Do Now: Lesson Warm-up

- List 3 of your favorite activities involving any kind of tech (Audio, Video, Internet, phone, computer, TV, etc.).

UNIX and “UNIX -like” Operating Systems

The Linux Operating System

MR. SABAUGH 12.01.22

Bell Labs

- AT&T (Bell System) was a regulated monopoly
- They controlled the entire telecommunication industry for much of the 20th century
- The monopoly was allowed by the U.S. government, however, the Bell System was obligated to license all its patents royalty-free, and it was barred from entering any industry other than telecommunications.
- They also had to devote a portion of their profits to innovation involving the improvement of telecommunication technology.
- This allowed for a wide range of research, and they had practically unlimited budgets, to work on new technology, without the need to produce profitable results.
- This type of atmosphere will likely never happen again, as even the largest corporations' profitability R&D departments have to show results in a timely manner that will lead to profitability

Bell Labs - The Company that Invented the Future

- The following video does a great job of encapsulating the Lab’s most important accomplishments.
- It covers only some of the important Bell Labs innovations, most of which we will also discuss here in class.
- Enjoy!

Bell Labs - The Company that Invented the Future

Information Theory

- Information theory is the mathematical treatment of the concepts, parameters, and rules governing the transmission of messages through communication systems.
- It was founded by Claude Shannon toward the middle of the twentieth century
- Is now a vigorous branch of mathematics fostering the development of other scientific fields, such as computer science, electrical engineering, communications, information technology, networking, statistics, biology, behavioral science, neuroscience, and statistical mechanics.
- The techniques used in information theory are probabilistic in nature and some view information theory as a branch of probability theory.

Information Theory

- In a given set of possible events, the information of a message describing one of these events quantifies the symbols needed to encode the event in an optimal way.
- ‘Optimal’ means that the obtained code word will determine the event unambiguously, isolating it from all others in the set, and will have minimal length, that is, it will consist of a minimal number of symbols.
- Information theory also provides methodologies to separate real information from noise and to determine the channel capacity required for optimal transmission conditioned on the transmission rate.

Transistor

- A transistor is a miniature semiconductor that regulates or controls current or voltage flow in addition to amplifying and generating these electrical signals and acting as a switch/gate for them.
- Typically, transistors consist of three layers, or terminals, of semiconductor material, each of which can carry a current.
- When working as an amplifier, a transistor transforms a small input current into a bigger output current.
- As a switch, it can be in one of two distinct states -- on or off -- to control the flow of electronic signals through an electrical circuit or electronic device.

Transistor

- On its own, a transistor has only one circuit element. In small quantities, transistors are used to create simple electronic switches.
- They are the basic elements in integrated circuits (ICs), which consist of a large number of transistors interconnected with circuitry and baked into a single silicon microchip.
- In large numbers, transistors are used to create microprocessors where millions of transistors are embedded into a single IC.
- They also drive computer memory chips and memory storage devices for MP3 players, smartphones, cameras and electronic games. Transistors are deeply embedded in nearly all ICs, which are part of every electronic device.

Transistor

- Transistors are also used for low-frequency, high-power applications, such as power-supply inverters that convert alternating current into direct current. Additionally, transistors are used in high-frequency applications, such as the oscillator circuits used to generate radio signals.
- A transistor can act as a switch or gate for electronic signals, opening and closing the gate many times per second. It ensures the circuit is on if the current is flowing and switched off if it isn't. Transistors are used in complex switching circuits that comprise all modern telecommunications systems. Circuits also offer very high switching speeds, such as hundreds of gigahertz or more than 100 billion on-and-off cycles per second.
- Transistors can be combined to form a logic gate, which compares multiple input currents to provide different outputs. Computers with logic gates can make simple decisions using Boolean algebra. These techniques are the foundation of modern-day computing and computer programs.

Transistor

- Invented at Bell Laboratories in 1947, the transistor rapidly replaced the bulky vacuum tube as an electronic signal regulator.
- Considered one of the most significant developments in the history of the PC, the invention of the transistor fueled the trend toward miniaturization in electronics.
- Because these solid-state devices were significantly smaller, lighter and consumed significantly less power than vacuum tubes, electronic systems made with transistors were also much smaller, lighter, faster and more efficient.
- Transistors were also stronger, required significantly less power and, unlike vacuum tubes, didn't require external heaters.

