Air Travel and The Space Race: Crash Course History of Science #37

Crash Course: History of Science
https://youtube.com/watch?v=QhULJr-LKbg
https://nerdfighteria.info/v/QhULJr-LKbg

Like the Industrial or Einsteinian Revolution, the Space Race is a trope, or a way of organizing a historical event into a story that makes sense. In this story, the two great powers that had emerged after World War II, the United States, and the Societ Union, competed to send communication satellites, dogs, and people into outer space. And also to intimidate the other side with the prospect of nuclear war. But before humans could send anything into space, first, they had to get into Earth's atmosphere.

[title sequence]

Folks dreamed about flying up into the heavens for centuries. You might have seen Leonardo da Vinci's sketches for personal flying machines for example. Those did not work. Since around CE 220 in China, people have used unmanned sky lanterns - hot air balloons, basically - to help messages escape the ground to everything from military signalling to festivals.

An human hot air balloons became popular in Europe in the late 1700s, starting in France. But these devices didn't travel fast, they couldn't handle strong winds, and they weren't very safe. So historians tend to start the history of air travel with two dudes from a large family: Orville and Wilbur Wright. These bros ran a bicycle shop in Dayton, Ohio. Actually though to be clear, their sister Katharine ran the household and handled their business finances.

But the brothers wanted to build a flying machine, and at the end of the Second Industrial Revolution, they did. Orville and Wilbur made lots of gliders and eventually a powered plane. They used wood and fabric and the petrol powered internal combustion engine and some bicycle parts. And keep in mind, the invention of the bicycle itself was only 25 years old. But first, they collected tons of data about wing shapes and airflow using a small homemade wind tunnel.

People had tried building flying machines, sure, but the Wrights used physical data to design one. And then the brothers took off on the first heavier-than-air flight on December 17, 1903, at Kitty Hawk in the outer banks of North Carolina. They made four flights on that first day. None was very long or high by modern standards, but all were extraordinary in 1903.

The Wrights wanted to commercialize their flyers but it took a while for people other than the aviation obsessed French to believe that they'd actually flown. Eventually however the Wrights conducted more demonstrations and convinced the US military to invest. Aviation took off for war, but also for mail and passenger services. With a more advanced engine, Charles Lindbergh flew across the Atlantic in 1927, and by the early 1930s well-off passengers could ride commercial airlines.

This revolutionized tourism and cargo and global culture. It made the whole world feel smaller. In terms of technical effects, air travel spawned whole new industries. Think about all of the many integrated technologies that allow you to fly. Fuel, ticketing, air traffic control, and so on. And despite our angry tweets, commercial air travel is one big highly functioning and safe system today. But air is not space.

Flying using a jet engine in a plane with fixed wings can get you high into the cold, oxygen low strata of the atmosphere, but to escape the atmosphere you need more power. The solution? A very big chemical reaction. Basically an explosion. The inspiration for the solution? Science fiction.

In 1865, French adventure writer Jules Verne wrote a book titled *From the Earth to the Moon.* In it, members of the Gun Club decide to go to the moon by creating - wait for it - a giant gun. Verne saw American settler colonization as a great adventure. Why not head to the moon and exploit the Mooninites? So science fiction matters. It influences how we, including real-life scientists and engineers, think about what the future can be. In this case, Verne was notable for trying to imagine a pretty dang realistic plan for space exploration, given nineteenth-centruy technology.

[Hanks makes *vwooosh!* noise]

Still real life giant gun making, or like, rocket science, didn't take off immediately. Between Verne and World War II, the discipline of chemistry took off. Especially in Germany. Scientists had access to new materials that simply had never existed before. So leading up to the war and directly inspired by Verne's novel, Nazi physicist Dr. Wernher von Braun developed chemical reactions that could propel a weapon far far away. And late in World War II, the Nazis launched his V2 rockets, the first long range guided ballistic missile against England, killing civilians.

But after the war guess who forgave this Nazi's crimes to make use of his engineering genius? Yeah, that was us here in the US of A. Von Braun became director of the Marshall Space Flight Center at NASA. Like airplanes, rockets changed warfare forever. Missiles replaced long range bombers for delivering nuclear weapons, and thus the Cold War began. Russians and Americans could now strike anywhere in the world. Apocalypse was only a button away.

By the way, this is still the case.

It's good to think about how we tell the history of the invention of weapons. For example, one curator at the Smithsonian argued that rockets on display there should be pointed down so that visitors would be confronted with destruction. Rather than pointed up and away, which implies victory without consequences. With new German designed rockets, Soviet and American engineers competed to fly farther. Much of the Cold War relates to the Space Race.

It began when the USSR launched the first satellite, Sputnik, on October 4th, 1957. This shocked the world and terrified many in the United States. Only a few years later in 1961, the Soviet Union sent the first human into space. Yuri Gagarin made one whole orbit of the Earth in a Vostok spacecraft, becoming the first cosmonaut, or "space sailor". Like Sputnik's launch, Gagarin's flight was utterly mind blowing. It symbolized just how far the Soviet physical sciences had come very quickly.

