Computing's Greatest Hits

Lawrence Snyder
University of Washington, Seattle

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

- Today we learn why certain computing technologies were huge breakthroughs.
  - It is always hard for those of us familiar with a technology to imagine what it was like without it: Try
  - The thing to look for: what did the new idea do that nothing else had done before?
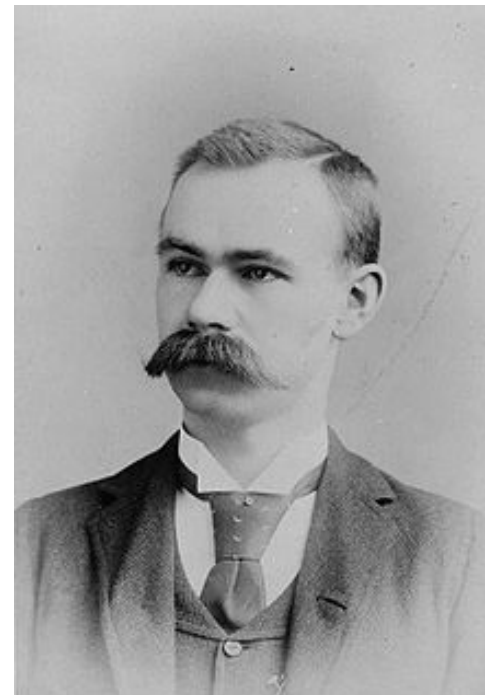
We Consider only BIG Milestones

- 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 Hand 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

