pictures. Figures 1 and 2. But, by way of introduction it is appropriate to say something about the pioneers who were responsible for the existence of the Manchester Mark I in the first place.

Fig1: Alan Turing, RIP

Fig2: Alan Turing, RIP

Two of the author's friends were the brains behind the development of the Mark I, namely Professor Freddie Williams and Professor Tom Kilbum. The former is, sadly, now dead, but Tom Kilbum is very much alive and very active. These two were assisted by three further friends, namely Dai Edwards, Alee Robinson, and Tommy Thomas.

Williams and Kilbum used skills they had developed during the War when working on radar to develop a random access memory for a computer. They stored pulses (binary digits) on the face of the cathode ray tube. To prove that the idea worked they had to build a computer to demonstrate their claims. This computer was built and has subsequently been labelled BABY: this was because it eventually became a prototype for the Ferranti Mark I computer. So, to demonstrate the viability of the Random Access Memory (RAM), Kilbum wrote a short program to find the Highest Common Factor. This program successfully ran for the first time on 21st June 1948. It was the world's first program to run in RAM.

Subsequently a full scale version of that Prototype was built by the firm of Ferranti Brothers in Manchester. This became known as the Ferranti Mark I, and the first machine off the production line was purchased by the Royal Society of England and delivered to the University of Manchester in 1951.

In 1998 a replica of the BABY was built to celebrate the 50th Anniversary of that first program running in RAM. It ran again the Kilbum Program on 21st June 1998, in Kilbum's presence.

In parallel with all of the above, Alan Turing went to Manchester.

2. Alan Turing

Alan Turing, was born in London on 23rd June 1912. He was a fascinating genius with many unusual ideas. Alan Turing was a great athlete, often running from his home the ten miles or so to his office in Manchester even in the pouring rain.

In 1931 he entered King's College Cambridge to study Mathematics. Three years later he graduated, and in 1934 he was elected a Fellow of King's College. On 4th September 1939, the day after the outbreak of the Second World War, he reported to the Government's Code and Cypher School at Bletchley Park, north of London. There he was in charge of the work on the German Naval encoding machine, the ENIGMA. To help with the decoding work, he designed a machine called the "Colossus". This machine, which was dependent on punched paper (teleprinter) tape for data storage, played a big role in helping to shorten the War.

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

In 1948, Alan Turing went to Manchester to join the two engineers. Professors Freddie Williams and Professor Tom Kilburn. In Manchester, Alan Turing worked on the Mark I Computer. Firstly he devised a primitive operating system for the input and storage of programs and data. All programs had to be written in binary, and all decimal data had to be converted to binary for input. Having designed that input system, Turing turned his attention to his long-standing interest, namely that of Morphogenesis.

Turing will be remembered for many things but outstanding amongst these will be his work on Computability and on the Turing-machine; his work on the Colossus at Bletchley Park; his own work on Morphogenesis; and his work on the Mark I. One of his most interesting works on Morphogenesis was an explanation for the "dappling" patterns on cows (the brown/white or black/white markings).

3. Turing, Richards, and Morphogenesis

Turing postulated that the "science" of growth (Morphogenesis) obeyed his Equation of Morphogenesis, viz

$$\frac{dU}{dt} = \Phi(\nabla^2)U + GU^2 - HUV,$$

$$V = \overline{U}_2.$$

It was postulated that the minute sea organism, about 1 millimetre in diameter and called Radiolaria, commenced life as a spherical organism and then grew according to the Turing Equation. Richards was given the task of solving that equation.

He solved the equation and produced a set of solutions which corresponded to the actual species of Radiolaria discovered by HMS Challenger in the 19th century. That expedition to the Pacific Ocean found eight variations in the growth patterns. These are shown in the following figures. The essential feature of the growth is the emergence of elongated "spines" protruding from the sphere at regular positions. Thus the species comprised two, six, twelve, and twenty, spine variations.

