THE MANHATTAN PROJECT - PERSONALITIES AND PROBLEMS

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LECTURE 5

BIBLIOGRAPHY, REFERENCES, AND GLOSSARY

https://bit.ly/3iOFb72
(This is a work in progress - comments/suggestions welcome)
Anyone with link can reference, not just Frommies
If you want editing privileges, just let me know
1. How big was The Los Alamos Ranch School for Boys? - the Albuquerque District survey consisted of ~54,000 acres of which all but ~8,000 acres was in national forest land already owned by the government; the remainder was grazing land and the school which was 732 acres; Camp Mather is 400 acres (as per Phil Ginsburg, Gen. Mgr, SF Rec & Park).

2. What happened to consideration of the centrifuge method? - “By January 1944 most of the engineering problems encountered with high-speed centrifuges had been overcome, but the project was dropped in the face of growing confidence in the eventual success of the competing electromagnetic-separation and gaseous-diffusion enrichment techniques, which already had received significant funding.”

3. Y-12 was the size of Golden Gate Park, how many people worked there? - at one point, 22,000.

4. (3rd class): On 11/26/42 Groves announced Oppenheimer and Los Alamos, but the letter from Conant wasn’t until months later - was Oppie able to work? - I think that the letter was just a formality with all the rules; Oppie was definitely working in the interim; also consider that he technically did not have a security clearance in that period.


6. How did Fermi build the reactor in Chicago without enriched uranium? ****

7. Why wasn’t Leo Szilard on Oppenheimer’s “dream team?” ****
AS ALL THE SCIENTISTS WERE BEING RECRUITED, WHERE’S LEO?

- Szilárd joined the staff of the Met Lab when it was organized in order to continue fission work
- Perhaps motivated by the banning of foreign-born citizens in the policy process, Szilárd remained vocal about his concerns
  - He urged scientists to “self-censor” their research
  - He questioned the competency of the military to manage the project
  - He spoke out about the horror of using such technology in a bomb against people

GROVES VS. SZILÁRD

- “Szilárd freely indulged in what he once identified as his favorite hobby - baiting brass hats. General Groves, in particular, had been outraged by Szilárd’s unabashed view that army compartmentalization rules, which forbid discussion of lines of research that did not immediately impinge on each other, should be ignored in the interests of completing the bomb” (Alice Smith, historian)
- “[Szilárd] is the kind of man that any employer would have fired as a troublemaker” - Groves
- In October 1942 Compton suggested to Groves that Leo be relocated, but later changed his mind
- Groves drafted (but never sent a letter calling for Leo’s internment
- Szilárd was tailed by Special Agents for the remainder of the war
- “One letter or phone call once in three months would be sufficient for the passing of vital information”
Stan(Islaw) Ulam is another of my personal heroes

- Polish-American mathematician and physicist
- Invented the Monte Carlo method of computation (a major component of Computational Physics)
  - For statistical simulations (think Covid-19)
  - You can see why this might be useful in bomb design
- Discovered the concept of cellular automaton while at Los Alamos
  - John Conway’s Game of Life
- Performed critical design calculations at Los Alamos
  - Including some that lead to the development of fusion bombs

“I was a young Assistant Professor at the University of Wisconsin. The war was on - I noticed that some other younger colleagues, especially, were disappearing from town. They couldn’t tell me where they were going - it was very secret. I learned that I was supposed to go somewhere, to New Mexico. Francoise [Ulam’s wife] wanted to know about the state of New Mexico. So, I went to the library and borrowed one of these WPA books on various states and there was one volume on New Mexico. Then, I noticed, looking at the back of the book, there was a list of previous borrowers. To my amazement, several names of people who disappeared the week or two before were put down as borrowers.”

-Stan Ulam
“Most of the important scientists traveled under false names in those days...the Army, who was responsible for the changes, had imagination and saved only the initials. Enrico was Eugene Farmer when he traveled, and Arthur Compton had two names, Mr. Comas and Mr. Comstock, one for the East and one for the West. ..We all got off the train at Lamy. I had hardly set foot on the platform when a blond soldier walked up to me. ‘Are you Mrs. Farmer?’ he asked. ‘Yes, I am Mrs. Fermi.’ ‘I was told to call you Mrs. Farmer’ ”