First Machine To Process Information
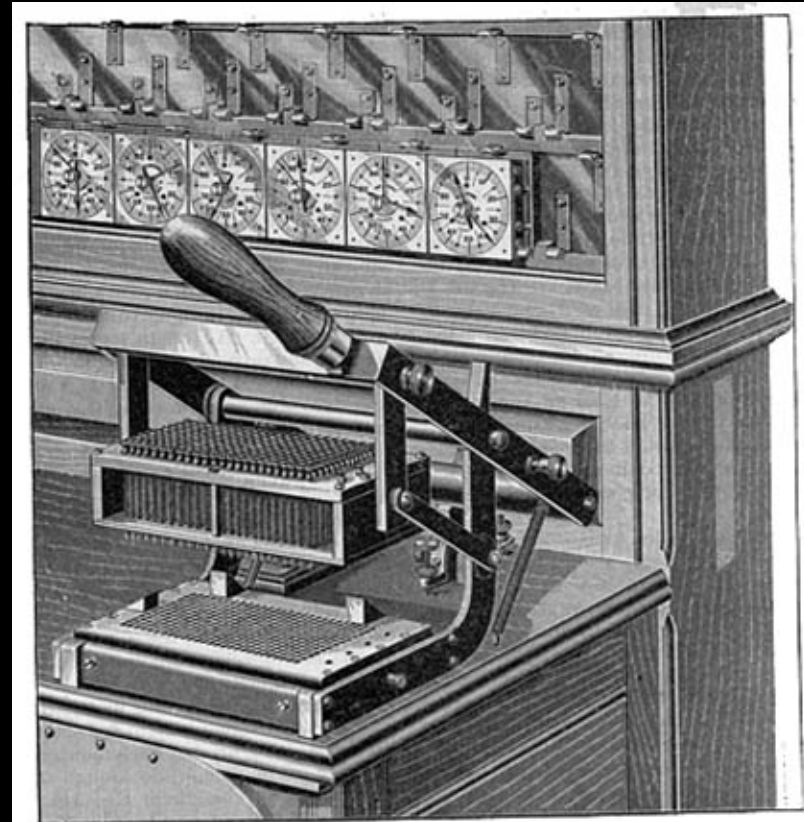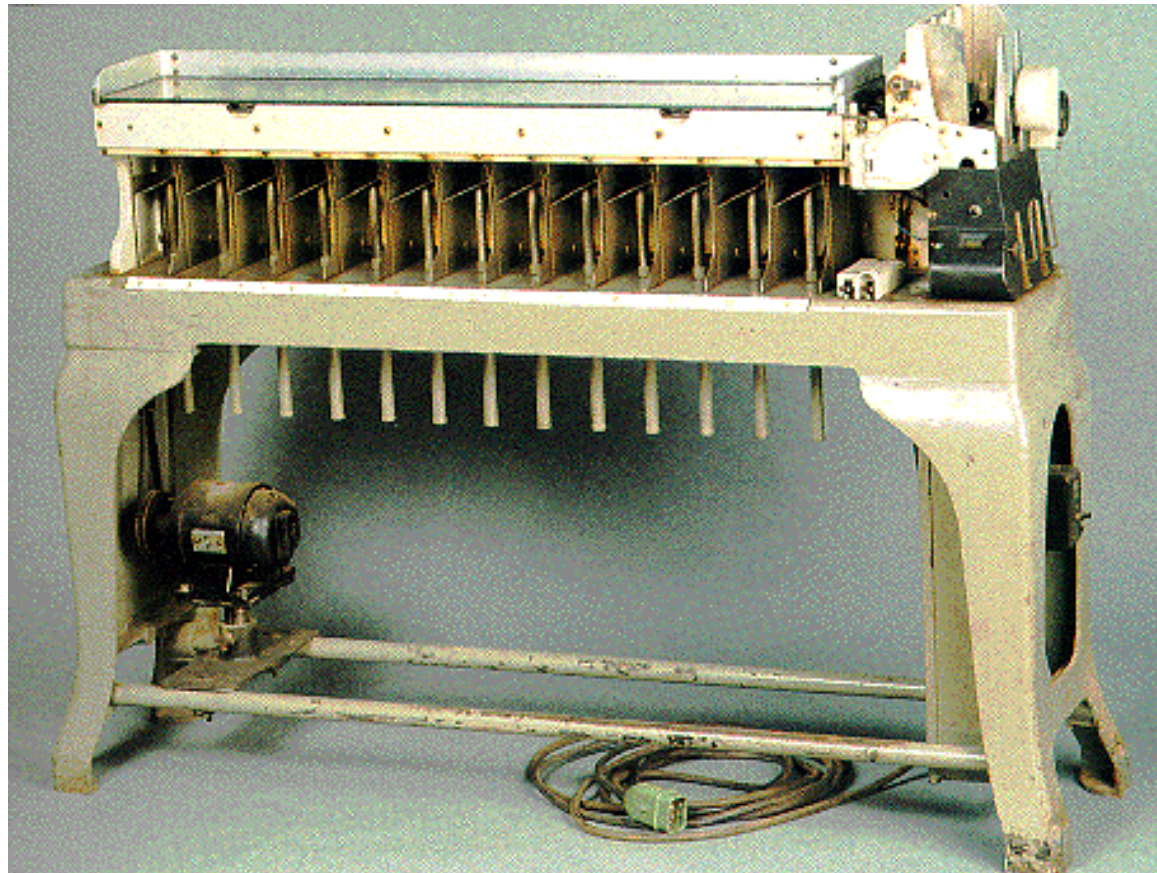

Hollerith Machine

Fig. 8 – Circuit-Closing Press.
Hollerith's Electric Sorting and Tabulating Machine.

