NE290D: Special Topics in Nuclear History, Politics, and Futures
Developing the Bomb

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Introduction

Agenda

- 1944 Developing the Bomb
- 1945 Building the Bomb

W6L12 Learning Outcomes

- Recall the major historical milestones in the investigation of nuclear weapons and describe the experiments that led to them.
- Organize the events on a timeline.
- Draw connections between the developments in 20^{th} century physics and latter Manhattan project.

1944: Developing The Bomb

1944 Jan: George Kistiakowsky arrives at Los Alamos, NM to assist Seth Neddermeyer in implosion research.

- It becomes increasingly clear that Neddermeyer's academic research style is unsuited to directing a rapidly expanding research and engineering program.
- 1944 Feb 16: George Kistiakowsky becomes a full-time Los Alamos staff member, replacing Seth Neddermeyer as leader of implosion research.

[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Jan: Problems with developing suitable diffusion barriers leads General Leslie Groves to switch planned production to a new type of barrier, creating months of delays in equipping the K-25 Plant for operation.

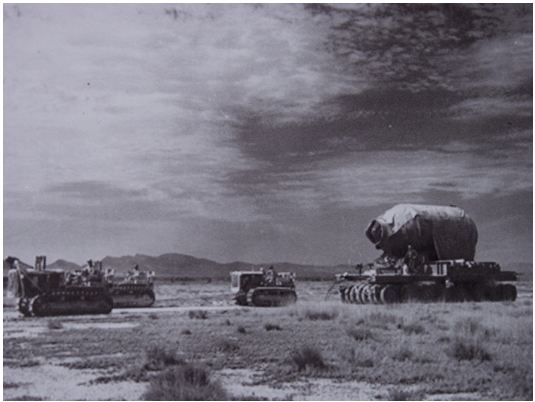
- 1944 Jan: Philip Abelson, after learning about the problems with the Manhattan Project's gaseous diffusion plant, informs J. Robert Oppenheimer about the progress in his research on liquid thermal diffusion technology.
- This eventually leads to the construction of the S-50 Plant at Oak Ridge.
- 1944 Sept 16: The S-50 Plant begins partial operation at Oak Ridge, TN, but leaks prevent substantial output.

[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Jan: Groves and Oppenheimer decide to plan for a fission bomb test.

- No test was envisioned before this.
- Groves stipulates that the active material must be recoverable if a fizzle occurs.
- Construction of Jumbo, a 214 ton steel container (25 ft $\times$ 12 ft), is authorized.



[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Jan 11: An implosion theory group is set up with Teller as head.

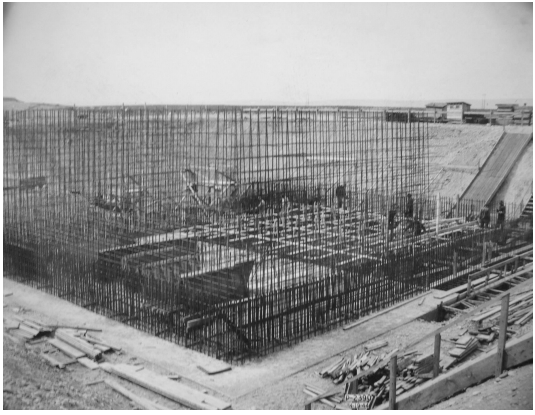
- 1944 Feb: The Los Alamos Governing Board reevaluates deuterium fusion research and determines that tritium would be necessary to make an explosive reaction. Priority of fusion bomb work is further downgraded.
- 1944 May: Six months after the start of accelerated implosion research, little progress towards successful implosion has been made.
  - Inadequate diagnostic equipment prevent accurate measurement of implosion process, and no scheme to avoid asymmetry has yet shown promise.
  - Approach is to use simultaneous detonation points over the surface of a sphere, and try different methods of inert spacers or gaps to suppress the shaped charge-like jets that form when detonation waves from adjacent initiation points merge.
  - Spalling from the interior surface of the hollow core is a serious problem.

[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Feb: Construction begins on the first reactor at Hanford, WA, the B Reactor.

- 1944 Feb: The Y-12 Plant sends 200 grams of uranium-235 to Los Alamos, NM.
- 1944 Mar: Segre has improved his spontaneous fission estimates in cyclotron plutonium (essentially pure Pu-239) to 11 fissions/kg-sec. This is still acceptable for gun assembly, but greatly narrows the margin of security.
- 1944 Dec 26: Processing of irradiated uranium slugs to separate plutonium begins at Hanford.