-Laura Fermi

Richard Feynman recalls that members of the Princeton contingent were told not to all book their tickets from Princeton to Albuquerque in fear that it would attract attention. Figuring that everyone else would follow instructions, he did book his ticket (with Arline) from Princeton but found himself also stuck with all the equipment (not people) that was being shipped to Albuquerque.
One very touching story of arrivals is that of Richard and Arline Feynman

- Richard was a part of the group coming “en masse” to Los Alamos from Princeton
- Arline was suffering from untreatable lymph node tuberculosis and needed special attention
- In advance of their arrival, Oppie found a sanatorium for Arline in Albuquerque so that Richard could regularly visit her
- When they left Princeton for Los Alamos on March 23, 1943, the railroad provided a wheelchair for Arline
- Arline passed away in June 1945 before the Trinity test

Feynman recalls that when he arrived at Los Alamos

- The dorms weren’t finished so they stayed at personal ranch houses
- There was a great deal of construction to be done and since the experimentalists had nothing to do, they told the construction company how to build the buildings
When Oppie arrived, with Kitty and son Peter, at Los Alamos in March 16, 1943

- The school had been closed by the War Department
- Since mid-December 1942, 3,000 army engineers had converted the location into a muddy construction site and fenced-in secret town with barracks, laboratories, a mess hall, a store, guard towers, etc.
- He was scheduled to move into the Headmaster’s House but instead commuted for several weeks from a hotel in Santa Fe and established the Santa Fe “branch office”
109 East Palace Avenue (1/2)

- Constructed as a Spanish hacienda in the 1600s
- Office space rented in Santa Fe by “Mr. Bradley”
- The office sign said “US ENG-RS” and operated as a housing office
- The only public-facing location of Los Alamos
- Under constant surveillance by the FBI and Army intelligence
- Existed as a cover to
  - Provide off-site office space for Oppie
  - Handle correspondence
  - Process all staff (and families) and visitors
- Office was “cleaned” every evening

109 East Palace Avenue (2/2)

- The office was run by Dorothy McKibbin with several staff members including Oppie’s secretary, Priscilla Greene
- Was enamored by Oppie, “I never met a person with a magnetism that hit you so fast and so completely as his did. I didn’t know what he did”
- Her job was to process IDs for new arrivals (sometimes up to 65/day)
  - Don’t ask questions; never repeat a name
  - “In the front door and out the back door”
  - Became babysitter, tour guide, banker, confidant, handled special personal order requests, etc. for all staff
Babies born at Los Alamos had this address on their birth certificates.
BATHTUB ROW

• The former homes of the Los Alamos Ranch School’s “masters” or teachers
• Highly coveted by Los Alamos staff because they had bathtubs

“HERE’S YOUR DAMNED ORGANIZATION CHART”
LOCAL ANGLE - FELIX BLOCH

- Stanford University
- Nobel Prize, 1952 - “new ways and methods for nuclear magnetic precision measurements”
- Left Los Alamos early
  - Did not like the military atmosphere
  - Was not interested in the theoretical work there
  - Joined the radar work at Harvard

HANS BETHE

- Born in Germany, moved to the United States in 1935 to work at Cornell University
- “I am about the leading theoretician in America. That does not mean the best. Wigner is certainly better and Oppenheimer and Teller probably just as good. But I do more and talk more and that counts too” (letter to his mother)
- 1967 Nobel Prize in Physics - “contributions to the theory of nucleosynthesis”
- “the supreme problem solver of the 20th century” (Freeman Dyson)
ROBERT SERBER

- A former student and later close associate of Oppenheimer
- He shuttled back and forth with Oppie between Caltech and UCB
- With his wife (Charlotte) was part of the "left wing" circle with Kitty and Frank
- The Oppenheimers and Serbers were the closest of family friends
- Worked in the Site Y Theory Group under Hans Bethe
- Created the code names "Little Boy" and "Fat Man"
- Charlotte lead the Site Y library where she was the only wartime female section leader
SOME DEFINITIONS (1/2)

• **Fissile** materials can fission by absorbing a neutron with very low kinetic energy (slow/thermal); simply adding the neutron adds enough energy to induce fission; fissile materials have an even atomic number and an odd atomic weight; U(235) and Pu(239) are fissile

• **Fissionable** materials can fission by absorbing a neutron if it has enough kinetic energy (fast) to bring to the nucleus to induce fission; U(238) is fissionable

• All fissile materials are fissionable, but not all fissionable materials are fissile

• So, you want fissile materials for bombs but fissionable materials will work just fine for reactors