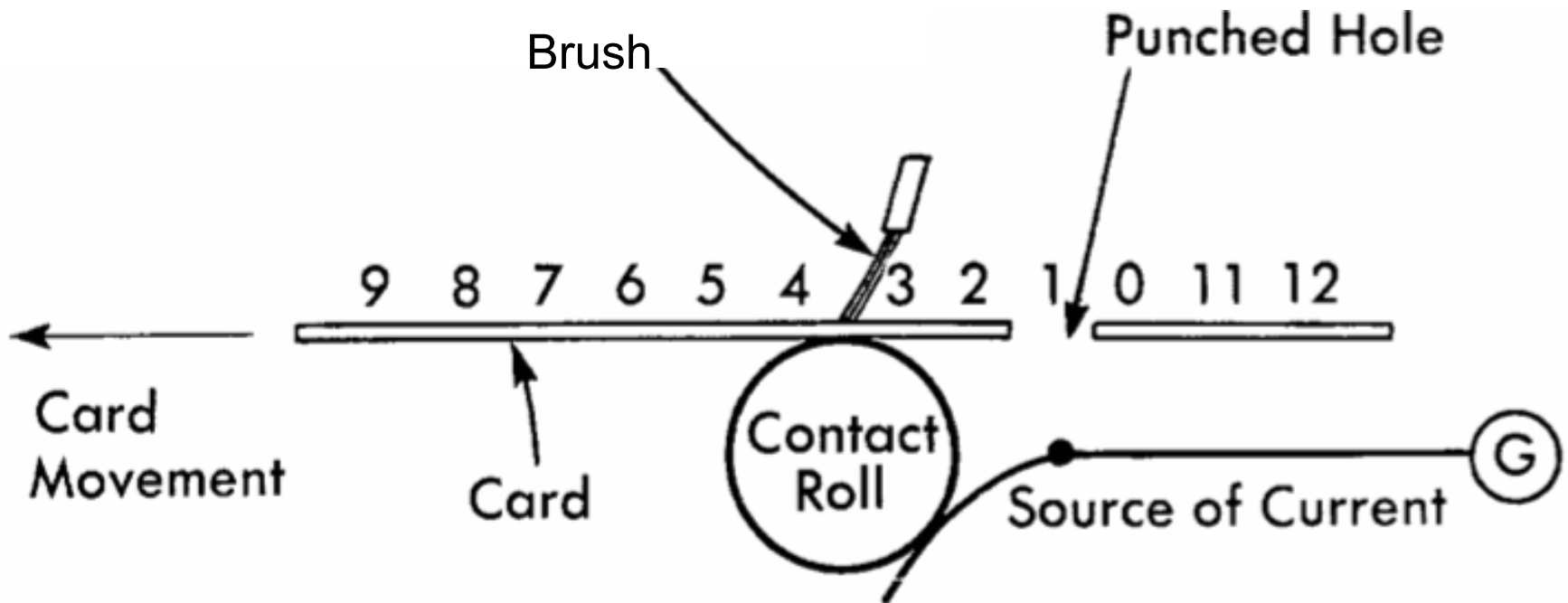# Machines Process Digital Data

- 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

Brush ⟶ (pointing to the brush above position 3)

Punched Hole ⟶ (pointing to position 1)

