



Mark Oliphant

- b. 1901 Adelaide, d. 2000
- Graduated from University of Adelaide before moving to Cavendish Lab to work under Rutherford
- 1937 appointed Professor of Physics at Birmingham University
- Highly influential in British Physics
- Worked on the development of RADAR, particularly the cavity magnetron which made airborne radar possible
- Became actively involved in the assessment of nuclear fission for the development of weapons
- Worked in the Manhattan Project with Lawrence



UK bomb program

- In early 1940, Otto Frisch (Lise Meitner's nephew) and Rudolph Peierls were working at the University of Birmingham under Oliphant
- As Germans, they could not get security clearance to work on the top secret project - RADAR
- So they worked on another project that wasn't secret: how much uranium would it take to build a bomb?
- Up to this time the best estimates were 12 - 40 tonnes which suggested it was not really practical, except maybe aboard a ship
- Instead, Frisch and Peierls calculated that the critical mass for pure U-235 would be a few kilograms



UK bomb program (2)

- In March 1940, they presented their results to Oliphant in the now famous Frisch-Peierls memorandum that opened with:
- *"The attached detailed report concerns the possibility of constructing a "super-bomb" which utilises the energy stored in atomic nuclei as a source of energy*
- *The energy liberated in the explosion of such a super-bomb is about the same as that produced by the explosion of 1,000 tons of dynamite*
- *This energy is liberated in a small volume, in which it will, for an instant, produce a temperature comparable to that in the interior of the sun*
- *The blast from such an explosion would destroy life in a wide area*
- *The size of this area is difficult to estimate, but it will probably cover the centre of a big city*

UK bomb program (3)

- *In addition, some part of the energy set free by the bomb goes to produce radioactive substances, and these will emit very powerful and dangerous radiations*
- *The effect of these radiations is greatest immediately after the explosion, but it decays only gradually and even for days after the explosion any person entering the affected area will be killed*
- *Some of this radioactivity will be carried along with the wind and will spread the contamination; several miles downwind this may kill people"*
- This is a quite remarkable description of events that would happen more than 5 years in the future

UK bomb program (4)

- In response, Oliphant and other leading scientists set up the MAUD Committee to oversee research into bomb production at 4 universities - Cambridge, Oxford, Liverpool and Birmingham
- The name MAUD meant nothing - Maud Ray had been Niels Bohr's childhood governess
- For the research, they were able to access heavy water that the French Deuxième Bureau had "borrowed" from Norway while it was still neutral
- The final report of the MAUD Committee was prepared in July 1941
- They concluded that a bomb could be developed by 1943
- The report was shared with the US Uranium Committee
- The response was - crickets!

UK bomb program (5)

- In France, nuclear research had been led by Frédéric and Irène Joliot-Curie (daughter of Marie Curie)
- Like the Germans, they had identified the problem with graphite as a moderator and settled on heavy water as a better alternative
- In 1940, 3 agents of the Deuxième Bureau arranged to "borrow" 185 kg of heavy water from Norsk Hydro – their whole available stock
- Despite an Abwehr presence in Norway, they were able to smuggle it to Oslo, then to Perth in Scotland and from there to Paris
- When France was invaded, Frédéric hid it in a Banque de France vault and then a prison
- From there it was carried by 33 French scientists and technicians to a British tramp steamer, Broompark, that, a few weeks after Dunkirk, also smuggled industrial diamonds, machinery and about 100 British evacuees out of Bordeaux

UK bomb program (6)

- In Birmingham, Peierls, on the recommendation of Max Born in Edinburgh, had taken on a brilliant young physicist, **Klaus Fuchs**
- No one paid much attention to why he had fled from Germany
- He had been an active communist and feared arrest
- He would make significant contributions to the UK and US bomb projects
- But he would also feed regular reports to the Soviet Union
- Post-war he was head of the Theoretical Physics Division at the UK Atomic Energy Research Establishment at Harwell
- He was exposed by the Venona project and in 1950 he was jailed for 9 years, going to E Germany after his release



UK bomb program (7)

- The British bomb program was renamed as Tube Alloys and was eventually fully absorbed into the US program as Britain was fully stretched for resources
 - 19 August 1943, the Quebec Agreement was signed by Roosevelt and Churchill, the latter saying it was the best deal he could get
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

UK bomb program (8)

- There was a subsequent top secret verbal agreement between Churchill and Roosevelt that was captured in an aide memoire dated 18 September 1944 and initialed by both
- 1. *The suggestion that the world should be informed regarding tube alloys with a view to an international agreement regarding its control and use is not accepted ...*
- 2. *Full collaboration between the United States and British Government in development of tube alloys for military and commercial purposes should continue after the defeat of Japan unless and until termination by joint agreement*
- 3. *Inquiry should be made regarding the activities of Professor Bohr and steps taken to insure that he is responsible for no leakage of information, particularly to the Russians*
- Roosevelt's copy went missing raising doubts over its existence
- Someone had taken the term 'tube alloys' too literally when filing it

US bomb program Phase 1

- In July 1939, refugee scientists Leo Szilard and Eugene Wigner decided to warn the US Government about the German bomb program
- They drafted a letter to President Roosevelt to be signed by Einstein as he was a celebrity in the US and would be less likely to be ignored
- *"... This new phenomenon would ... 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. A single bomb of this type carried by boat and exploded in a port, might well destroy the whole port together with some of the surrounding territory ..."*
- He did receive a polite reply
- *"My dear Professor,*
- *I want to thank you for your recent letter and the most interesting and important enclosure. I found this data of such import that I have convened a board ... Please accept my sincere thanks."*