SOME DEFINITIONS (2/2)

• **Reactor-grade** uranium requires ~3%-4% U(235) or pretty close to natural uranium

• **Weapons-grade** uranium requires 90%+ U(235) only available after an enrichment process
“Everybody assembled in the big library reading room on the first floor of the Technical Area, the building where the theoretical physicists had their offices. We had a little blackboard set up in front and a lot of folding chairs spread around the room. Fifty people on hand, something like that. Scientific staff, a few visiting VIPs. There was hammering off in the background, carpenters and electricians working out of sight but all over the place. At one point during the lectures a leg came bursting through the beaverboard ceiling. One of the workmen misstepped and they had to pull him back.”
When Oppie’s first recruits arrived in March, few knew what we were working on. Rumors stitched bits and pieces of the facts to pure conjecture: radium-laced poison gas, electric rockets, windshield wiper blades for submarines. So Oppie had me write up some talks to bring our colleagues up to speed. We used the lab’s unfinished library; while chatting workmen clattered in and out, I raised my voice above their senseless noise.

-Robert Serber
MATERIAL 49 - CONSIDER THE CONTEXT

- Serber was a theoretician, not an experimentalist
- Clearly “material 49” is Pu-239
- But they only had grams of it (and considering its atomic weight, that really wasn’t very much)
  - Some from the Met Lab
  - Some from the X-10 reactor
- They didn’t really know
  - What it really looked like in metallic form
  - Was it really fissile? Would it spontaneously fission?
  - Could they machine it?
  - Bombs engineering parameters
  - Etc., etc.

‘The object of our work was to produce a bomb—But Oppie stopped me cold. He said ‘better lose that word. I tried again:

A gadget of the kind we hope to make is likely to result in several kinds of damage, which I’ll outline briefly here. Since just one kilogram of 239Pu has so-some septillion nuclei, we can expect that this device will yield a very wide range of pathological effects within a thousand meter radius. The radioactivity will be a million curies ten days afterwards, tending to render the locality unfit for habitation for some m The gadget also will initiate acoustic waves, and their velocity will superpose on the velocity with which the vaporized material will be convected from the blast in jets and set the waves will overtake itself and build a well-defined destructive front. Thus, if destructive action is regarded as a function of the pressure amplitude it follows that the likely radius of noteworthy mechanical destruction will be about a mile. As you can see, these are not insignificant results. But they involve considerable cost. Since the materials this work requires are precious, they constrain us to maintain as high efficiency as possible. Our aim is, simply put, the maximum release of energy per nucleus.’
REMINDER - DEFINITION OF CRITICALITY

- Otto Frisch first applied the term to fission reactions
- When a fission chain reaction in a mass of fissile material is self-sustaining, it is **critical**
- A **subcritical** mass does not have the ability to sustain a chain reaction
- A **supercritical** mass, once a chain reaction has started (either induced or spontaneous), will proceed at an increasing rate
- A spherical shape can make the difference between a mass being critical or subcritical
- Because a sphere is the optimum shape for a specific volume (e.g., water drops) and has shortest average distance between elements (e.g., atoms)
"I wish you would express to the scientists assembled with you my deep appreciation of their willingness to undertake the tasks which lie before them in spite of the dangers and personal sacrifices. I am sure we can count on their continued wholehearted and unselfish labors. Whatever the enemy may be planning, American science will be equal to the challenge. With this thought in mind, I send this vote of confidence and appreciation."

-Letter from FDR to Oppenheimer, read at June 29, 1943 meeting
THE BRITISH INVASION - THE QUEBEC AGREEMENT

* On August 19, 1943 an agreement was signed between FDR and Churchill - “Articles of Agreement governing collaboration between the authorities of the USA and UK in the matter of Tube Alloys” - Congress did not know about this

1. The US and UK would pool their resources to develop nuclear weapons with a free exchange of information;
2. Neither country would use them against the other;
3. Neither country would use them against other countries without consent; *
4. Neither country would pass information about them to other countries without consent;
5. That “in view of the heavy burden of production falling upon the United States,” the President might limit post-war British commercial or industrial uses of atomic energy.