9 8 7 6 5 4 3 2 1 0 11 12

Card Movement ⟵

Card

Contact Roll

Source of Current — G

Sensing Punch Allows Some Action

- When the circuit closes, some mechanical action can happen
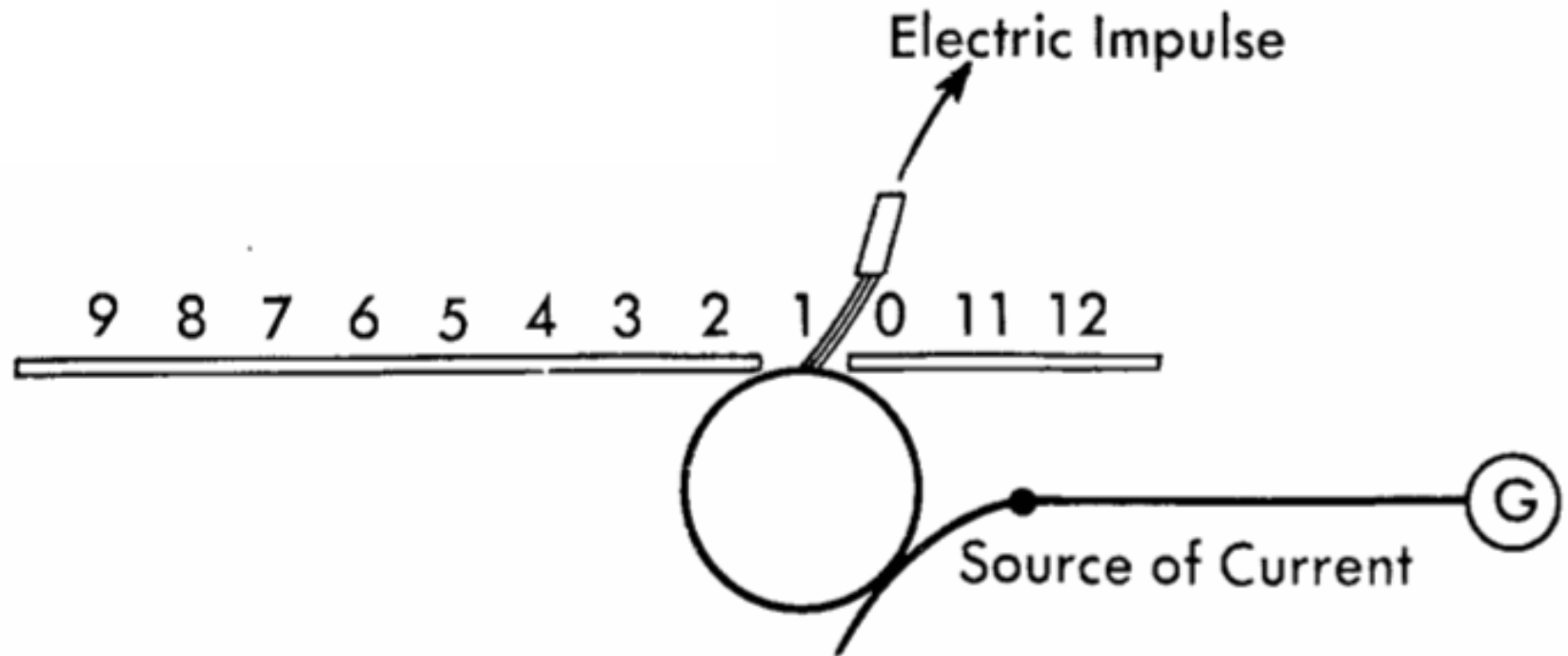
Computing w/o Computers

