Lecture 2
HST-415
September 8

Building the Bomb

Nuclear Narratives

- stories -- the way in which we order things is important.
- Stories that rise up against all odds are stories that we like
- We have a chaotic/comedic narrative for nuclear narratives
- The first book on the History of the Atomic Bomb: released three days after the bombing of Nagasaki: *A General Account of the Development of Methods of Using Atomic Energy for Military Purposes.*
    - Released by the government. This book was written during the Manhattan Project
    - The original title was supposed to be Atomic Bombs.
- This book was rereleased by Princeton and called it the *Atomic Energy For Military Purposes*. This was translated to Russian almost immediately.
- **Why release this? Leslie Groves:** (head of the Manhattan Project) This book contains everything we can say about this secret project. Nothing more can be said about this project. If you do not give people information, then they will start looking for it and you do not know what they will find. Avoiding further leaks. **H.D. Smyth:** Civic duty and what it means to live in a democracy. They pushed this out because we need to get this information out there or people are going to panic.
- Smyth's report is about how physicists learned things and then they figured out how to build an atomic bomb. Mainly, there is theoretical physics in this book as opposed to some of the other things that should be in it.
- There is not actually a race for the atomic bomb.

Phases of a nuclear weapons program

Phase	Goal	Methods	Primary Output
Exploratory	To see if a nuclear weapon is feasible	Small-scale experiments and theoretical studies	reports
Pilot	To evaluate the feasibility of manufacturing methods	Building medium-scale facilities	Reports, plans, tacit (experience) knowledge, test samples
Production	Making actual nuclear weapons	Building large-scale facilities, designing bombs, preparing for use	Fissile materials, atomic bombs

USA started the exploratory program the same year with Germany but Germany never made it to production with the atomic bomb (got to the pilot program). The UK only did an exploratory program along with the USSR and Japan.

Essentially, there was no race to make an atomic bomb. **Why did the USA make an atomic bomb?** Only one country decided to make an atomic bomb.

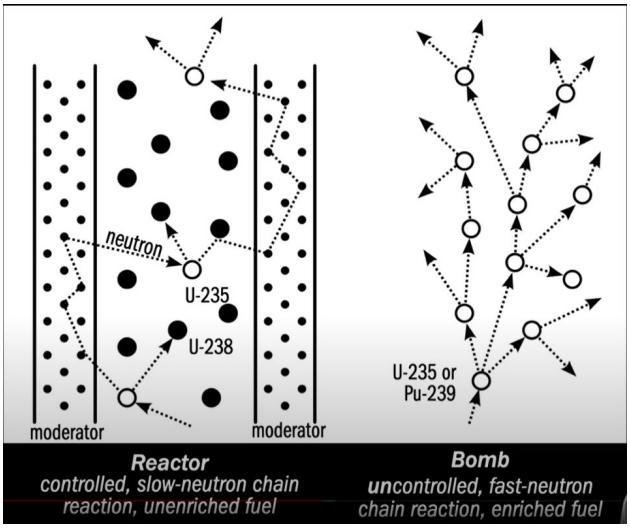
Deciding to Make An Atomic Bomb

State of knowledge in 1939

- Two isotopes of uranium
- U-235 is the only one that is fissile. U-238 will absorb slow neutrons without fissioning (killing chain reactions) These two are chemically identical but only differ by three neutrons.
- Nuclear reactors seem very possible.
- Einstein-Szilard letter (1939): we don't need an atomic bomb but maybe this is possible. Roosevelt creates the Uranium Committee. The National Bureau of Standards makes sure that the scales at the grocery store are correct (this uranium committee is housed under this). They have access to scientists and academics and they need to do research on them.
- This was no secret (Uranium Committee). It was not very intense secrecy.
    - They did not include Einstein. It is probably political as to why he is not a part of the committee.
- This is meant to keep an eye on the fission work (limited funding 10k). The military was mostly uninterested in this at first. This sounds like a wacky idea.
- The Uranium committee is an exploratory project. This later gets absorbed into other wartime research committees (NDRC, OSRD). Bush created the National Defense Research Committee.
- From 1939-1941 there was very little interest and very little progress (from people on the committee). They had no idea whether this was possible and they think this is a problem for the next war.
- **James Conant, president of Harvard,** believed that this was not doable in 3-4 years. He believed this is going to happen in the next few decades. He said this to Bush in 1941.

Atomic Piles

- Believed nuclear reactors are possible (atomic piles). Reactors produce a steady chain reaction, not an exponentially growing one (which would result in an atomic bomb). Bombs use fast neutron chain reactions while reactors use slow neutron chain reactions.
- Bombs require <u>enriched fuel</u> and reactors use <u>unenriched fuel</u> and a <u>moderator</u> to slow neutrons.
- U-238 absorbs a neutron it will turn into plutonium 239 which is fissile. Plutonium is a relatively stable element. This could be used as bomb fuel. You can use traditional chemistry to remove the plutonium from your reactor fuel.



