Mainframe Computers

Thomas J. Bergin

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American University

Industry beginnings...

- **March 1946** Eckert and Mauchly leave Moore School and establish the *Electronic Control Company (ECC)*

- **December 1947** ECC re-founded as the *Eckert Mauchly Computer Corporation (EMCC)*

- **1948** contract with U.S. Census Bureau for **UNIVAC**, the *UNIVersal Automatic Computer*

- **February 1950** EMCC sold to Remington-Rand

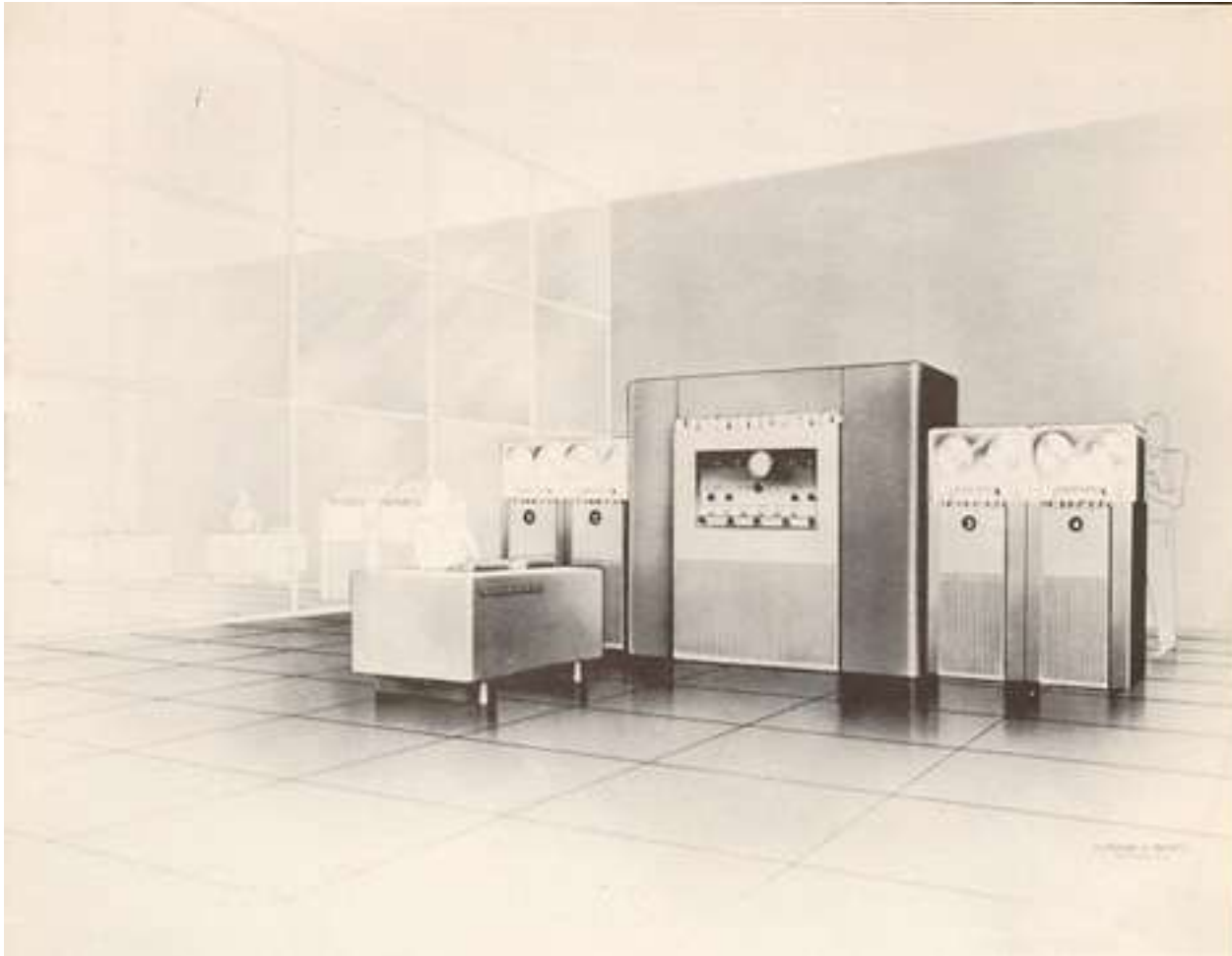- **March 31, 1951** 1st UNIVAC delivered to Census

Electronic Control Company (ECC)
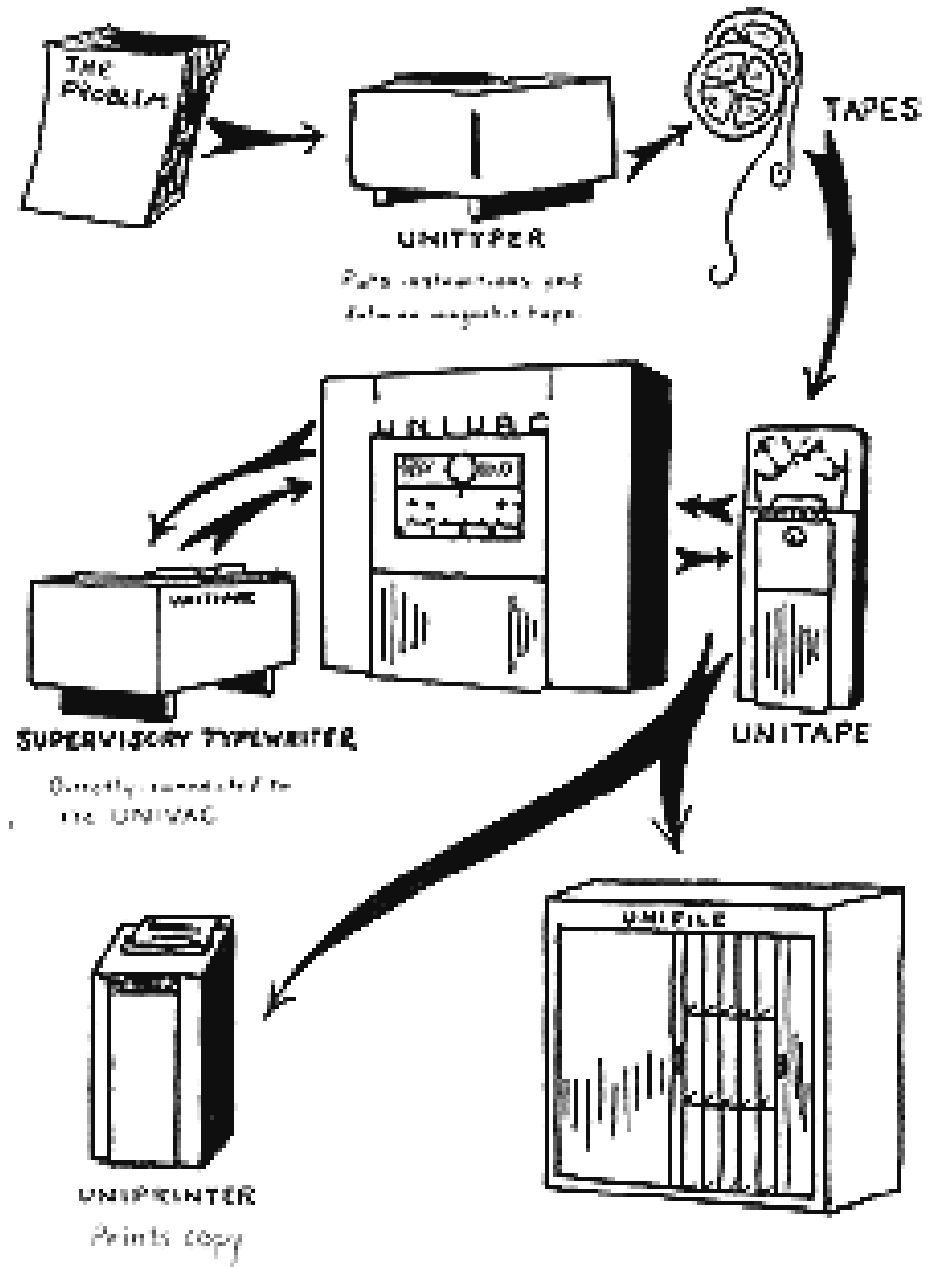
Eckert-Mauchly Computer Company