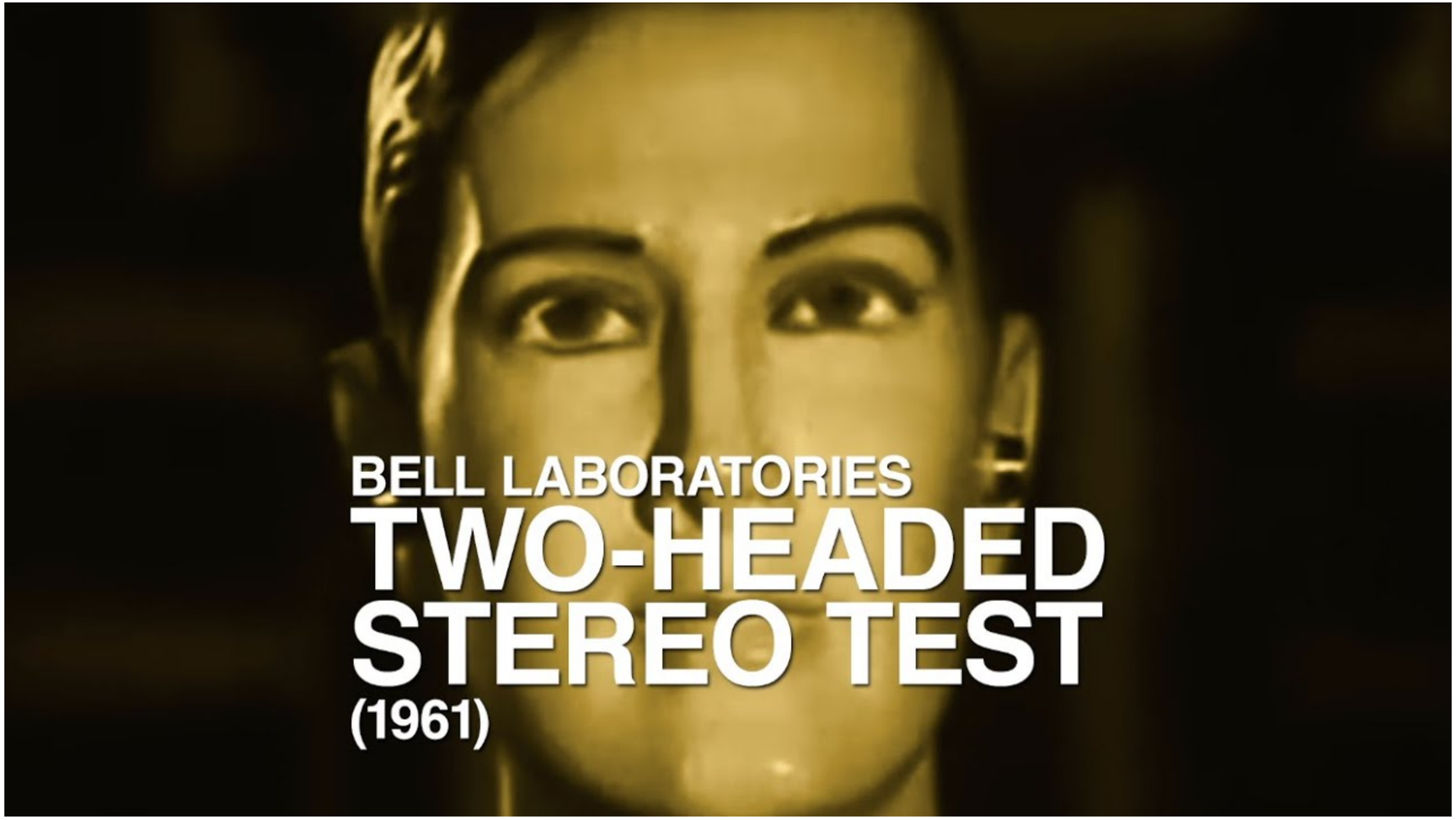
Transistor

- As the size of transistors has exponentially decreased, their cost has fallen, creating many more opportunities to use them.
- Integrating transistors with resistors and other diodes or electronic components has made ICs smaller.
- This phenomenon regarding miniaturization relates to Moore's Law, which states that the number of transistors in a small IC would double every two years

Stereophonic Sound

- We may take stereo for granted now, but it was groundbreaking at the time.
- It revolutionized the recorded music industry, and developed hi-fi (high fidelity) sound systems and headphones that would be in everyone’s home and now ears.
- Surround sound would not be possible without stereo first. (2 channel, 5.1, Dolby, etc.)

