where did computing come from?

why does it have the elements it has?

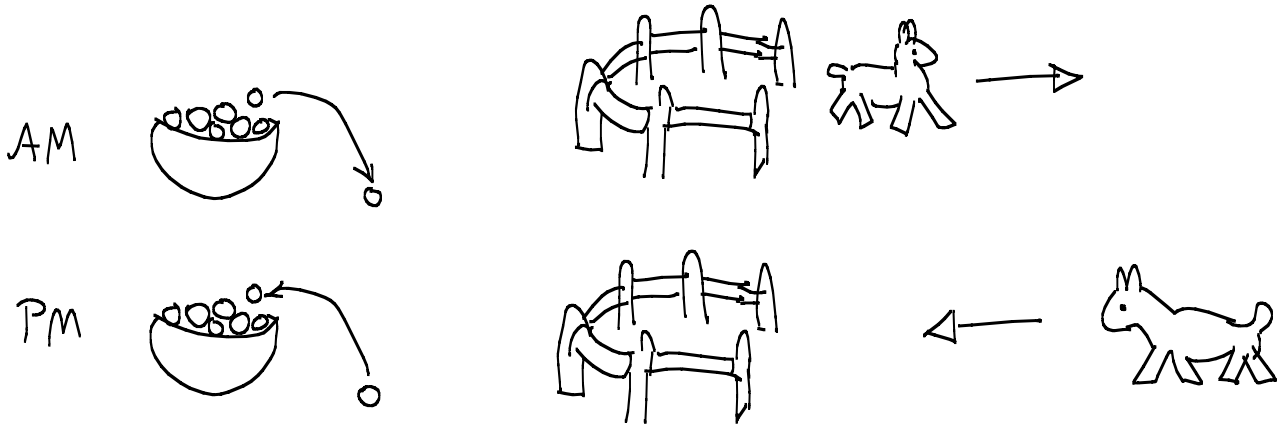
what is computing?

Is computer science, science? What does it study?

- Is that natural phenomena?
- what is information?

History

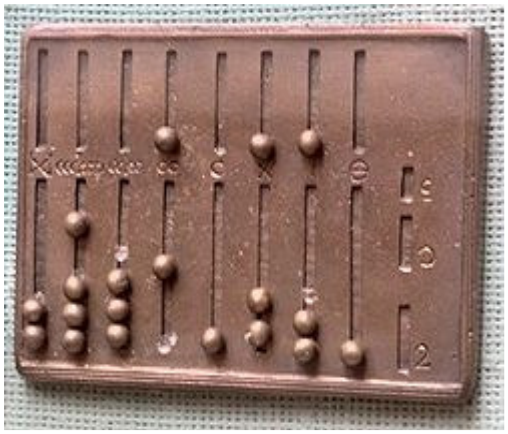
Aids/extensions of cognition?



Decision process: look for lost sheep?

- representation (essentially?)
- information (?)
- transformation/process (?)

Abacus, Sumerian, 2700 BCE



numbers base 60: divisible by 2, 3, 4, 5, 10, 12

base 16

Babylonia, Egypt, China, India, Maya, Inca,

...

Antikythera mechanism

Greek, 150 BC

Planetary positions

geared clockwork

— digital (?)