- 1948 Contract drawn up between EMCC and the US Census Bureau for the production of UNIVAC (UNIVersal Automatic Computer)

- September 1949 BINAC (Binary Automatic Computer) delivered to Northrop Aviation

- **March 31, 1951 First UNIversal Automatic Computer (UNIVAC) delivered to US Census Bureau**
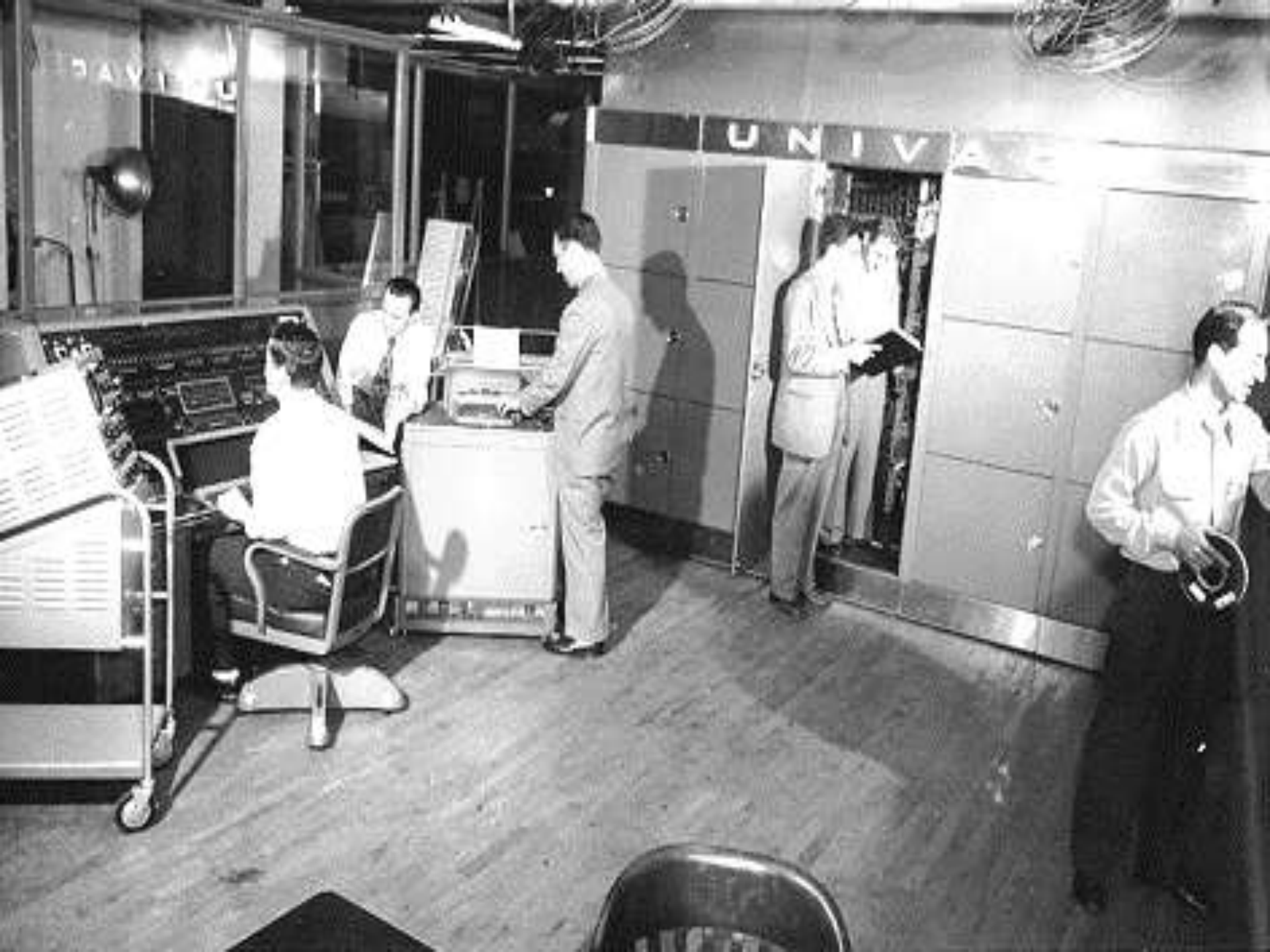
EMCC Sales Brochure

FLOW CHART FOR UNIVAC OPERATION

UNIVAC SYSTEM

UNITYPER

Puts instructions and data on magnetic tape.

TAPES

UNIVAC

SUPERVISORY TYPEWRITER

Directly connected to the UNIVAC

UNITAPE

UNIPRINTER

Prints copy

UNIFILE

John Mauchly leaning on UNIVAC

Eckert-Mauchly Computers

ENIAC	**EDVAC**	**BINAC**	**UNIVAC**
Decimal	Binary	Binary	Decimal
Wire	StorPrgm	StorPrgm	StorPrgm
10 digits	44 bits	14 bits	6 chars
125KHz	1 MHz	4 MHz	2.25MHz
FunctTbl	MagDrum	MagTape	MagTape
18,000	3,600	1,400	5,400
18,000sqft	490 sqft	n/a	352 sqft

Remington Rand UNIVAC

- 43 UNIVACs were delivered to government and industry
- Memory: mercury delay lines: 1000 words of 12 alphanumeric characters
- Secondary storage: metal oxide tape
- Access time: 222 microseconds (average)
- Instruction set: 45 operation codes
- Accumulators: 4
- Clock: 2.25 Mhz

J. Lyons and Company

- Lyons tea-shops were a feature of British urban life in the mid-twentieth-century, a popular place to meet friends and eat snacks. Supplying the right number of cakes to the right shops on the right day was a difficult logistical problem. Partly for this reason - and partly because the management of Lyons & Co. were avid modernizers - the company took a strong interest in the first experimental computers.