Stereophonic Sound



LASER

- A laser produces a very narrow or coherent beam of light that is useful in many technologies and instruments.
- The letters in the word laser stand for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.
- Lasers produce a narrow beam of light in which all of the light waves have very similar wavelengths. The laser's light waves travel together with their peaks all lined up, or in phase. This is why laser beams are very narrow, very bright, and can be focused into a very tiny spot.
- Because laser light stays focused and does not spread out much (like a flashlight would), laser beams can travel very long distances. They can also concentrate a lot of energy on a very small area.

LASER

- Lasers have many uses. They are used in precision tools and can cut through diamonds or thick metal. They can also be designed to help in delicate surgeries.
- Lasers are used for recording and retrieving information. They are used in communications and in carrying TV and internet signals.
- We also find them in laser printers, bar code scanners, and DVD players.
- They also help to make parts for computers and other electronics.
- Lasers are also used in instruments called spectrometers that help scientists figure out what things are made of. For example, the Curiosity rover uses a laser spectrometer to see what kinds of chemicals are in certain rocks on Mars.

The Cellphone Network

- In 1947, the same year that the transistor was invented and 40 years before there were a million American cell phone subscribers, an engineer at Bell Labs sketched out the rough design for a standard cellular phone network.
- D.H. (Doug) Ring laid the intellectual groundwork for what is our most widespread digital information technology. Ring was thinking about car phones and it took a long time for technology to catch up to the vision, but the basics were there in his early research.
- In 1977, AT&T and Bell Labs constructed a prototype cellular system.

CCD

- A charge-coupled device (CCD) is a light-sensitive integrated circuit that captures images by converting photons to electrons.
- A CCD sensor breaks the image elements into pixels. Each pixel is converted into an electrical charge whose intensity is related to the intensity of light captured by that pixel.
- The CCD was invented in 1969 at Bell Labs by George Smith and Willard Boyle for the primary purpose of computer memory. Michael F. Tompsett later refined the CCD's design to better accommodate imaging.
- Like all integrated Circuits, they kept getting smaller, making smaller and smaller cameras
- We would not have smartphone cameras or Instagram without them.

