The development of the bomb - TEVA
Object: Piece of Uranium

Contains:
- Overall scientific advancements in attempts to make the bomb work
- Use of weapons and how atomic bomb is unique compared to them
- Materials needed for the bomb (connection to regional locations)
- Testing and its impact
- Connection to historical significance

Interactive aspects/visuals:
- Object 3 showcase + installation
  - Interview from seycove about what the object means to them
- Significant scientists / people

Evidence
  - Photos from the time
  - Photos from Los Alamos

Sub section: The science of the bomb

Contains:
- chain reactions / the success of them and how they work
- The physics of atomic science
- Significant scientists / people
- Connection to historical significance

Interactive aspects/visuals:
- Visual / keynote animation of chain reaction
- Lots of science imagery

RESEARCH (science)

Sources:
1.

2. The science of nuclear weapons visualized https://www.visualcapitalist.com/science-of-nuclear-weapons/
3. Lise Meitner: https://www.britannica.com/biography/Lise-Meitner

RESEARCH (development)

Sources:

1. ~~Brittanica WW2: https://www.britannica.com/technology/atomic-bomb/Development-and-proliferation-of-atomic-bombs~~
2. ~~Brittanica Big Science:~~
3.
4. ~~The race for he atomic bomb: https://www.dhm.de/blog/2023/02/28/the-race-for-the-atomic-bomb/~~
5. ~~The making of the atomic bomb National Museum of WWII: https://www.nationalww2museum.org/war/articles/making-the-atomic-bomb-trinity-test~~

SOURCE 1: Development of atomic bombs

Brittanica WW2: https://www.britannica.com/technology/atomic-bomb/Development-and-proliferation-of-atomic-bombs

- The first atomic bomb was build it New Mexico during WWII in the Manhattan Project
  - Los alamos was the main site for the atomic bomb laboratory on November of 1942
- J. Robert **Oppenheimer** was in charge along with Brig. Gen. **Leslie R. Groves**
- Code name was **"Project Y"**
- The first ever bomb to be dropped used uranium and was dropped in 1945
- Vannevar Bush was an electrical engineer who developed the Differential analyzer and oversaw the government mobilization of scientific research in wwII

SOURCE 2: Big science

Brittanica WW2: https://www.britannica.com/technology/atomic-bomb/Development-and-proliferation-of-atomic-bombs

- A style of scientific research
- "Now I am become death, the destroyer of worlds" - Oppenheimer
- Big Science is characterized by large-scale instruments and facilities, supported by funding from government or international agencies, in which research is conducted by teams or groups of scientists and technicians.

- Big science is described as Big Science as part of the new political economy of science produced by wwII
  - Big science brings a bunch of brains together
- "This weapon, which has the capacity to end civilization was developed as a mean to save western civilization"
- Germany discovered that nuclear fisson was possible and the worry from the west is that they would use to to create the atomic bomb, but the west ended up doing it
- The first 2 decades of the early 20th century were periods of incredible intellectual daring

SOURCE 3: The race for the atomic bomb
The race for he atomic bomb: https://www.dhm.de/blog/2023/02/28/the-race-for-the-atomic-bomb/

American perspective
- Germany discovered that nuclear fisson was possible and the worry from the west is that they would use to to create the atomic bomb, but the west ended up doing it
- 1 month before Germany invaded Poland Albert Einstein sent a letter to president Truman
  - He pointed our that Germany was probably working on creating an atomic bomb based on the chain reaction of nuclear fisson
  - "A single bomb of this type, carried by boat and exploded in port, might very well destroy the whole port together with some of the surrounding territory. However some bombs might very well prove too heady for transportation by air"
- Truhman decided to speed up developments of nuclear tech bc he was worried that Germany would do so before -> creation of the MP
- Germany discovered that nuclear fisson was possible and the worry from the west is that they would use to to create the atomic bomb (1938)
- Germany discovered that nuclear fisson was possible and the worry from the west is that they would use to to create the atomic bomb, but the west ended up doing it

German perspective
- On behalf of the German Army Ordnance Office, Nobel laureate Werner Heisenberg travelled with Carl Friedrich von Weizsäcker to German occupied Copenhagen in September 1941 to consult with the Danish nuclear physicist Niels Bohr. Because the German scientists failed to make groundbreaking progress in the development of atom weapons, the arms production efforts under German armaments minister Albert Speer continued to concentrate on conventional weapons. In the course of the war, Bohr emigrated to the United States, reported to the Americans on German initiatives to build an atomic bomb, and contributed important theoretical findings to the development of American nuclear weapons.

