



NE290D: Special Topics in Nuclear History, Politics, and Futures

Investigating Nuclear Weapons and Getting Prepared

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January 19, 2021 – W4L8



Introduction

Agenda

- ▶ 1939-1941
Investigating
Nuclear Weapons
- ▶ 1941-1942 Getting
Organized

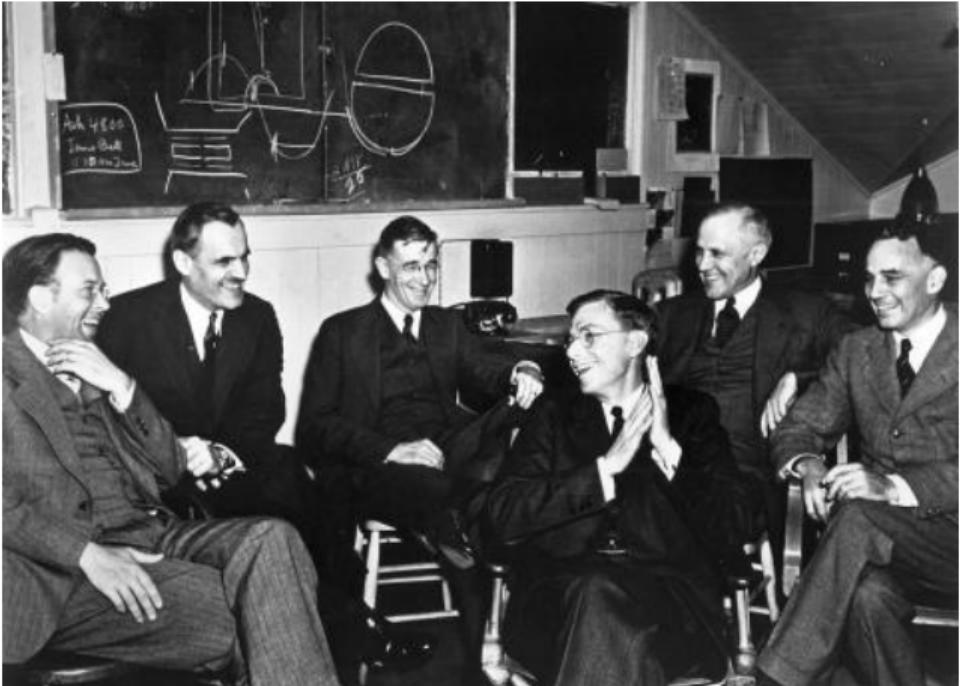
W4L8 Learning Outcomes

- ▶ 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 20th century physics and latter Manhattan project.

1939-1941 Investigating Nuclear Weapons

October 21, 1939: The first meeting of the Advisory Committee on Uranium

- ▶ The physicists argue for urgent government attention, but Adamson is hostile.
- ▶ Teller requests \$6,000 for research on preliminary uranium-graphite slow neutron experiments, which is grudgingly approved.



¹ <https://www.atomicheritage.org/history/timeline>

1939-1941 Investigating Nuclear Weapons

February 1940: Otto Frisch and Rudolf Peierls consider fast fission in uranium-235.

- ▶ Based on a theoretical estimate of the fast fission cross section they estimate the critical mass of pure uranium-235 at “a pound or two”, and that a large percentage could be fissioned before explosive disassembly.
- ▶ They also estimate the likely effects of the bomb, and possible assembly methods, as well as estimates of the feasibility of isotope separation.



¹ <https://www.atomicheritage.org/history/timeline>



1939-1941 Investigating Nuclear Weapons

April 9, 1940: Germany invades Denmark and Norway

The New York Times.