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1944: Developing The Bomb

1944 June 6: Allied forces launch the Normandy invasion.

- 1944 July: Air Force Lt. Col. Paul Tibbets begins organizing the 509th Composite Group, which will deliver atomic bombs in combat, at Wendover Field, Utah.
- 1944 Aug: The Air Force begins modifying 17 B-29s for combat delivery of atomic weapons at the Glenn L. Martin plant in Omaha, Nebraska.

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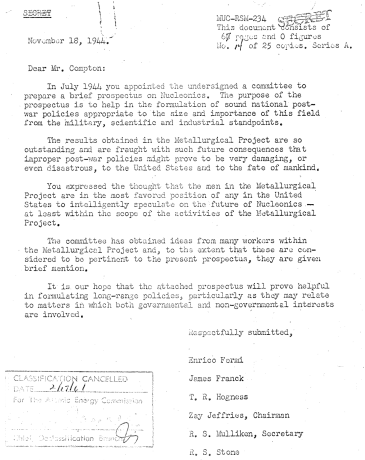
1944: Developing The Bomb

1944 July: Scientists at the Chicago Met Lab issue the "Prospectus on Nucleonics"

- Begins a discussion of international control of atomic energy.
- 1944 Sept: President Franklin Roosevelt and British Prime Minister Winston Churchill sign the Hyde Park aide-memoire, pledging to continue researching atomic technology.



SECRET

November 18, 1944.

MUC-RSM-234 SECRET
This document consists of 17 pages and 0 figures
No. 11 of 25 copies, Series A.

Dear Mr. Compton:

In July 1944 you appointed the undersigned a committee to prepare a brief prospectus on Nucleonics. The purpose of the prospectus is to help in the formulation of sound national post-war policies appropriate to the size and importance of this field from the military, scientific and industrial standpoints.

The results obtained in the Metallurgical Project are so outstanding and are fraught with such future consequences that improper post-war policies might prove to be very damaging, or even disastrous, to the United States and to the fate of mankind.

You expressed the thought that the men in the Metallurgical Project are in the most favored position of any in the United States to intelligently speculate on the future of Nucleonics — at least within the scope of the activities of the Metallurgical Project.

The committee has obtained ideas from many workers within the Metallurgical Project and, to the extent that these are considered to be pertinent to the present prospectus, they are given brief mention.

It is our hope that the attached prospectus will prove helpful in formulating long-range policies, particularly as they may relate to matters in which both governmental and non-governmental interests are involved.

Respectfully submitted,

Enrico Fermi
James Franck
T. R. Hogness
Zay Jeffries, Chairman
R. S. Mulliken, Secretary
R. S. Stone
C. A. Thomas

CLASSIFICATION CANCELLED
DATE 7/26/61
For the Atomic Energy Commission
Dept. Declassification Branch

[1] https://www.atomicheritage.org/history/timeline

[2] https://www.marshallfoundation.org/library/wp-content/uploads/sites/16/2015/05/xerox1482-45_opt.pdf

1944: Developing The Bomb

1944 Oct 12: The first B-29s arrive in the Mariana Islands to begin bombing Japan.

- Japan has so far remained free from air attacks (except for the symbolic Doolittle raid in 1942).
- 1944 Nov 24: The first B-29 raid on Japan begins. 100 planes are launched, only 16 bombs hit the target factory.

[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Dec 8: Polish Physicist Joseph Rotblat resigns from the Manhattan Project upon learning that an American atomic bomb will not be used against Nazi Germany.

- Marks a change in thinking by many scientists.

[1] https://www.atomicheritage.org/history/timeline

1944: Developing The Bomb

1944 Dec 22: First Fat Man bomb assembly is completed as production gets underway.

- Explosive lenses and nuclear material are not yet available.
- Bomb assemblies are used for airdrop and ground handling practice.

[1] https://www.atomicheritage.org/history/timeline

1945: Building The Bomb

1945 Jan 20: Curtis LeMay takes command of the Twentieth Air Force in the Marianas.

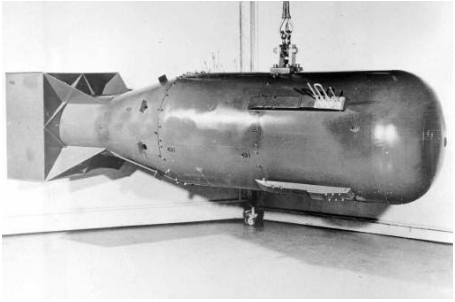
- The fleet contains 345 aircraft, but in three months of bombing none of the nine top priority targets have been destroyed.
- The first stage of the K-25 Plant is charged with uranium hexafluoride and begins operation.
- 1945 Feb: Admiral Nimitz, Commander in Chief, Pacific Ocean Areas, is notified of the nature of the atomic bomb project.

