Computing's Greatest Hits

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A Short History of Digital Info

- One goal of CS Principles is to understand how computers and digital information are "game changers," how they *create* opportunities
- I start that by highlighting progress of "data processing" over last 120 years or so (it's very incomplete)

- Think back to the days when we used quill pens and did everything by hand
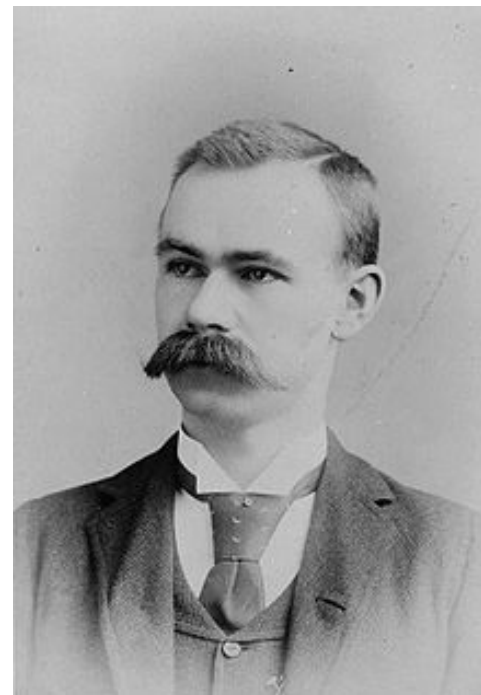
We Consider only BIG Milestones

- Digitization – make information machine readable
- Electronic computers – a machine with "soft" programming
- Transistor – a switch with no moving parts
- Integrated circuits – logic + connective circuits created together by photolithography
- "Personal" computer make everyone digital
- Internet – connected computers are better
- WWW – one universal language (http) lets us communicate!

The Problem with Writing ...

- Only **people** can read it ... [Though recently, *some* progress in handwriting analysis has occurred; limited use.]
- First serious advance in digitization: punch cards
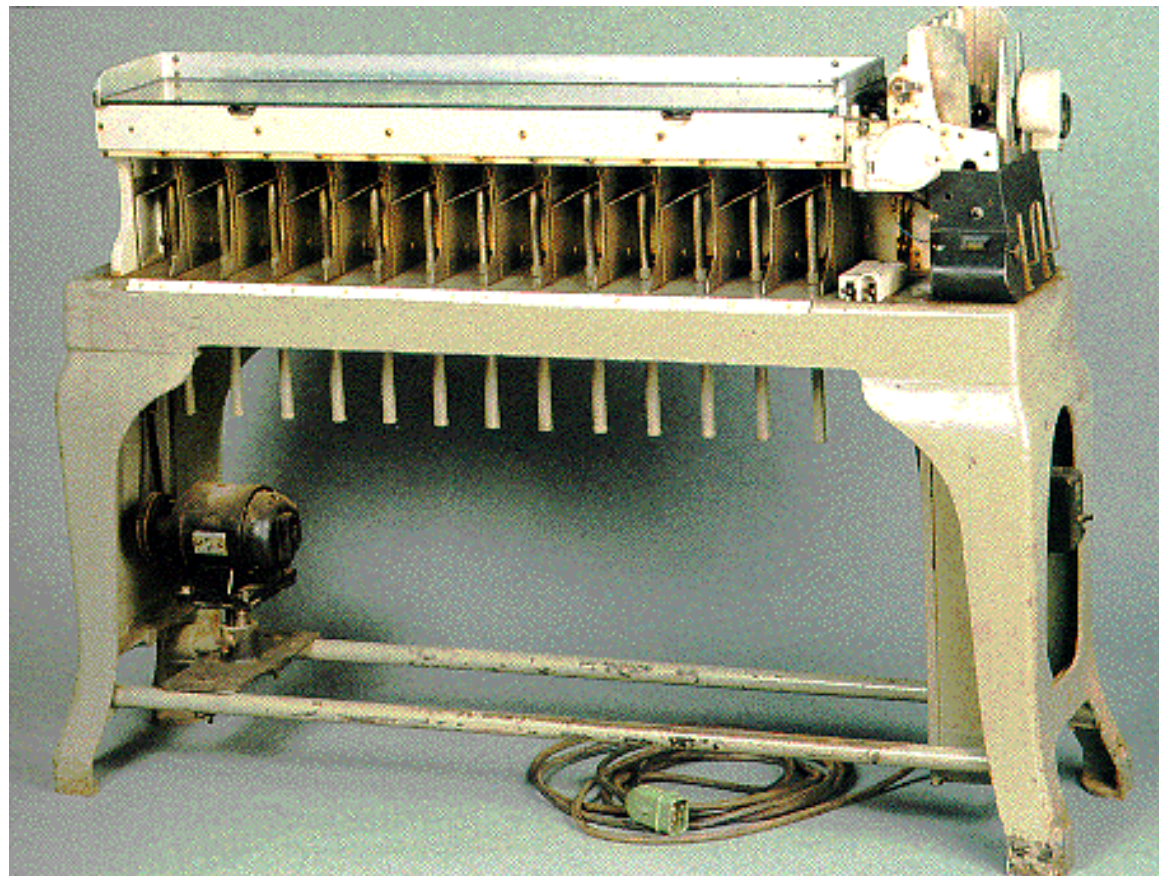- Herman Hollerith develops idea for 1890 census