US bomb program Phase 1 (2)

- Physicists have long claimed that this letter kick started the US bomb program
- In reality, not a lot was done in response to it
- The board was the Uranium Committee that was chaired by Lyman Briggs, the Director of the Bureau of Standards
- When Briggs received the MAUD Committee reports, he knew what to do with them
- They were marked Top Secret so he put them in his safe and didn't tell anyone

Oliphant's intervention

- In August 1941, Oliphant travelled to the US to find out what had happened to the reports
- *"I called on Briggs in Washington, only to find out that this inarticulate and unimpressive man had put the reports in his safe and had not shown them to members of his committee. I was amazed and distressed."*
- Oliphant then visited his good friend Lawrence to enlist him as an ally
- Lawrence duly proceeded to kick down doors in Washington and elsewhere to get Oliphant a proper hearing from people who mattered
- Unlike Briggs, they took Oliphant seriously and ...
- On 9 October 1941 Roosevelt approved the atomic bomb program
- Leo Szilard wrote *"If Congress knew the true history of the atomic energy project, I have no doubt that it would create a special medal to be given to meddling foreigners for distinguished services, and Dr Oliphant would be the first to receive one."*

US bomb program Phase 2

- With Lyman Briggs now sidelined, **Vannevar Bush**, head of the National Defense Research Committee, and **James Conant**, a chemist and President of Harvard, became the most influential drivers of the program with direct access to the President
- The **S-1** (*no longer Uranium*) committee met on 18 Dec 1941 and laid out an intensive research program to scope out the bomb development
- The senior scientists on S-1 were US Nobel Prize winners Lawrence, **Harold Urey** and **Arthur Compton**
- Urey, Professor of Chemistry at Columbia University, had discovered Deuterium and was an expert on isotope separation
- Compton was Professor of Physics at the University of Chicago and headed up what became known as the Metallurgical Laboratory, a cover for plutonium production

US bomb program Phase 2 (2)

- 17 June 1942 Roosevelt signed off on the S-1 recommendations and a budget of \$90m
- Both uranium and plutonium would be tested as bomb materials
- Uranium would be enriched and 3 methods were selected
- Plutonium had only been discovered in 1941 by scientists at Berkeley but its fissile properties were soon recognised
- Plutonium would be produced from U-238 in reactors
- Because of its different chemical properties it could be separated more easily from uranium than U-235 could from U-238
- Both heavy water and graphite would be tested as moderators
- When things were still going too slowly, Bush appointed Col. Leslie Groves to head the project

Lieut. General Leslie Groves

- b. 1896 Albany, NY d. 1970
- Army Corps of Engineers
- In 1940 when the army was starting a massive recruitment drive, he was given the task of sorting out the mess in the contracting department responsible for building all the army camps
- In 1941 he was put in charge of building the Pentagon, the largest building in the world at that time
- His success in each of these roles made him a logical choice to run a hugely complex project
- He was promoted to B/G, given the highest security clearance and emergency procurement powers
- Groves appointed Robert Oppenheimer to run the scientific program, beginning an extraordinarily successful but unlikely partnership



Leslie Groves (2)

- *First, General Groves is the biggest S.O.B. I have ever worked for.*
- *He is most demanding. He is most critical. He is always a driver, never a praiser.*
- *He is abrasive and sarcastic. He disregards all normal organizational channels.*
- *He is extremely intelligent. He has the guts to make difficult, timely decisions.*
- *He is the most egotistical man I know. He knows he is right and so sticks by his decision.*
- *He abounds with energy and expects everyone to work as hard or even harder than he does.*
- *He ruthlessly protected the overall project from other government agency interference, which made my task easier.*
- *He seldom accepted other agency cooperation and then only on his own terms.*
- *... And in summary, if I had to do my part of the atomic bomb project over again and had the privilege of picking my boss I would pick General Groves.*
- M/G Kenneth D. Nichols

Robert Oppenheimer

- b. 1904 New York d. 1967
- Brilliant theoretical physicist
- Harvard graduate, PhD under Max Born at Göttingen
- Professor at Berkeley, 1936
- Politically he was left-wing and had no experience of working on large projects
- He was also an intellectual bully prone to extreme sarcasm and humiliation
- But he came with the recommendation of Lawrence and Compton
- Groves was impressed by Oppenheimer's singular grasp of the practical aspects of designing and constructing an atomic bomb, and by the breadth of his knowledge
- Oppenheimer now started to demonstrate superb skills in leading a large team of highly intelligent, often difficult scientists towards a common objective



Robert Oppenheimer (2)

- Victor Weisskopf, who had also spent time at Göttingen, put it thus:
- *"Oppenheimer directed these studies, theoretical and experimental, in the real sense of the words.*
- *Here his uncanny speed in grasping the main points of any subject was a decisive factor; he could acquaint himself with the essential details of every part of the work.*
- *He did not direct from the head office.*
- *He was intellectually and physically present at each decisive step.*
- *He was present in the laboratory or in the seminar rooms, when a new effect was measured, when a new idea was conceived.*
- *It was not that he contributed so many ideas or suggestions; he did so sometimes, but his main influence came from something else.*
- *It was his continuous and intense presence, which produced a sense of direct participation in all of us; it created that unique atmosphere of enthusiasm and challenge that pervaded the place throughout its time."*