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HISTORY OF DIGITAL COMPUTERS
and
ESSENTIAL ELEMENTS OF A COMPUTER

A Brief Outline 1/

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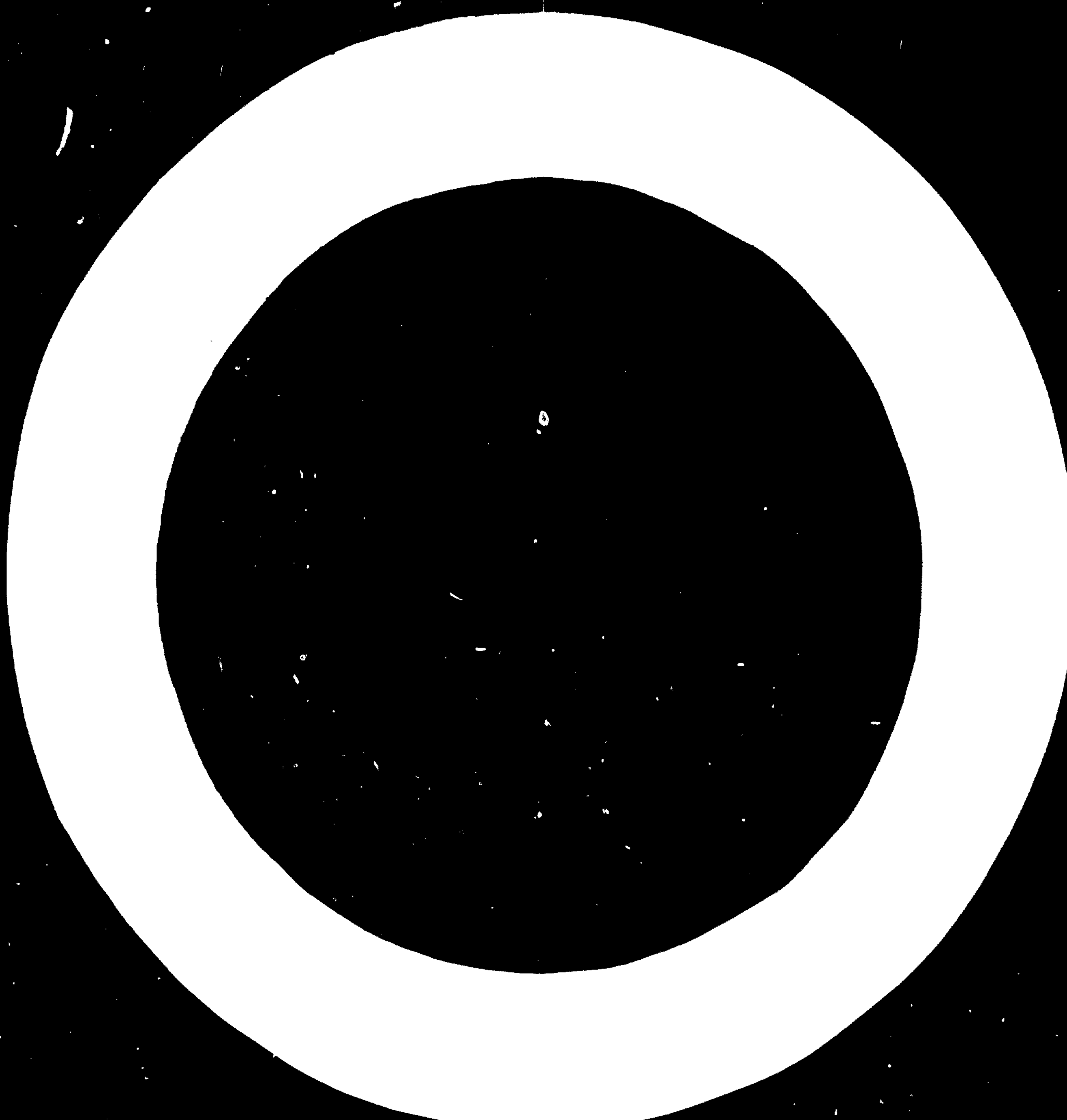

The history of calculating machines and the advent of the first computer

Before 1935

- The computer as a calculating aid
- Abacus (2000 years B.C.) in China
- "Invention" of zero
- Blaise Pascal (1642): adding and subtracting machine
- Leibnitz (1670): multiplying machine
- Charles Babbage (1812): analytical engine - first attempt to design an automatic machine
- About 1890: mass-produced components of sufficient precision and sufficiently low-priced to allow production of hand-driven desk calculators
- Separate developments: (1895) Hollerith (USA) development of punched cards and punched card machines

1935 - 1946

- 1936 Zuse - I: working of the machine determined by a built-in programme.
  Something about the further development of the Zuse Company
- 1940-44 E. Stilbitz: Bell-computers Mark I t/m Mark V. Use of electro-mechanical (telephone) switches
- 1944 Harvard Mark I. Developed by H.H. Aiken (weight: several tons)
- 1946 ENIAC (Electronic Numerical Integrator and Calculator), the first automatic electronic computer. Designed by Dr. John Mauchly and J. Prosper Eckert, University of Pennsylvania Moore School of Engineering. 18,000 electronic tubes, 30 tons, filled a whole cellar. Used for the calculation of cannon ball trajectories, 5,000 additions per second.