Source: www.man.ac.uk

- After witnessing the Cambridge EDSAC, a sophisticated machine completed in 1949, Lyons decided to build their own computer based on the same mercury delay-line techniques. Lyons - the tea-shop company - built the first electronic stored-program computer for the office in 1951. They called it LEO: Lyons Electronic Office

  Source: www.man.ac.uk
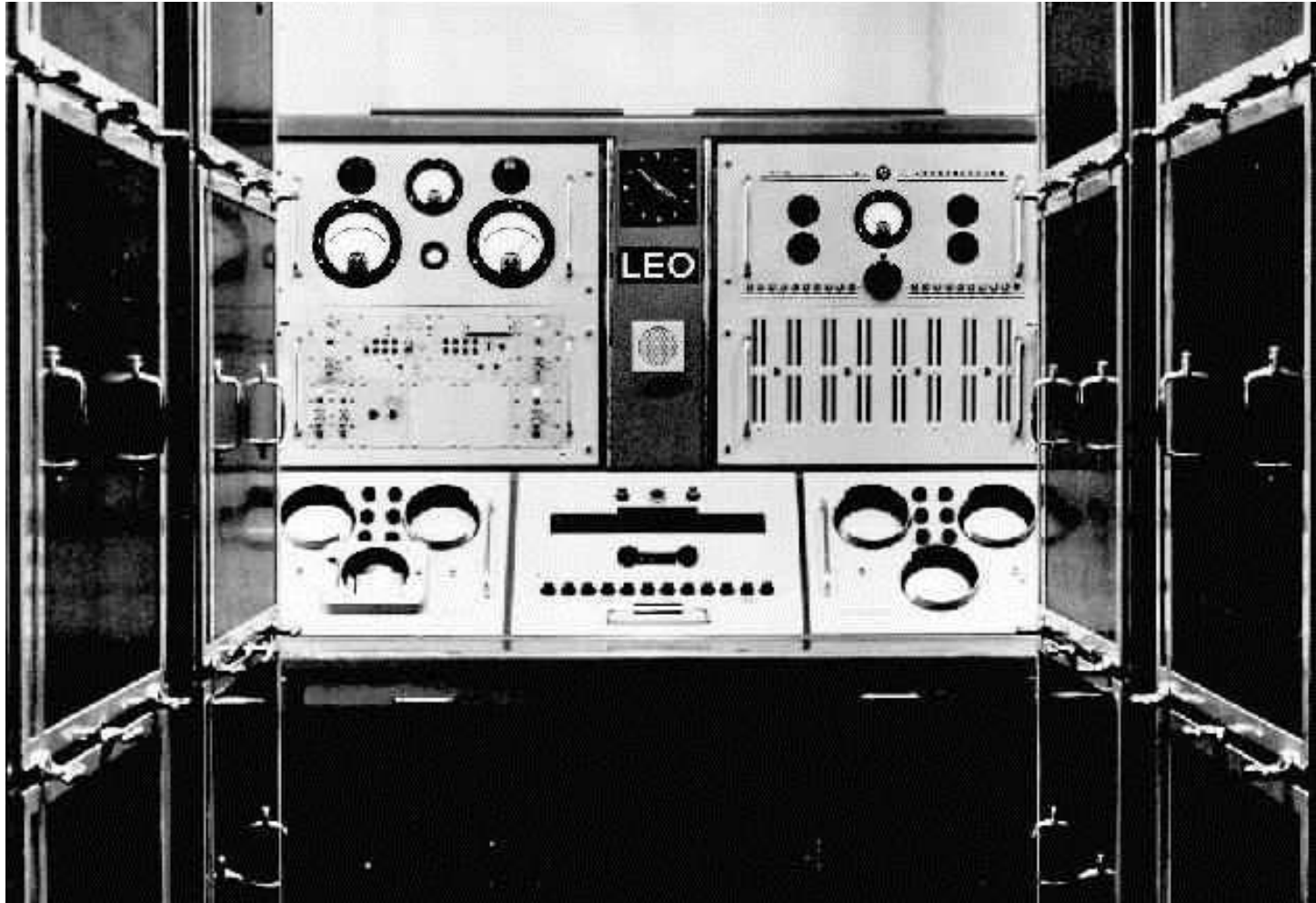
EDSAC (Cambridge University)
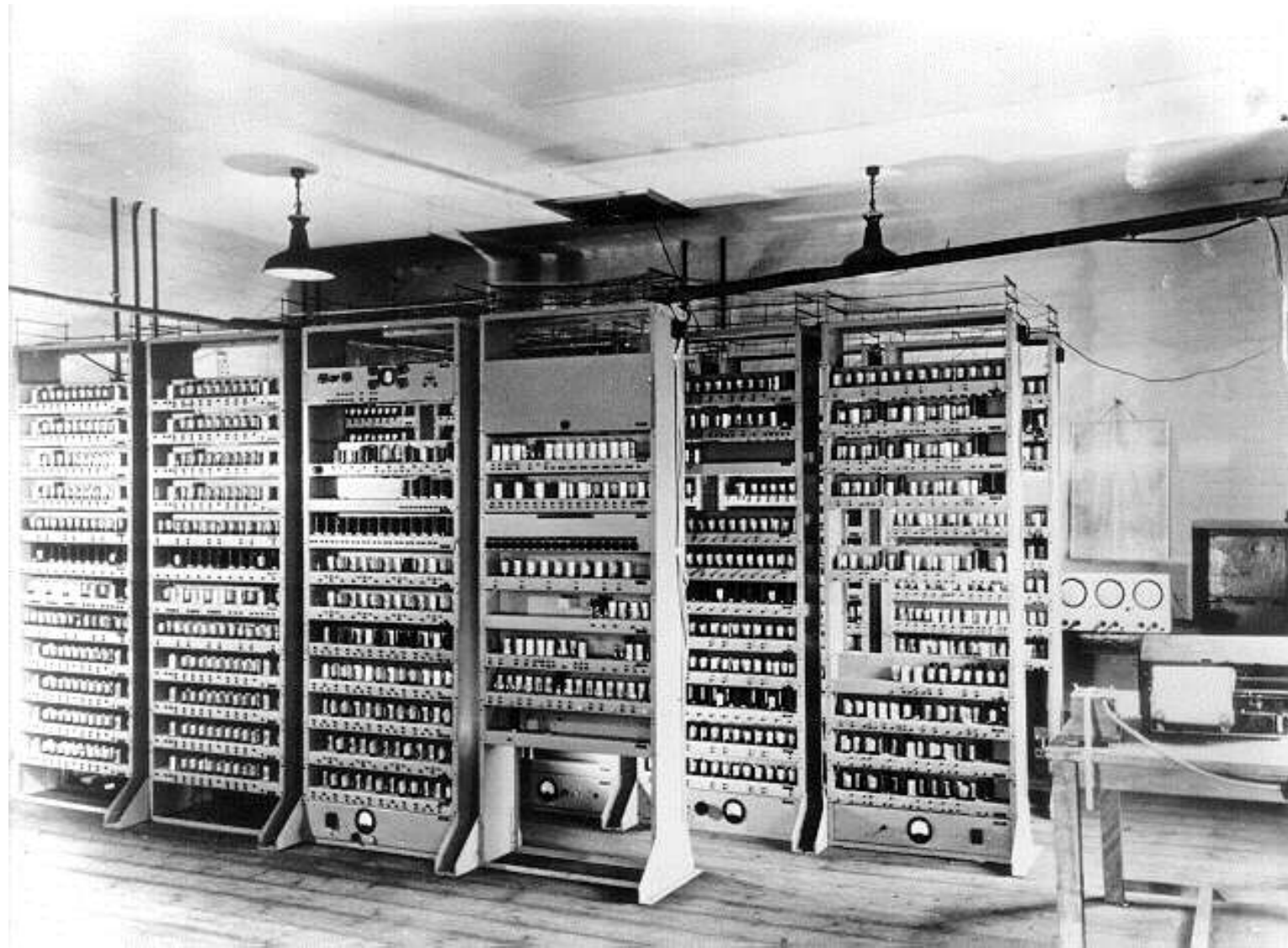
W.D. and H.O. Willis at Bristol

