

# 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

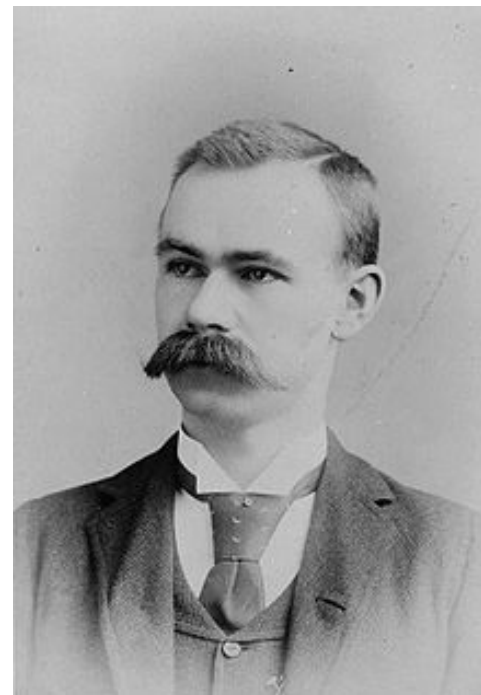
- Digitization – make information machine readable
- Electronic computers – a machine with “soft” programming
- Transistor – a switch with no moving parts
- Integrated circuits – logic + connective circuits created together by photolithography
- “Personal” computer make everyone digital
- Internet – 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

Lp	A	B	C	A	B	C	Lp	Cht	N	Gn	Ac	Ci	Ct	SM	Ir	HM	WI	A	C	E	F	o	d
Ch	D	B	F	D	L	F	Lo	Cht	S	Sk	Ma	Lb	FV	Ol	Ca	X	To	B	D	X	*	b	*
Lo	G	H	I	G	H	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cn	K	L	M	K	L	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CS	N	O	P	N	O	P	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
LS	Q	R	S	Q	R	S	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Kn	*	b	*	*	b	*	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
RN	*	b	*	*	b	*	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
QC	g	h	i	g	h	i	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
AV	x	i	m	x	i	m	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
So	*	b	*	*	b	*	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	3	1	2	7	1	2	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