Out of an empire of serfs, the USSR had evolved into a scientific leader capable of breaking new ground, including cultural ones. In 1963 cosmonaut Valentina Tereshkova piloted Vostok 6, bringing womankind into space. She is still alive by the way and has offered to take a one way trip to Mars.

So how did Americans respond to all of this? In 1961 US president John Kennedy publicly threw down a scientific challenge: to land a man on the moon before the decade is out. Bam. Verne strikes again. The Mercury program of the early 1960s put Americans into space, but the Apollo program successfully landed humans on the moon.

Thought Bubble, show us the wonder of moon travel.

This program was complex, but it boiled down to a few components:

- Using advanced computers to chart a course to get to the moon
- Crossing thousands and thousands of miles
- Training pilots to be astronauts or "star sailors"
- Designing a command module that could land on the moon

and then take off again
- And building a rocket to leave the Earth with enough force to carry not a small satellite, but astronauts in a module.

The launch vehicle that got humans to the moon was the Saturn series designed by Werner von Braun's team. Like other giant liquid fueled rockets, it worked by mixing chemicals that would react violently, creating tremendous force that was directed straight down, sending the vehicle up in the opposite direction. In this case the chemicals were liquid oxygen, liquid hydrogen, and Rocket Propellant One or RP1, which was basically kerosene that had a bunch of dangerous chemicals added to make it super explosive.

After several missions and a few disasters, NASA felt they could safely send humans to the moon and back in 1969. So on July 16th astronauts Neil Armstrong, Buzz Aldrin, and Michael Collins took off from Merritt Island Florida on the 11th Apollo mission. On July 20th, the ir eagle lander touched down in the moon's Sea of Tranquility. Neil Armstrong became the first human to set foot on a planetary body other than Earth. He was the soon after joined by Buzz Aldrin.

As young folks on vacation will do, Buzz and Neil planted the flag of the United States, took some moon selfies, called President Nixon, and stole some rocks. Total hooligans. And then they returned to Earth, four days after landing on the moon. Thanks, ThoughtBubble.

There are lots of movies about the Apollo Program's numerous successes and even one of its terrifying failures, Apollo 13, which actually was arguably one of the most successful missions by the way, because NASA was able to correct the disaster. And the Apollo Program was as much a managerial success as a technical one. It's a great example of Big Science - research projects so big that no individual lab can do everything from beginning to end. So work is broken off into chunks, like the Manhattan Project.

But not all Big Space Science has been about winning wars; take the Hubble Space Telescope, Mars Rover, or the Cassini-Huygens Satellite. The epistemic value of these missions is incalculable. Their practical utility? Almost zero.

Alas, space exploration is super expensive and Congress has to choose how to spend tax payer's money. On the same day that they cancelled funding for the revolutionary physics experiment, the Superconducting Super Collider in 1993, they approved funding for the Space Shuttle. This was a big loss to particle physics but a win for astronauts. The shuttle program itself was retired in 2011. One response to this lack of public funding has been an explosion of private space agencies, developing space tourism.

Another solution has been international collaboration. Despite persisting political tensions, Russia and the US collaborate on space science to this day. Perhaps most notably since 1998, Americans, Russians, Japanese, Europeans, and Canadians have worked together to run experiments on the International Space Station. It's above us right now, humanity's only outpost beyond the safety of the atmosphere and a physical of how the quest to understand our universe can bring us together.

All of this space travel has given us new epistêmê, such as a better understanding of the age of the universe... like, the age of everything, and new technê, including: solar cells, freeze drying, digital cameras, GPS, and better weather prediction. It's also given us modern communications technologies and yeah, spy satellites. But space science has also filled space with tons of junk, including rocket parts, dead satellites, and human waste, which raised the question of whose job it is to clean up? That is, who owns space?

Well space law generally says that no one gets to own space. But that begins to become problematic for super useful orbits, like geosynchronous orbits, or circular paths 35,786 kilometers above sea level, that follow the rotation of the planet and so are fixed above specific points on earth. You can only have so many satellites at useful geosynchronous points. The US, Russia, China, and EU already have many of the best spots. Yet another way that equatorial countries face an unequal landscape in science.

So space science raises tough questions about power and knowledge, shared resources and competition between nations. But there's only one Earth, and space science also provides some good models on how to share. After all, the Apollo project was named after the Greek god of music, truth, and healing, not the god of war. As President Kennedy said in 1962: "We shall not see space filled with weapons of mass destruction, but with instruments of knowledge and understanding."

Next time we're going to come back to solid ground with a new perspective on Earth's place in a vast universe. It's the birth of ecology and earth systems science. *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 of these nice people. And our animation team is Thought Cafe. Crash Course is a Complexly Production. If you want to keep imagining the world complexly with us, then check out some of our other channels like Sexplanations, Healthcare Triage, and Mental Floss. If you would like to keep Crash Course free for everybody, forever, you can support the series at Patreon, a crowdfunding platform that allows you to support the content you love.