source: LEO Computers Society *www.leo-computers.org.uk*

LEO console

source: LEO Computers Society *www.leo-computers.org.uk*

J. Lyons

- May 1947 T.R. Thompson and O. Standingford visit America (Goldstine at Princeton)
- Nov 1947 Lyons Board authorizes aid to Cambridge University
- May 1949 EDSAC completes 1st live job
- Feb 1951 LEO demonstrated to Her Royal Highness Princess Elizabeth
- LEO: Lyons Electronic Office (Fall 1951)

LEO (Lyons Electronic Office)

- November 1951, Cadby Hall Bakery Valuations
July 1953, Pilot payroll for bakeries

- July 1954 Decision to build LEO II

- November 1954 LEO Computers Ltd.

- December 1955, Pilot Ford payroll

- August 1959 Army and Air Force Officers payroll for 9000 on Hartree House Bureau (service bureau)

LEO II Installations

- 1 J. Lyons & Co. Ltd.   London   May 1957
- 2 W.D & H.O. Wills   Bristol   Sep 1958
- 3 Stewarts & Lloyds   Corby   Jun 1958
- 4 Ford Motor Co (parts)   Aveley   Dec 1958
- 5 Leo Computers Ltd   London   Jul 1959
- 6 Ministry of Pensions   Newcastle Nov 1959
- 7 British Oxygen Co.   Edmonton   Feb 1960
- 8 Standard Motor Co.   Coventry   Jul 1960