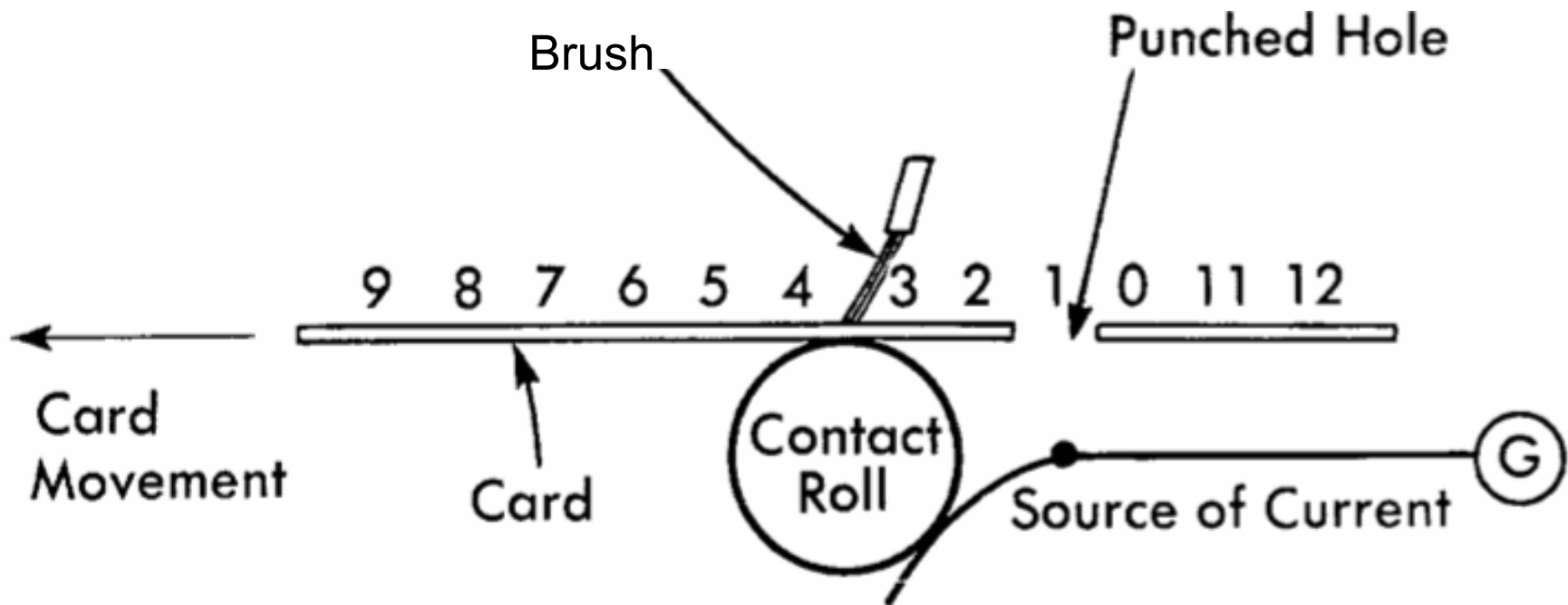Hollerith Card, Courtesy IBM

Machines Process Digital Data

- Mechanical methods – sensing a hole in a card or not – allows machines to help w/work