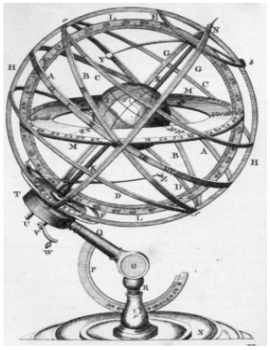
Greek Astrolabe

150 BC

Solar system calculations

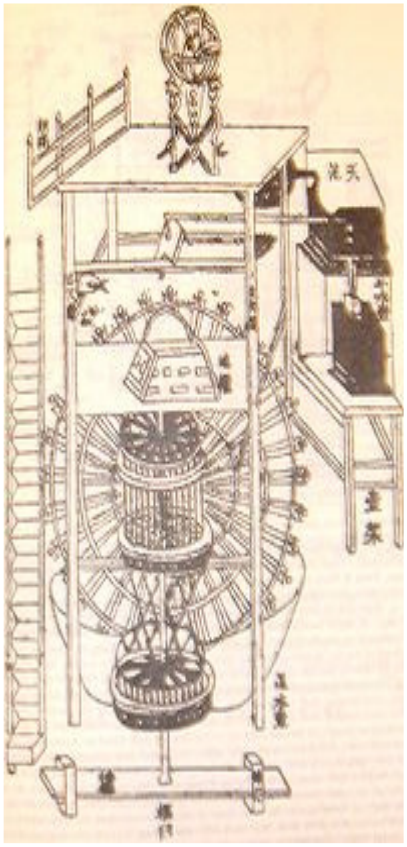
Time

analog



Chinese water-powered

Armillary, 750 AD

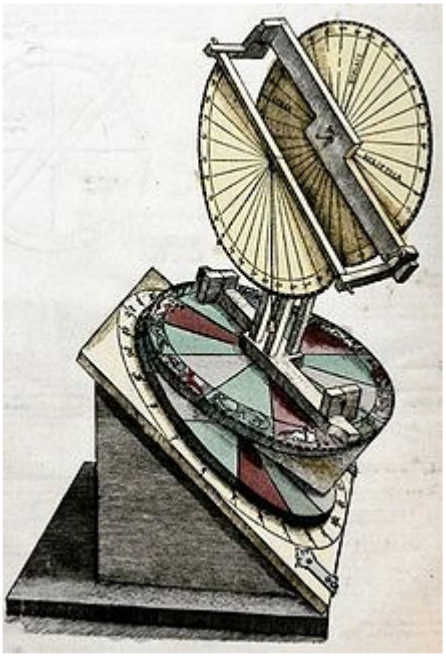


Chinese Water-tower Clock

1,000 AD

~1200 AD Islamic geared

Calender, Astrolabe



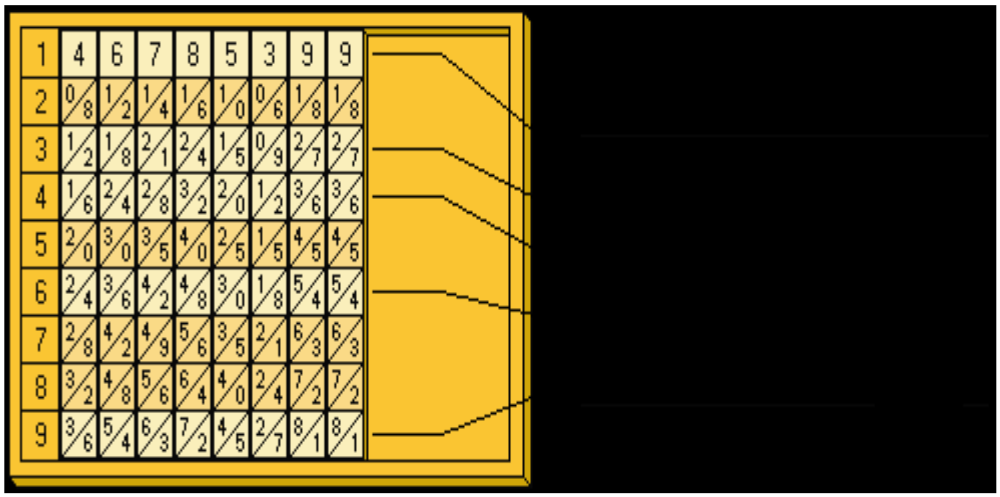
~1300 AD

Programmable analog calendar

1600

Napier's Bones

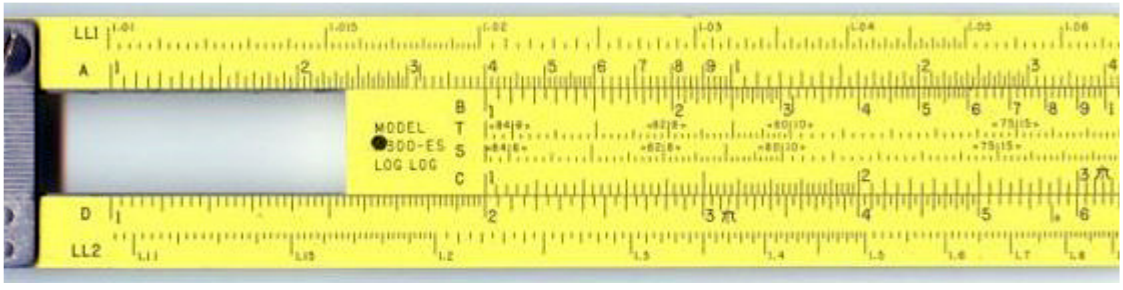
Multi / Div



1	4	6	7	8	5	3	9	9
2	0/8	1/2	1/4	1/6	1/0	0/6	1/8	1/8
3	1/2	1/8	2/1	2/4	1/5	0/9	2/7	2/7
4	1/6	2/4	2/8	3/2	2/0	1/2	3/6	3/6
5	2/0	3/0	3/5	4/0	2/5	1/5	4/5	4/5
6	2/4	3/6	4/2	4/8	3/0	1/8	5/4	5/4
7	2/8	4/2	4/9	5/6	3/5	2/1	6/3	6/3
8	3/2	4/8	5/6	6/4	4/0	2/4	7/2	7/2
9	3/6	5/4	6/3	7/2	4/5	2/7	8/1	8/1

1620

Slide Rule uses logs: multi/div → add/subtract analog

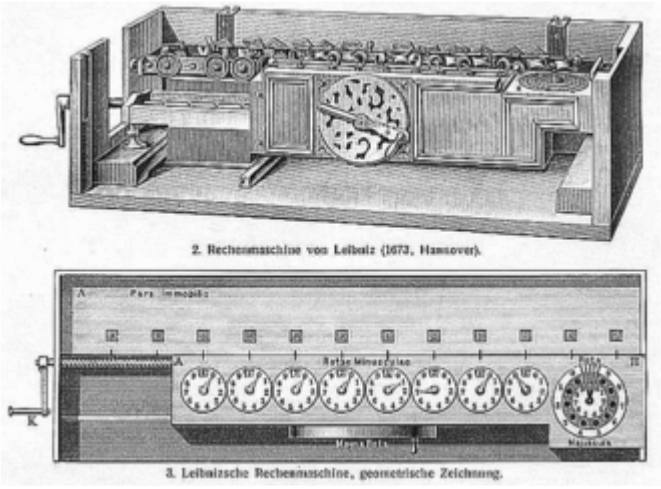


1642 Pascal's calculator

1672 Leibniz's

Stepped Reckoner

– digital



1801 Jacquard's

Programmable loom

– punched cards = program

1820 de Colmar's

Arithmometre

logs / exponential

Trigonometry

1835 Babbage's

Analytic Engine

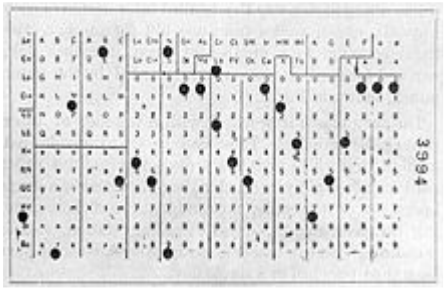
– programmable (branching, loops)

Lovelace → programs for Bernoulli Numbers

1889 Hollerith's

Punched-card info storage

Ekhart → differential eqn.s



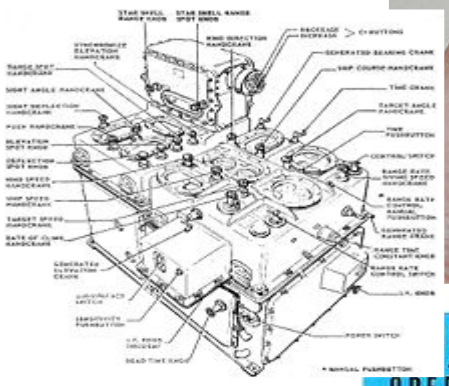
Census data compilation
Sorting / counting

(Von-Neumann → stored program arch.)