- 9. Ilford Limited (films)   Ilford   Nov 1960
- 10 W.D. & H.O. Wills   Bristol   Apr 1961
- 11 Ford Motor Co (payroll) Dagenham   Jan 1961

- May 1961 LEO III available for trials
- January 1962 LEO III timesharing trials
- #1 Leo Computers Ltd Machine Bureau
- 94 LEO III's installed (1967-1974)
- 1981 Post Office takes LEO 326s out of service after 12-15 years of operation.

British Computer Industry

- February 1963 LEO Computers Ltd. merges with English Electric

- October 1964 English Electric purchases Lyons' holdings; becomes English Electric LEO Marconi

- March 1967 Merger with ICT to form International Computing Limited (ICL)

Ferranti Electric, Inc.

- Mark I February 1951 (U of Manchester)
- 4000 vacuum tubes
- 12000 resistors
- 2500 capacitors
- Memory: 256 words in electrostatic storage
- The Ferranti Mark 1 was the world's first commercially available general-purpose computer. The first machine off the production line was delivered to the University in February 1951. It was replaced in 1958.
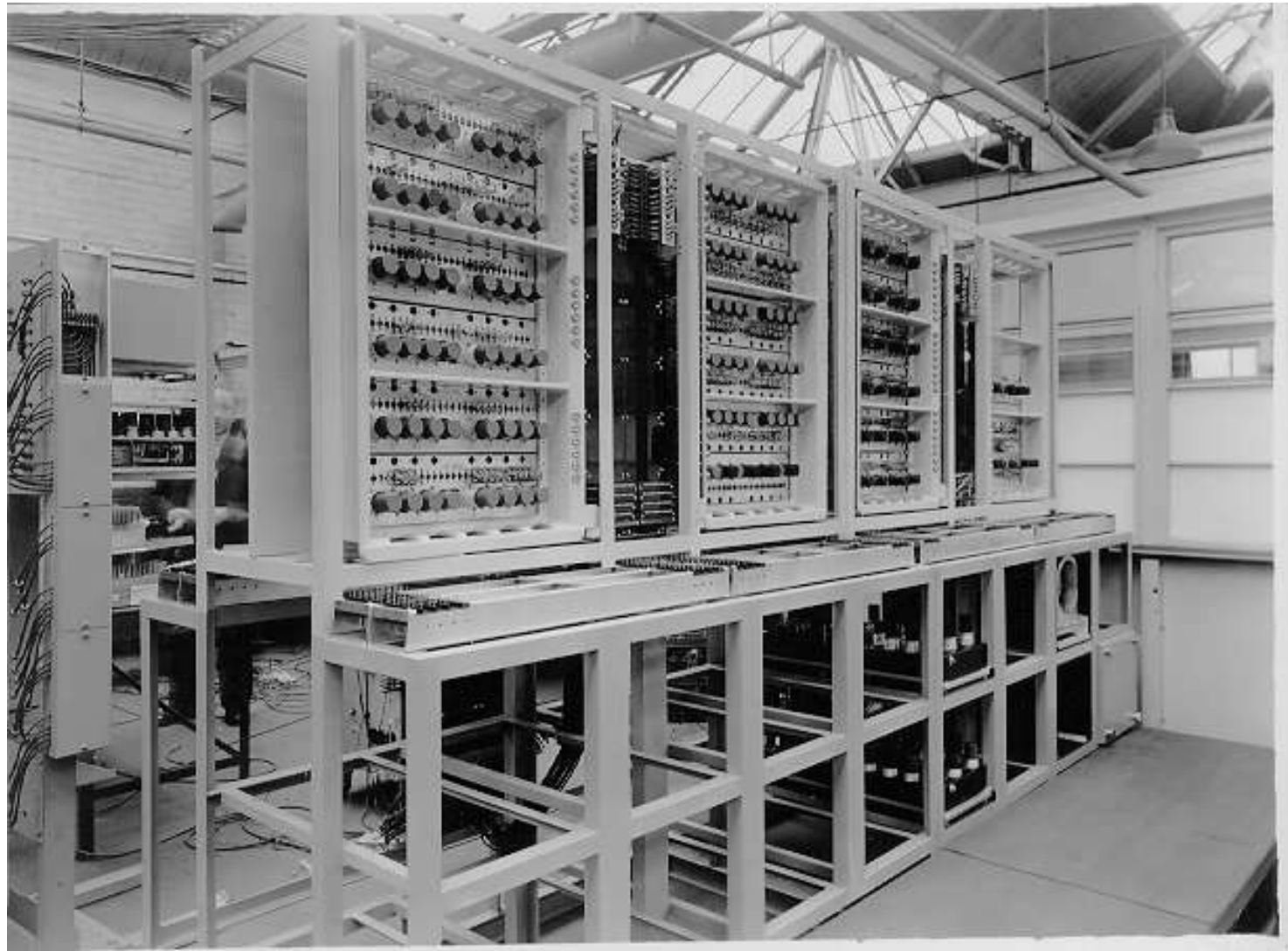
Manchester Mark I
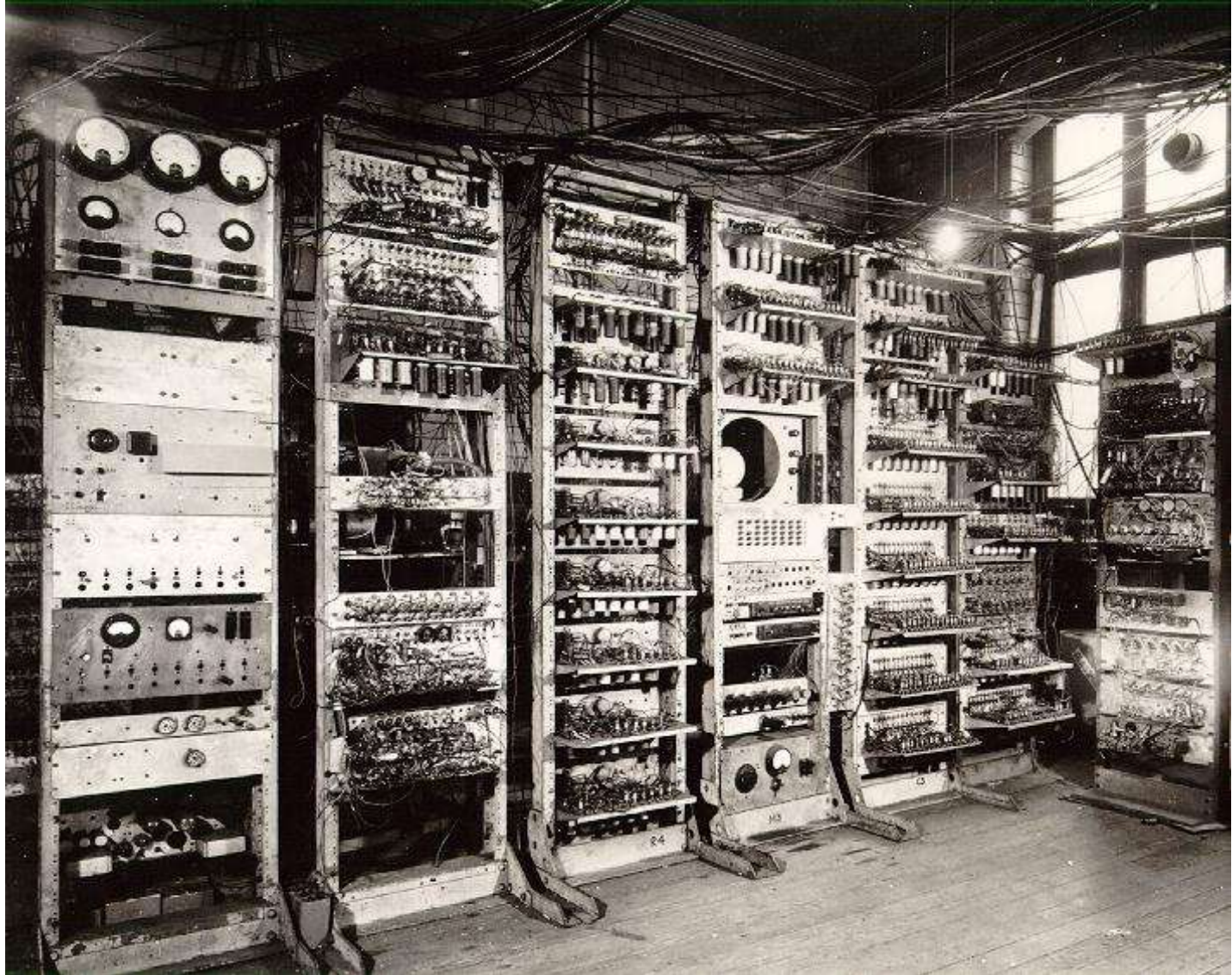
FERRANTI