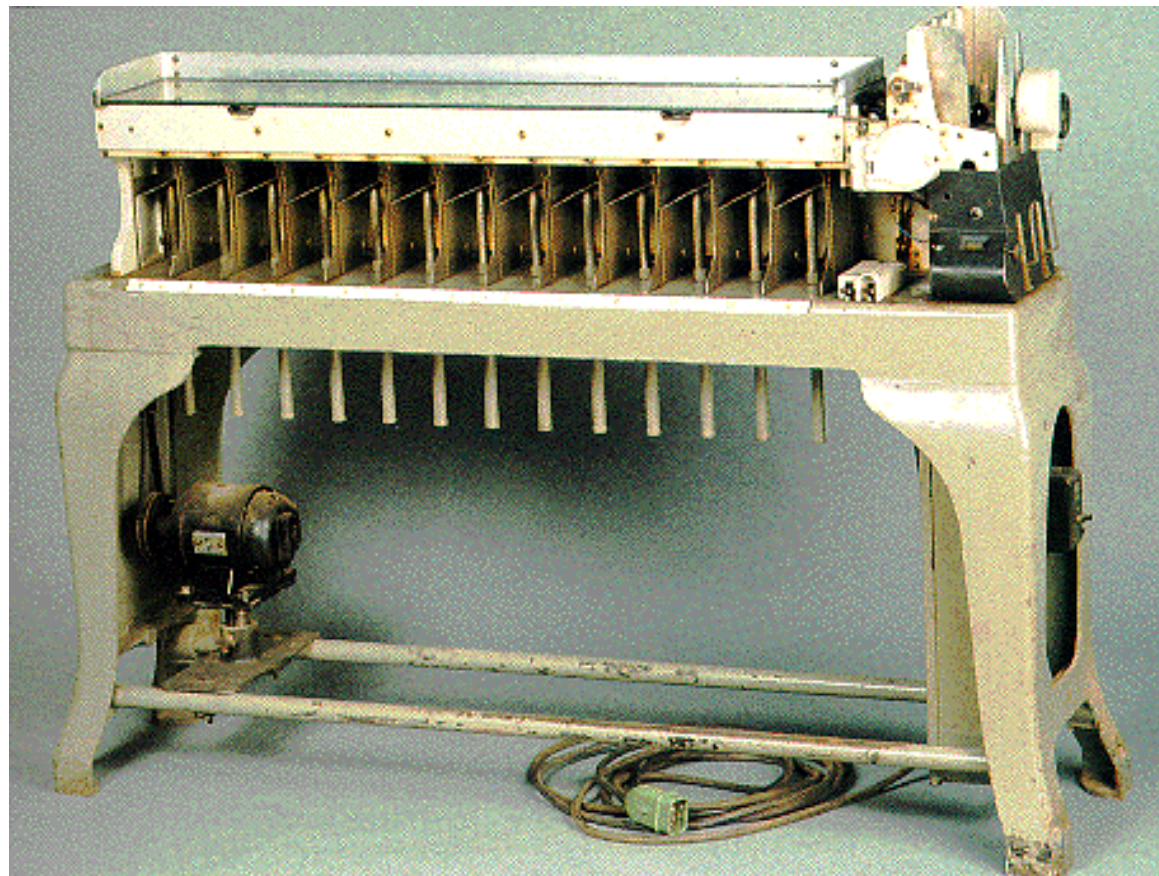
Hollerith Card, Courtesy IBM



# Machines Process Digital Data

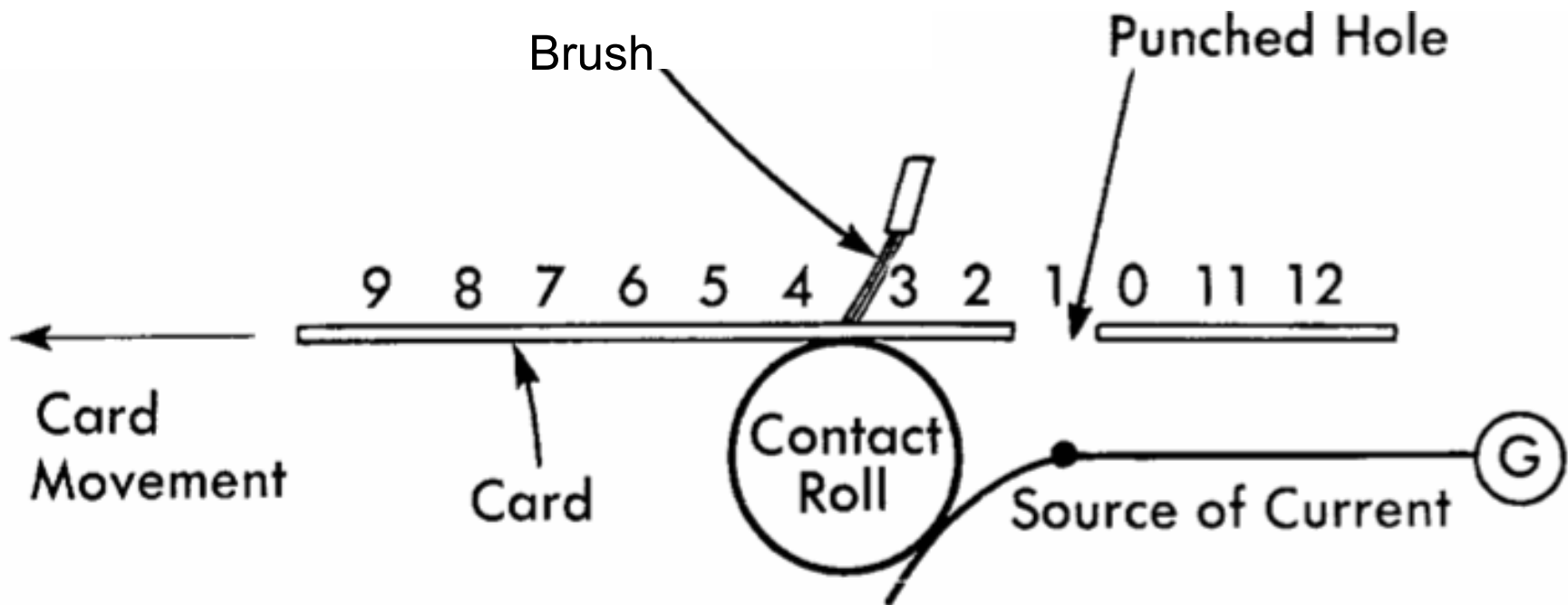
- Mechanical methods – sensing a hole in a card or not – allows machines to help w/work