~ 1930s

Analog

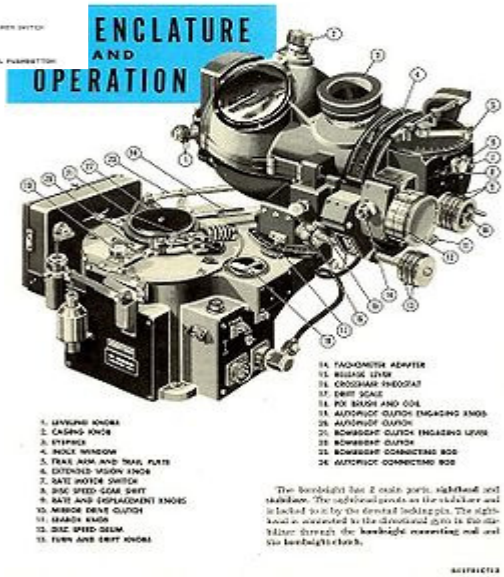
Mark I
Fire Control
Computer



~ 1930 Water Integrator, USSR

diff. eqn.

Norden
Bombsight



1836 – 1930 Differential Analyzer

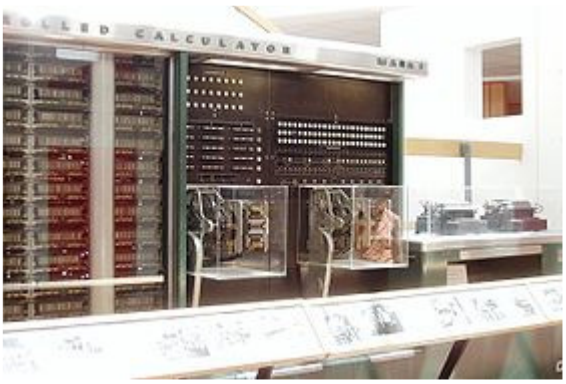
Coriolis
Thomason
Kelvin
Pollen
Bush
Zuse

Integration
differentiation

1944 Aiken's electro-mechanical
IBM mark I

Grace Hopper → bugs

Artillery Gunnery Tables

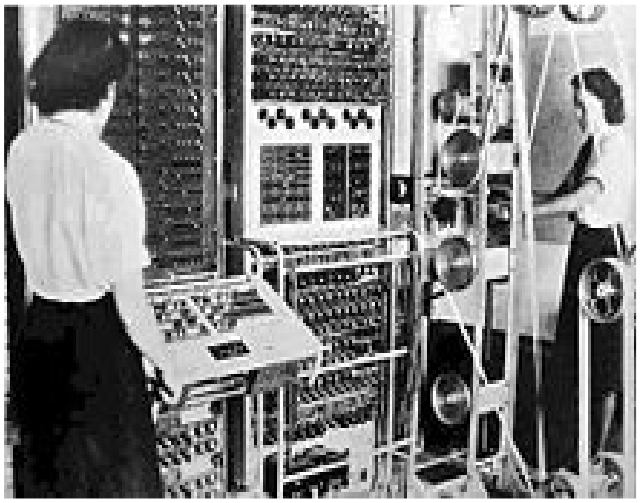


1936 Turing ⇒ Mathematical Model of "Computation"

Church, Kleene, Post

– WWII Code Breaking
– Enigma EN/DE –coder

– Collossus
Electrical
w/ paper
Tape
a "guessing"
machine
for code cracking



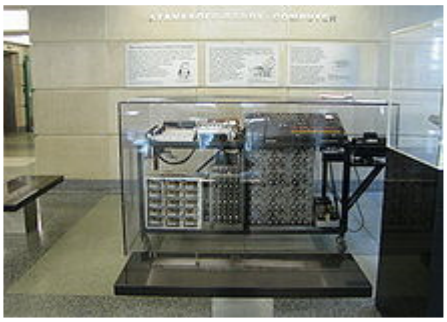
1941 Zuse's
electro-mechanical

(later, 1st Turing Complete + language)

Binary, Floating Point
calculator w/ loops
30,000 machined parts
too hard to build

Atanasoff-Berry Computer
1st electronic digital computer
300 vacuum tubes

Capacitor/drum storage



linear equations, not programmable

Shannon: applies Boolean Algebra

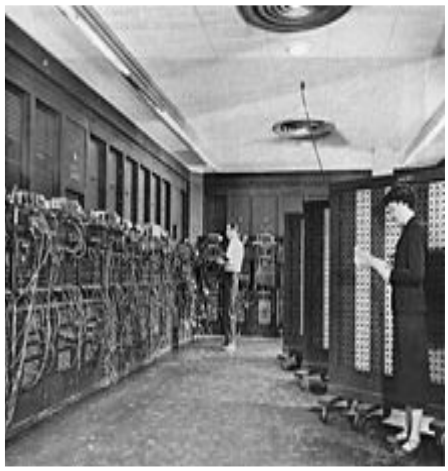
Stiblitz: remote control by telephone/Teletype

