What Is a Computer? An Answer from the Past

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By now, literally millions of people have asked the question, "What is a computer?"

Millions of replies have defined it in many different ways, and the definition has changed over time as computers have increased in capacity and capability. This article contains one of the earliest definitions by J. Presper Eckert, one of the fathers of the computer field. The purpose of this contribution to the *Annals* is to record in the published literature a press release on the EDVAC II effort from March 1947 when no stored-program computers existed anywhere.

Background

J. Presper Eckert and John Mauchly were the leaders of the team at the Moore School of Electrical Engineering at the University of Pennsylvania that designed and built the ENIAC for the US Army's Ballistics Research Laboratory (BRL). Early discussions between the US Army and the Moore School were held in March 1943, and construction started in May of that year in the basement of the Moore School.

The Army was so pleased with the early progress that the contract was extended in October 1944 to cover research into construction of the Electronic Discrete Variable Automatic Computer (EDVAC). EDVAC was a major improvement over the ENIAC because it was to be a stored-program computer. Although ENIAC was working well by the spring of 1945 and considerable work had been done on the EDVAC, a disagreement over patent rights resulted in Eckert and Mauchly leaving the Moore School in March 1946 to start their own computer company. The engineers at the Moore School continued working on the EDVAC project, and a delay-line memory was working well in March 1947.[1] Unfortunately, the EDVAC project experienced numerous delays, and the computer was not put into operation at BRL until April 1952.[2] By this time, many other stored-program computers were in operation in the United States and England.

Eckert and Mauchly established the Electronic Control Company (ECC), the first American computer company, in March 1946 in Philadelphia, Pennsylvania. By September, ECC had a contract with the National Bureau of Standards to study the specifications for an EDVAC-type computer to assist the US Census Bureau with census processing. It seems clear that this press release (which I include in its entirety here), released to the press on 7 March 1947, shows Eckert's thinking about an improved EDVAC, which he called the EDVAC II.

On 24 May 1947, Eckert and Mauchly agreed to rename the computer the Universal Automatic Computer, or Univac.[3] This served to separate their effort from the work at the Moore School and avoid further controversy.[4] In December 1947, ECC was renamed the Eckert-Mauchly Computer Corporation (EMCC). The Univac was delivered to the US Census Bureau on 31 March 1951.[5]

"A Complete EDVAC [II] Computing System" was written by J. Presper Eckert in early 1947. Although the onionskin copy in my possession has no date, a different version was found on the website http://vintchip.com that contains this statement: "Release for Morning Papers Friday March 7, 1947."[6] Thus, the version I include here is slightly older than the one released to the press.

The onionskin copy[7] I have of this paper was given to me by Armand Adams during the 50 Years of Army Computing celebration at the Aberdeen Proving Grounds, 13–14 November 1996.[8] The provenance is discussed after the paper, along with a short biography of Armand Adams.

I transcribed the paper into Microsoft Word with minimal editing (correcting only obvious typos). The original was indented and used underlining, which I have maintained. The images were scanned and processed with Adobe Photoshop to remove the brown cast of the 67-year-old paper.

A footnote in the original paper (which follows in the next section) indicates it was written by J. Presper Eckert, who also did the drawings. We are fortunate that the materials that Armand Adams gave me contained an earlier pencil sketch of the EDVAC II as well as one page of Eckert's pencil draft. These artifacts allow us to see Eckert's vision for the new computer not only in his words and drawings but in his handwriting as well.

A Complete EDVAC Computing System

This simplified description of a complete EDVAC computing system with drawings, was prepared by J. Presper Eckert, Jr. of the Electronic Control Co., 1215 Walnut St., Phila. 7, Pa. He and Dr. John Mauchly are the designers of both the ENIAC and the EDVAC. Much of this work was done at the University of Pennsylvania under an Army Ordnance Contract. At present, The Electronic Control Co. is preparing designs for an EDVAC computing system for the U. S. Census Bureau.[9]

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The complete arrangement of an EDVAC computing system is shown in Figure 1. This drawing shows the machine proper, along with the various auxiliary units which are required to make it a useful computing system. The auxiliary units include tape writers, a tape printer, and a library cabinet holding reels of magnetic tape memory.

Since the speed of a computer such as the EDVAC is quite high, several tape writers will be required in order to produce sufficient problem data to keep the EDVAC, itself, efficiently employed. All instructions for the operation of the machine are given by means of the magnetic tape. Many of the problems will use parts of instructions and data which have already been used with previous problems. Since this information is kept in the magnetic memory of the library, much of the burden is removed from the tape writers in supplying the necessary tape to keep the EDVAC going.