The Manchester Universal
Electronic Computer

FERRANTI

18/7/49

Kilburn Highest Factor Routine (amended) —

Function	C	25	26	27	Line	0 1 2 3 4 5	13 14 15
-24 to C	$-b_1$	—	—	—	1	000 11	010
c to 26			$-b_1$		2	010 11	110
-26 to C	b_1				3	010 11	010
c to 27			$-b_1$	b_1	4	110 11	110
-23 to C	a	T_{acc}	$-b_n$	b_a	5	111 01	010
Subt 27	$a-ab_n$				6	1 011	001
Test					7	—	0 11
Add 20 to bl					8	00101	100	or 000
Subt. 26	r_n				9	01011	001
c to 25		r_n			10	10011	110
-25 to C					11	10011	010
Test					12	—	011
Stop	0	0	$-b_N$	b_N	13		111
-26 to C	b_n	r_n	$-b_n$	b_n	14	01011	010
Subt. 21	b_{n+1}				15	10101	001
c to 27	b_{n+1}			b_{n+1}	16	11011	110
-27 to C	$-b_{n+1}$				17	11011	010
c to 26			$-b_{n+1}$		18	01011	110
22 to bl.		r_n	$-b_{n+1}$	b_{n+1}	19	01101	000

20	-3	10111 etc
21	1	10000
22	4	00100

23	$-a$
24	b_1

	init.	final
25	—	$r_N (\to 0)$
26	—	$-b_N$
27	—	b_N

or 10100

Replica: Computer Conservation Society

http://www.computer50.org/mark1/gal3.html
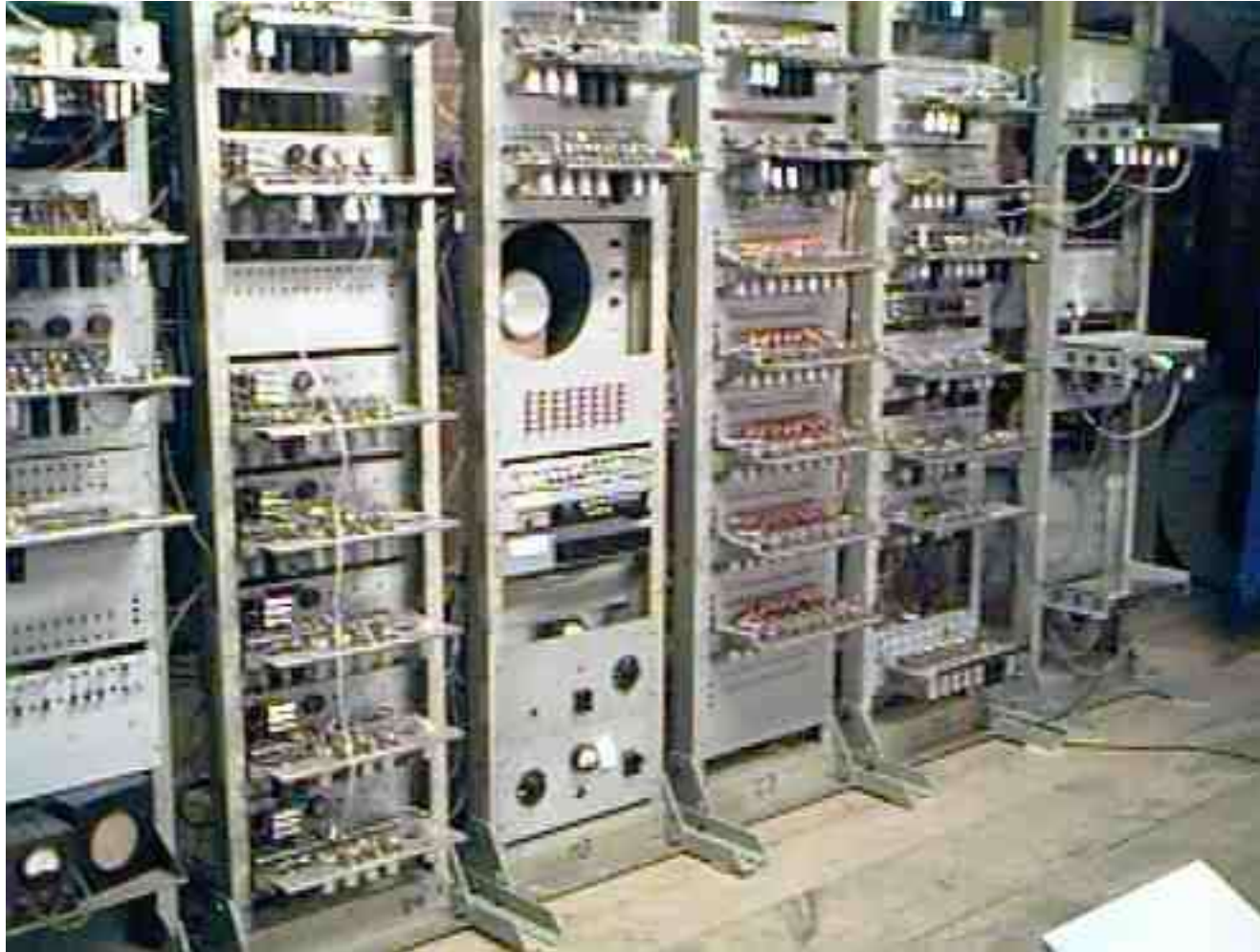
Milestones

- **February 1951 First Ferranti Mark I delivered to Manchester University**

- **March 31, 1951 First UNIVAC delivered to US Census Bureau**

- Spring 1952, MANIAC and ORDVAC copies of the IAS machine are operational

- June 1952 *IAS machine operational*

- 1952 *EDVAC finally finished*

- *Core memory installed on Whirlwind and ENIAC*

Early IBM Machines

- Naval Ordnance Research <u>Calculator</u> (NORC)
  - *the most powerful and effective calculator which the state of the art would permit.*
- Memory: 264 Williams Tubes
- Addition: 15 microseconds
- Multiplication: 31 microseconds
- Parts: 9000 vacuum tubes, 25000 diodes
- Finished: 1954   Active until 1968
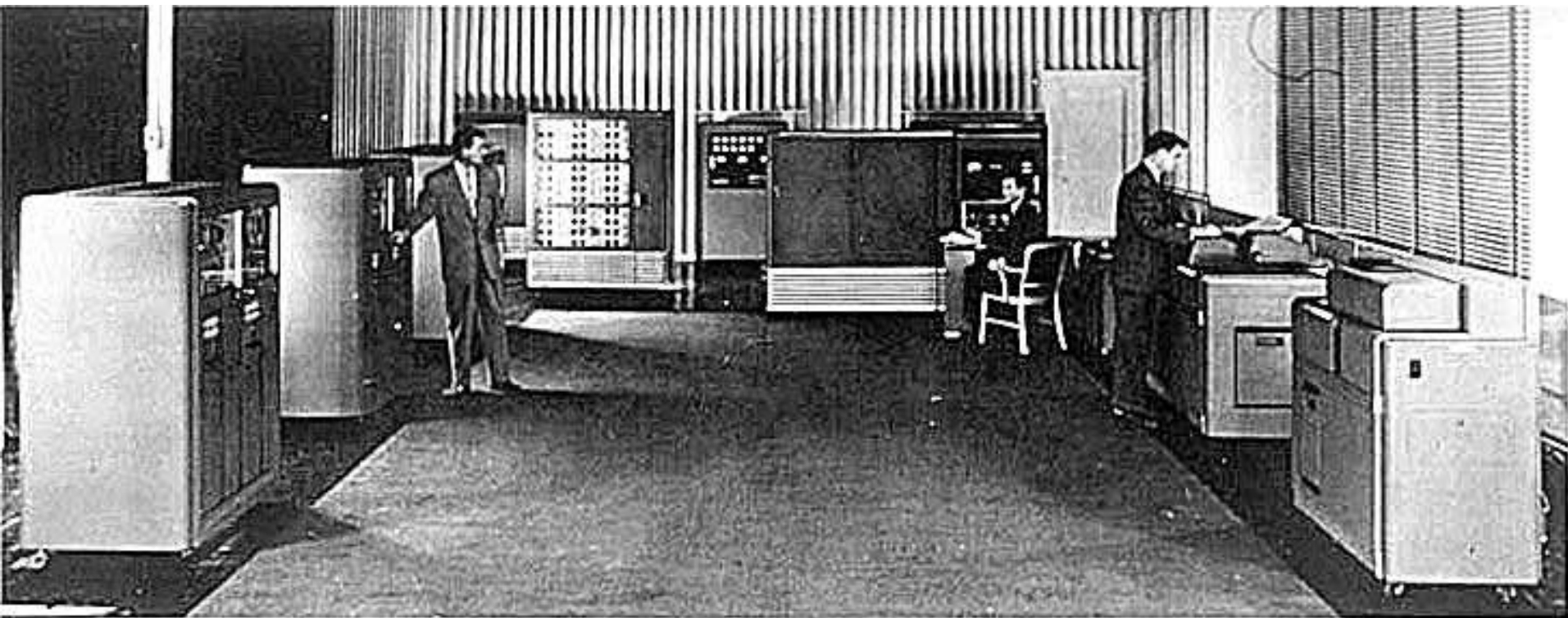
# IBM 650 (drum based)