1945

Eckhart, Mauchly ⇒ ENIAC, EDVAC

1st Electronic, General Purpose

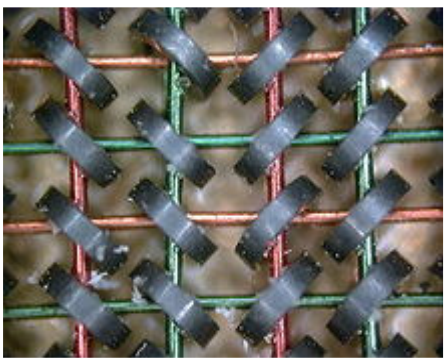
-- add/subtract 5000/s,
(1000 times faster than any other machine. Colossus couldn't add).
-- multiply, divide, and square root modules
-- High speed memory: 20 words (about 80 bytes)
-- 30 tons
-- 18,000 vacuum tubes

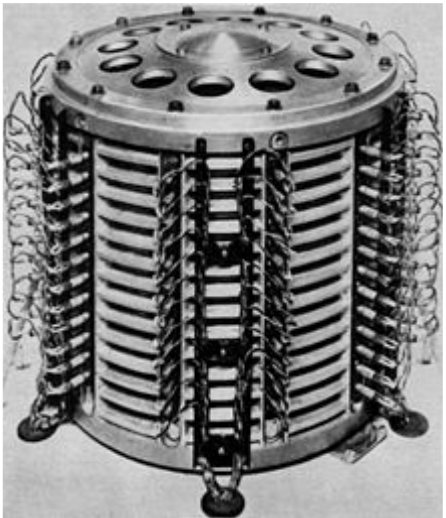


Patch-cable programming, Memory = mercury acoustic delay