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



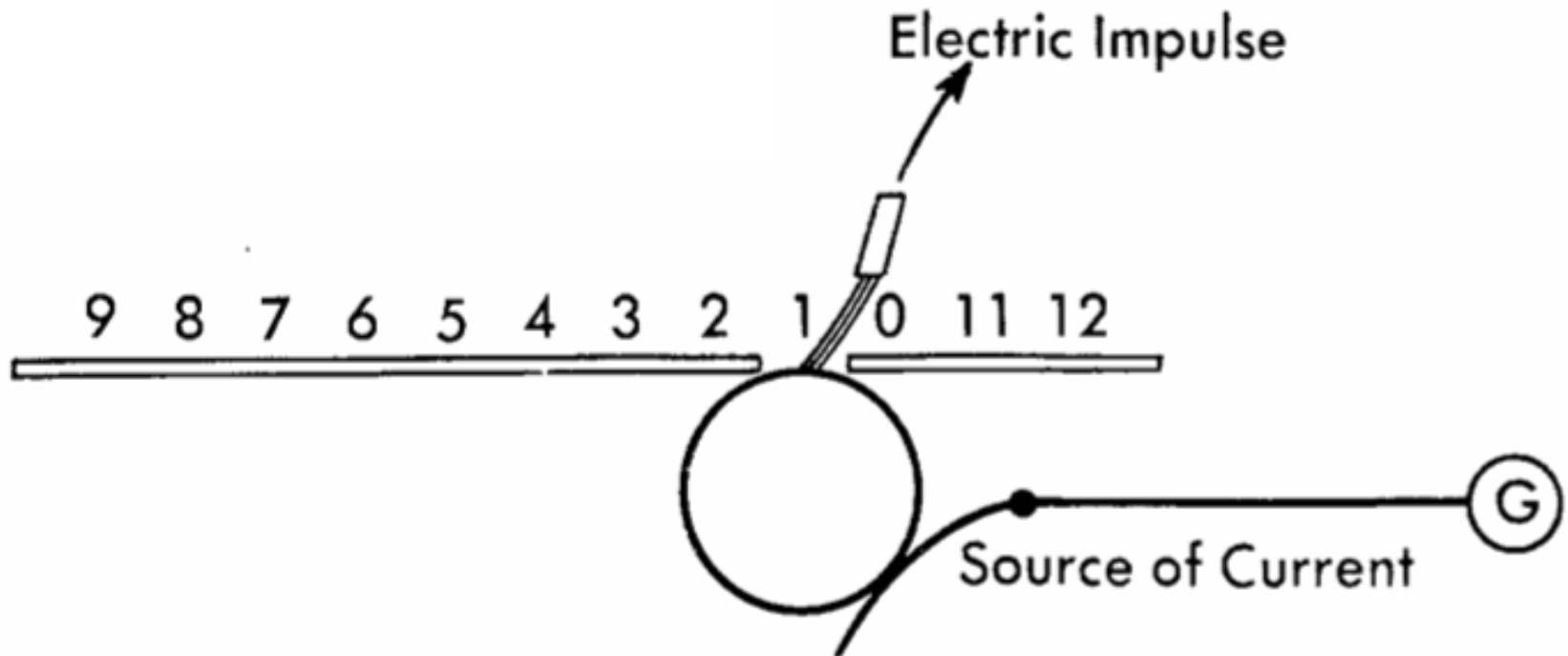
# No Computer Needed To Process Data

- 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



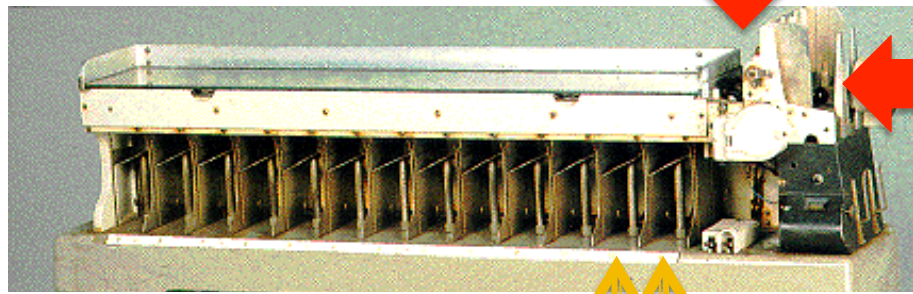
# Computing w/o Computers

- 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



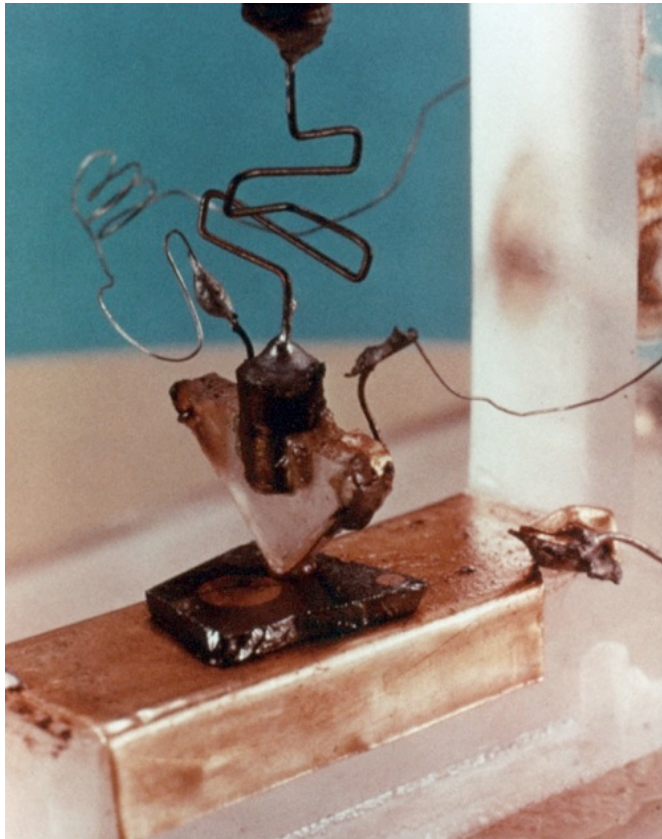