After 1946

- The Univac - CDC - IBM story
- John von Neumann (The Institute for Advanced Study of the Princeton University; Hungarian): first analytic treatment by a mathematician of automatic calculators.

First, second, etc. generation

- Generation concept as a commercial gimmick
- First generation (1949 - 1960). Vacuum tubes. Big machines, much dissipation of heat. Simple business data processing applications (payroll, simple bookkeeping, order administration)
  Experiences with the IBM 650
  (From use of a service bureau to 40 million dollars a year!)
- Second generation (1959 - 1964) Use of transistors and ferrite cores; smaller, more reliable computers.
  A bigger main memory, faster and a better price/performance ratio.
  Many new applications.
- Third generation (1964) Use of integrated circuits.
  New memory types (plated wire, thin film). Anew, a better price/performance ratio.
- Fourth generation: later than 1969
  The pace of development is slowing down. The input/output bottleneck; a smarter "internal" organization.

The next fifteen years

- The task ahead. Illustration by means of: investment in computers (about equal to that in motor-cars), required personnel (5% of working population or more!). Reason for this explosion.
- Technological rate of progress: will slow down (speed, miniaturization). Throughput will increase by better organization within a computer and by development of better and standardized application packages.
- Man-machine systems and machine-machine systems
  a. Satisfaction of user requirements in terms of functions performed, not procedures used to perform them
  b. Standardization (with lead to casualities, the 5 billion dollar gamble of IBM)
  c. Make the gear an extension of man (interactive mode)
  d. New ways of organizing the machine and systems of machines (Sequential and parallel processing)
- Some concrete expectations (Partly based upon "A fifteen-year forecast of information-processing technology" published by the "Research and Development Division Naval Supply Systems Command, Washington, D.C.) Only those expectations are chosen which will have a direct impact on the processing of information (like the information needed for controlling a project).
  a. Techniques for machine reading of general print will have been developed (for books, newspapers, etc): 1975
  b. Sophisticated micro-electronics with permit design of very compact self-contained modular input terminals: 1972

c. A new class of machines available will be the information retrieval system. They will be characterized by very large memory requirements, and the ability to handle large memories including multiple peripheral systems: 1975

d. Standard T.V. sets will come into substantial use as I/O-terminals: 1972

e. Six- to ten-fold improvement in throughput cost-effectiveness of overall EDP systems (also contributed to by advances in circuit speeds): 1980

f. Wide-spread use of source data automation devices: 1972

g. Transmission charges based on distance and bit rate as well as time, i.e. based on data volume transferred: 1973

h. The use of computers (and electronics in general) in the educational process will expand rapidly and significantly: 1972.

The essential elements of a computer

Some basic concepts

- The stored programme concept (Babbage, Zuse and Aiken). The influence of von Neumann. Illustration by means of the calculation of the average of n numbers. External solution (panels with wires) and internal solution. Instruction and execution cycle. Address and instruction modification. (The latter means in general bad programming.)
- The decimal and non-decimal representation (The invention of zero by the Sumeric people.) Binary, octal and hexa-decimal representation.
- Hardware and software

  a. Hardware: the physical object(s)

  b. Software: the procedures

  Separation of the hard- and software pricing: **the software business** is a big one.

Basic hardware structure of a computer

Elements: a. central processing unit subdivided into arithmetic unit and control unit

b. memory

c. input/output units

- The CPU

  Performs the arithmetic under control of the control unit
  Addition and multiplication in the binary system

- Memory

  Word, byte, bit, checkbit
  Address, indirect addressing
  example $Y = A/B + C$

- <u>The I/O units</u>

  Stress the critical nature of the I/O function. An illustration of computing (hypergeometric distribution) versus business data processing.
  Adding speed versus I/O speed
  Some solutions: parallel processing
  buffer techniques

Basic software structure of a computer

- From looping via an artificial head towards an operating system
- Flow-charting (Short, refer to 10.5: The basic concepts of programming by Mr. Nijssen)
- Programming (in higher level languages)
- The compilation and execution of a simple FORTRAN-programme used to illustrate the importance of the operating system.

<u>Types of CPU</u>

Look-ahead processing, multiple processors

<u>Memory types</u>

Registers, central core, slow core, drum, magnetic disks (the "Furnace"), magnetic tapes, data cells, magnetic strips, punched cards.

<u>Types of I/O units</u>

Card-reader, printer, console typewriter, touch-tone devices, alphanumeric and graphical displays.

<u>Data capturing devices</u>

Mark sensing cards, touch-tone devices, punched cards, OCR, card-to-tape, card-to-disc.

<u>Types of operating system</u>

- Serial (batch-) processing
- Time-slicing
- Multiprogramming
- Multitasking

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