Card Sorter
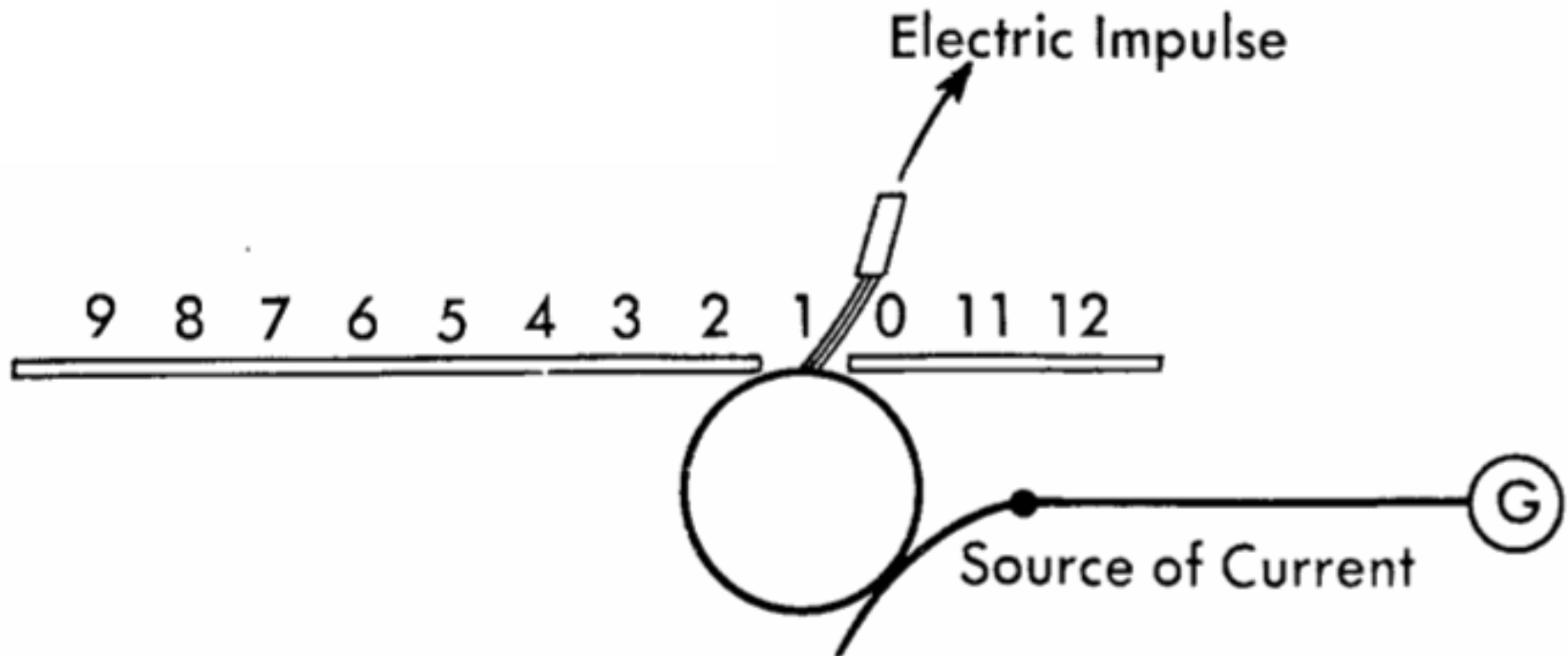It's **not** a computer!

No Computer Needed To Process Data

- A mechanical machine can "read" a card with … a "metal brush" … notice card motion

Sensing Punch Allows Some Action

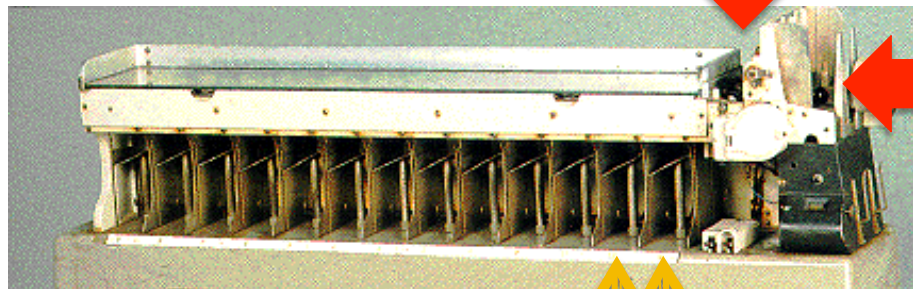- When the circuit closes, some mechanical action can happen

Computing w/o Computers

- Suppose Hollerith coded men as 0, women a 1

How many men and women in the population?

card counter

census data

Machine Reads Cards,
   Puts women in this slot
   Puts men in this slot
… producing 2 piles
Run each pile through again
   just to count them -- done

Meanwhile, w/o Digital Data

- Poor Kermit must go through census sheets, counting (and probably making mistakes)

The message: "Digitizing" makes information discrete, it's either there (1) or not (0), and a machine can determine that fact using mechanical or electronic means. Once data is digital, it is just a matter for engineers to build more capable machines

Next Big Things … Very Big!