---

magnetic
Core memory





Manchester Mark I

magnetic drum storage

1947

Transistor ⇒ miniaturization

1954 Silicon Transistor

SSI

MSI

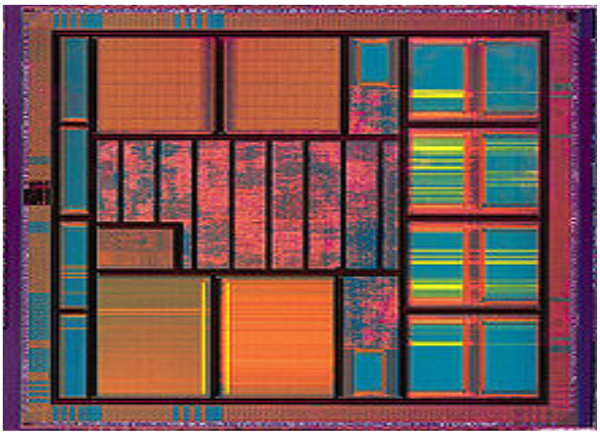
LSI

1970 VLSI

ULSI

SOC

WSI



ATMEL System on a chip

flash-based μ-controller

Bigger/Smaller

Faster

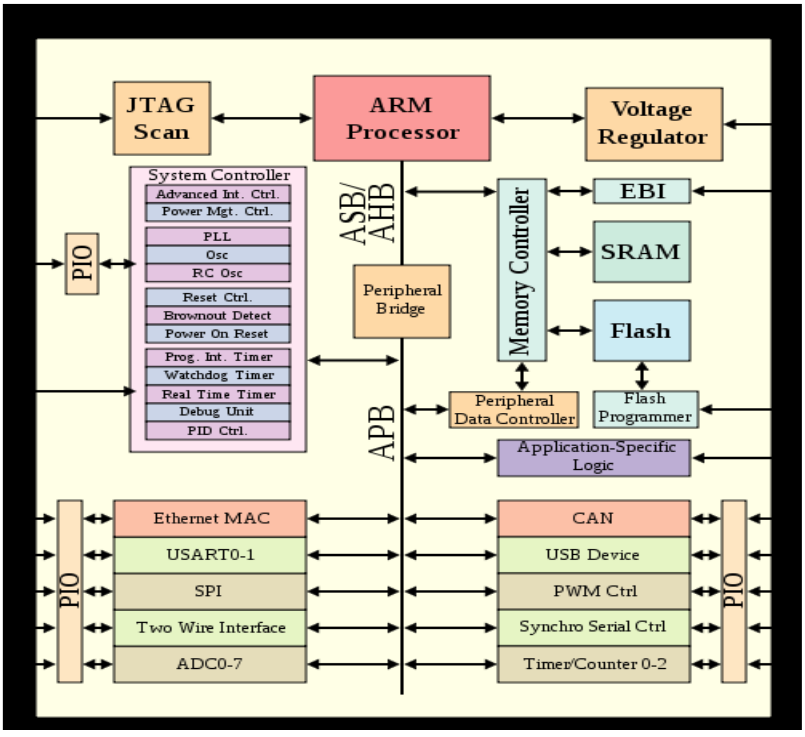
cheaper

more reliable

less power

Valuable

⇒ makes CS interesting