Japanese perspective
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- In the course of the war, Bohr emigrated to the United States, reported to the Americans on German initiatives to build an atomic bomb, and contributed important theoretical findings to the development of American nuclear weapons.

- Like their colleagues in Germany, the Japanese nuclear scientists shared the erroneous assessment that the development of nuclear weapons would not have a decisive effect on the outcome of the war, and nuclear research remained only one of several efforts to produce armaments.

Overall

- Compared with the USA, the Axis Powers remained far behind as to the extent, organisation, concentration of potentials, and financial investment in nuclear arms
- After having accessed secret documents on the German research of nuclear weaponry, the scientists participating in the Manhattan Project came to an astounding conclusion
  - : "[It] is clear that the total potential of the German uranium project was considerably inferior to that of the Americans. This might have been due to the limited possibilities of the German economy or to an unfavourable disposition of the government. The fact remains that an independent group of scientists, far smaller than ours, achieved relatively much under unfavourable conditions."
- German nuclear physicists had set off on the right path and reached conclusions analogous to those of the Americans, which theoretically could have resulted in the successful development of nuclear weapons.

Turning point

- German nuclear physicists had set off on the right path and reached conclusions analogous to those of the Americans, which theoretically could have resulted in the successful development of nuclear weapons.
- The idea of the manhattan project that a weapon like this, of such mass destruction was so terrifying that it could cause prosperity as it would end the war

SOURCE 4: The trinity test and the making of the atomic bomb
The making of the atomic bomb National Museum of WWII: https://www.nationalww2museum.org/war/articles/making-the-atomic-bomb-trinity-test

- Achieving the monumental goal of splitting the nucleus of an atom, known as nuclear fission, came through the development of scientific discoveries that stretched over several centuries

German discovery of fission

- Austrian-Swedish physicist Lise Meitner, working with German chemist Otto Hahn, was among the first to achieve the successful fission of uranium. However, the antisemitism of the Nazi party forced Meitner, who was Jewish, to flee and settle in Sweden. While in Sweden, Meitner identified and named the process of nuclear fission.
- Meitner's findings became a tipping point in the development of nuclear weapons, but as the world once more moved into war, it was the Germans who held the potential key to nuclear power.

The US takes action

- When news of Hahn and Meitner's discovery of fission reached Szilard in his New York City home in early 1939, Szilard began work to confirm their findings.
- In July 1939, Szilard contacted the prominent Jewish German theoretical physicist Albert Einstein at his home on Long Island, New York, to discuss German advances in nuclear development. Together, Szilard and Einstein drafted a letter to US President Franklin D. Roosevelt.
  - In the letter, dated August 2, 1939, the warning was clear: "This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed." The letter did not reach Roosevelt until

October, but once he learned of the potential risks presented by nuclear weaponry, he responded by forming the Advisory Committee on Uranium, which held its first meeting on October 21, 1939.

The Manhattan Project

- the question of uranium development and the potential construction of an atomic bomb gained renewed interest after the attack from Japan on Pearl Harbour -> made it go faster after 1941
- It formed in 1939
- The MP found that uranium could be used in the creation of the atomic bomb
  - the limitation of resources quickly became evident and prompted committee leaders to turn to the military for help
- Los Alamos was the site of MP weapons research laboratory. This Los Alamos site would become the location for the construction of the atomic bombs. The last primary site Groves selected was Hanford, Washington, which he designated to produce plutonium from the uranium isotope U-238.
- After receiving formal approval from President Roosevelt on December 28, 1942, the Manhattan Project developed into a massive undertaking that spread across the United States.
  - With over 30 project sites and over 100,000 workers, the Manhattan Project came to cost approximately $2.2 billion.
- there appeared to be two possible paths toward building atomic bombs: uranium and plutonium. The Manhattan Project built both kinds of bombs, ultimately resulting in the construction of Little Boy, a gun-method uranium bomb, and Fat Man, an implosion-method plutonium bomb.

The Trinity Test

- The test bomb, nicknamed Gadget, contained 13 pounds of plutonium, as well as the implosion-method of detonation
- The test was much more successful than Oppenheimer anticipated. He had expected an explosion equivalent to .3 kilotons of TNT; instead, the resulting blast equated to roughly 21 kilotons of TNT.

Conclusions

- The success of the Trinity Test exceeded the expectations of Groves and most of the scientists involved in the MP
- The choices of the atomic bomb: everyone justified it bc it meant it would end the war. Ppl were exhausted and they were willing to kill 100,000 + ppl in japan just to finish this battle.