# By Mid 20<sup>th</sup> Century ~ 1960

- 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**”

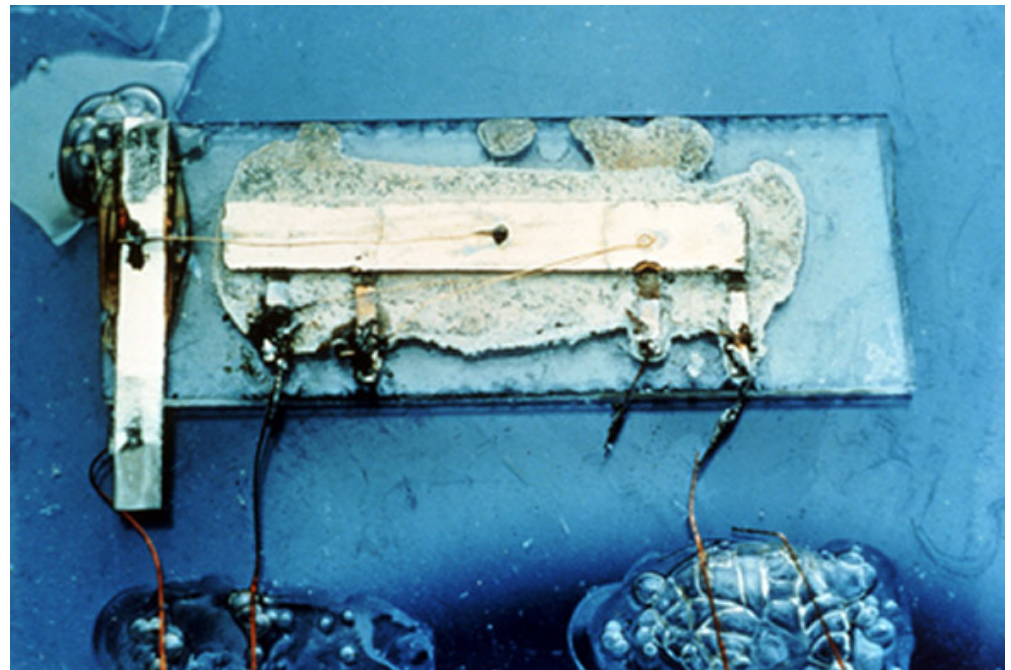
Message: Computers take the task specification (program) and digital data as inputs, making them very versatile machines; one machine does it all! Programming becomes critical technology.