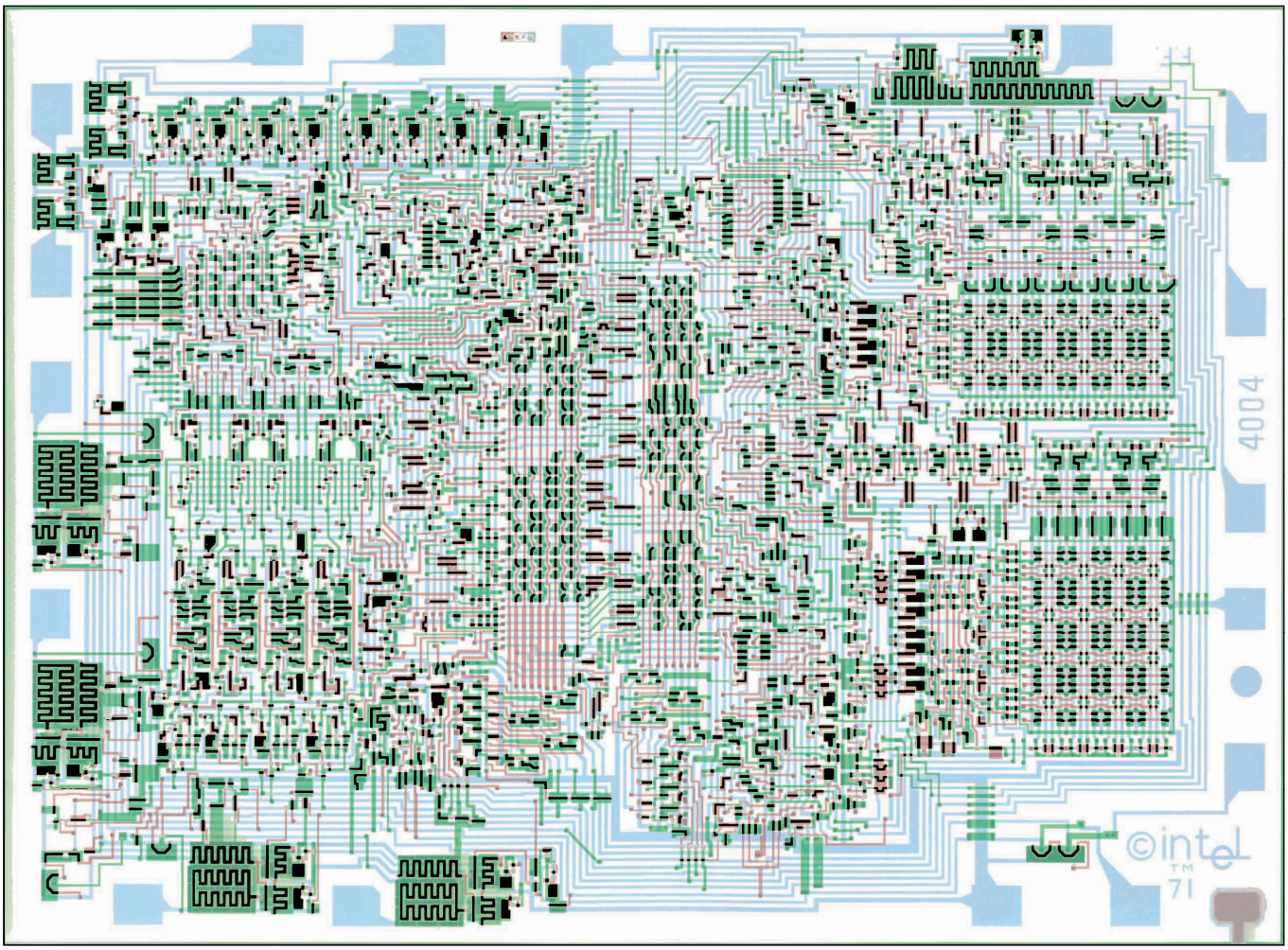


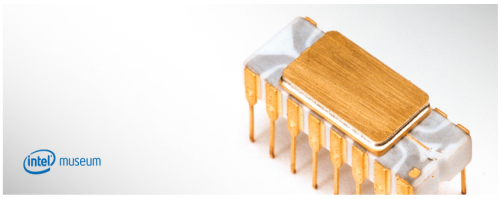
intel
4004

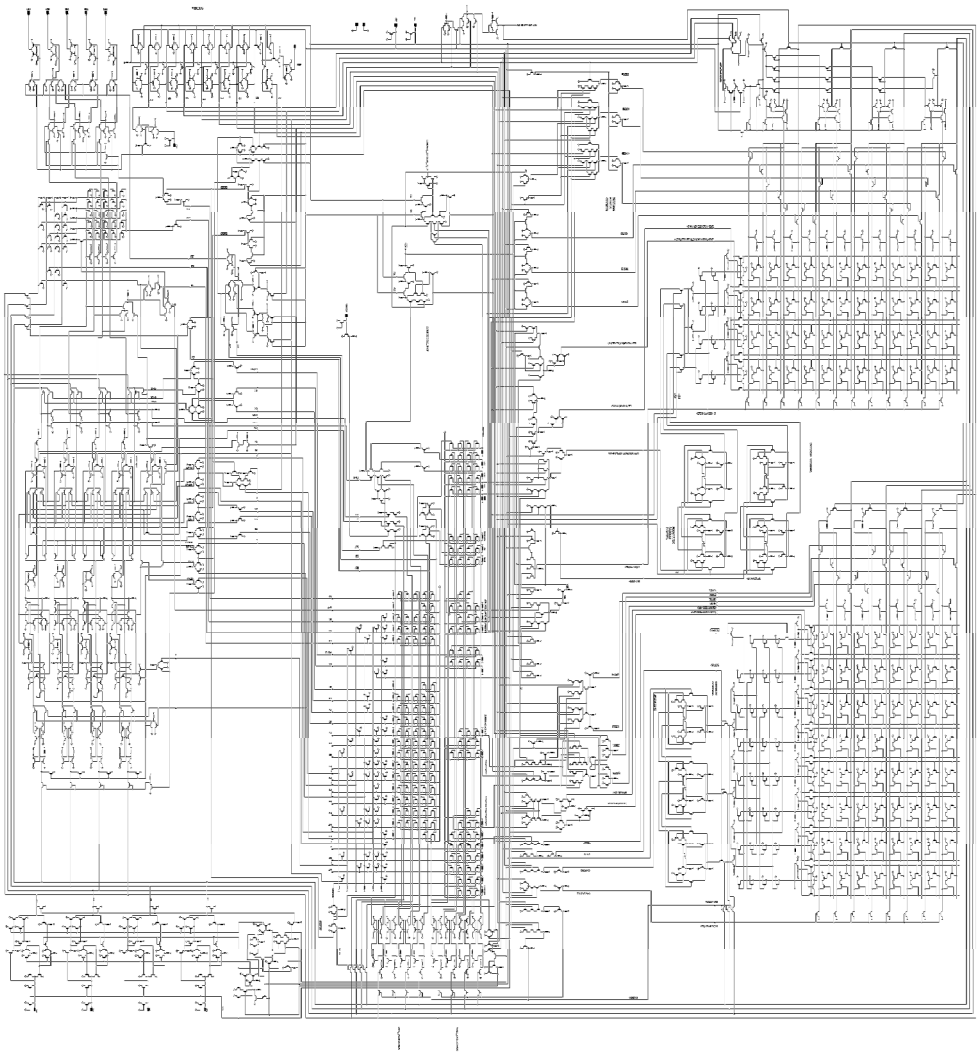
1970

1st
integrated
CPU

2,300
Transistors





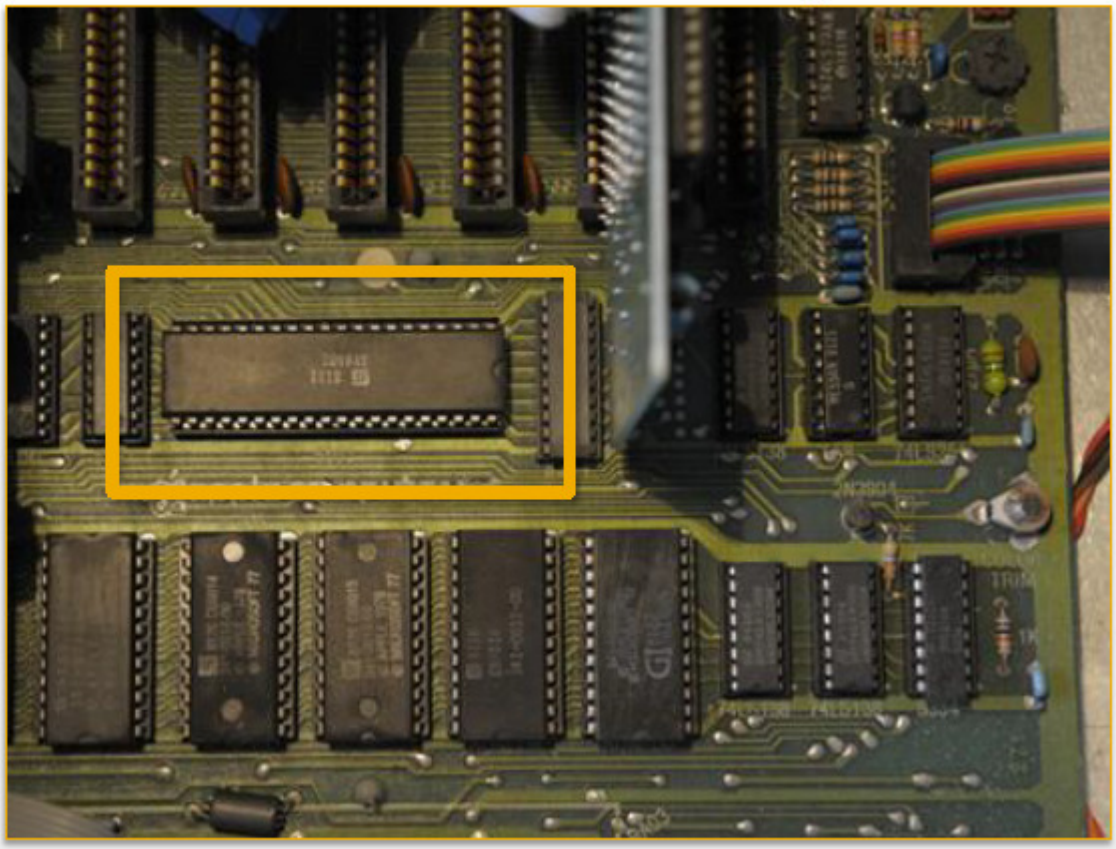


http://visual6502.org/docs/6502_in_action_14_web.pdf

MOS Technology's 6502 CPU

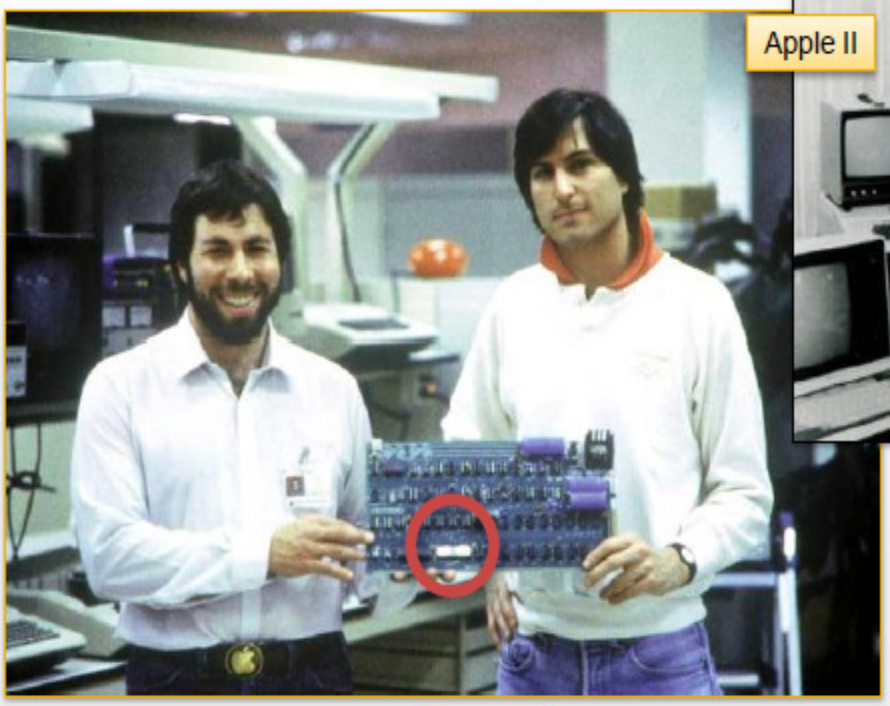
Released 1975
Apple I, II
Commodore PET, C64
Atari 2600 (6507)
Atari 400, 800
Nintendo NES