TIMELINE (development of the bomb/the race):

Germany:

- 1938: Otto Hahn and Fritz Strassmann discover nuclear fission, a crucial breakthrough in atomic physics.
- 1939: Nazi Germany initiates its nuclear program under the leadership of Werner Heisenberg. However, the effort is limited by a lack of resources and support from the Nazi regime.
- 1942: German scientists realize the potential of nuclear weapons and attempt to convince Hitler to allocate more resources to their program, but it remains underfunded.
- Late 1944: Allied bombing raids severely disrupt the German atomic program, and it ultimately fails to produce a functional atomic bomb.

Japan:

- 1939: Japanese physicist Yoshio Nishina begins research into nuclear physics, leading to a small-scale atomic bomb project.

- 1941: Japan starts to import uranium ore from occupied territories for its nuclear program.
- 1942: The Japanese program faces resource shortages, technical challenges, and limited expertise. It struggles to make significant progress.
- 1945: With Japan's war effort deteriorating and the Pacific Theater nearing its end, the Japanese atomic bomb project is abandoned.

United States:

- 1938: President Franklin D. Roosevelt authorizes the creation of the Advisory Committee on Uranium (later the Manhattan Project), officially launching the U.S. atomic bomb program.
- 1942: Major General Leslie Groves is appointed to lead the Manhattan Project, overseeing the construction of research and production facilities.
- 1945: The United States successfully develops two types of atomic bombs - "Little Boy" (uranium-235) and "Fat Man" (plutonium-239).
- July 16, 1945: The first successful test of an atomic bomb, code name: "Trinity," takes place in New Mexico.
- August 6 and 9, 1945: The United States drops atomic bombs on Hiroshima and Nagasaki, leading to Japan's surrender and the end of World War II.

SOURCE 5: Nuclear fission

Brittanica WW2: https://www.britannica.com/technology/atomic-bomb/Development-and-proliferation-of-atomic-bombs
- atomic bomb is a weapon with great power that results from the sudden release of energy upon the splitting or fission of the nuclei of a radioactive nuclei such as plutonium or uranium

- splitting causes the nucleus to split and in the process of splitting, a lot of thermal energy and gamma rays is released + a few neutrons
    - These extra neutrons strike another nucleus and it causes a chain reaction

Video of chain reaction -> **https://www.britannica.com/video/22590/Sequence-events-fission-neutron-uranium-nucleus**

- Many isotopes of uranium can undergo fission but **uranium-235** undergoes fission more readily and emits more neutrons per fission than other isotopes
    - Plutonium-239 has the same qualities
- The assembly of fissionable material must be brought from **subcritical** to **critical state** extremely suddenly

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✨ WRITING

German Discovery of Fission:
In the late 1930s, German physicists Otto Hahn and Fritz Strassmann made a groundbreaking discovery: nuclear fission. This process involved splitting the nucleus of an atom, releasing a tremendous amount of energy. Lise Meitner and Otto Frisch later provided the theoretical explanation for this phenomenon.

This discovery had far-reaching implications, as it revealed the potential for harnessing nuclear reactions as a powerful energy source or, as feared, as a weapon of mass destruction.

The US Takes Action:
Recognizing the significance of nuclear fission and fearing that Nazi Germany might develop an atomic bomb, physicist Albert Einstein and other prominent scientists urged the U.S. government to take action. This plea led to the establishment of the Manhattan Project in 1939, a top-secret research and development program dedicated to creating an atomic bomb. The project was led by physicist J. Robert Oppenheimer and involved a vast array of scientists, engineers, and technicians.

The Manhattan Project:
The Manhattan Project was a massive, highly classified research effort spread across multiple locations, including Los Alamos, New Mexico. Scientists like Enrico Fermi and Richard Feynman worked tirelessly to develop the bomb's design and build the necessary infrastructure for its production. The project also involved the construction of massive facilities like the Hanford Site in Washington and Oak Ridge in Tennessee for the production of fissile materials.

The Trinity Test:
The culmination of the Manhattan Project was the Trinity Test, which took place on July 16, 1945, in the New Mexico desert. The test involved detonating the world's first atomic bomb, and it was a resounding success. The explosion released an enormous amount of energy, confirming the feasibility of creating a devastating weapon. The Trinity Test marked a pivotal moment in history and set the stage for the use of atomic bombs in the closing days of World War II.

Conclusion: The race to the atomic bomb was a critical aspect of World War II, and the outcomes in each country were shaped by factors such as political support, access to resources, and scientific expertise. The United States emerged as the victor, achieving the first successful deployment of atomic weapons, while Germany and Japan struggled to keep pace and ultimately failed to produce operational bombs.