Other Programs

- **Germany**: created Uranverein. Decided to work on making nuclear reactors only, bombs not feasible or necessary for war. They thought that bombs would be necessary in the next war, not right now.
- **Japan:** Scientists and military study problem in 1942 and concluded that even the USA can't make a bomb in time for war, so they kept their program small. France was invaded by Germany in 1940. USSR had no significant resources for a program but they had espionage sources.
- **United Kingdom:** Physicists at the university of birmingham consider how much uranium material would be needed for an atomic bomb. Frisch and Peierls are Jewish. So they know what the stakes are. They are the ones who are most afraid. Fear is a motivating power for looking seriously at this problem. FRisch-Peierls Report concludes that only 5 kg of uranium-235 is necessary to create a bomb.
    - The UK creates MAUD which looks into the question, concludes a bomb is feasible, but the USA needs to do it.
    - MAUD is code for a secret uranium program (Because of Bohr). Turns out, this was not the case, he just had a nanny and told his nanny that he was fine.
- If the Germans can do it, the USA must do it. The UK sent a report to the USA and nobody ended up reading it. So the UK sends representatives to the USA. Bush is convinced and then they stage a coup and accelerate the bomb program to the "pilot" stage. The Uranium Committee becomes the **S-1 Committee.**
- 1942: Bush thinks a bomb can be created and believed it would cost $400 million (5x under the actual). The British thought it was easier to make than it was but because the USA had put in too much money to stop the production.
- FDR approves the Army taking over construction jobs with the goal of making an atomic bomb = Manhattan Project.

  The Manhattan Project
    - Manhattan Engineer District: 1945 A bunch of universities are participating in this project.
    - The original HQs were in Manhattan. This was seen that this was going to need a lot of cooperation with industry.
    - "I told you it couldn't be done without turning the whole country into a factory. You have done just that" -Bohr. There was a 20% turnover because people were not told of what they were doing.
    - 600k people worked on the atomic bomb. 1/100 people working on the atomic bomb.
    - If you were not drafted into the military and old enough to work, you were working on it.
    - Most of the job is this giant construction job and then research.

Manhattan Project Heads

- **Leslie R. Groves** was the military head of the Manhattan Project. He did not want to do this. He wanted to go to Europe. He was also part of the creation of the Pentagon. Became a general and then he wanted this to become the number 1 top priority project in the world. Through sheer force of will, he was able to get this to happen. Created his own secret security forces and

created his own secret empire essentially. He was really rude and the scientists hated him. When the scientists did not want him to understand what they were saying, they used really big words and so he decided to lean his head outside of a window until the scientists realized that he wasn't listening and then he came back and dominated the conversation.

- **J. Robert Oppenheimer**: scientific director of project theoretical physicist from Berkeley. Grew up on the Upper East Side. Reinvents himself as a student and then came back and brought back theoretical physics with a european method. Oppenheimer had no idea how to run large projects (only had experience with large seminars). Far left wing, read a lot of Marxism, eccentric, well-spoken, etc. Groves is charmed by him.
    - Oppenheimer had a lot of communists in his family and this was a problem with security but that did not phase Groves from hiring him.
- **Metallurgical Laboratory**: U of Chicago. Many women involved in the Manhattan Project. More women working on it than the Apollo project. They were doing more reactive work here. First reactor was built here. This was more proof of concept.
    - Only safety mechanism was neutron absorbing material.
- **Radiation Laboratory, Berkeley**: develop particle accelerators, basic theory, isotope separation methods.
- **Site Y: Los Alamos:** Research and bomb design. Housing at universities was a major security problem which is why they chose this place in New Mexico. Isolated laboratory.
- **Site X:** Oak RIdge. This was in Tennessee and this was a uranium enrichment place. No given person was only supposed to know anymore than they are supposed to know. This compartimization is what defined the Manhattan Project.
- **Hanford: Site W:** Plutonium reactors in Hanford, Washington. This is where they built their industrial size reactors.
- Uranium ore is a major supply issue for this project.
- 73% of ore came from the Belgian Congo. Highest amount of richest uranium in their mine. 75% U/g
- 9% of the ore from canada. 30% U/g
- Groves tries to make contracts so that uranium and thorium is only supplied to the USA.
- Cost of bomb: 2 billion dollars total (50-180 billion nowadays). Generated 1% of the US patents.
- 63% on Oak Ridge (enriching of uranium)
- 21% on Hanford
- 4% on Los Alamos

Fissile material production costs greatly exceed research costs. 30 pounds of plutonium and 140 pounds of uranium.