[1] https://www.atomicheritage.org/history/timeline

1945: Building The Bomb

1945 Feb: Uranium gun design is completed and frozen.

- Only planning for deployment and combat use once the U-235 is delivered is now required.
- Additional studies of an improved gun design, begun on Dec. 7 and later abandoned, are underway.



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1945: Building The Bomb

1945 Feb: Tinian Island is selected as the base of operations for atomic attack.

- 1945 Feb 19: Marines land on Iwo Jima, a Japanese observation post for the B-29 raids.
- Over the next two months 6,281 marines are killed, and 21,865 are wounded in capturing the island from 20,000 defenders.
- 1945 Feb 23: A fire bomb test raid on Tokyo with 172 planes burns one square mile, the most destructive raid on Japan to date.

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1945: Building The Bomb

1945 Feb 28: A meeting between Oppenheimer, Groves, Kistiakowsky, Conant, Tolman, Bethe, and Charles Lauritsen is held to fix the design approach for the plutonium bomb.

- Work will focus on the solid core gadget, use explosive lenses, use a modulated initiator, and electric detonators.
- The use of Composition B and Baratol for the lenses was also decided, as was the multiple lens configuration and detonator arrangement.
- Solid core compression has not been demonstrated at this time.
- The goals are:
  - Solve detonator timing problem, have detonators in full production, and begin large-scale lens production (Apr 15).
  - Begin hemisphere shots to measure shock wave convergence (Apr 25).
  - Demonstrate implosion compression in full scale test (May 15).Begin lens fabrication for The Trinity Test (June 4).Begin assembly of The Trinity Test Gadget (July 4).
- 1945 Mar 5: Oppenheimer officially freezes explosive lens design.

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1945: Building The Bomb

1945 Mar 9-10: General Curtis LeMay launches an all-out low altitude firebomb raid on Tokyo with 334 B-29s.

- Flames engulf 15.8 square miles of the city, killing about 100,000 people and injuring 1,000,000 (41,000 seriously).
- 1945 Mar 11-18: During these eight days fire raids with similar tactics are launched on Nagoya, Osaka, and Kobe; the second, third, and fourth largest cities in Japan.
- An additional 16 square miles of city are burned, killing more than 50,000 people.
- 1945 Apr 3: Preparations begin at Tinian Island to support the 509th Composite Group, and to assemble the atomic bombs.

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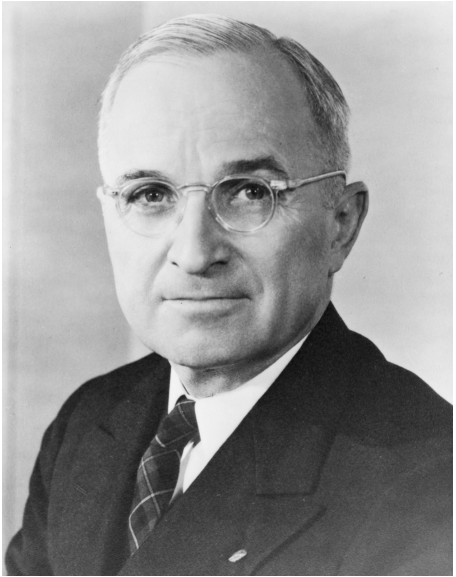
1945: Building The Bomb

1945 Apr 12: President Roosevelt dies and Harry S. Truman become president.

- 1945 Apr 13: President Harry Truman learns of the existence of atomic bomb development from Secretary of War Henry Stimson.
- 1945 Apr 27: The first meeting of the Target Committee to select targets for atomic bombing. Seventeen targets are selected for study: Tokyo Bay (for a non-lethal demonstration), Yokohama, Nagoya, Osaka, Kobe, Hiroshima, Kokura, Fukuoka, Nagasaki, and Sasebo (
- Some of these are soon dropped because they had already been burned down.



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Course Discussion

- What do you guys like? dislike?
- What is effective? What isn't?
- How could this be modified for in-person teaching? for Undergrads?