LATE CITY EDITION
POSTSCRIPT
Cloudy, preceded by rain later.
Temperature Thursday-Mon., 62; 54-44

**GERMANS OCCUPY DENMARK, ATTACK OSLO;
NORWAY THEN JOINS WAR AGAINST HITLER;
CAPITAL IS REPORTED BOMBED FROM AIR**

**HOUSE TO CONSIDER
WAGE ACT CHANGES
EARLY NEXT WEEK**

**Leaders in Scruple Memo
Also State Bill for Court Review of Agency Rulings**

LAW ACTION LIKELY

**Preparations of Amendments
Expect Drive to Reopen of
All Labor Legislation**

**House Consideration Next Week
Waited for the 1st to Introduce
The Wagner Act in Congress
for the League-Wheeler bill to prove
ineffective, and then to consider
changes by governmental agencies.**

(Page 1) In a ruling by the Supreme
Court to review the Labor Board's
recommendations, the administration
has announced that it will not oppose
the bill in Congress if the Senate
rejects the Wagner bill.

It was also announced that the
Senate majority leaders had agreed
that "the interests of all concerned
will be served by the prompt
introduction of a bill which would
provide a better measure than the
one now before the Senate."

Colonel Harrington, WPA Adminis-
trator, said he planned to refer
provisions of the Senate Committee
recommendations to a committee
working on the Senate bill.

ROOSEVELT EFFIGY FRONT GUN TARGET

YESTERDAY President Roosevelt
was asked to return
Mrs. Eleanor M. Roosevelt's
request that her husband not
be shown in pictures with
the station of copies of
the *Guernica* painting.

Also, the First Lady said she
wants the president to return
the painting to the National
Museum of Art, New York, after
it has been exhibited.

**BRITISH EXPLOSIVES
READY FOR RUSSIAN
FRONT**

Heavy Artillery Service
Worked 12 in Congress Shot
Its Capital as Target

**Fleet of Barges Obtained at
Danube Port-Nazis Charge
Plot to Block River**

THE INTERNATIONAL SITUATION

REICH SHIP IS SUNK IN NORWAY

ALL MEN IN UNIFORM

NARVIK IS OCCUPIED

**Troops Cross Border as
Ships Embark Others in Sudden Nazi Blow**

DANES FALLING BACK

**Germans Say They Act
to Forestall Foe and
Protect Neighbor**

COPENHAGEN TAKEN

Swedes Mobilizing

NEW THEATER OF WAR IS OPENED

**NORWAY DECLARES ALLIED MINES BRING
WAR ON GERMANY A PROTEST BY OSLO**

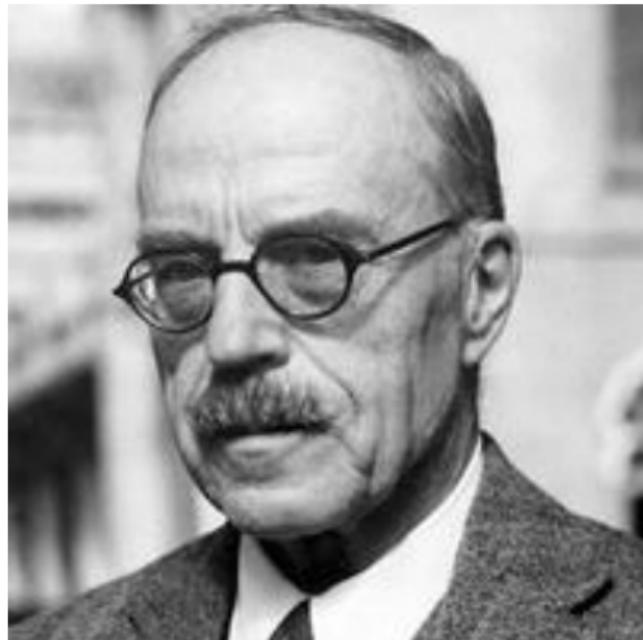
Copyright, 1940, by The New York Times Company.
Vol. LXXXIII, No. 30,000. Price on front page. One copy, \$1.00.
NEW YORK, TUESDAY, APRIL 9, 1940.
P THREE CENTS. www.nytimes.com

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<https://www.atomicheritage.org/history/timeline>