The science of the bomb (subsection)

Uranium and its role in the bomb
Uranium played a pivotal role in the development of the atomic bomb. The atomic bomb is fundamentally based on the process of nuclear fission, where the nucleus of an atom, in this case, uranium-235, is split into two smaller nuclei, releasing an immense amount of energy. In the Manhattan Project, scientists and engineers used two main isotopes of uranium: uranium-235 and uranium-238.

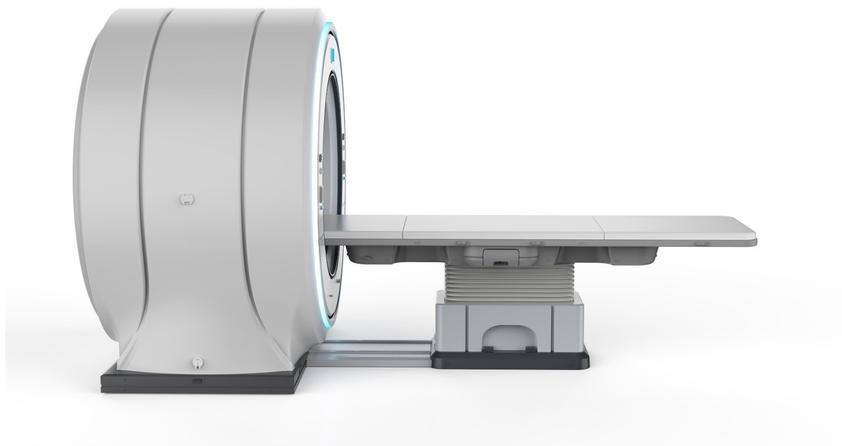
Uranium-235, when it undergoes fission, releases a tremendous amount of energy, making it suitable as the primary fissile material in atomic bombs. The first operational atomic bomb, "Little Boy," dropped on Hiroshima, used uranium-235. Achieving the critical mass necessary for an explosion was challenging, but with significant scientific and engineering efforts, this was overcome.

Uranium-238, on the other hand, can be converted into plutonium-239 through a process called neutron bombardment. Plutonium-239 can also serve as a fissile material and was used in the implosion-type atomic bomb "Fat Man," dropped on Nagasaki.

The discovery of nuclear fission in uranium-235 by Otto Hahn and Fritz Strassmann in 1938 was a turning point, laying the foundation for the atomic bomb's development. The Manhattan Project harnessed the energy released during the fission of uranium nuclei to create a new and devastating weapon, significantly influencing the course of history during World War II.

Future advancement

Object: Commercial MRI



Contains:

- how the science from the manhattan project impacts our lives today in positive ways
  - Renewable energy, MRI's, (and more)
- How the atomic bomb reveals out future advancements too

Interactive aspects/visuals:

- Object 6 showcase + installation
  - Interview from seycove about what the object means to them
- photos of the advancements we made bc of the MP

C-E-R: Further reasoning

RESEARCH

Sources:

- Radioisotopes for Imaging Disease
- https://kids.frontiersin.org/articles/10.3389/frym.2022.722112#
- The legacy of the Manhattan Project https://ahf.nuclearmuseum.org/ahf/history/peaceful-nuclear-innovations/#:~:text=Radioactive chemical tracers emitting gamma,in various forms of tumors.

SOURCE 1: Uses in medicine
https://kids.frontiersin.org/articles/10.3389/frym.2022.722112#

- Radioisotopes enable doctors to perform medical imaging of the body which helps with diagnosis and treatment
  - They are given to a patient either by injection or through food or drinks at the hospital
  - As the radioisotope travels inside the body and special cameras outside the body can detect the radiation -> creates an image or video if the body's bones and soft tissues
  - Nuclear fission reactions release various kinds of radiation, including radioisotopes, radiation waves, and high-energy particles, each with a variety of medical uses
  - Radioisotopes can be used in medical research, cancer treatment, and for medical imaging, which is useful for planning and monitoring therapy
- Gamma rays can be used to sterilize medical tools for surgery
- Protons and electrons can be used as external beams, positioned to target and kill tumour cells

Radiotherapy
- Radiotherapy treatment of cancer is to damage the DNA of cancer cells
  - In damaging DNA, the cancer cell no longer knows how to keep itself alive
  - Results in a reduction of cancer cells in a patients body

Sterilization
- radiation is also used to sterilize the medical tools
- In food production, radiation is used to kill infectious microbes like salmonella typhi