- Electronic computers came just after WWII

ENIAC

By Mid 20th Century ~ 1960

- Large and medium-size companies used card based digital data; **mechanical** processing
- Computers began to replace mechanical b/c a computer's "processing instructions" (program) could be easily changed, & they perform more complex operations – flexibility
- Computers & memory much more expensive – this sets conditions for the "**Y2K** Problem"
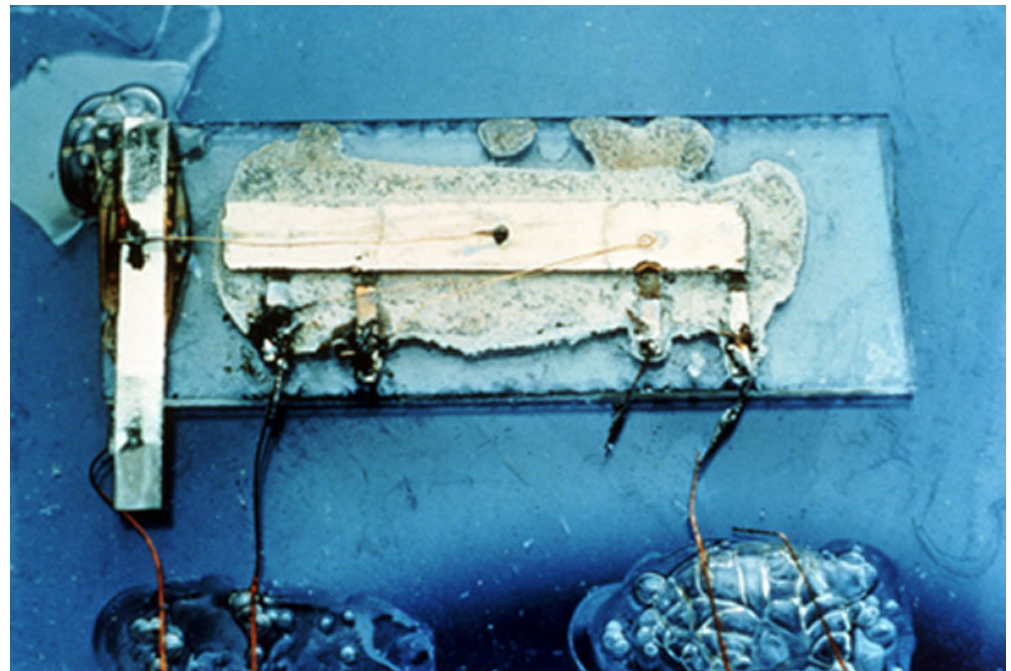
Message: Computers take the task specification (program) and digital data as inputs, making them very versatile machines; one machine does it all! Programming becomes critical technology.

Next Big Things: Integrated Circuits

- Transistors – solid state switching
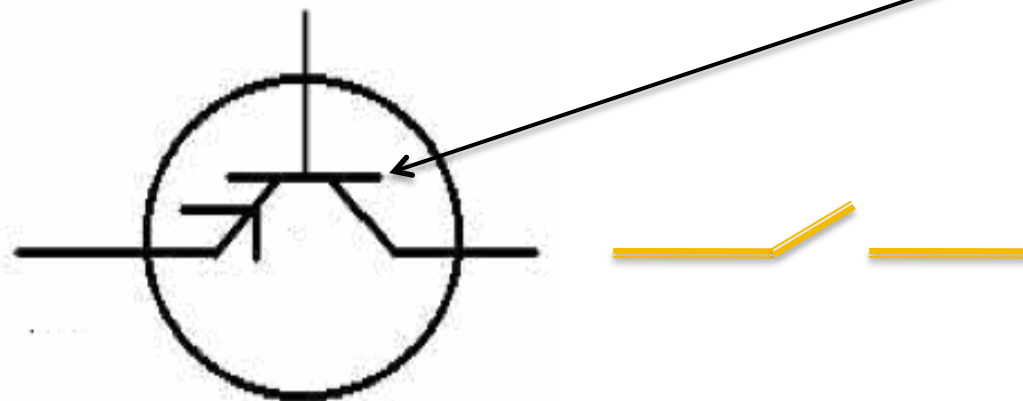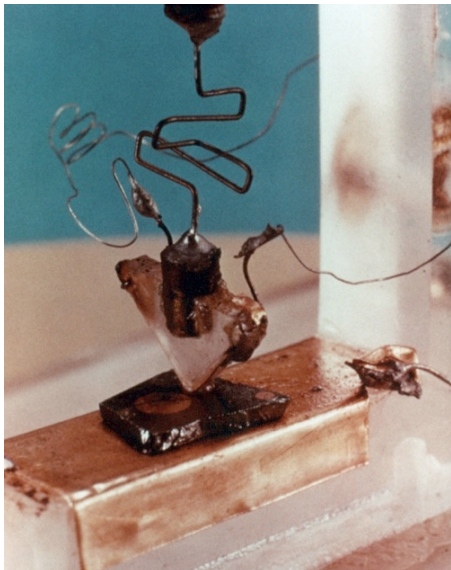- Integrated Circuit – all circuit parts fabbed at once from similar materials
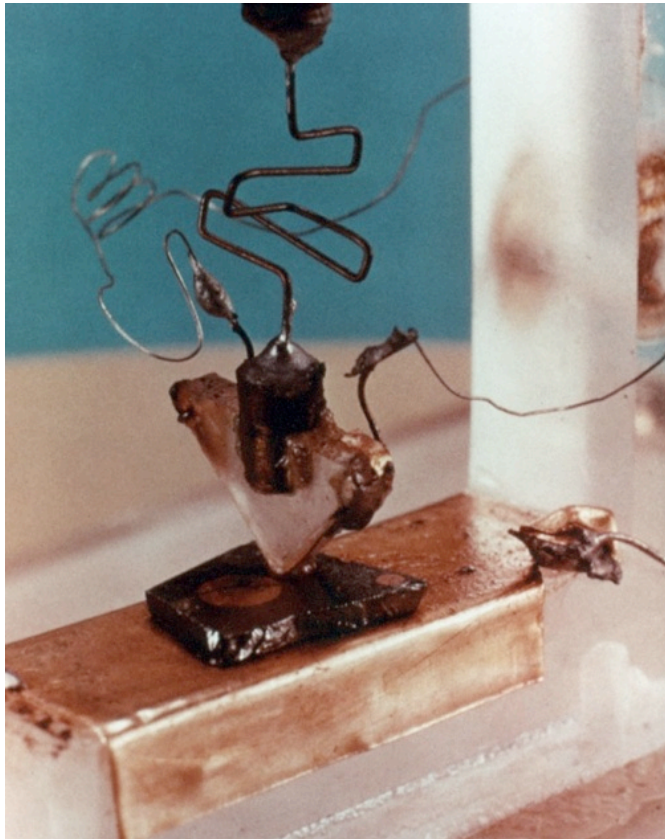
1st transistor

