The Atomic Bomb: Crash Course History of Science #33

Crash Course: History of Science
https://youtube.com/watch?v=w4q1fG1vh5I
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===== (00:00) to (02:00) =====

[introduction]

We tell a lot of stories about science and politics on Crash Course, but it's hard to get much more political than the Manhattan Project. This is the story of the bomb that earned a capital B, and the scars it left on 20th century science and culture. It's not a happy story. Sorry in advance.

[title montage]

[background]

The story picks up where we left off last time, with Einstein writing the president of his new homeland - the United States - urging him to build a nuclear weapon before Hitler.
But. How did Albert even know about this amazingly powerful weapon?

[the road to the letter]

For that, we turn to Hungarian-American physicist, Leó Szilárd. Szilárd read about Ernest Rutherford's work with electrons and in 1933 realized that it was theoretically possible to split apart an atom's juicy center and create nuclear fission, releasing vast amounts of energy and thus splitting apart another atom. And another. And another.

Thus, Szilárd came up with the idea of a nuclear chain reaction, which could mean a new form of energy... or a super-weapon. Szilárd, with the help of hot shot Italian physicist Enrico Fermi, quickly patented the idea of a nuclear reactor or "atomic pile" in 1934. This device would cause a self-sustaining nuclear reaction. Then in 1938, German physicists actually achieved fission in the lab. And also Hitler annexed Austria. And a year later, Poland. War descended once again on the world.

Szilárd decided that only his and Fermi's invention could save it. So he drafted a letter to President Roosevelt, with some input from some couple of other physicists. Only, Szilárd wasn't famous enough to just, you know, high-five Roosevelt and get a nuclear weapons program off the ground. But, he knew someone who was: Albert Einstein, the most famous scientist in the world and possibly ever, signed Szilárd's letter.

===== (02:00) to (04:00) =====

[the letter's implications]

It was only two pages and it's really worth Googling. It basically said there's the possibility of this new super-weapon, and the German's might get it first.

Now let's be clear, Einstein was a pacifist. But he was also, like, a very smart, deeply pragmatic person. In his mind the only question was would the Americans, Germans, or Russians split the atom first. And he foresaw a potentially very bad ending for Germany, the Jewish people, the free world, and Science. He foresaw literally the end of the world.

What happened next is really, really hard to understand from today's perspective. The US Government, with a little help from Canada, ran an enormously expensive and secret weapons program for four years. Secret even from Congress. There were no leaks, so almost no one on Earth understood the possibility of nuclear physics until it was too late.

[the Manhattan project]

This program was code-named The Manhattan Project, and it was perhaps the first and clearest example of Big Science. Government sponsored, multi-year, multi-sided, field-defining work. The Manhattan Project involved 43,000 people, including a who's who of European and North American scientists in the 40s. From Szilárd and Fermi, to the great Hungarian-American mathematician and computer scientist, John von Neumann.

The Project had several parts, but most of the science-ing happened in a couple places. Take us on a fateful ride, ThoughtBubble.

[into the ThoughtBubble]

First stop, the University of Chicago. Underneath the football stadium. That's right. The biggest science ever got physically started in a place no one would ever look for it, which sounds like the plot of a B-Movie. There, in December of 1942, Enrico Fermi - the Architect of the Nuclear Age - created the very first controlled chain reaction: Chicago Pile 1.

Keep in mind, the Europeans who'd fled Hitler and the Americans and Canadians who were now managing their novel experiments had no idea how far Hitler's team might have gotten. Everything was secret, new, and a guess. This was science at war.

[end of 4A. Conclusions]

===== (04:00) to (06:00) =====

[map graphic, we're leaving Chicago and headed west]

Second stop, the mines on the Navajo Nation, which included parts of Arizona, New Mexico, and Utah. Here, starting in 1944, the people who call themselves the Diné (pronounced di-neh) mined a yellow rock containing naturally high amounts of the heavy metal, uranium.

The Diné would continue to mine the nation's uranium for decades, until 1989, long after the peak of the Cold War. No one knows the full extent of the radiation exposure, but we can uncontroversially say that mining radioactive ore lead to higher rates of lung cancer. The US Government didn't act to address this problem until 1990, a long, long time after World War II.

Okay, back in time, third stop, Los Alamos Laboratory in New Mexico. Here, American physics boss Julius Robert Oppenheimer A.K.A "The Father of the Atomic Bomb" oversaw the project's scientific research and the design of the nuclear weapons.

And on July 16th, 1945, the team lead by Oppenheimer set off the world's first atomic explosion at the Trinity Site near Los Alamos. The bomb was much bigger than anyone had anticipated. A large mushroom cloud appeared high over the desert. The test was a success.

Famously Oppenheimer summed up the moment by quoting the epic Hindu scripture the *Bhagavad Gita*:

[recording of Oppenheimer plays]

"...now I am become death, the destroyer of worlds."

[Hank's narration resumes]

In the story, this is a line that Vishnu says when he takes on a fearsome, multi-armed form. Which meant basically that Oppenheimer recognized two things: developing a nuclear weapon was like being a god, and this weapon was weapon was about appearing more fearsome to one's enemies. Thanks, ThoughtBubble.