# Next Big Things: Integrated Circuits

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



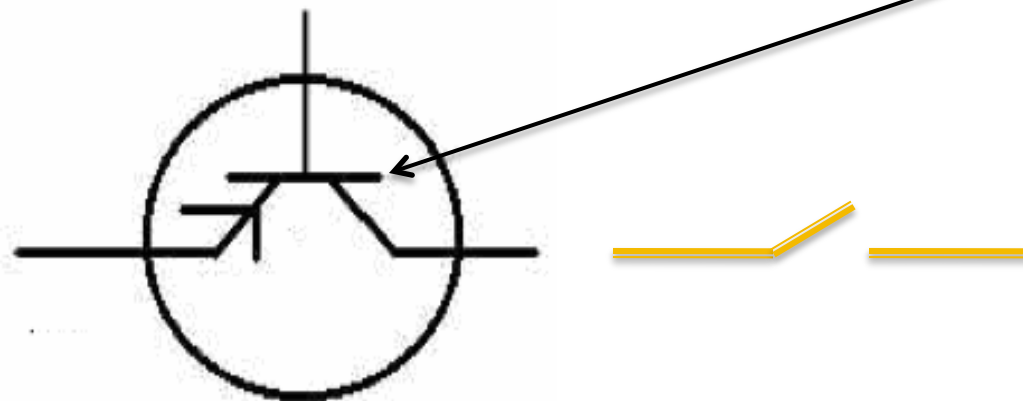
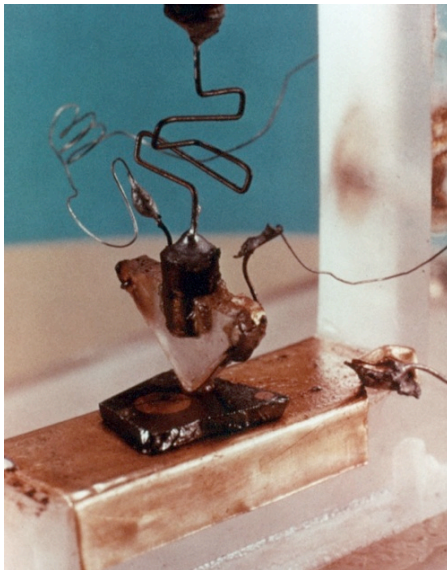
1<sup>st</sup> transistor