- 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

Big Idea: Digitized Data

- Although digitization had been used for millennia (using your 10 digits), Hollerith digitized data and made it machine readable

  - Once machine readable, it's "just" a matter of engineering to make better machines to process it

  - Hollerith demonstrated idea in 1890 census; punch cards reigned well into the 1960s

Not Perfect …

- Big problem with card machines is the program – what computation they do – has to be hardwired. Literally. And it needs a person to run the machine.

Next Big Thing … 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 machines b/c a computer's "processing instructions" (program) could be easily changed, & they perform more complex operations – flexibility
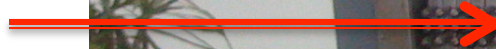
Soft Instructions

- Digital computers solved the "hardwired" program problem by storing the program in memory – the instructions were SOFTware
- How does this work?
  - Build machine to perform a small set of basic operations coded as instructions
  - List the program instructions in the memory
  - Computer reads instructions from mem, does op
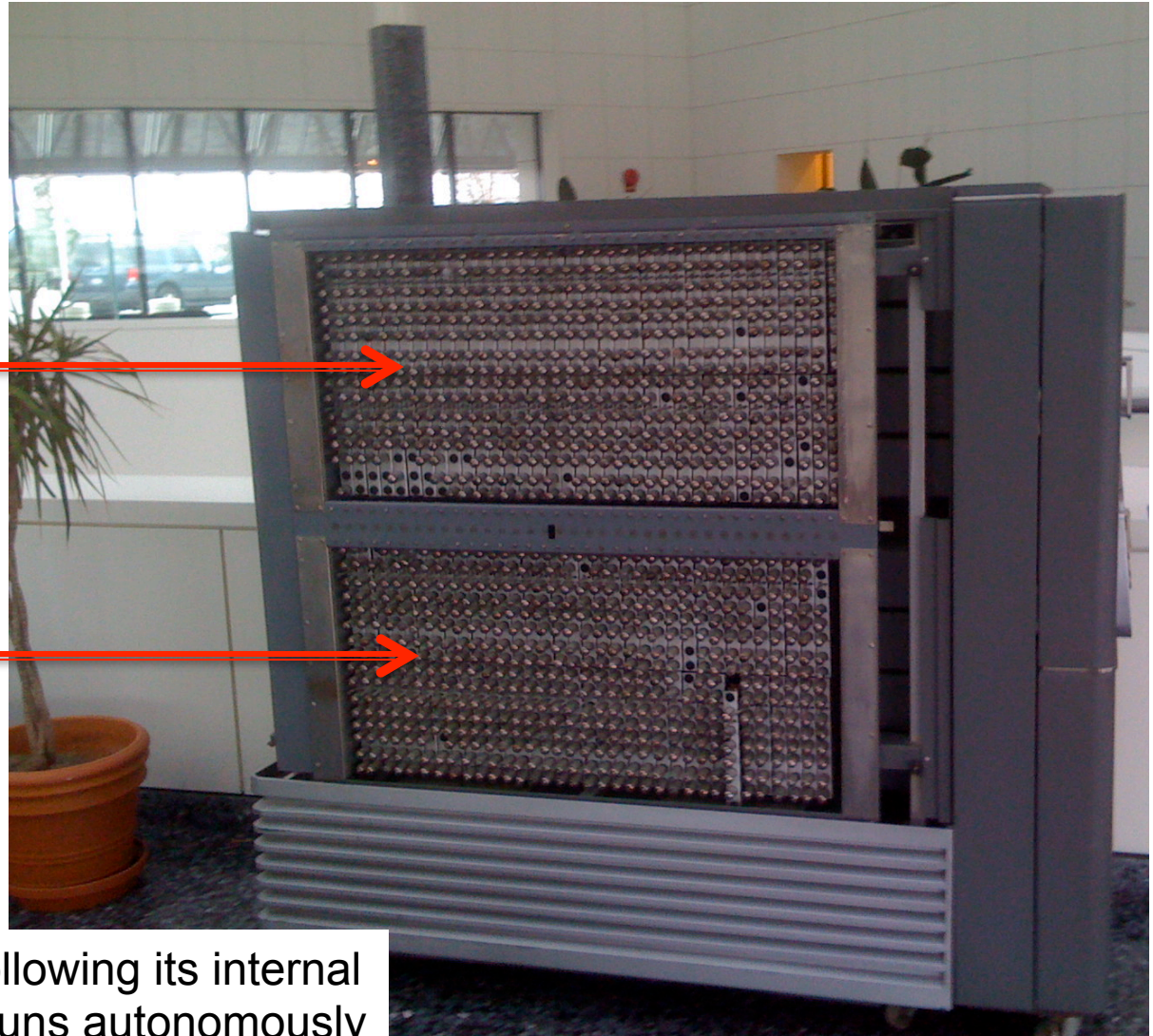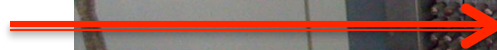 - Change program simply by changing memory