The tape printer takes those tapes, which contain the final results which are to be used or examined, and prints on paper the information it reads from these tapes.

Frequently, part of the information computed and recorded on the tapes is reabsorbed by the machine and used in further parts of a completed computation routine. Some tapes, upon which results have been recorded, are sent back to the library as they will fit in with later computations, which are to be made. This procedure can simplify considerably later processes.

The main function of the library, however, is to store the routines which are common to many problems and thus simplify the process of setting up a new problem.

The EDVAC, or computer proper as detailed in Figure 2, contains the memory tanks and their associated tube circuits. It further contains an Arithmetic tube circuit which enables the machine to perform all the common processes of arithmetic (addition, subtraction, multiplication, etc.) and, finally, it contains a control circuit which coordinates all the units including the magnetic tape memory.

The top panel of the machine contains three components of considerable importance. The first is a checking screen used to display the contents of any part of the memory system of the machine. It can track down and display the numbers in any part of the computer where they are stored or used. This checking screen allows the computer to be slowed down, like the ENIAC, and the numbers checked at any desired stage in the course of a problem. This screen replaces

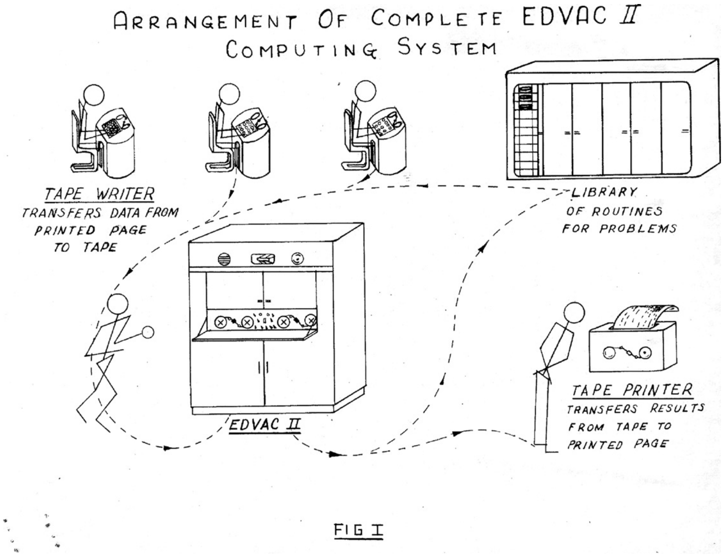
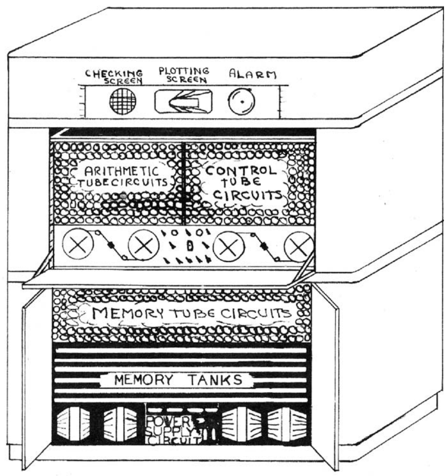


Figure 1. Arrangement of the complete EDVAC II computing system.



PROPOSED APPEARANCE FOR EDVAC II

Figure 2. Proposed appearance for EDVAC II.

more than 2500 tiny neon bulbs which were wired into the panels of the ENIAC for checking.

The second component on the top panel is the plotting screen. This screen allows the values which make up the solution of a problem to be plotted, so as to give the operator a graphic picture of the result which has been obtained. The drawing shows the screen displaying the shock wave and flow pattern which surround a shell fired at super-sonic velocities. Examination of this display will aid the operator in deciding what values he should use next in seeking the desired solution by means of what is, essentially, a highly developed trial and error method. This shell