1st integrated circuit

Solid State Electronics

- A transistor is a switch: If the gate (black bar) is neutral, charge cannot pass; if gate is charged, the wires are connected

Solid State Electronics

- Transistors are smart, but "wiring them up" with other parts is labor intensive
- **Integrated circuits** — transistors + resistors + capacitors — are created together in one long recipe — small, cheap, reliable
- Key fabrication process is *photolithography* — the transistors are "printed" on the silicon!

Photolithography

close-up of chip pattern with photoresist

light

mask

lens

pattern repeated

wafer with photoresist
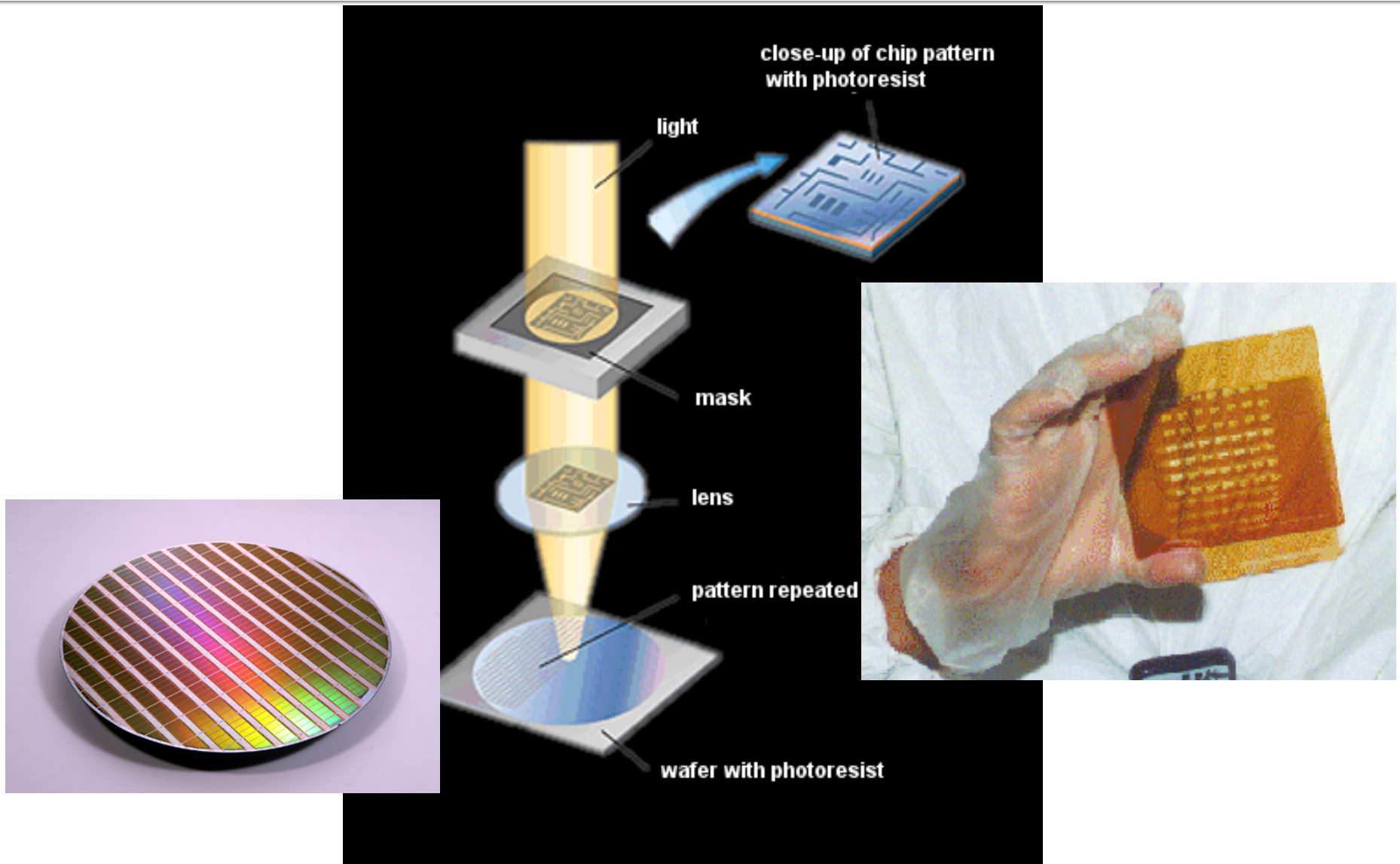
Integrated Circuits
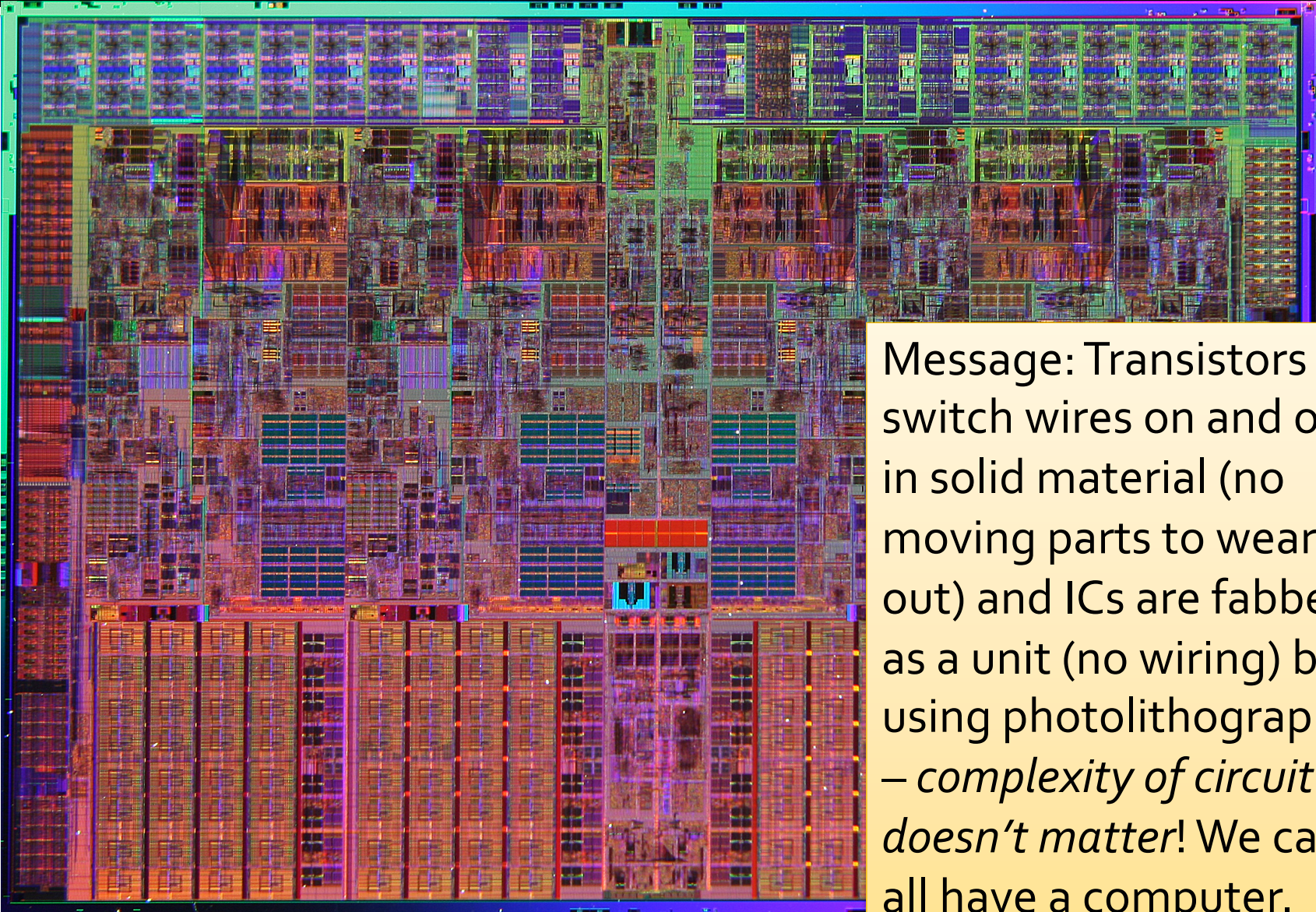
Message: Transistors switch wires on and off in solid material (no moving parts to wear out) and ICs are fabbed as a unit (no wiring) by using photolithography — *complexity of circuit doesn't matter*! We can all have a computer.

