With this telegraph, a device invented way back in the mid-1800s, I can communicate with you, even if you're hundreds of miles away.

I can update you on stock prices or the movements of enemy troops. Or who's going to the next week on Ru Paul's Drag Race!

What's harder to do is make you laugh, tell you a long story, sing you this metal song I wrote, or show you this hilarious cat who's terrified of this little toy rabbit—it's adorable, trust me! For that more emotional, audiovisual mode of communication, let's ditch the telegraph and leverage some basic scientific discoveries about sound, light, and electricity made during the nineteenth century. *Hank sings the Crash Course theme* [Intro Music Plays] The telephone, invented in the 1860s and '70s, took personal communication to the next level. Both Scottish–Canadian inventor Alexander Graham Bell and American engineer Elisha Gray created working telephone systems in 1876, and the priority dispute between them is fascinating.

But the telephone didn't lend itself to popular entertainment. It was a one-on-one technology, not a way of communicating to the masses. So it wasn't until the invention of commercial sound recorders and motion picture cameras, in the late 1800s, that you could consume the same media as other people around the globe.

And for those devices, we need to head back to the Menlo Park laboratory of Thomas Edison. Who was, by the way, also working on the telephone! Edison developed the phonograph, which literally means "sound writing," in 1877, shortly before the lightbulb and electrical power system that made him famous.

Maybe Edison was interested in recording, amplifying, and playing back sounds because he was hard of hearing. He might have imagined alternative strategies for recording that hearing people wouldn't have thought of. Edison's team invented a recording cylinder, which offered good sound quality.

It worked by vibrating a thin membrane wrapped around the cylinder, and then amplifying those vibrations, or making them louder. But other inventors created the commercially popular record—a big, flag disc that stores audio information easily by using the ridges of records to encode sound waves. Either way, phonographs are pretty simple and durable—and still in use!

All of you "long play"-collecting vinyl heads are enjoying a fancier version of the phonograph every time you start your turntables. Edison's cylinders were originally used mostly for office dictation by big companies and had little impact on the consumer market. In fact, Edison invented a lot of stuff that consumers would either ignore or outright despise.

Probably the funniest example of an Edison-fail was the talking doll, created in 1890. The doll had a recorder in its chest that could play back "Mary Had a Little Lamb" and other kid-friendly hits. But the sounds grew faint quickly, making an already creepy object that much creepier.

Even Edison called the dolls his "little monsters!" And Edison's magnetic ore separator—which was basically a big electromagnet that could pick up tiny bits of ore left behind by conventional mining—straight-up bankrupted him! That said, this was actually a brilliant application of the new science of electromagnetics. Just too far ahead of its time to work efficiently in practice.

Edison had better luck—post-doll, post-ore separator—with moving pictures. As with his other inventions, he wasn't the first inventor, just the one who made a practical commercial system. Today, historians credit French artist Louis Le Prince with the first workable movie camera.

In 1888, he created the first known movie, a very short one showing off Roundhay Garden in Leeds... it's apparently a good garden... haven't seen it myself. Then, Le Prince disappeared from a train and was never seen again, so… Thought Bubble, show us how Edison made movie magic: As with the lightbulb, Edison didn't do the inventing himself, but relied on hiring creative experts. Still, he was the self-proclaimed Napoleon of technology.

So in the 1890s, Edison and Scottish inventor William Dickson rolled out the Kinetograph, the first motion picture camera, which Dickson invented at Menlo Park. Film movie cameras work by taking lots and lots of photographs called frames. When they're played back quickly, they give the illusion of motion, because the human brain can only process so many images per second before it just gives up.

Edison also created the prototype for the Kinetoscope, the first device for individual movie viewing, in 1891. He debuted this device in Brooklyn in 1893. And in 1895, Edison created the Kinetophone, adding sound to his movies via a cylinder phonograph.

Edison's early movies were not exactly Oscar-worthy, although perhaps YouTube-worthy. They were only one minute long, and they often lacked elements we associate with cinema today, such as plot. One of his early movies, for example, simply depicted three of his blacksmiths, doing some smithing.

Other memorable Edison productions included "The Kiss," "Fred Ott's Sneeze," Annie Oakley shooting glass balls, "Frankenstein," and everyone's favorite, "Professor Welton's Boxing Cats!" Most of these were shot in the first movie studio, the Black Maria, which was created at Edison's bigger, newer lab in West Orange, New Jersey. One notable exception was "Electrocuting an Elephant" which was filmed at Cony Island in which the aging elephant Topsy was killed using alternating current. It was sad and weird, and also popular.

Thanks Thoughtbubble! Kinetoscope and Kinetophone movies took off in saloons. And to Edison, this was enough.

Movies didn't need to be long or complex: they'd never make any money that way! And besides, people have short attention spans. Other cinematic entrepreneurs had different ideas.