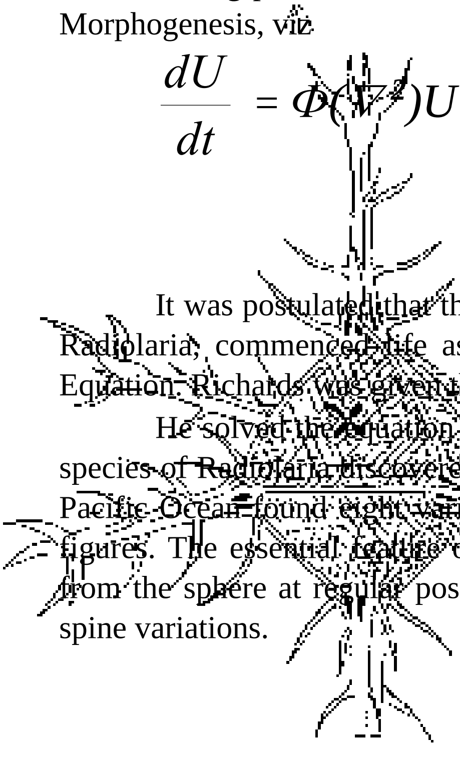

Fig5: Circopurus octahedrus with 6 spines and 8 faces

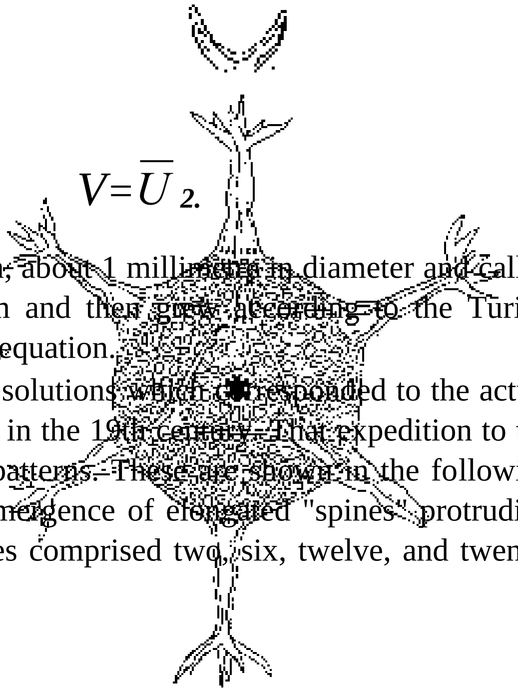

Fig6: Circogonia icosahedra with 12 spines and 20 faces

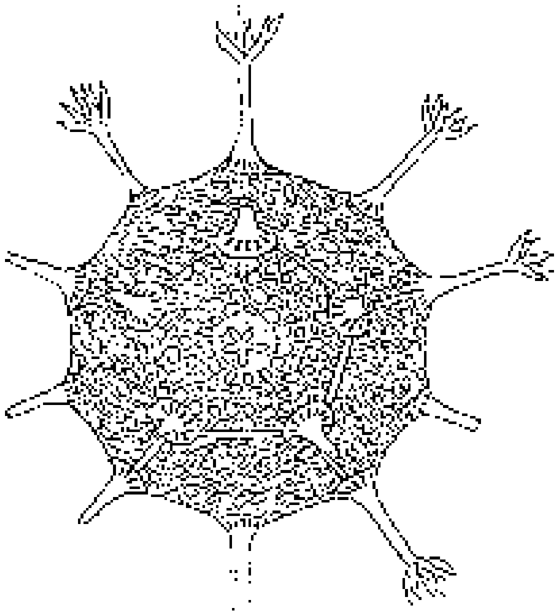

Fig8: Circorrhegma dodecahedra with 20 spines and 12 faces

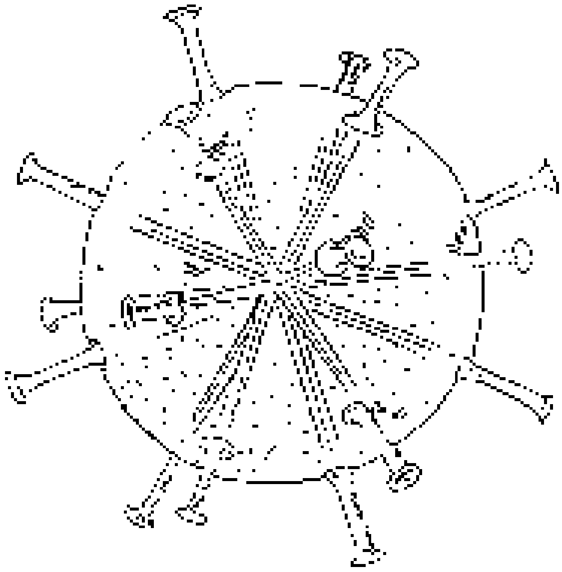

Fig8: Cannocapsa stethoscopium with 20 spines

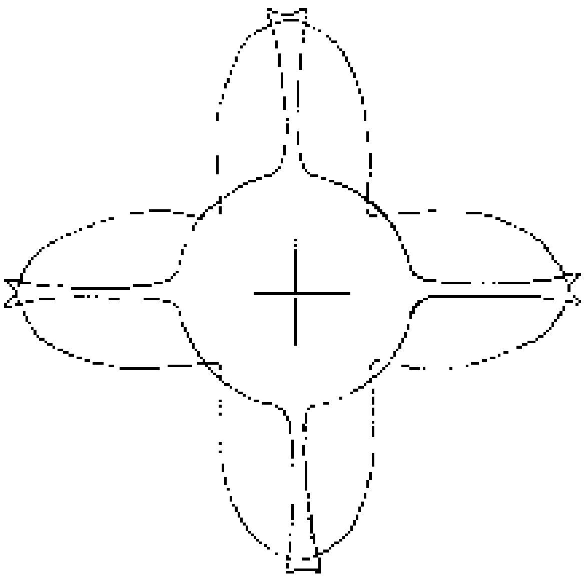

Fig9: The computer solution superimposed on Circopus sexfurcus

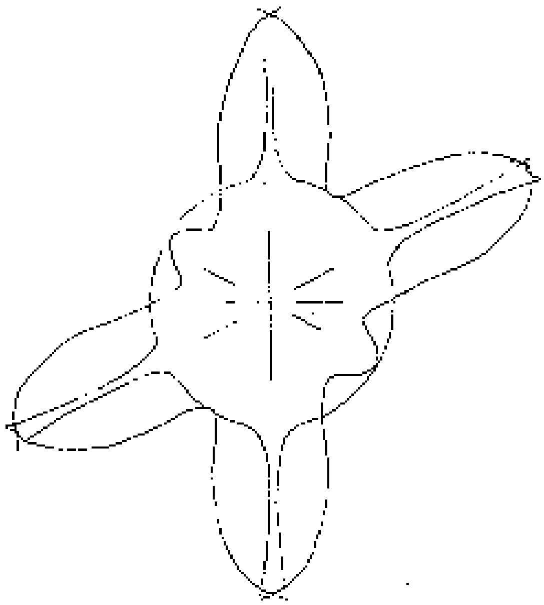

Fig10: The computer solution superimposed on Circogonia icosahedra

Thus, Figure 3 has two spines, one at the north pole and one at the south pole. Figure 4 shows a version with 6 spines. Figure 5 shows another species with 6 spines and Figure 6 has 12 spines. Figure 7 has 20 spines as does Figure 8.

Solving the Morphogenesis Equation produced theoretical solutions corresponding to the 2, 6, 12, and 20 spine variations. Richards then compared the shape of the computer solution with that of the actual creatures discovered by HMS Challenger. Figure 9 shows the solution for the 6 spine variant superimposed on the real 6 spine Radiolaria, the species Circopus Sexfarcus. The ratio of sphere to spine fits exactly. Figure 8 shows the fit for the 12 spine version, ie superimposing the computer solution upon Circogonia Icosahedra.

The work of Richards seemed to vindicate Turing's Theory of Morphogenesis.

4. The aftermath

Finally Richards subsequently used the Mark I to solve the Wave Equation for wide angle optical systems. The results were published in his paper to the Royal Society in 1956. In the course of that work he produced what is believed to be the world's first computer produced graph-plot, using the alphabet on a teleprinter. To produce the contour effect, individual letters were chosen containing greater or lesser amounts of ink to produce alternate dark/light contour bands.

5. Conclusion

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 the day of his death, 7th June 1954, but alas it never transpired. So he will be remembered for four things, namely (1) being a son very much loved by his mother who told the writer much about him, (2) being the genius behind the Colossus Computer, (3) for his ideas on the Universal Computing Engine and his paper on computability and (4) for his pioneering work on Morphogenesis.

The writer was glad to have worked with him.

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