Next Big Thing: Personal Computers

- Ken Olsen, Founder of Digital Equipment, "There is no reason for any individual to have a computer in their home [1977]"

Computing Comes To Everyone

- Regular folks – not just government, military, scientists, banks and companies – could now apply computers to their interests
- Created a demand for digital data: news, pics, audio, video, books, etc., causing old technologies to digitize rapidly. Now it matters to everyone if a machine can "read" it
- From about 1985 most "new" information has been digital
- Quickly, people acquired enormous amounts of information

Digital Rocks

Message: Computers can be easily transformed to do new things, and being cheap, we can all have some, motivating us to want digital everything

Next Big Thing: Internet

- Invented in 1969, it took almost 20 years to get out of the lab and into public consciousness
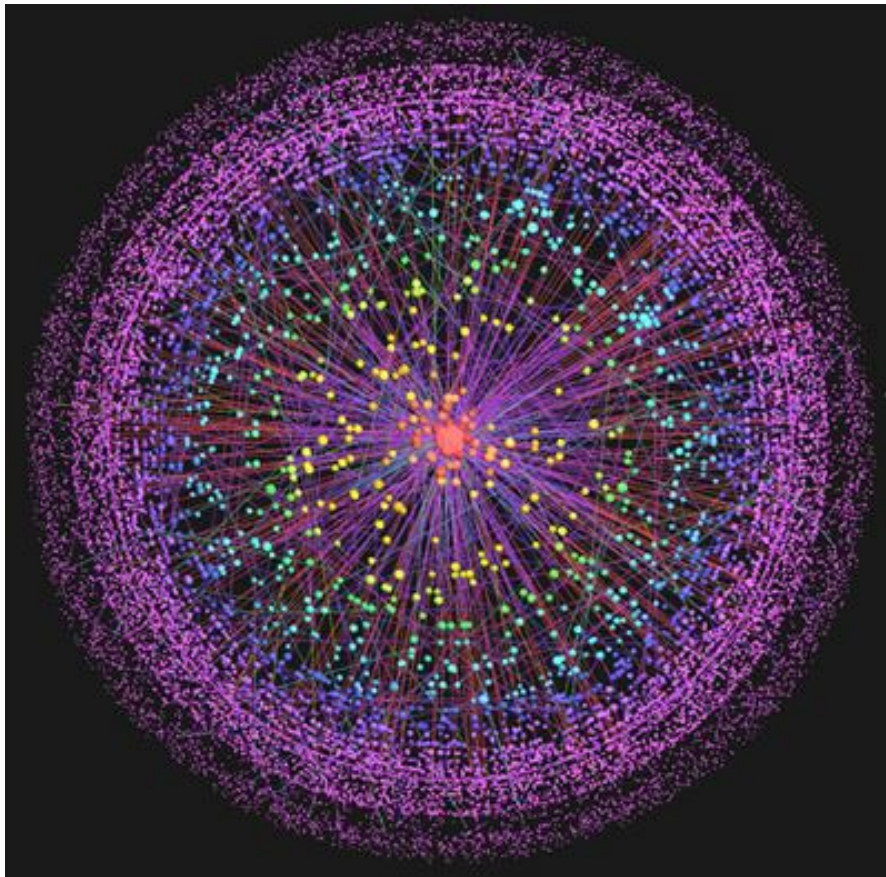
"On the Internet, nobody knows you're a dog."