1<sup>st</sup> 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

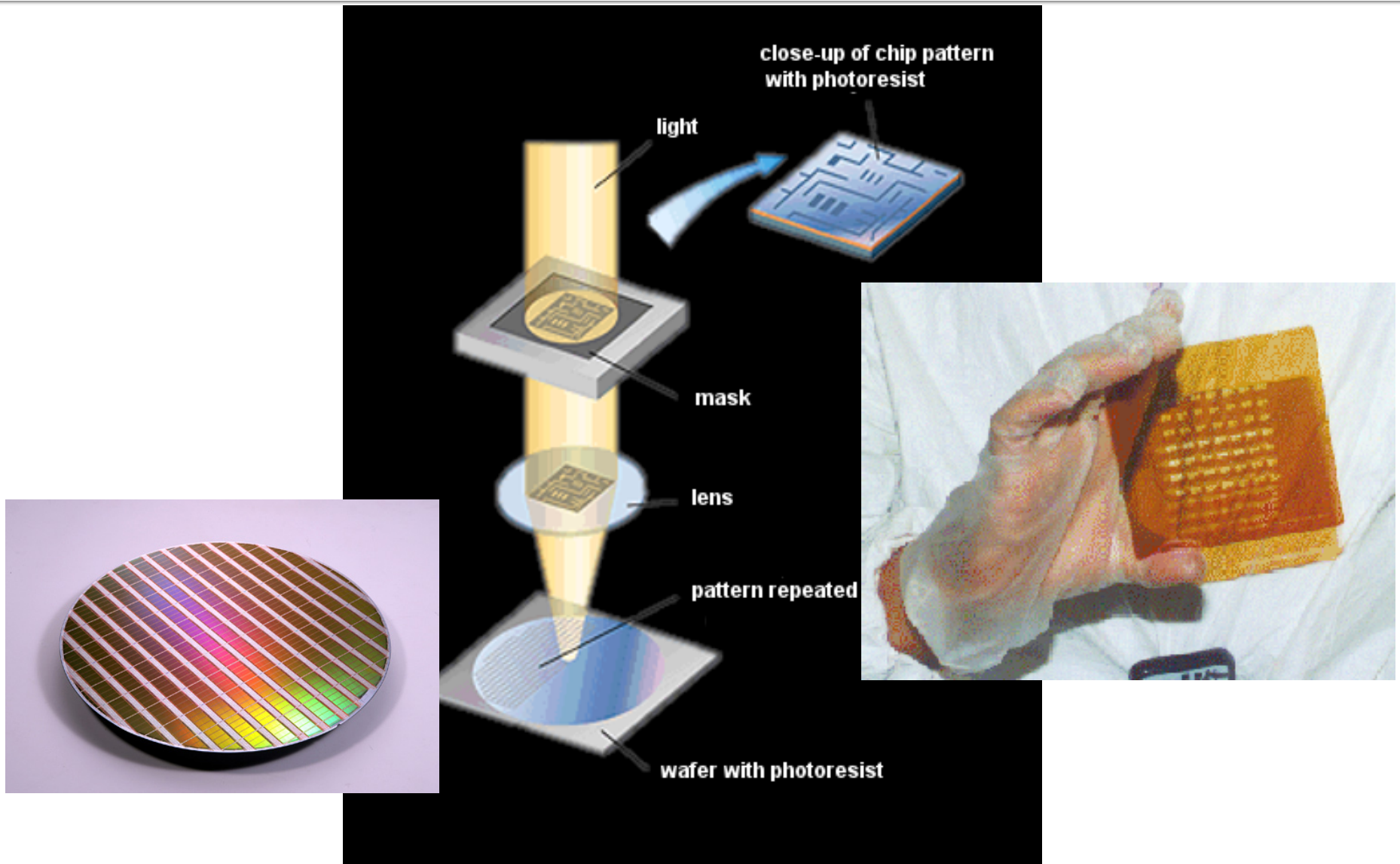


# Solid State Electronics

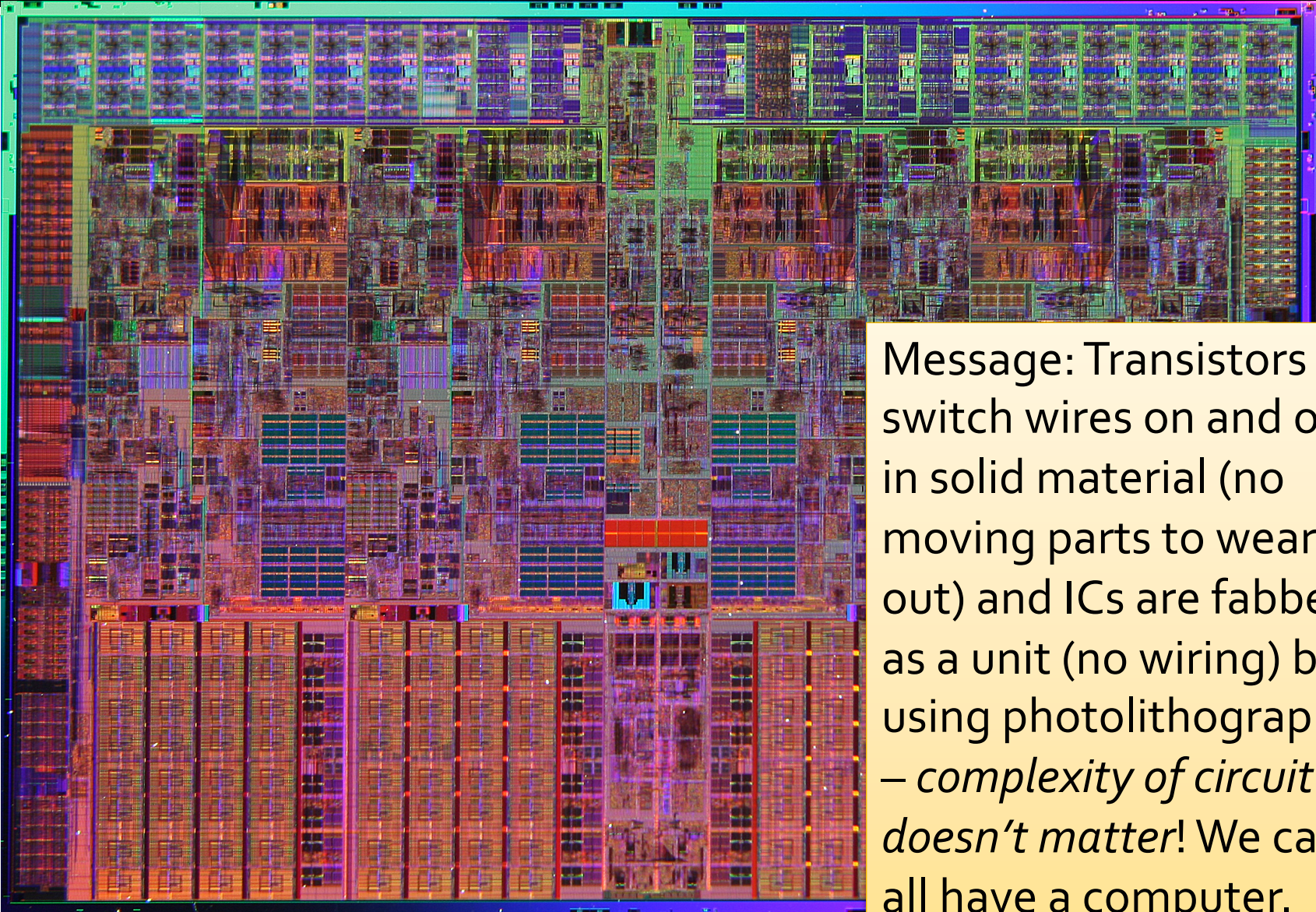
- Transistors are smart, but “wiring them up” with other parts is labor intensive
- **Integrated circuits** – transistors + resistors + capacitors – are created together in one long recipe – small, cheap, reliable
- Key fabrication process is *photolithography* – the transistors are “printed” on the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