SOURCE 2: Legacy of the Manhattan project
https://ahf.nuclearmuseum.org/ahf/history/peaceful-nuclear-innovations/#:~:text=Radioactive

- Radionuclides / radioactive isotopes or radioisotopes are atoms with an unstable nuclear tat undergo radioactive decay -> results in gamma rays, alpha, and beta particles

Medical
- Radioisotopes are used for diagnosis, treatment, and research
- Radioactive chemical tracers emitting gamma rays can provide diagnostic information about a person's internal anatomy and the functioning of specific organs

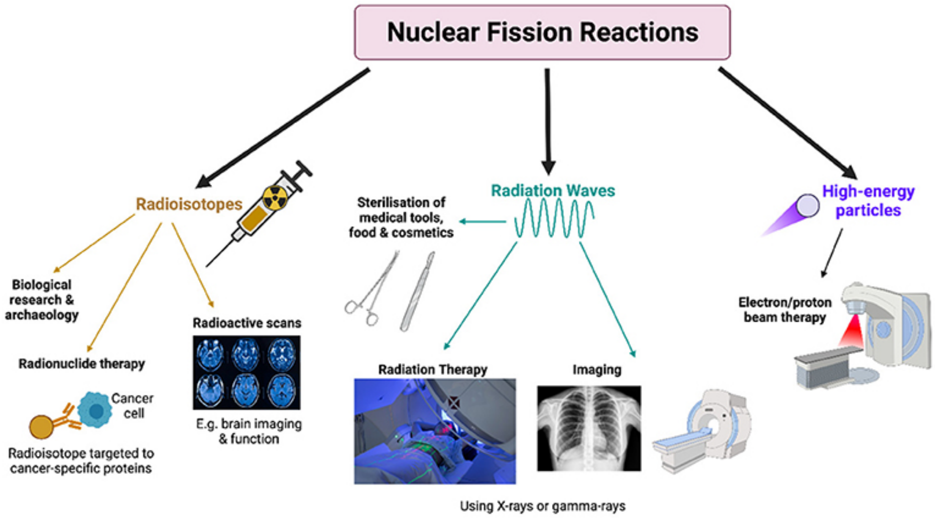
Industry
- Radioisotopes are also useful in agriculture and industry. To preserve food, radiation is used to stop the sprouting of root crops after harvesting, to kill parasites and pests, and to control the ripening of stored fruit and vegetables

Examination
- In industries such as construction and mining, radioisotopes can be used to examine welds, to detect leaks, to study the rate of wear, and to detect erosion and corrosion of metals.

Measurement
- Also used in geology, archaeology, and paleontology to measure ages of rocks, minerals, and fossil materials.

Nuclear power

- Although developing an atomic bomb was the Manhattan Project’s main objective, the work done during the war has had many other implications for science and technology
- While in the past decades concerns over waste disposal and costs have stymied the growth of US nuclear power, recently it has become an ever-more-appealing option in the age of global warming and skyrocketing oil prices
    - Senators are calling for 100 new nuclear reactors in twenty years to meet growing energy demands.



Nuclear Medicine

- Since the discovery of radium by French physicists Marie and Pierre Curie in 1898, physicians had used the isotope to treat a variety of disorders, from acne to hemorrhoids to cancer
- The vast amount of research conducted during the Manhattan Project on radioisotopes and other radioactive elements helped advance scientist’ understanding of the use of atomic energy for medical purposes.

WRITING

- legacy of atomic science
- The weapon of mass destruction was necessary in saving the lives of ppl in the future (without the MP, we would have much less advancements in science

The Legacy of the Manhattan Project

The legacy of the Manhattan Project extends far beyond the development of atomic weapons. It played a pivotal role in the emergence of nuclear science in various industries. Nuclear energy generation, for example, found its roots in the research conducted during the project. Today, nuclear power plants provide a significant portion of the world's electricity, offering a low-carbon alternative to fossil fuels. Furthermore, nuclear science has applications in agriculture, helping to improve crop yields and food safety through irradiation techniques. In industrial applications, it's used for material testing, such as detecting structural flaws in bridges and pipelines.

The Positive Impact

While the destructive power of nuclear weapons is well-documented, the Manhattan Project's legacy also includes positive impacts that have saved countless lives. In medicine, the development of techniques like radiation therapy has revolutionized cancer treatment. Radiation therapy targets and destroys cancer cells, offering hope to millions of patients. Additionally, medical imaging technologies like X-rays and MRIs owe their existence to the principles of nuclear physics developed during the Manhattan Project. These diagnostic tools have been instrumental in early disease detection, leading to improved patient outcomes and longer, healthier lives.