1939-1941 Investigating Nuclear Weapons

April 10, 1940: First meeting of the MAUD Committee



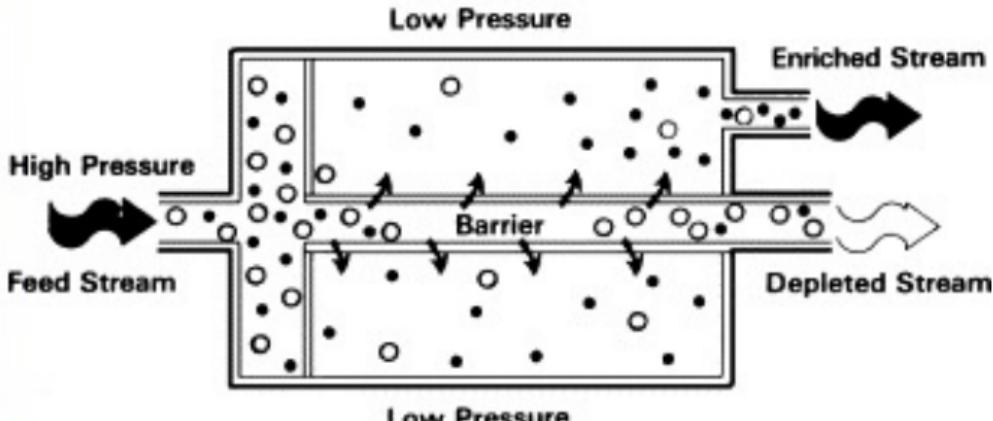
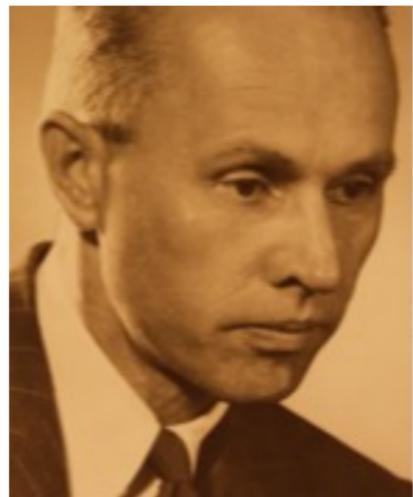
April 27, 1940: Second meeting of Briggs Committee



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1939-1941 Investigating Nuclear Weapons

May 1940: George Kistiakowsky suggests gaseous diffusion to produce uranium-235



¹ <https://www.atomicheritage.org/history/timeline>

¹ Knief, Ronald Allen. "Nuclear energy technology: theory and practice of commercial nuclear power." (1981).

1939-1941 Investigating Nuclear Weapons

July 1, 1940: The NDRC takes over responsibility for uranium research.

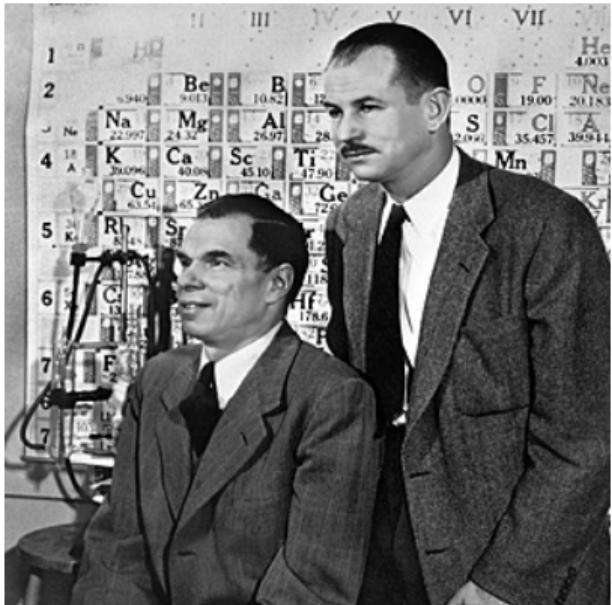
- ▶ In his final report, Lyman Briggs requests \$140,000 for further work: \$40,000 for lab measurements, and \$100,000 for large scale uranium-graphite studies.
- ▶ Bush approves only \$40,000.