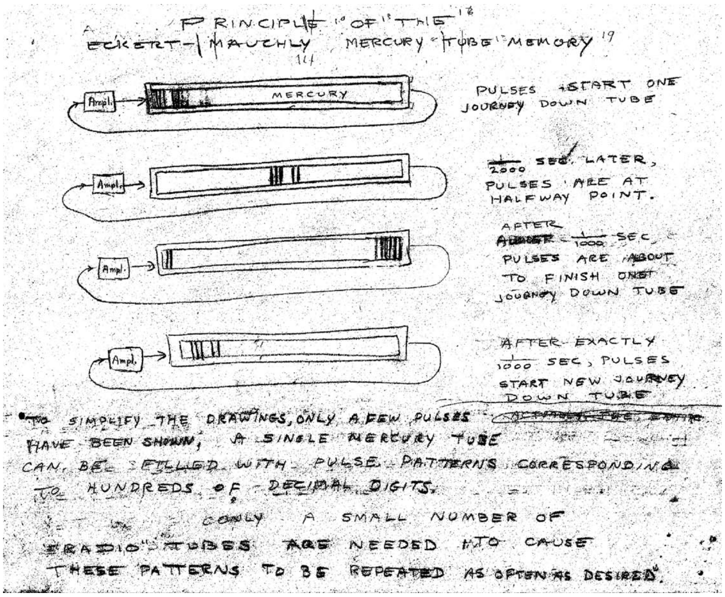


Figure 3. Pencil sketch of Eckert-Mauchly Mercury Tube Memory.

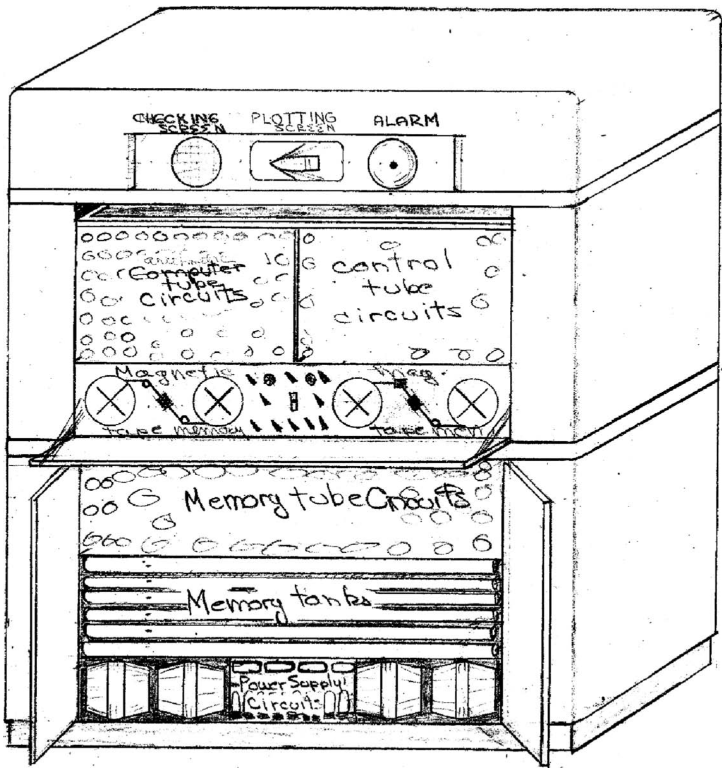


Figure 4. Pencil sketch of EDVAC II. This is another version of the illustration in Figure 2.

problem is characteristic of the type of problem for which the machine was designed.

The computer can, by computation, change the form of the pattern plotted on the screen to give a different view or perspective or it can scale or magnify a given portion in any way that may be desired.

The third component on the top panel is [an] alarm bell (or other signal device, if desired) which can be used to signify failure of some part of the system, an error in the computing or simply the end of the problem, as is desired. The computer is entirely automatic in operation in that once the magnetic memory tapes have been loaded into the machine, it will perform the problem and record the results on a magnetic memory tape without further human intervention.

The heart of the computer is the memory which consists of a system of Mercury tanks as shown in the simplified drawing Figure 3.

A group of waves or impulses which represent a digit or part of a number, (in a manner analogous to the dots and dashes of the Morse Code) are sent into the tank from some other part of the computer. These impulses are normally spaced 1/1,000,000 of a second apart. The tank delays these impulses 1/1000 of a second, or the time to allow 1000 impulses to enter the tank. Thereafter the impulses flow from the other end of the tank and would be lost from the memory if they were not caught and reinserted in the beginning of the tank again by a specially designed electronic amplifier which used ordinary "radio" tubes. Thus, by limiting the number of impulses put into the input of the tank to 1000, one may hold them indefinitely by such circulating system, until any or all of them are required in a problem. Since some spaces in the tank will be emptied when some numbers are removed, these places may be reused as often as is desired by refilling these vacancies. This can be done in such a way as not to disturb the other impulses. This type of circulating memory or repeating memory is reminiscent of the small boy who is sent to the store by his mother to get a large number of different items. The list is so large that he finds he cannot remember it longer than a minute or so. He is, however, able to remember all of the items he must get by continuously repeating the list of items to himself on his way to the store, and thus, continuously reminding himself of his intended purchases. The mercury tank is able to do just this, but with greater probable accuracy and at least 200,000 times as fast.