[exit ThoughtBubble, back to Hank]

By mid-1945 the biggest enemy of the democratic world was no longer Germany. The Allies had invaded and retaken France in June. Now the US wanted to end the Pacific war with Japan. And the United States had a totally new weapon, one that created devastation on an unprecedented scale. The only choice left was whether or not to use it.

===== (06:00) to (08:00) =====

Most historians today agree that the reason for dropping the bomb cited at the time, that is, to prevent a long and drawn out war with Japan, is wrong. Part of the challenge in writing the Bomb's history, especially right after the war, was that many official documents were classified. Once documents began to be declassified, such as Truman's diaries at the Potsdam conference, which became publicly available in 1978, historians began to change the narrative of why Truman dropped the bomb.

[truman's decision]

President Truman - Roosevelt had died earlier in 1945 - was aware that Japan was militarily weak, and American victory was basically inevitable. Truman was also quite aware of the number of casualties that would result from the use of an atomic bomb. The decision to drop it was a well-informed one. Besides immediate military victory, two other reasons factored into this decision. One, to justify its monumental cost. And two, to intimidate all enemies, present and future, of the United States.

[the bombs]

On August 6th, 1945, the Enola Gay, a B-29 Superfortress Bomber named after the mother of the pilot, took off from an island six hours away from Japan. At just after 8 in the morning Hiroshima time, the Enola Gay dropped a 10,000 pound uranium-235 bomb nicknamed "Little Boy" that exploded over the city. This was the first and deadliest atomic bombing in history.

Three days later, on August 9th, 1945, the United States dropped a second atomic weapon, a plutonium-239 weapon nicknamed "Fat Man" on another port city, Nagasaki. About 200,000 people died in the bombings and in the months afterward. Japan surrendered unconditionally. It remains the only nation to have been attacked using an atomic weapon.

The long term impact was unknown and unknowable. Even the scientists who created the bomb didn't know what would happen, although they had some pretty strong guesses. After the war, Oppenheimer became director of the Institute for Advanced Study at Princeton, and now there's an opera about him. Japan rebuilt. The United States experienced an unprecedented economic boom.

===== (08:00) to (10:00) =====

[4A. Conclusions displayed]

Yet the end of World War II and the revelation of the Manhattan Project did not bring about world peace - but a smoldering global super-conflict called the Cold War, between the Soviet Union and the United States. The stakes? Control of most of the world. The rules of this game, nuclear physics. The units of success: number of atomic bombs, size of atomic bombs, and... that's it.

Yeah, weird for the conflict that pretty much organized global politics for 40 years. Okay, so what did the physicists come up with? The thermonuclear, or hydrogen bomb, which used fusion - or the joining together of nuclei - to create an even bigger reaction than the first generation fission reactors had been able to.

The United States invented this one too. The Teller-Ulam design, named after physicists Edward Teller and Stanislav Ulam, is still secret to this day... which is kind of amazing. Teller was... intense? He advocated for using thermonuclear weapons for all kinds of reasons, including digging convenient, giant artificial harbors. You know... a totally justifiable use of a novel super-weapon.

[the further ramifications of nuclear weapons]

Jokes aside, the United States and Soviet Union continued to build and test these weapons. Between 1946 and 1958, the US tested a series of giant nuclear bombs at Bikini Atoll, which caused permanent damage, displacing the Bikini islanders. Forever. From their own nation. This is just one of the most heinous examples of the lasting social and ecological damage of nuclear physics.

Nuclear fission used for energy production has not been blameless either. You might have heard of the terrible accidents at Three Mile Island in 1979, Chernobyl in 1986, and Fukushima Daiichi in 2011. You may not have heard about the accident in 2014 at the Waste Isolation Pilot Plant in New Mexico. When the wrong brand of *kitty litter* was used in containment, a drum of nuclear waste exploded.

Nuclear waste is incredibly dangerous for thousands of years. And there's literally tons of it. And no one knows what to do with it. So it all comes down to kitty litter. Anyway. We'll return to the Anthropocene, or the global ecological collapse, a little later.

[exasperated smile]

===== (10:00) to (12:00) =====

[nuclear technology today]

The different applications of nuclear energy are still hotly debated today, and so are the different ways of telling the history of this technology. For example, when the Smithsonian National Air and Space Museum tried to mark the anniversary of dropping the atomic bomb on Hiroshima with an exhibit in the 1990s, a debate erupted. Was the United States justified in using this weapon? How should historians of technology think about weapons? In fact, this became known as the History Wars.

On the application side, many groups of scientists, such as the Union of Concerned Scientists, have criticized nuclear weapons and energy programs as unnecessary. That is, these can be seen as good examples of the problem of creating shiny new technologies simply for technology's sake. Or maybe, as social scientist Carol Cohn pointed out in 1987 in her classic portrait of the US culture of strategizing about global nuclear war, *Sex and Death in the Rational World of Defense Intellectuals,* the whole point of bigger, better weapons of mass destruction was just to prove you had the bigger... bomb.

[what's coming up]

Next time, the world is still at war. It's time to examine antibiotics, Nazi science, and the rise of biomedicine.

[end credits and acknowledgements]

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===== (12:00) to (12:05) =====

[no narration, promotional screen for *Crash Course* themed augmented reality posters, order now at dftba.com]