"Historical Notes: My Transition From Microwave Radar to Computer Engineering"

by

Frederick B. Wood, Ph.D.

I. Notes On Computer Development (Written 3/14/52 at University of California, Berkeley)

In consideration of possible computer developments it is significant to review the process of the invention of other things such as windmills, heliocopters, and radat and to examine their philosophical significance. (alos more elementary inventions such as the lever, etc.)

Radar in elementary forms was developed in the late 1930's and saw its general application on a major scale during World War II. A long series of theroetical discoveries and practical techniques accomplished in many related fields were necessary to make the functioning of radar possible. During World War II, the problem of how electric eels navigate came to be investigated. It was found that eels navigate by radar similar to the direction finding of bats by ultra-sonic waves. In another field we find that the inventor of the helicopter was a scientist and philosopher who had been studying the flight of bees. From these illustrations one may see the plausibility that the basic principles of operation of some great inventions already existed in nature, although they were not always discovered in nature until after man had invented electro-mechanical devices using these principles.

This leads to consideration of the possibility that if a distinctly new principle of accounting by computing machines can be developed, that it may utilize some operating principle existing in nature, but not yet discovered by --- such as the electronics and mechanics of the human brain.

II. Notes on My Education and My Initial Outlook on the Computer Industry (written while working for IBM 8/19/53)

After I graduated from University High School, Oakland, Calif., in 1936 I entered the University of California, majoring in electrical engineering. My elective courses outside of engineering were in physics and economics. I was elected to Phi Beta Kappa, Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Pi Mu Epsilon (mathematics) and was a student officer of the A.I.E.E. My B.S. degree was conferred with honors in May 1941. I worked for rwo summers in the Pacific Gas and Electric Co. electric meter shop and worked part time in my senior year in the U. C. High Voltage Laboratory on the develpment of resnatron tubes and on glow discharge phenomena.

Starting in February 1941, I was employed by the M.I.T. Radiation Laboratory. There I worked on the design , construction, and test of protype microwave transmission lines and radio frewuency circuits of radar sets. Then I worked on gas transmit-receive tubes at the Radiation Laboratory in cooperation with Raytheon Mfg. Co. I conducted acceptance tests on the 721A tubes for the Navy, (which resolved a controversy between two manufacturers as th the best design for the 721A.)

Then I designed and tested frequency meters, radar beacon frequency reference cavities, and echo boxes. I handled the distribution of ten-centimeter wavelength standard frequency cavities to the Army, Navy and principal radar manufacturers.

After working a few months on writing instruction manuals for radar test equipment, I was promoted to Section Chief of the Test Equipment Instruction Manual Section of the Radiation Laboratory. While supervising the manual writing, I developed an improved procedure for instructing personnel on testing radar with frequency-modulated test sets which was adopted by the Navy.

I wrote or edited over fifty M.I.T. Radiation Laboratory reports, principally on radar test equipment.

From March to September of 1o46, I worked part-time at the University of California Radiation Laboratory in Berkeley, consulting on the procurement and use of microwave r-f test equipment.

I was appointed the Harry H. Hilp Fellow in Engineering at U. C. for academic year 1946-47 and 1947-48. I studied graduate courses in Electrical Engineering and mathematics, and economics. My thesis title for the M.S. in June 148 was "Coupling of Power from a Resonant Cavity or Load at Microwave Frequencies."

I was reappointed Harry H. Hilp Fellow in Engineering for 1948-49 and continued as a research engineer (part-time) in the Microwave Laboratory for 1949-52. During the period I took further graduate courses in mathematics, physics and electrical engineering. My reserch for he Ph.D. was completed in the summer of 1952 and the degree was conferred in June 1953. The thesis title was "Coupling between Waveguides and Cavity Resonators for Large Power Output."

I joined the IBM Research and Development Laboratory because the program of IBM is oriented in a direction to bridge the gaps between the specialized fields of physical science, engineering, social science, and philosophy that are the major stumbling blocks to the solution of the major problems of our civilization. The development of business acconting machines to save dollars in business has also made available tools for attacking broad economic, psychological, and social problems which must be solved if our civilization is to maintain a position of leadership in the world. The particular protion of the overall program that appeals to me for the immediate future is the development of logical circuit elements which in their application involve philosophy (logic) and in their internal operation involve the theory of electricity and magnetism.

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The IBM Research Laboratory presents an opportunity for me to make a more general application of my training to the long run problems of our civilization. I joined the IBM Laboratory, because it offered an opportunity to work on projects which potentially come closer to applying engineering toward the solution of the long run problems of our country. By way of explanation , engineering work with differend organizations is weighted toward solution of immediate short-run problems such as improved radar, bombsights, radar countermeasures, etc. or it is weighted toward commercial development which may expand and stabilize the economy. The nature of the internatinal situation at times requires primary emphasis on the short run problems. It is my opinion that in the long run the nations that will most successfully come through the present international crises are those who are able to understand more cuickly what is happening in their economy and to take steps to control or correct instabilities while reserving and developing the freedom of the individuals. The extension of computing techniques offers a clear path toward solving aspects of the long-run problems of society.

There is an initial contradiction, in that the direct solution of Maxwell's equiations is not necessarily the case for computer problems, as is often the case for radar problems. My line of intersest now is to bridge from electromagnetic theory to communication theory(information theory and cybernetics) by means of components such as coheres, electrostatic equipment utilizing the theory of electricity and magnetism in their internal operations and being a part of a communication system.

See "Trends and Equilibria in Nature and Society."

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I examined the potential course of the various research and development organizations in relation to the more significant problems of our age. The development of our civilization and science and engineering has reached a stage where the various fields of engineering and science habe become very specialized and subdivided. An integration of the specialists appears to be required to make further advances in the psychological, social and economic sciences. The company doing the most to provide the tools in the form of computing systems was found to be IBM. Thus I believe that IBM is in a postion to develop a more obvious connection between the design of electrical components, their use in logical circuits, and the application of computing machines to the long run problems of our civilization.

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