Additional Materials

Also with the Eckerd paper was a pencil sketch of the EDVAC II (see Figure 4, which is

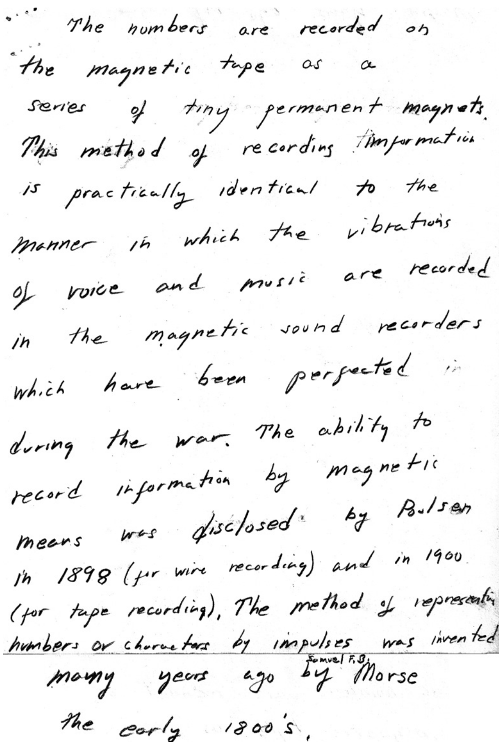

... The numbers are recorded on
the magnetic tape as a
series of tiny permanent magnets.
This method of recording information
is practically identical to the
manner in which the vibrations
of voice and music are recorded
in the magnetic sound recorders
which have been perfected in
during the war. The ability to
record information by magnetic
means was disclosed by Poulsen
in 1898 (for wire recording) and in 1900
(for tape recording). The method of representing
numbers or characters by impulses was invented
many years ago by Samuel F.B. Morse
the early 1800's,

Figure 5. One page of a pencil draft of the Eckert paper, "A Complete EDVAC Computing System."

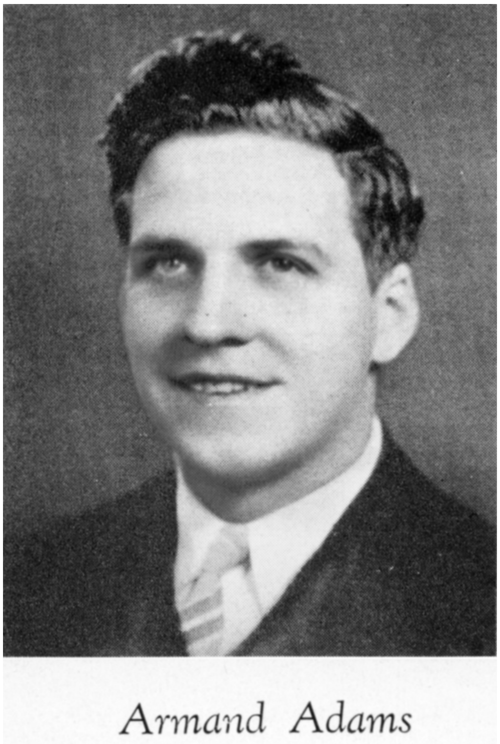


Figure 6. Armand Adams. Photo originally appeared in the 1942 Spartan Yearbook. (Courtesy of the Drexel University Archives.)

a less tidy version of Figure 2) and one page of Eckert's handwritten draft in pencil (see Figure 5).

Provenance

I met Armand Adams during the 1996 ACM Computer Science Conference (16–18 February 1996) when I chaired the history track. He attended every one of the six history sessions, so I introduced myself at one of the coffee breaks. Armand said he was a retired electrical engineer and had been the chief engineer at EMCC. He said he also worked for the Univac Corporation in public relations and was retired from Unisys. I was astounded to be talking to someone who was there "at the beginning."

In fall 1996, I served as a member of the program committee for the Army's 50th Anniversary celebration at Aberdeen Proving Ground. Armand also served on that committee.[10] The first day's program was to conclude with a panel of pioneers, including Harry Huskey and Herman Goldstine.[11] Unfortunately, Harry Huskey took ill at lunch, so I asked Armand Adams to fill in. He was happy to do so.