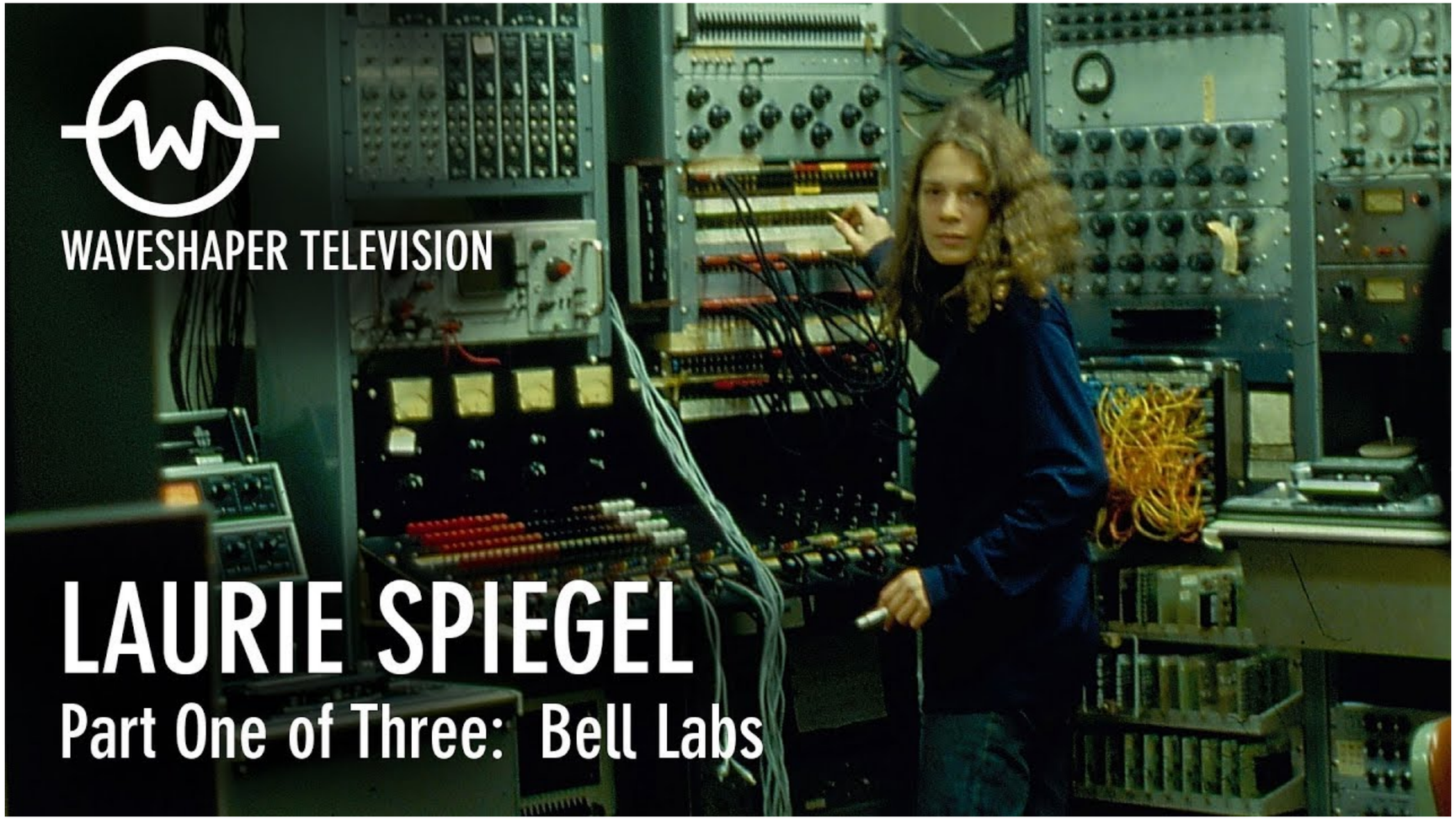
Solar Cells

- Solar cells are devices that use the photovoltaic effect to convert the energy of light directly into electricity, producing electrical charges that can move freely in semiconductors.
- The process was discovered as early as 1839, but the first solar cell was introduced by Bell executives in 1954.
- The first generation of solar cells was produced on silicon wafers either using monocrystalline or polycrystalline silicon crystals.
- Solar is a critical element in the ‘Green’ energy revolution, as well as a cost-saving device to reduce the heating and electricity bills of millions of homes.

Digital Synthesis
Spotlight on Computing Pioneers: Laurie Spiegel

- NYC Composer, programmer, and music technologist, Laurie Spiegel
- Best known for her use of interactive and algorithmic logic as part of the compositional process
- NASA asked her to arrange a piece of electronic music to communicate with extraterrestrial life on the opening track of the "Sounds of Earth" section of the golden record placed on board the Voyager spacecraft in 1977
- Another work, titled "Sediment", was included in the 2012 film The Hunger Games
- She has been inducted into the National Women's Hall of Fame
- We will watch a short video about her work as an artist-in-residence at Bell Labs as a composer, programmer, and the first public demonstrator of digital synthesis in the 1970s.

