A History of Computing in the Twentieth Century

Early Research on Computers at RCA

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The way we entered into the computer field at RCA was through the initiative of Col. Simon from the Franklin Arsenal in Philadelphia in 1939. The Germans had a great dominance in the air and the Allies were very poor at antiaircraft fire control. While the guns could shoot the planes, it was very difficult to aim them with the mechanical "directors" of the day, which were much too slow. Col. Simon had the foresight to believe that electronics could provide the required speed. He approached us at RCA to see whether we would be willing to look into the matter.

There appeared immediately two approaches. One, which was what we would call digital, would be based on the then existing cosmic ray counters, and the other, then called continuous and that we now call analog, would be sort of an imitation of what was done mechanically.

And so we undertook the job. In fact I was the first man to start working on it and I can't remember whether we started before or after the invasion of Poland, but it was just at the very beginning of the war.

My first inclination was to start with the analog approach in imitation of the mechanical directors, but I soon found out that making anything that works with a precision of 1% was practically a miracle, and to do it at any reasonable speed was a double miracle. Since the equations obviously required far more precision than that, I went on the digital approach quite soon. I was soon joined by a few others, including Richard L. Snyder, Lesley E. Flory, and George A. Morton….

We were in the formative years (1942-1943) of digital computers, and we gradually became acquainted with the relatively few who were interested in his field. We had many visitors. Among them was John von Neumann, who came to see us frequently and who became very familiar with our research. We also had frequent visits from Herman Goldstine. We had contacts with the Moore School of Electrical Engineering of the University of Pennsylvania, essentially our neighbors in Philadelphia (we were in Camden, New Jersey).

It became apparent that digital computers would be much more useful for the war effort for solving urgent computation problems such as calculating ballistic tables than for fire control. The very large number of tubes required made them impractical for field use for which their speed, though high, was still insufficient for real-time computations. On the other hand, their three-order-of-magnitude-greater speed with respect to mechanical computers made them a godsend for lengthy numerical computations.

We thought of the difficulties involved with a computing machine requiring thousands of tubes and the failure rates that it would entail. This led us to invent a single tube capable of performing all the arithmetic. When I explained the principle of the Computron, as we called the tube, to Warren Weaver, who was then head of the NDRC, he became fascinated by it and immediately gave us a contract for its development. There were many beams in the tube, each guided by deflecting electrodes and each striking separate targets. The targets of one beam were connected to deflecting electrodes of others. Because of secondary emission, the targets assumed one or another of two stable voltages, without the necessity of any coupling resistances. After the inputs were applied the various intermediary electrodes performing the carry operations trickled successively to their stable potentials and the output appeared in the final electrodes without any explicit timing pulses. We demonstrated the principle with a model having several cells. However, the technology was too intricate for a follow-up, as we were attempting in a sense "integration" in the difficult vacuum technology.

During that period the matter as to whether RCA should undertake the building of a complete computing system with many thousands of tubes was considered. Actually, in 1943, the Moore School obtained a contract for starting the building of what became the ENIAC. I recently confirmed that date with Professor Brainerd. We eagerly transmitted all the expertise we had to the Moore School. There were many mutual visits. Also, I remember giving several talks at the Moore School. There was a mood of great patriotism, everything was done for the war effort, and there were no questions asked about authorship or patent rights. A great deal of intangible and undocumented information was transmitted. Two concrete devices from RCA were adopted in ENIAC: the resistive matrix function generator already mentioned and a decimal ring counter that had been designed by Igor Grosdoff.

There was a hiatus in our research, but not in our interests in digital computers, from 1943 until after the war in late 1945. This was the period of EDVAC and an evolution in thinking that gradually resulted in the realization of the great benefits of a truly random access memory. In the fall of 1945, von Neumann suggested that we cooperate in the building of the Institute for Advanced Study computer. The decision was made that we should undertake the random access method.

Perhaps because of my dislike for analog deflection in a cathode-ray tube (CRT) I conceived a purely digital tube -- the Selectron -- or the selective electrostatic storage tube. The tube had two orthogonal sets of parallel bars, which controlled an overall bombardment of electrons. By means of these bars, all current could be stopped expect[sic] in a given "window." This purely digital addressing mechanism was used to select a location for writing and reading. For storage, electrons were allowed through all windows, bombarded discrete metallic elements, and kept them at one or the other of two stable potentials through a secondary emission mechanism identical to the one used in the Computron. We were engaged again in integrated vacum-tube[sic] techniques. This time we brought research to a successful conclusion, developing not only the tube but the circuits to drive it. I believe this was in late 1949 or early 1950.

The tube Division of RCA at Lancaster produced about 2000 Selectron tubes, the first being available in late 1950 or early 1951. Looking at the project in retrospect, I believe its timetable was remarkably short -- only four years from conception to product -- particularly when considering that the maximum manpower at the Laboratories was only three persons. Yet considerable technology had to be developed.

Of course, at the time the progress did not seem so fast. It is natural that our friends at the Institute became a bit impatient when we had delaying difficulties, as they were eager to have some definite memory to incorporate in the advancing design of the computer. It turns out that in 1947 or 1948, Professor Williams at Manchester invented a way to use an ordinary unmodified CRT for a random access memory, and Julian Bigelow decided to use it for the IAS machine. The Selectron was chosen by the group at Rand, who built a so-called copy of the IAS machine -- the JOHNNIAC. Bill Gunning and Keith Uncapher at Rand made a superb job of the circuits for the Selectron. In fact, the Selectron memory worked for many years and was still operating well when it was finally replaced by a core memory….

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