On the morning of the second day, before the conference started, Armand asked me to accompany him to his car. In his trunk was a box of artifacts from his career, including Univac brochures, black and white photographs, and the Eckert manuscript. He said he wanted me to have them and add them to my collection. At that time, I had a small museum at American University.

Biography of Armand Adams

Armand Ernest Adams was born in Philadelphia, Pennsylvania, on 9 August 1917. His father, Ernest, a machinist, was born in Latvia in 1893. His mother, Anna, was born in Germany in 1895.[12] After high school, Armand worked for Rohm & Haas and attended Drexel University's evening school, where he studied electrical engineering. He graduated in 1942 while working for the Charles Lenning Company in Philadelphia.[13] Lenning manufactured chemicals and was later bought by Rohm & Haas. The 1940 US Census shows Armand working as an apprentice electrician.

In 1943, Armand joined the engineering staff of the Frankford Arsenal and worked in the Anti-aircraft Fire Control Laboratory. In 1952, he cofounded the Arga Instrument Company, which merged with Beckman Instruments in 1957. Armand then joined the Sperry Rand Corporation. When he retired in 1984, he was the director of public relations and facilities planning for the Philadelphia operations of Unisys.[14]

When I met Armand, he told me he had been chief engineer at EMCC, a claim he reiterated at the Univac Conference on 17–18 May 1990.[15] According to Unisys company history, Remington Rand acquired EMCC in 1950.[16] Thus, Adams must have started at EMCC sometime after December 1947 and before the Remington Rand acquisition in 1950. During his long career, he collected a range of artifacts, some of which he shared with me and I now share with *Annals* readers.

References and Notes

1. M.R. Williams, *A History of Computing Technology*, 2nd ed., IEEE CS, 1997, p. 412.
2. *Ballisticians in War and Peace: A History of the United States Ballistic Research Laboratories*, vol. I: 1914–1956, vol. II: 1957–1976, and vol. III: 1977–1992, Aberdeen Proving Ground (nd).
3. N. Stern, *From ENIAC to UNIVAC: An Appraisal of the Eckert-Mauchly Computers*, Digital Press, 1981, p. 106.
4. In June 1945, the "First Draft of a Report on EDVAC" was distributed by Herman Goldstine to the Moore School staff and other interested scientists. When Eckert and Mauchly attempted to file a patent on the EDVAC in 1947, they were denied because the information had been in the public domain for more than a year. This was to become one of the largest controversies of the early days of computing.
5. Williams, *A History of Computing Technology*, p. 360
6. A slightly different version of this paper is available www.vintchip.com/DOCUMENTS/ADAMS.html. The website was created by Greg Barber, who purchased the materials on eBay some years ago. Greg is no longer maintaining the site and could not shed any light on the provenance of the materials on his website.
7. Onionskin is a thin, lightweight, translucent paper that was used to make multiple copies of a typewritten document using carbon paper.
8. See T.J. (Tim) Bergin and W. Moyer, "50 Years of Army Computing: From ENIAC to MSRC," *IEEE Annals of the History of Computing*, vol. 19, no. 3, 1997, pp. 76–77.
9. This was a footnote on p. 1 of the onionskin copy in Bergin's possession.
10. T.J. Bergin, ed., *50 Years of Army Computing: From ENIAC to MSRC: A Record of a Symposium and Celebration, November 13 and 14, 1996*, ARL SR-93, Aberdeen, Sept. 2000.
11. Harry Huskey and Herman Goldstine were both associated with the ENIAC project. Huskey went on to work with Alan Turing at the National Physical Laboratory and later created the basic design of the National Bureau of Standards SEAC (Standard Eastern Automatic Computer), operational in 1950. Goldstine worked with John von Neumann at the Institute for Advanced Study on the IAS computer (1952) and authored *The Computer from Pascal to von Neumann* (Princeton Univ. Press, 1972). J.A.N. Lee, *Computer Pioneers*, IEEE CS, 1995.
12. Ancestry.com was used to obtain some of the Armand Adams biographical data, including his father's and mother's names, employment and countries of origin, and the 1940 census information.
13. *1942 Spartan Yearbook*, Drexel Univ., pp. 45, 46, 82. (Courtesy of Drexel Archives.)
14. Obituary, *Delaware County Times*, 19 Nov. 2004 (online).
15. A transcript of this conference is available at "Univac Conference," OH 200, Charles Babbage Inst., p. 4; http://conservancy.umn.edu/bitstream/104288/1/oh200uc.pdf.
16. See "Unisys – A History of Excellence," www.unisys.com/unisys/about/company/history.jsp?id=209.

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