Apple II Plus motherboard



6502-based Personal Computer

Steve Wozniak, Steve Jobs



Apple I

[Klein] CCL 1.3

Paul Allen, Bill Gates

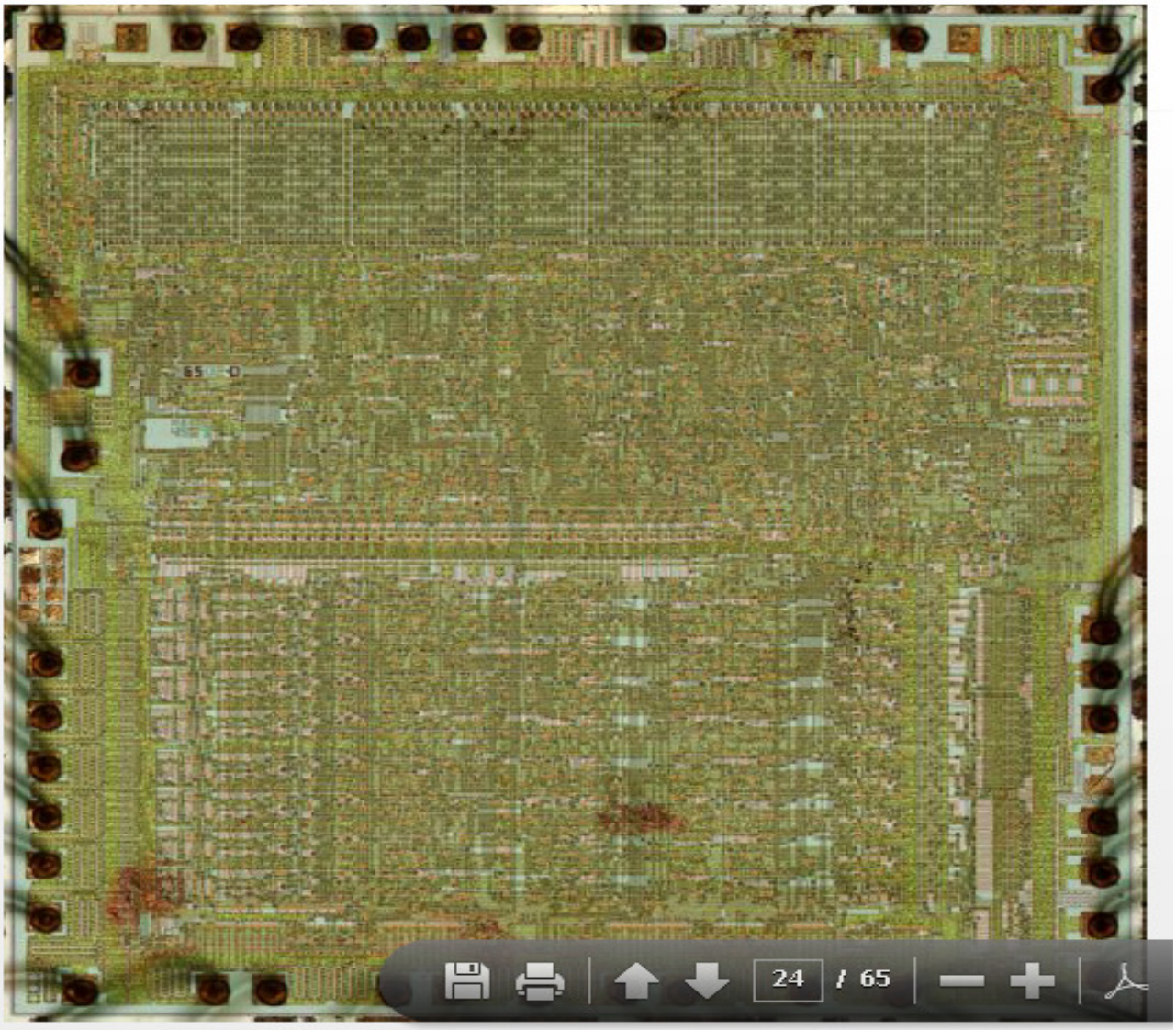
Apple II

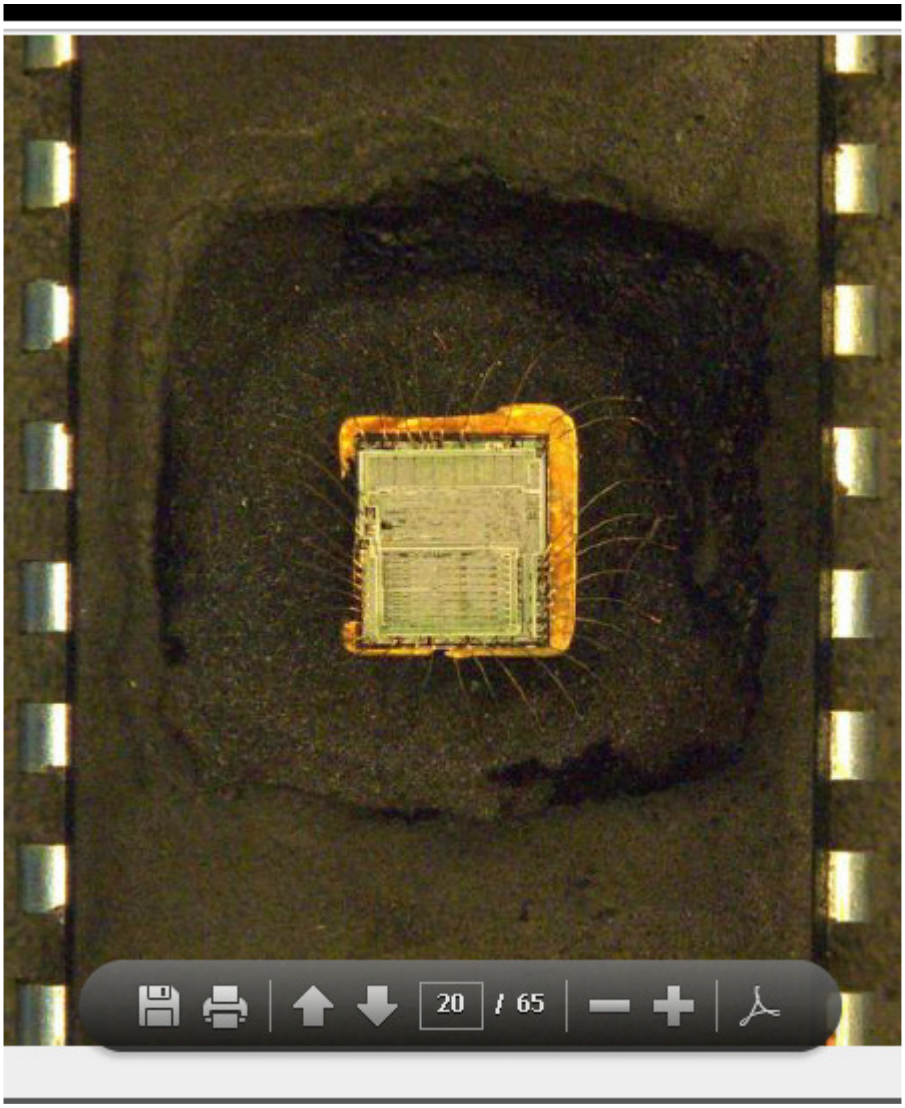
[Klein] CCL 1.3

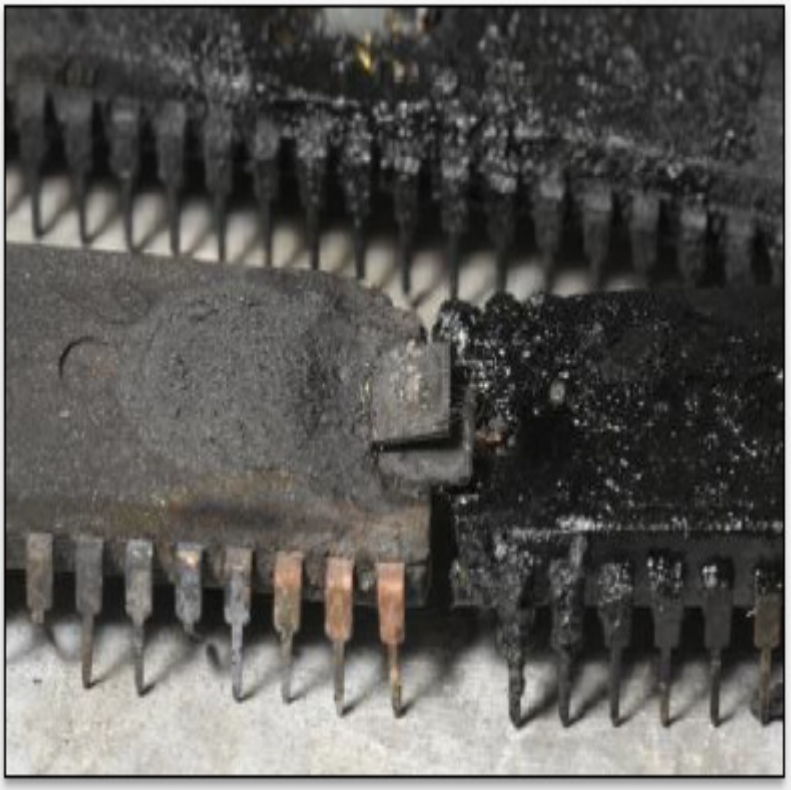
Commodore PET

Chip Design by Hand, c.1976

- No digital representation
- Designs lost
- No computer optimization
- Interesting physical features




20 / 65



Beyond Numerics | TM, formal languages, proposition checking (Leibniz, Frege, Russell, Hilbert)

VOICE ENCODING ⇒ Video, audio, sonar, radar, .. signal processing (filters)

ENCRYPTION

networks, radio, optical, ...

embedded in machines of all types

Learning/parsing/translation/theorem proving/game playing

Machine control, robotics

instrumentation: transform data to human accessible form

sensing, modeling

design, test

finance, banking, auctions, buying/selling, advertising

Web, data repositories, webs of connectivity, cooperative processes

chess

Jeopardy

checkers

go

Tic/Tac/Toe

The extended mind

feynman