IBM 650 Console
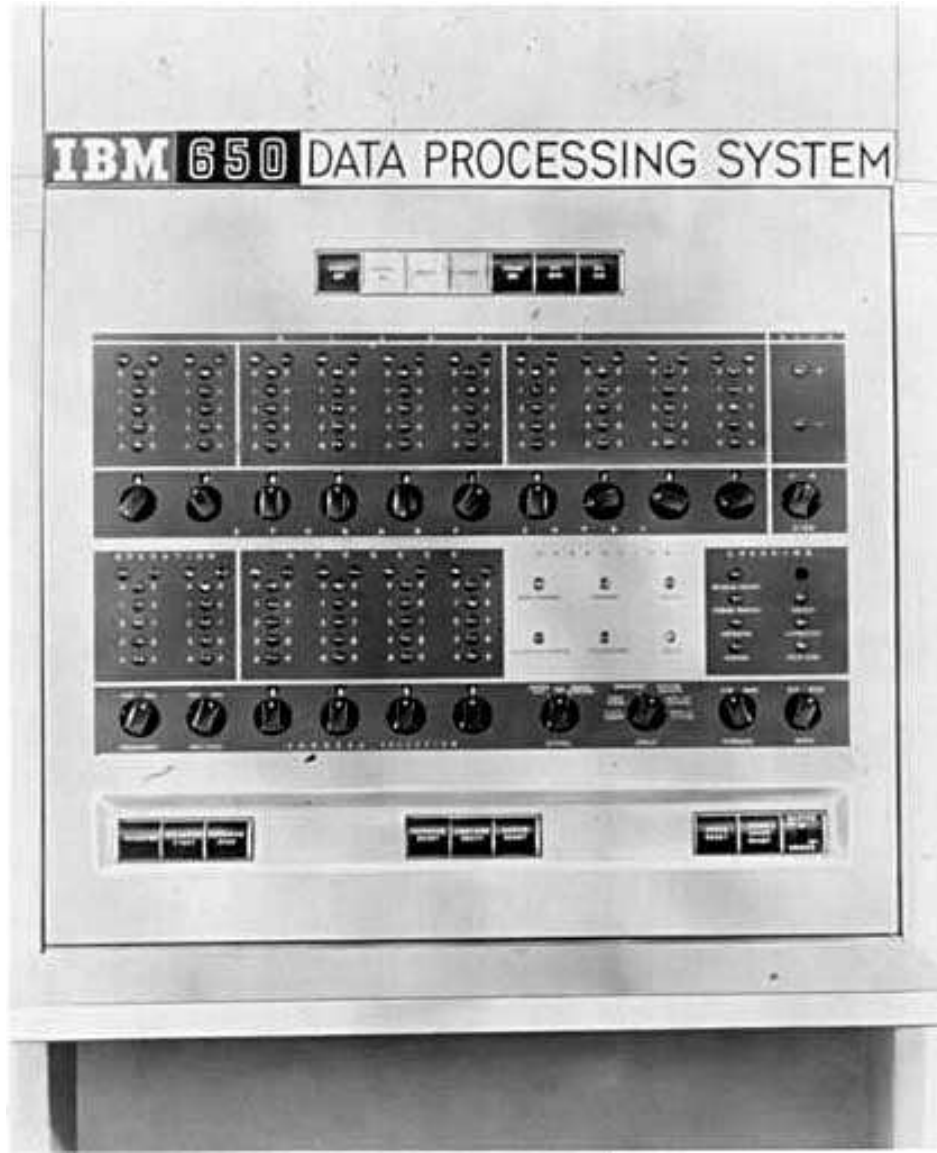
IBM 701 (Defense Calculator)

- Addition time: 60 microseconds

- Multiplication: 456 microseconds

- Memory: 2048 (36 bit) words using Williams tubes

- Secondary memory:

  – Magnetic drum: 8192 words

  – Magnetic tape: plastic

- Delivered: December 1952: IBM World Headquarters (total of 19 installed)

IBM 701(Defense Calculator)

IBM ELECTRONIC DATA PROCESSING MACHINES—TYPE 701
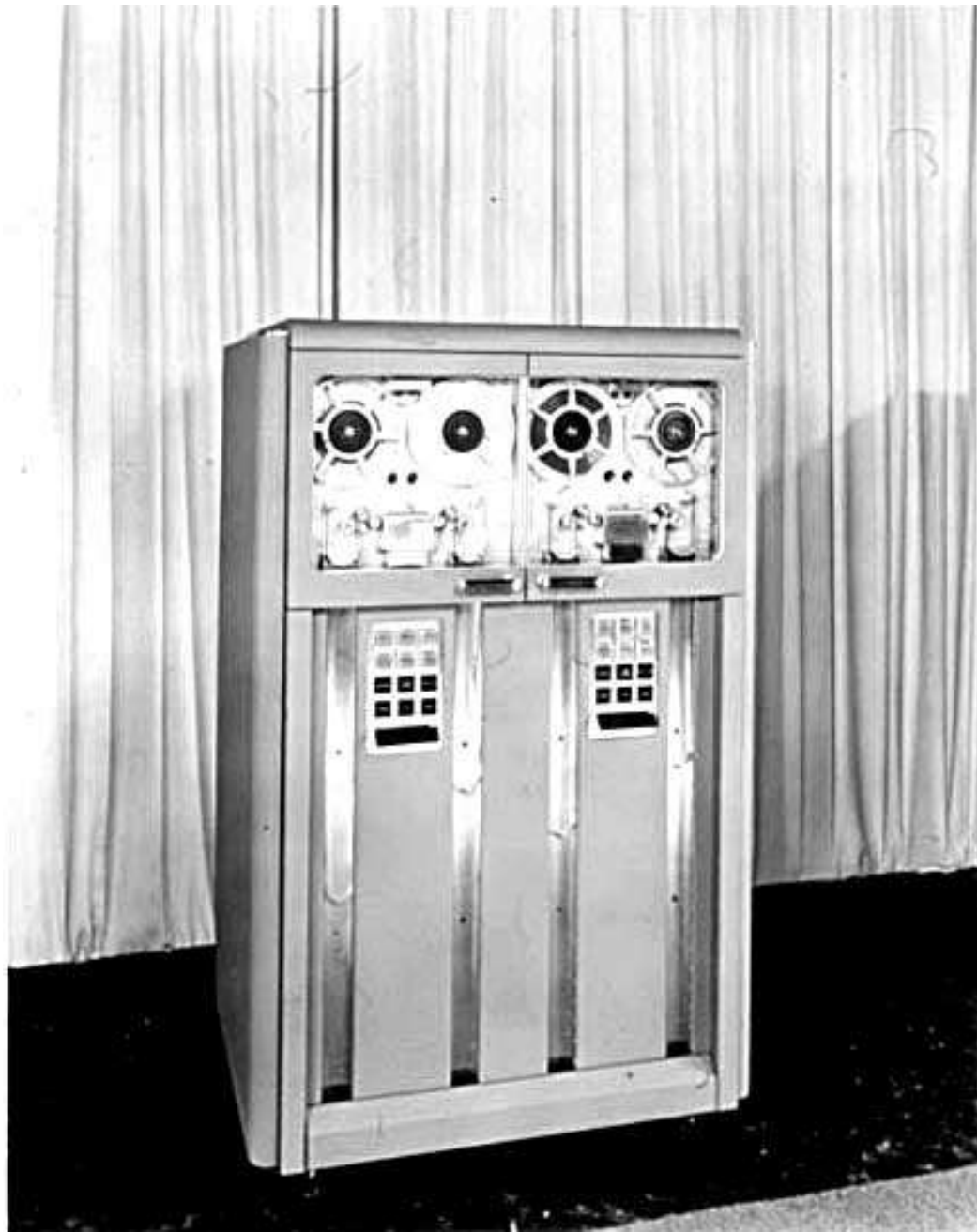
IBM 701 (Defense Calculator)

T.J. Watson at console; *IEEE-CS timeline*

- Only nineteen 701s were manufactured (the machine could be rented for $15,000 per month). The first 701 went to IBM's world headquarters in New York. Three went to atomic research laboratories. Eight went to aircraft companies. Three went to other research facilities. Two went to government agencies, including the first use of a computer by the U.S. Department of Defense. Two went to the Navy and the last machine went to the U.S. Weather Bureau in early 1955.

- The 701 had electrostatic storage tube memory, used magnetic tape to store information, and had binary, fixed-point, single address hardware. The speed of the 701 computers was limited by the speed of its memory; the processing units in the machines were about 10 times faster than the core memory. The 701 also led to the development of the programming language FORTRAN.