THE BRITISH INVASION

* On September 10, 1943 it was agreed

* British scientists would be sent to Los Alamos under the same security restrictions governing American scientists there
* Exchange of information on centrifuge and thermal diffusion processes (which might affect the decision of which one to drop)
* No exchange on electromagnetic processes since the British had done no real work in this area (later changed to include Oliphant since he was a good friend of Lawrence)
* Collaboration with the Met Lab
* One prize that the British brought with them was their consultant…Niels Bohr and his son Aage (Nicholas and James Baker) who by then had escaped Denmark for Sweden
“How would you like to work in America?” James Chadwick asked Otto Frisch in Liverpool one day in November 1943?

“I would like that very much,” Frisch remembers responding.

“But then you would have to become a British citizen.”

“I would like that even more.”

• Frisch was the first to arrive with his wife at Los Alamos on December 13, 1943

• Chadwick arrived on January 12, 1944 but left in a few months to Washington DC because his family hated Los Alamos (he did commute)

A GENERAL PERSPECTIVE OF THE SITES

• Los Alamos certainly has the legend around it - the epitome of a secret lab in an isolated place

• Clinton Engineer (Oak Ridge) has the legend of being a secret city not on any maps

• The Met Lab has the legend of a secret project hidden away on a university campus with guards and security

• Los Alamos and the Met Lab were run like academic/university labs (scientists, technicians, admin staff) because they were

• Clinton Engineer Works and Hanford Engineer Works were run like factories (because they were), operated and managed by private industry; (there was some research work at X-10 for a while)

• Who remembers the directors of Site X and Site W? You do remember the directors of Los Alamos and the Met Lab…
LOS ALAMOS (SITE Y) AND HANFORD (SITE W) WERE A STUDY IN CONTRASTS

• Hanford
  • Had no Nobel Prize winners (except for the visits by Fermi)
  • There were no “rock-star”, Oppie-like figures
  • There were no Shakespearean-like stories for books, movies, television
  • There wasn’t the decompartmentalization that Oppie insisted upon at Los Alamos - estimate was that less than .1% of staff knew what was going on
  • Depended upon the working people who wanted to help win the war but also wanted a job
  • Made what happened at Los Alamos possible

What town has bachelors galore?
It’s Hanford.
Unmarried maidens, three or four?
It’s Hanford.
What town with lovely dames is rife,
More than you’ve seen in all your life,
But each is someone else’s wife,
In Hanford.
What town has excellent police?
It’s Hanford.
And still cannot maintain its peace?
It’s Hanford.
There’s knifings, shootings, stick-ups, run,
And every kind of crook and thum.
They chase them out, but more still come,
To Hanford.
ARRIVALS AT HANFORD

• If you were going to Hanford
  • It wasn’t because you received a personal invitation from Oppie, but saw recruitment material
  • You weren’t greeted at the train station, welcomed by Dorothy McKibbin, or driven around
  • You maybe didn’t even bring your family
  • You weren’t really aware of what your job would be - “working out West” or “doing important war work”

“The recruiting posters were really funny. ‘Come to the evergreen state of Washington. Sparkling rivers. Snow-capped peaks. Wonderful fishing and hunting.’ What do they come to? They come to a desert.”

-Steve Buckingham, Hanford worker
IF YOU WORKED AT HANFORD (1/2)

• You
  • Were probably older than 38
  • Were skilled in your trade, not an apprentice
  • Knew how to do your job with minimal specifications (more notes and sketches rather than blueprints and engineering drawings) and not ask too many questions - “don’t ask or you won’t have a job tomorrow”
  • Knew how to keep your mouth shut even around fellow workers - security was strict, FBI agents were mixed in with the work force and recruited informers

IF YOU WORKED AT HANFORD (2/2)

• If you were told to wear protective gear, you didn’t ask why
• If you were a minority you could expect
  • Regulation: no more that 10-20% African-American
  • Racism/“Jim Crow” - offsite but not onsite
  • Segregated housing (offsite and onsite); Richland (white), Pasco (non-white)
  • Separate dining facilities (offsite); integrated (onsite)
• Richland grew from 300 to 25,000 in just a few years
• But, there was a strong and active union and actually some strikes!
THE WORK TURNOVER WAS HIGH

- The isolation
- The long hours
- The “termination winds” and the dust
- “The plant is no longer run by E.I. DuPont because I’s left”
Besides Good Pay Why Did Workers Stay?

While the rest of the country was rationing, Hanford was “all you can eat”

Quantity and types of food was classified information

Entertainment
SECRECY

• The public, state officials, local officials did not know what was going on

• The press was constantly told “a big story is coming” and “if you hold off, you’ll be the first to know”

• Rumors were rampant (especially due to the DuPont involvement)

• “Why so much going in, but nothing coming out?”