# Photolithography



# 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

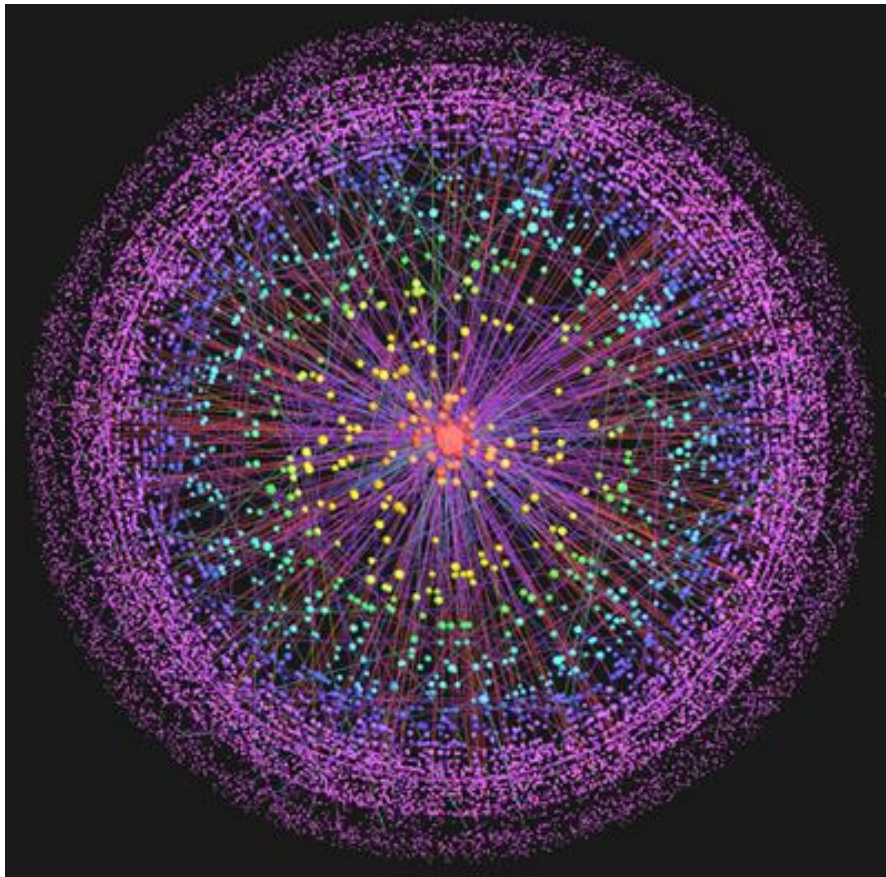
- Regular folks – not just government, military, scientists, banks and companies – could now apply computers to their interests
- Created a demand for digital data: news, pics, audio, video, books, etc., causing old technologies to digitize rapidly. Now it matters to everyone if a machine can “read” 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