Expansion to market

- IBM 702 Commercial calculation
  - first delivered in 1955
- IBM 704 Magnetic core memory
  - replacement for the IBM 701
- IBM 705
  - first delivered in 1956
- IBM 709
  - first delivered in 1958

UNIVAC Family Tree

- 1946 ENIAC
- 1950 BINAC
- 1951 UNIVAC
- 1952 UNIVAC 1101
- 1960 UNIVAC 1105
- 1964 UNIVAC 1108
- 1969 UNIVAC 1106

UNIVAC I

UNIVAC 1107
at Case Institute of Technology

First Generation (1951-1958)

- 1952 to 1957
- stored program: vacuum tubes
- large electronic storage
- introduction of core storage
- buffering
- random access
- FORTRAN

Transistor

- William Shockley starts research on semiconductors at Bell Labs in 1939 with the idea "that it should be possible to replace vacuum tubes with semiconductors"

- William Shockley, Walter Brattain, and John Bardeen announce the transistor in 1948 (they win the Nobel prize in 1956)

Second Generation (1958-1964)

- 1958 Philco introduces the TRANSAC S-2000
  - first transistorized commercial machine
- IBM 7070, 7074 (1960), 7072(1961)
- 1959 IBM 7090, 7040 (1961), 7094 (1962)
- 1959 IBM 1401, 1410 (1960), 1440 (1962)
- ALGOL, COBOL

IBM 1401 Data Processing System

Euphemisms

- IBM and the BUNCH:
  - Burroughs
  - Univac
  - National Cash Register (NCR)
  - Control Data (CDC)
  - Honeywell
- Snow White and the Seven Dwarfs:
  - RCA (Radio Corporation of America)
  - General Electric (GE)

Third Generation (1964-1971)

- April 1964 IBM announces the System/360
  - solid logic technology (integrated circuits)
  - family of "compatible" computers
- 1964 Control Data delivers the CDC 6600
- nanoseconds
- telecommunications
- BASIC

IBM System/360

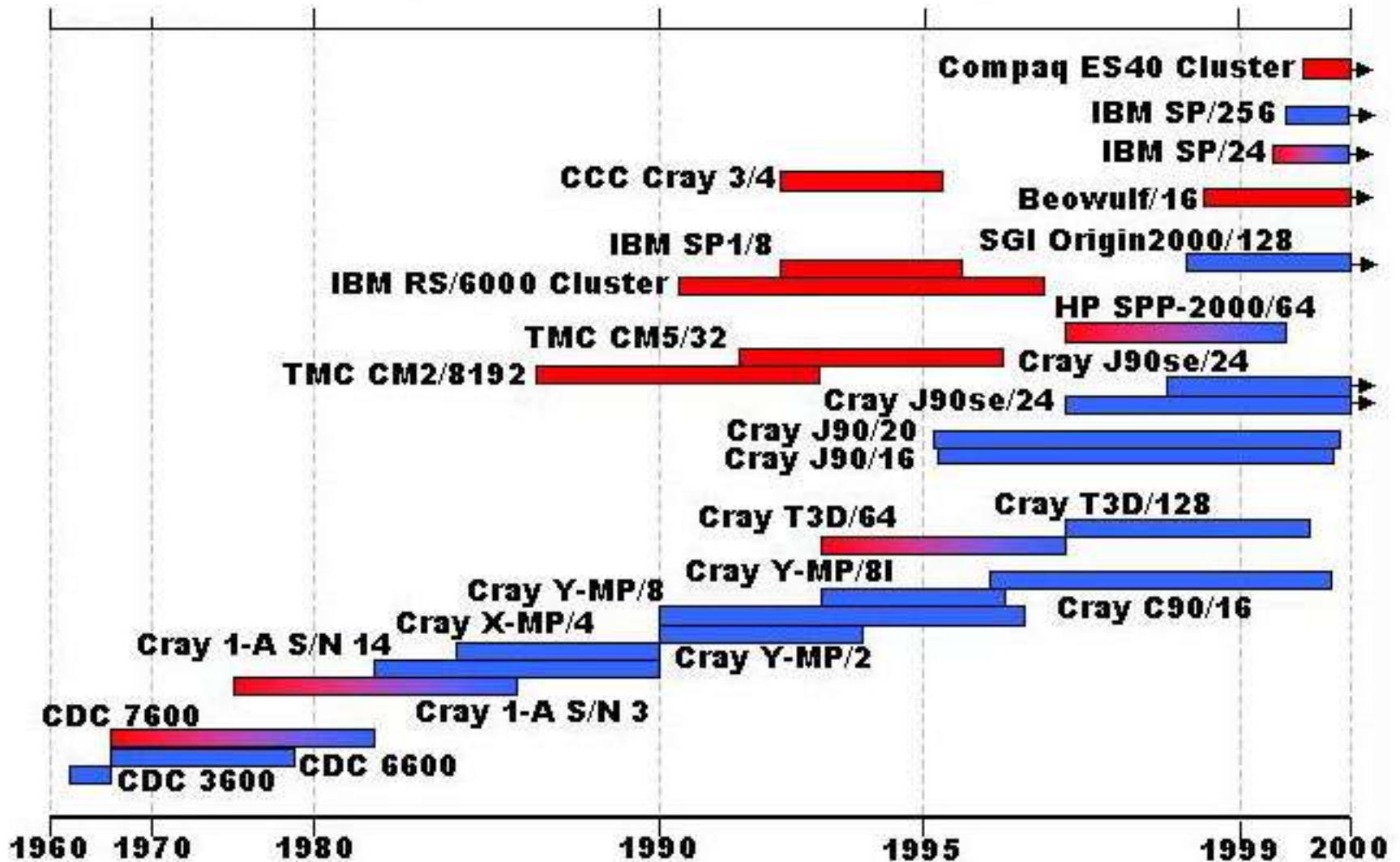GV20-9329   Design Model

IBM's Billion Dollar Gamble

- Model 30 750 nanoseconds cycle time
- Model 40 625 ns 19-32 mil core
- Model 50 500 ns
- Model 65 200 ns   13-21 mil core
- Model 75 195 ns
- Model 95 60 ns   magnetic film memory

CDC 6600

History of Supercomputing at NCAR

Source: www.scd.ucar.edu/computers/gallery/index.html

Fourth Generation (1971-)

- Large scale integrated circuits (MSI, LSI)
- Nanoseconds and picoseconds
- Databases (large)
- Structured languages (Pascal)
- Structured techniques
- Business packages

THE COMPUTER TREE

References

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- David E. Lundstrom, *A Few Good Men from Univac*, MIT Press, 1987

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- Emerson Pugh, et.al., *IBM's 360 and Early 370 Systems*, MIT Press, 1991

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- Hendry, *Innovating for Failure: Government Policy and the Early British Computer Industry*, MIT Press, 1989.

Show and Tell

- Martin Weik, BRL Report No 971.
- UNIVAC metal tape
- UNIVAC wooden models and brochures
- UNIVAC module
- Punched Card Data Processing Annual, 1952
- IBM 1401 Models
- IBM System/360 Models