Connecting Up

- Computers are useful; connected computers are awesome
- If n computers are connected, adding one more gives n new connections!
- Communication with friends or businesses all over the world became easy and casual – some people even found out about time zones
- Digital media allows people to share each other's information at no cost

Connectivity to Change the World

Message: The Internet is a general mechanism to communicate digital data – it doesn't matter what it is: music, email, video …

Next Big Thing: WWW + http

- Today, all computers "speak" a common language: hyper-text transfer protocol

WWW Is The Servers + The Data

- Two phenomena make the WWW brilliant
  - All computers use one standard protocol (http) meaning for once all of the world's people – who don't speak the same natural language – have a surrogate that does
  - Publishing and accessing information is completely decentralized – generally, no one limits what you put out or go after

Seeing Other People's Digital Info

Message: WWW exploits one protocol, neutralizing differences at endpoints; the Internet's universal medium lets us look at other people's digital info
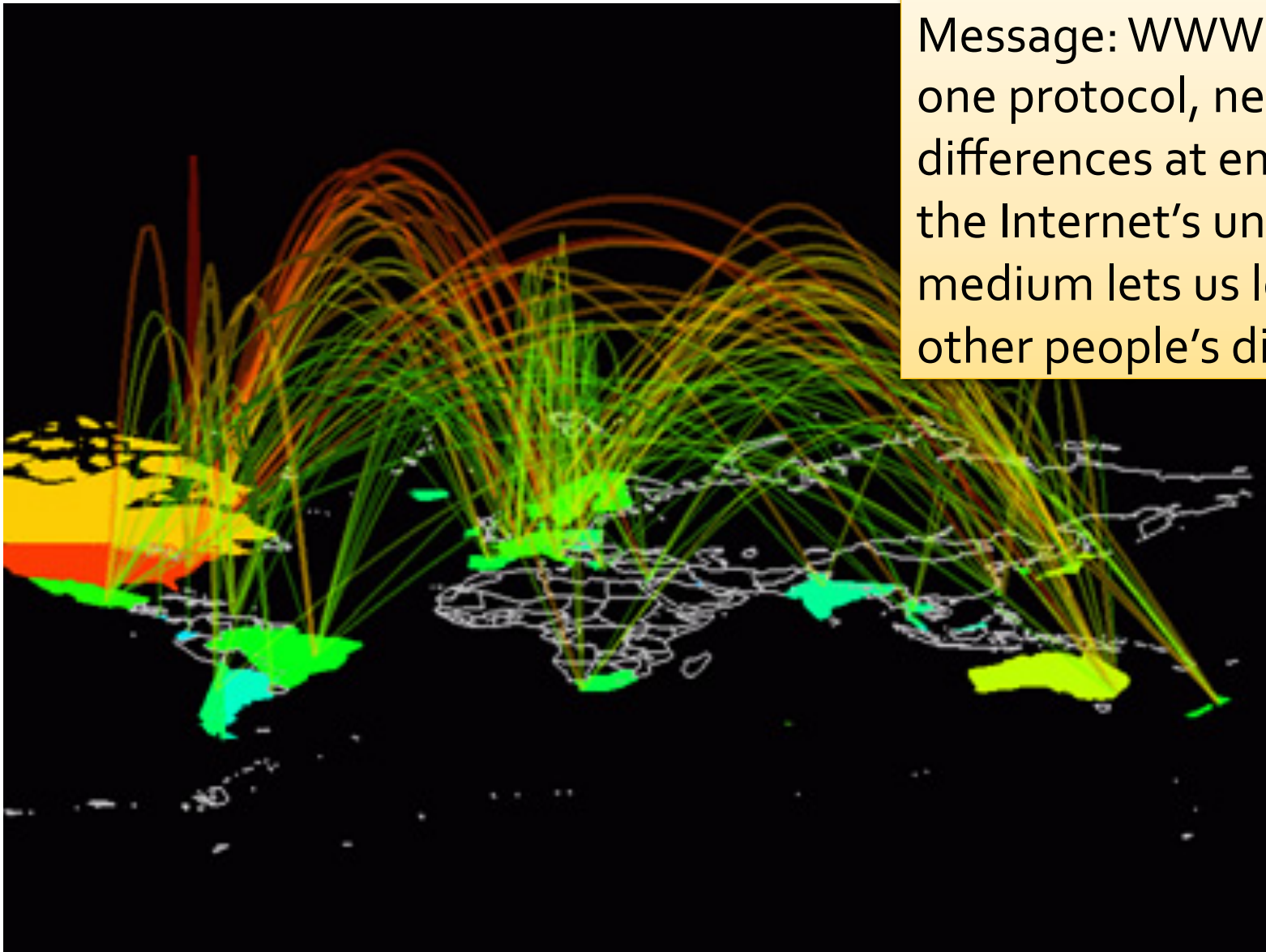
In Summary

- Punch cards, first wide use of digitization
- Digital info can be processed by machines
- Computers are digital processing machines in which instructions are easily changed
- (Solid state) transistors give a "no moving parts" switch implementing computers
- Integrated circuits (ICs) make fab easy/cheap
- Photolithography allows ICs to be complex
- Networking – connecting computers is power
- WWW – unifies worlds with 1 protocol and access to "all" digital data