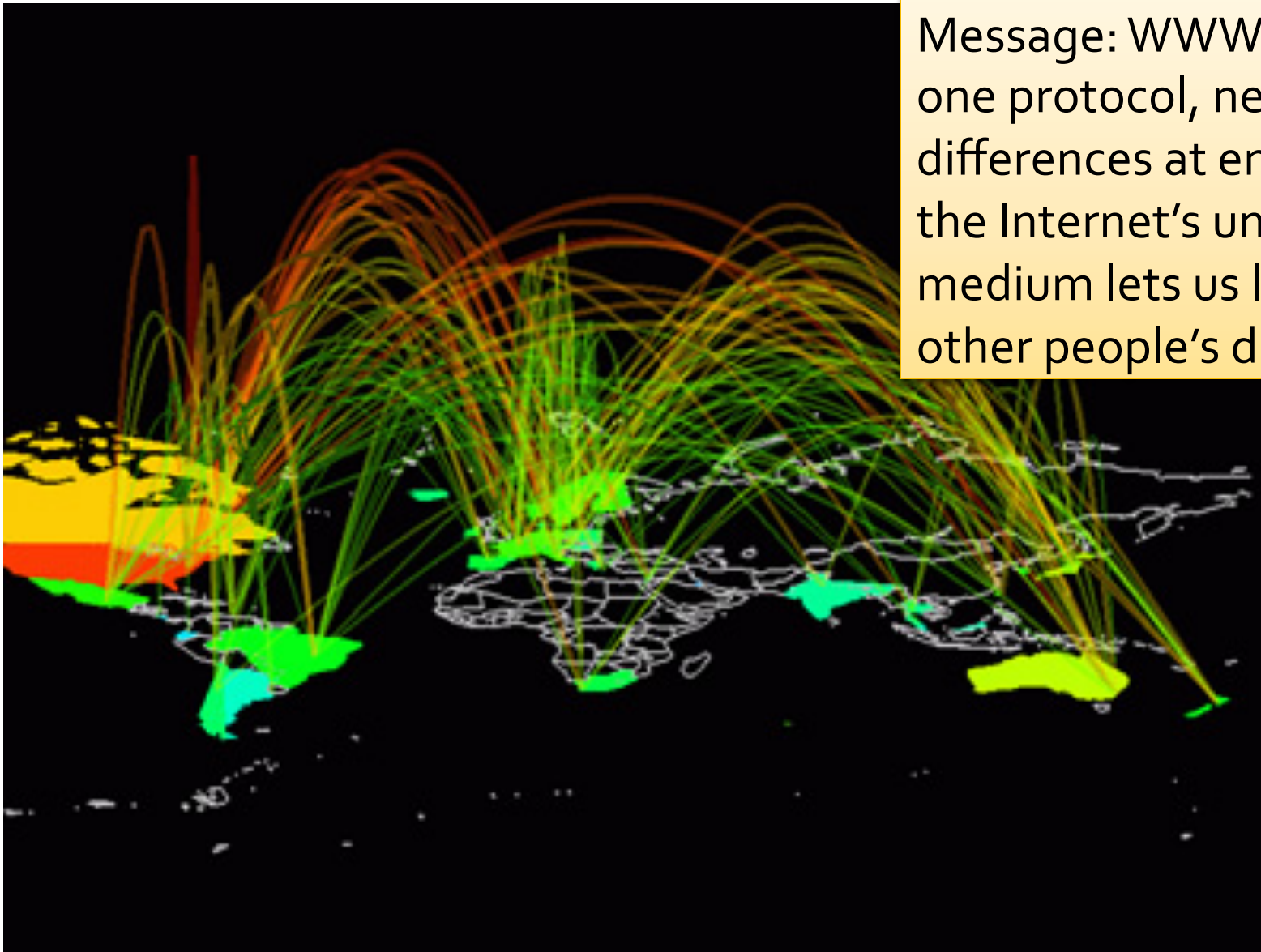
# WWW Is The Servers + The Data

- 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