¹ <https://www.atomicheritage.org/history/timeline>

1939-1941 Investigating Nuclear Weapons

March 6, 1941: Glenn Seaborg discovers plutonium.



March 28, 1941: Kennedy, Seaborg and Segre show Plutonium can slow fission.



¹ <https://www.atomicheritage.org/history/timeline>



1939-1941 Investigating Nuclear Weapons

May 1941: Tokutaro Hagiwara at the University of Kyoto discusses the possibility of a fusion explosion being ignited by an atomic bomb.



¹<https://www.atomicheritage.org/history/timeline>

²Hagiwara K. Concerning uranium. Tonizo Laboratory, Japan, April 1943. Copy document and English translation in the private collection of P.S. Reagan. Kansas City, MO

1939-1941 Investigating Nuclear Weapons

June 28, 1941: The OSRD is established. Vannevar Bush is put in charge.

- ▶ Bush creates the larger and more powerful Office of Scientific Research and Development (OSRD)
- ▶ empowered to engage in large engineering projects in addition to research



¹ <https://www.atomicheritage.org/history/timeline>

1939-1941 Investigating Nuclear Weapons

August to September, 1941:
Enrico Fermi begins assembly of
a subcritical pile.

- ▶ Contains 30 tons of graphite and 8 tons of uranium oxide.
- ▶ Gives a projected k value of 0.83, indicating that purer materials are needed.



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1939-1941 Investigating Nuclear Weapons

September, 1941: Fermi muses to Edward Teller whether a fission explosion could ignite a fusion reaction in deuterium.

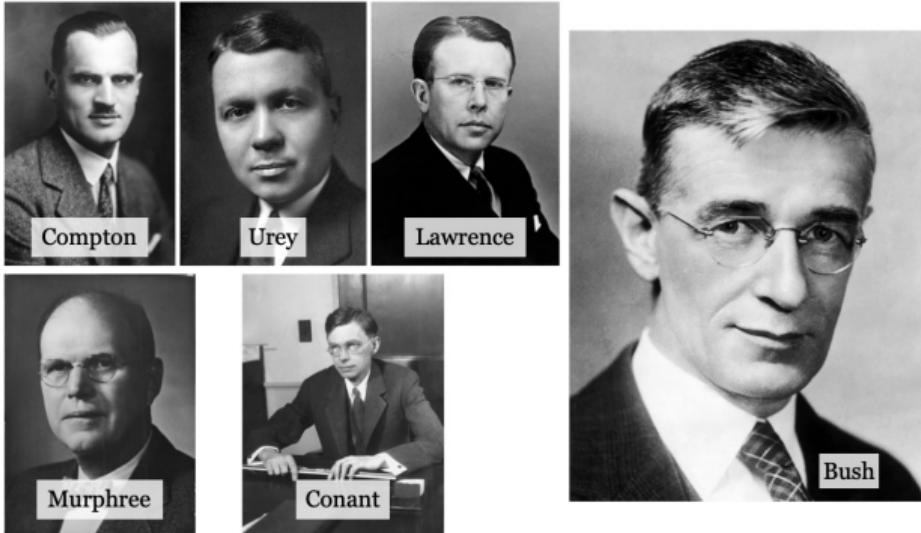


¹<https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

December 6, 1941: Bush holds a meeting.

- ▶ Arthur H. Compton remains in charge.
- ▶ Harold Urey is appointed to develop gaseous diffusion and heavy water production at Manhattan, NY;
- ▶ Ernest O. Lawrence will investigate electromagnetic separation at the University of California at Berkeley;
- ▶ Eger Murphree will develop centrifuge separation and oversee engineering issues.
- ▶ James B. Conant advocates pursuing Pu-239, but no decision on this is made.



¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

December 7, 1941: Japan attacks Pearl Harbor.

- ▶ December 8, 1941: The US declares war on Japan.
- ▶ December 11, 1941: The US declares war on Germany and Italy following their declaration of war on the US.
- ▶ December 18, 1941: The first meeting of the S-1 project is held, sponsored by the OSRD. S-1 is dedicated to the full scale research development of fission weapons.



¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

April 1942: Fermi relocates to the Chicago Met Lab.

- ▶ He builds an experimental pile in the Stagg Field squash courts.
- ▶ Begins planning the construction of the world's first man-made critical pile, to be called CP-1.
- ▶ Fermi's efforts now shifts from demonstrating feasibility to securing graphite and uranium of adequate purity and in sufficient quantity to build the reactor.

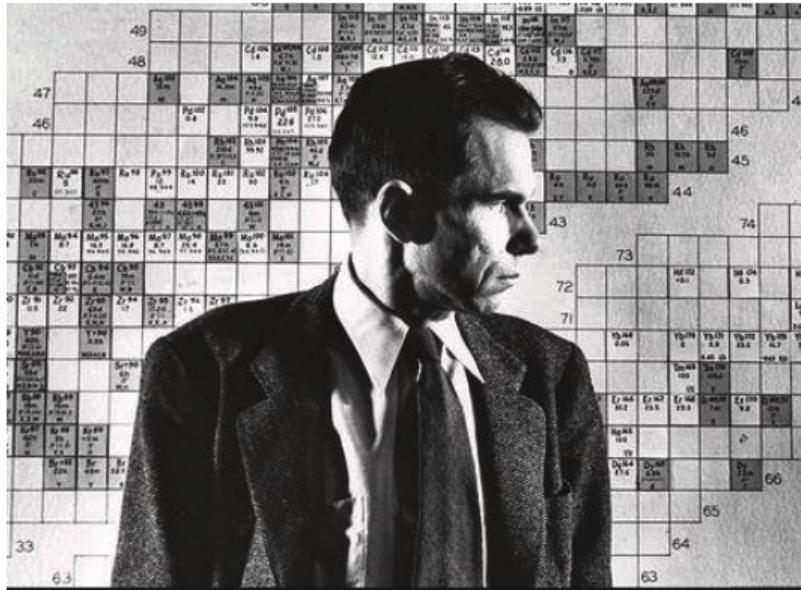


¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

April 1942: Glenn Seaborg arrives in Chicago.

- ▶ He starts work on developing an industrial-scale plutonium separation and purification process.
- ▶ Percival Keith of the Kellogg Co. begins designing a gaseous diffusion pilot plant.



¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

May 18, 1942: Oppenheimer takes his place

- ▶ Gregory Breit, who has been coordinating physics research on fast neutron phenomena, quits, leaving the neutron physics effort without leadership.
- ▶ Arthur H. Compton asks J. Robert Oppenheimer to take over in his place.
- ▶ Robert Oppenheimer writes Ernest O. Lawrence that the atomic bomb problem was solved in principle and that six good physicists should have the details mostly worked out in six months.
- ▶ His optimism is based on the belief that gun assembly would suffice for both uranium and plutonium.



¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

May 23, 1942: S-1 program leaders discuss priorities

- ▶ James B. Conant urges proceeding with *all* options for producing fissionable material simultaneously
 - ▶ gaseous diffusion,
 - ▶ centrifuge,
 - ▶ electromagnetic separation,
 - ▶ plutonium breeding using both graphite and heavy water reactors.
- ▶ He argues that redundant development will reduce the time to successful production to the shortest possible time, regardless of cost.