• Workers would disappear without notice

SO WHAT WAS GOING ON?

BACK TO OUR REACTOR PHYSICS
So these reactors could be run with careful mixtures of natural uranium (uranium dioxide) and moderators and control rods to filter out the slow neutrons. Otherwise the reactors (at Site X and Site W) would be using up the enriched uranium that was needed for bombs.

- **CP-1**
  - Temporary
  - ~25 ft. high, base was ~30 ft. square
  - ~.5 watt power

- **X-10**
  - Permanent
  - 38 ft. x 47 ft. x 32 ft.
  - ~4 mW power

- **Reactor B**
  - Permanent
  - 46 ft. x 38 ft. x 41 ft.
  - ~250 mW power
When Reactor B was first turned on, it would not sustain a chain reaction

**Engineers to Groves:** “We need more fuel rods”

**Groves to Engineers:** “No, the scientists will figure it out”

**Engineers to Groves:** “Who will take the blame if they can’t?”

**Groves to Engineers:** “How many more do you need?”

- Reactor fuel rods contain natural/U(238) uranium
- Of all the neutrons flying around, some cause U(238) fission, some cause U(235) fission, some get absorbed by the U(238) nuclei
- The result is fuel rods “contaminated” with Pu(239)
- The Pu(239) is chemically separated from the irradiated fuel rods
- That’s what Hanford (Site W) was doing to create “weapons-grade”/fissile plutonium

**Correction!** - Hanford was creating “product” from “base metal”
Fuel rods stay in reactor about 6 weeks

Placed in pond so all decays can occur

Shipped off for processing

1 ton U ore = ~.5 pound Pu (compare that with U(235))
February 1945

Matthias hand-delivers first shipment of “product”/“material 49” (~1.5 lbs.) to Los Alamos and a steady pipeline begins.

The Chemistry and Radioactivity Groups now had enough to study its properties.
THE Y-12 - LOS ALAMOS PIPELINE

• “Material 25”
• First shipment March 1944 - 200 grams (.45 lbs) at 12% enrichment
• Hand-carried by train using circuitous routes and soldiers in disguise (salesmen with briefcases)
• By April 1945, Y-12 had produced about ~55 lbs (25 kg) of weapons-grade U(235)
• Was producing ~200 grams per day
• By mid-July, Y-12 had produced > 110 lbs (50 kg)

JOHN “JOHNNY” VON NEUMANN

• Neumann János Lajos - one of “the Martians”
• Often on shortlists for “smartest man in history”
• Mathematician, physicist, computer scientist, engineer, etc. - expert on the mathematical theory of shockwaves
• “Most mathematicians prove what they can, von Neumann proves what he wants”
• One of Stan Ulam’s good friends who “disappeared from the University of Wisconsin”
• One of any computer scientist’s heroes - “von Neumann machine”
JOHNNY’S COMPUTERS

• “Human computers” mainly women (including Teller’s wife)

• “Five or six women would work at tables with Marchant desk calculators. The ‘computers’ would process 10-14 digit numbers according to instructions. After each ‘computer’ checked her calculations twice, the supervisor would then check their results for errors. Errors from these bulky, loud machines were rather common due to their heavy daily use”

• Analog computers and calculators

• Feynman’s “hobby” was to keep them running lead to him supervising the process

• Later came early punched card machines from IBM (Stanley Frankel)

GEORGE “KISTY” KISTIAKOWSKY

• Harvard chemist and explosives/munitions expert

• Born into “an old Ukrainian Cossack family which was part of the intellectual elite in pre-revolutionary Russia”

• Fled from Russia to Germany during the revolution and later to the US.

• “explosives could be made into precision instruments”

• Lived in the Ranch School’s pump house rather than a dormitory

• Insisted to Groves that his teenage daughter (Vera) be able to spend the summers with him
NOW THAT LOS ALAMOS HAD THE PRODUCT

- It was going to be up to Johnny and Kisty to make these designs work

IF THIS WERE A CLASS WHERE I GAVE HOMEWORK ASSIGNMENTS

This would be one for next week:

“Los Alamos From Below” (long version) - Richard Feynman

https://www.youtube.com/watch?v=PuDk2sA_kNs
LIFE GOES ON AT SITES X & Y

These two guys were great friends