Digital Synthesis



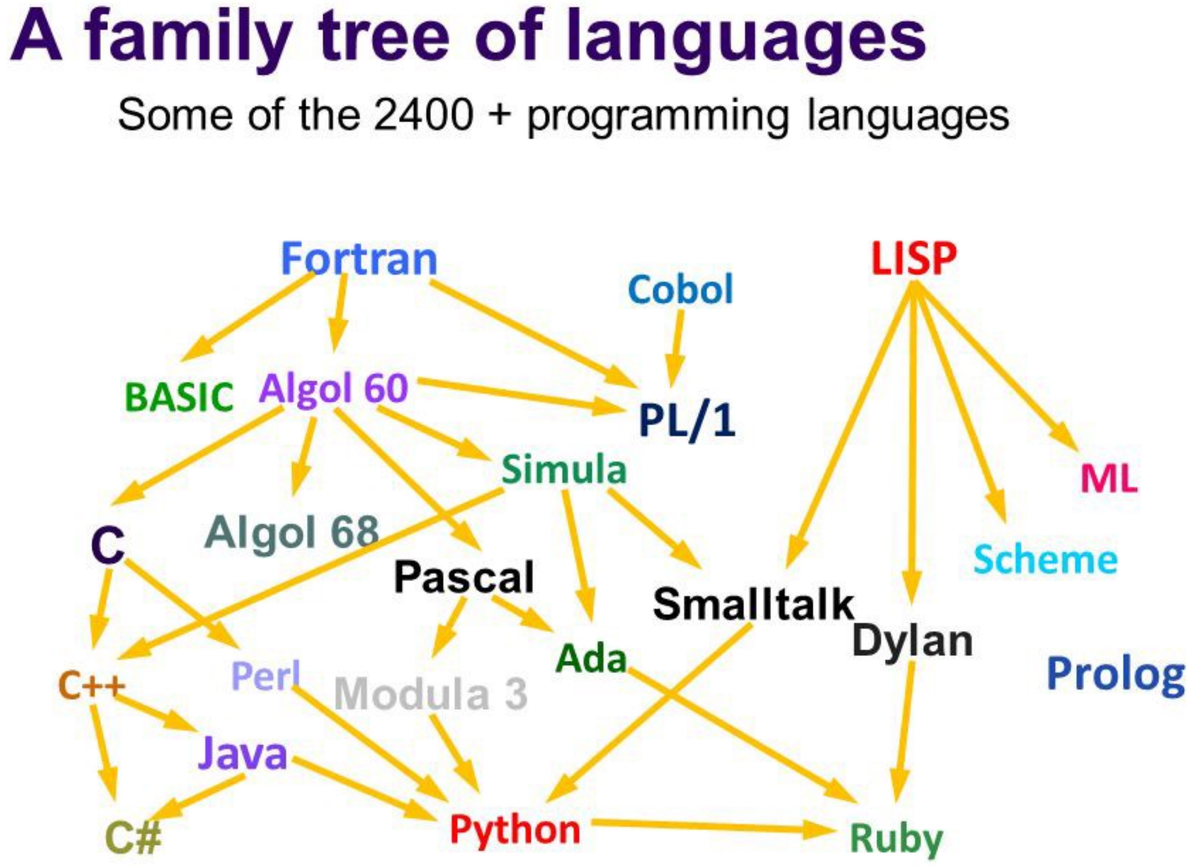
Computer Animation

UNIX
Spotlight on Computing Pioneers: Brian Kernighan

- We will discuss UNIX in more detail later in this unit
- Brian literally wrote the book on the C Programming Language with C's creator Dennis Ritchie
- He also wrote the UNIX Programming Environment
- With a front-row seat during the creation of UNIX, and with his amazing ability to write some of the best-selling, and easy-to-understand computer programming books of all time, he has become one of the most trusted chroniclers of the computer research department at Bell Labs
- He is the co-creator of the AWK language, which we'll study in this unit
- A long-time employee at Bell Labs for over 25 years
- We will watch a short video where he talks about what it was like to work at Bell Labs and the development of UNIX