Unfortunately for them, Edison was an enormous patent troll! He had the patent on the camera, so he kept suing other movie makers on the east coast. Which is one reason why they kept moving to Los Angeles, the eventual epicenter of the movie industry.

The other reasons were the better natural lighting and weather, and the larger number of very good yoga studios-slash-juiceries. Dickson left Edison Studios to found Biograph Pictures, and the French kept innovating. Brothers Auguste and Louis Lumière invented the cinematograph in the 1890s with the idea of holding mass screenings.

And, finally, in 1902, the U. S. Court of Appeals ruled against Edison, finding that his company couldn't hold the patent on all movie cameras, just the specific model Dickson invented.

But by then, cinema had moved to the west coast, and the world would finally be able to bask in the glory of Point Break. Radio came decades after cinema. Which may sound odd—it's just sound, after all.

But radio waves have to travel long distances without losing fidelity, or accuracy. Whereas movies were carted around using physical reels of film. Scottish physicist James Clerk Maxwell predicted the existence of radio waves back in the 1860s.

But German physicist Heinrich Hertz discovered in 1885 that a wire carrying an electric current will radiate, or give off, electromagnetic waves when it's swung back and forth. That is, he made an antenna. Hertz researched the waves that antennae give off, becoming the first person to show in an experiment how to make and detect electromagnetic waves.

His work led directly to radio. Today we measure the frequencies of electromagnetic waves in units called hertz. Radio waves—the longest type of electromagnetic wave—are measured in kilohertz, megahertz, or gigahertz.

Inspired by Hertz's research, a young Italian inventor engineer named Guglielmo Marconi worked in the 1890s on how to send telegrams wirelessly. Many people were interested in wireless communication, but it was Marconi who first developed a working system. At home in Bologna, he sent and received the first radio signals.

Soon after, Marconi traveled to Britain to commercialize his system. By 1899, he sent the first wireless telegraph signal across the English Channel. And by 1901, he was able to send a single letter, "S," across the Atlantic Ocean, from England to Newfoundland, Canada.

In this humble, sibilant way, radio was born! And so Marconi won the Nobel in 1909. In fact, Nikola Tesla developed a working radio system even before Marconi, but it was Marconi's that took off commercially.

That process took a long while. Regular radio broadcasts began in 1920, in Pittsburgh, at the 100-watt station KDKA. And the British Broadcasting Corporation created the first radio network in 1922.

Radio broadcasts soared in popularity and became profitable thanks to advertising. By 1936, three quarters of American households owned a radio. Unlike a telephone, a radio worked without laying expensive copper wires.

So this invention, and the automobile, connected cities to rural areas and changed how people consumed music and sports. Radio also became a tool of political propaganda and an indispensable way of communicating important news. The greatest example of this occurred on October 30, 1938, when Orson Welles directed an adaptation of H.

G. Wells's novel, "War of the Worlds," in which terrifying Martians invade earth and subdue humanity. Some people didn't understand that this was a drama - maybe they like, flipped on midway through, and mistook the realistic radio announcements for actual news, causing a panic.

As radio was taking off, television was invented and built on the infrastructure that supported it. And, like radio, TV would take a long time to move from prototypes to commercial networks. Numerous people contributed to its development, but one name stands out.

Scottish engineer John Baird invented a mechanical TV in the early 1920s. He used transparent rods to transmit images of only thirty lines at at time, or pretty low resolution. Baird demonstrated the first televised images in 1924, and moving ones in 1926.

In 1928, he transmitted an image of a human face across the the Atlantic Ocean. A year later, the BBC began broadcasting Baird's TV system. He even worked on color TV before 1930—a tech that wouldn't become standard until the 1950s.

But in the end, the BBC switched to electronic, rather than mechanical TV, adopting a system by Marconi's company in 1936.

Still, TV was expensive to produce, and receivers were expensive. World War Two caused an intervening distraction, so television didn't take off as an industry until the 1940s.

Telstar, the first satellite for global broadcast, was launched in 1962. And then, on July 20, 1969, people all over the world watched as a human set foot on the moon. We'll get to space soon!

Think of all of the communications technologies required to enable almost everyone alive to watch the same Super Bowl, World Cup, or EuroVision final! These technologies emerged from intensive, competitive corporate research programs. Corporate invention at Menlo Park set the stage for later R&D; hubs at Standard Oil, General Electric, DuPont, Bell Labs, IBM Labs, and Google X.

These places sought to, and seek to, turn basic scientific discoveries about electromagnetism into patents and profits. Next time—we're probing our own gray matter: it's the birth of psychology and psychiatry! Crash Course History of Science is filmed in the Dr. Cheryl C. Kinney studio in Missoula, Montana and it's made with the help of all this nice people and our animation team is Thought Cafe. Crash Course is a Complexly production.

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