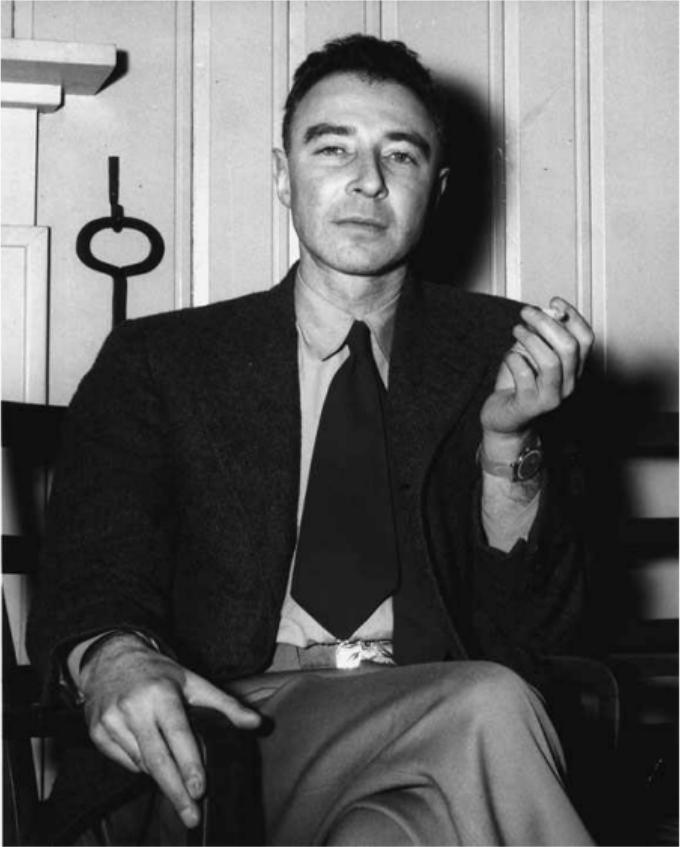


¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

June 1942: J. Robert Oppenheimer leads an effort on fast neutron physics

- ▶ Prepares an outline for the entire neutron physics program.
- ▶ Production of plutonium through marathon irradiation by cyclotron begins.
- ▶ Chicago Met Lab engineering council begins developing plans for large scale plutonium production reactors.
- ▶ President Roosevelt approves a plan for spending \$85 million for a weapon development program.



¹<https://www.atomicheritage.org/history/timeline>



1941-1942 Getting Organized

Enrichment Options

1941-1942 Getting Organized

July to September, 1942: Oppenheimer assembles theoretical study group in Berkeley to examine the principles of bomb design.

- ▶ Included are J. Robert Oppenheimer, Hans Bethe, Edward Teller, John Van Vleck, Felix Bloch, Robert Serber, and Emil Konopinski.
- ▶ During the summer the group develops the principles of atomic bomb design, and examines the feasibility of fusion bombs.
- ▶ Oppenheimer emerges as a natural leader. The group estimates the mass of U-235 required for a high yield detonation at 30 kg (estimated at 100 Kt), megaton range fusion bombs are also considered highly likely.
- ▶ During this period Richard C. Tolman and Robert Serber discuss the idea of using explosives to collapse a shell of fissile material in place of the gun assembly method.
- ▶ Serber reports that they co-authored a short paper on the subject, although this paper has not been found. At this time Enrico Fermi and his staff are busy arranging for the materials required for Chicago Pile 1.



¹ <https://www.atomicheritage.org/history/timeline>

1941-1942 Getting Organized

August 13, 1942: The Manhattan Engineer District is formally established.

- ▶ August 20, 1942: Glenn Seaborg isolates pure plutonium through a separation process suitable for industrial scale use.
- ▶ August 29, 1942: A status report by James B. Conant is relayed to the Secretary of War by Vannevar Bush indicating the very positive results of Oppenheimer's group. Bush adds his concerns about the organization and leadership of the project, requesting new leadership be appointed.



¹ <https://www.atomicheritage.org/history/timeline>



Final Project Discussion

Option 1

Historical answers to modern problems.

With your newfound understanding of nuclear history and its impact across the 20th century, consider a problem facing the nuclear community that transcends a scientist, technical, economic, security-driven, etc., propose a solution to the present, for the future, based on the past. Write up your solution as a paper for one of the journals discussed.

Option 2

Tell me a nuclear bedtime story.

Given our discussions of the weaving of history, science, literature, and its impact on society, consider either adapting a work of literature to fit the scope of an important historical event in nuclear physics, nuclear engineering, or national defense such that a reader would be compelled to consider the weight or your theme.