You still use this feature today when you double-click an app

IBM 701 Had 2K Memory Words
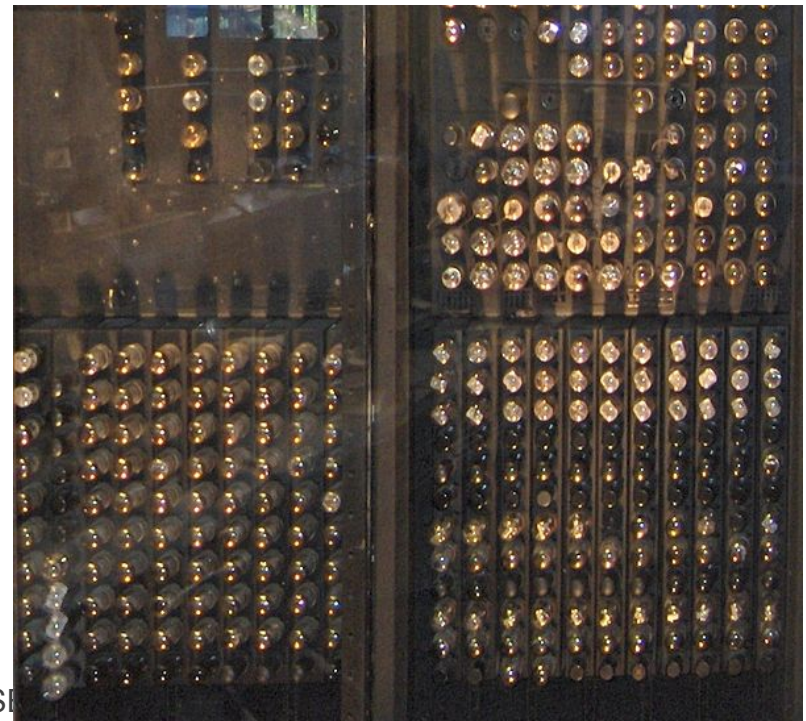

Program Goes In
This Memory

Data Goes In This
Memory

A machine following its internal
instructions runs autonomously

Not Perfect …

- Big problem with early computers: they were built with vacuum tubes – they're pretty, but …
  - It takes a lot of tubes for a computer (17,468 in ENIAC)
  - They draw a lot of power – Philly's lights dimmed
  - Not reliable … computers were VERY TEMPERMENTAL

Next Big Idea

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

Gate Neutral

Gate Charged

Current Flow
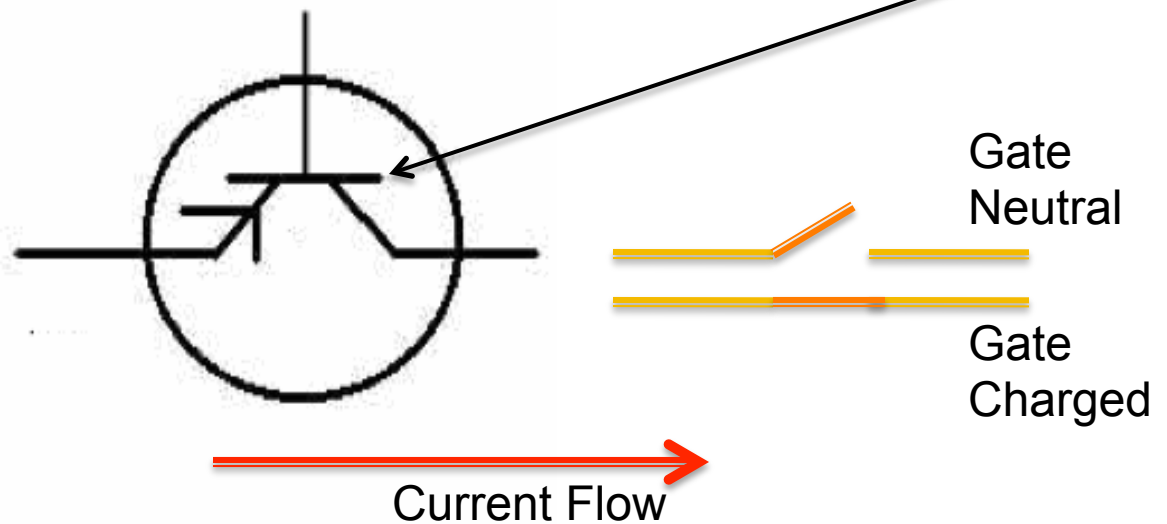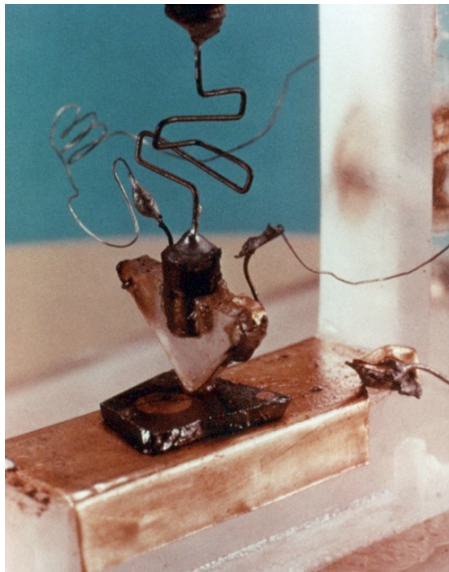
Transistors Change The Game

- First win: Much more reliable … there are no moving parts
- Second win: Much lower power requirements
- Third win: Smaller physical size

Computers kept running and could do so autonomously

Solid State Electronics

- Transistors are smart, but originally they were used one-at-a-time: "wiring them up" with other parts is labor intensive
- Computers are built out of transistors (3), resistors (2) and capacitors (2)