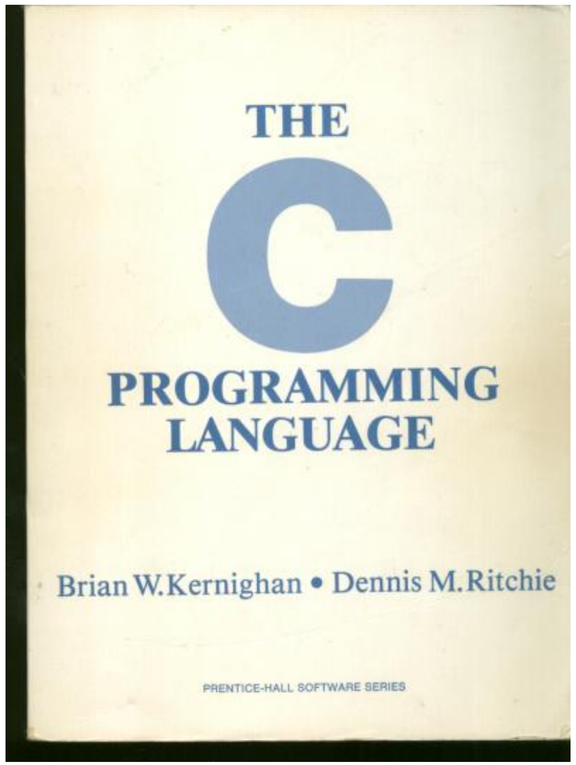
UNIX

The C Programming Language



The C Programming Language

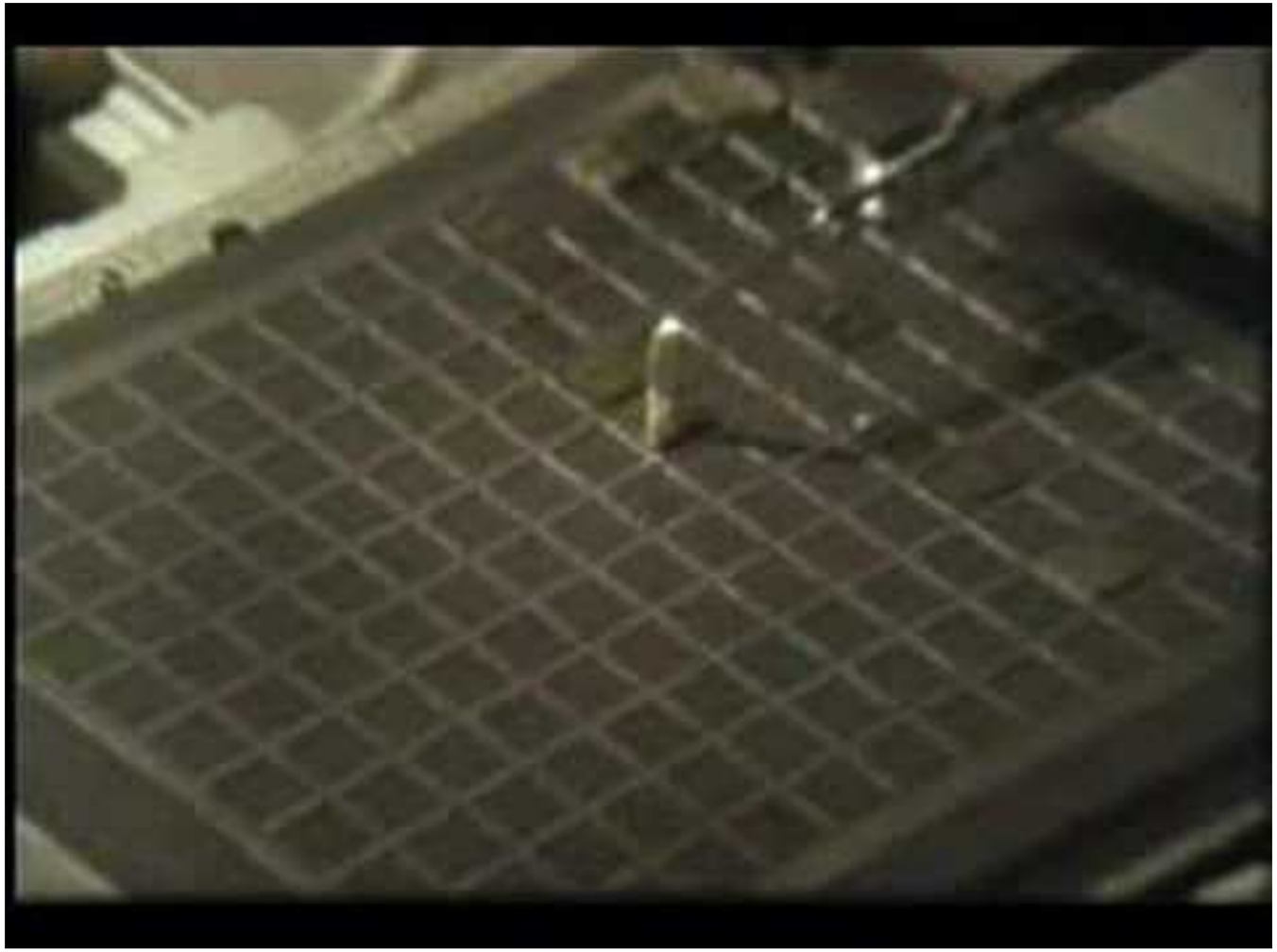
- We will talk more about The C Programming Language later in this unit



Bell Labs Innovations

- Let us review what we've learned and some other Bell lab inventions we missed with this music video from the 1980's
- Pay attention and enjoy

Bell Labs Innovations



Bell Labs Innovations

- Did you get all that?
- I hope you wrote it all down!
- (Just kidding)