

## **Vannevar Bush and Ernest Lawrence – Two key individuals**

In the last episode of this series, we explored the early precursor activities that led to the Manhattan Project. We also saw that there was widespread knowledge around the world among the scientific and especially the physics communities regarding uranium 235 and its potential to create nuclear fission. That fission could theoretically be used as a very powerful bomb was becoming well understood. Thus the potential that Germany would pursue such a powerful weapon was held as a very high and most likely probability.

While the British MAUD Committee was attempting to get the attention of the United States in 1940 and 1941, on June 28, 1941, US Executive Order 8807 created the Office of Scientific Research and Development. This office superseded the work of the National Defense Research Committee that President Roosevelt had appointed Bush to lead in June 1940. The OSRD was given almost unlimited access to resources including funding.

Vannevar Bush was selected by President Roosevelt to head the OSRD and reported directly to the president. As Bush had been doing with the NDRC he continued and even expanded his leadership of research on uranium through the OSRD. He was President Roosevelt's key military, science and industry advisor regarding how the US prepared for entry into World War II.

The "S-1 Section" of the OSRD superseded the Briggs Advisory Committee on Uranium that had first met on October 21, 1939. This organization had been formed as a direct result of the letter Leo Szilard and Albert Einstein prepared and Einstein signed that was delivered to President Roosevelt by economist Alexander Sachs on October 11, 1939. Note the quick response.

The Briggs Advisory Committee on Uranium was headed by Lyman James Briggs who was director of the National Bureau of Standards. The committee had four specific objectives, one of which was to "make uranium (fission) chain-reaction bombs." Leo Szilard was given \$6,000 to continue to pursue neutron experiments at Columbia University with Enrico Fermi.

A note from Eugene Wigner received by Lyman Briggs on April 14, 1941 indicated that a colleague of Wigner's had brought him a message that contained information that a "number of German physicists are working intensively on the problem of the uranium bomb under the direction of Heisenberg" and that Heisenberg himself was trying to delay the work as much as possible, fearing catastrophic results of a success. Heisenberg gave the advice to "hurry up if U.S.A will not come too late." See why folks felt there was a race to get the atomic bomb before Germany!

The Briggs Advisory Committee on Uranium became the S-1 Project of the National Defense Research Committee on July 1, 1941. The Office of Scientific Research and Development, led by Vannevar Bush who had been given responsibility for all fission research, absorbed the NDRC and Briggs and his S-1 Project reported to Bush.

Recall from our last episode in this series that Marcus Oliphant of the British MAUD committee came to the US in August 1941 to find that Briggs had not shared the MAUD report with his advisory committee on uranium. Things were changing quickly with regard to who had responsibility for uranium research in the US. Vannevar Bush was gaining responsibility and Briggs and his Bureau of Standards was losing it.

During the latter months of 1941 after Oliphant's visit assured that US scientists understood the MAUD report's singular message that a uranium 235 bomb was feasible and that the British were working on such a project without the necessary resources, Bush continued to solidify his overall responsibility for research on uranium and pulled all US uranium efforts into his organizations.

Meanwhile, Ernest O. Lawrence, who had been awarded a Nobel Prize in Physics in November 1939 increased his efforts to convince anyone and everyone that his cyclotrons at the University

of California at Berkley's Radiation Laboratory held the key to creating the needed separation of uranium 235 from uranium 238. He would continue this strong effort until ultimately Y-12 was constructed to implement his idea.

Lawrence had first received a patent for his cyclotron in 1934. He had proven that his method could produce high energy particles that turned in a circle at increasing speed. He used the basic principles of magnetic fields to accelerate the particles. So, it was a simple thing for him to easily see how this same magnetic field theory and centrifugal force would readily separate uranium 235 from uranium 238. He was sure it would work, without a doubt. It must have been frustrating for him to see others thinking some other method would be better suited for solving the problem.

One way to think about solving the problem is to consider an illustration that exaggerates the situation a bit. Consider holding two one foot lengths of rubber bands in your hand and having a golf ball attached to the end of one of the lengths and to the other one having a ping pong ball attached. If you then swing the two balls around in a circle, you know what will happen...the golf ball will swing out farther than the ping pong ball. Think of uranium 238 as the golf ball and uranium 235 as the ping pong ball. Even though there is only three neutrons difference in mass between the two, that is a sufficient difference in mass to cause separation adequate enough to enable the capture of the lighter uranium 235.

Lawrence could see this and knew he could make a cyclotron type machine he called a Calutron (CALifornia University cycloTRON) that would use two magnets, a vacuum chamber, a sending mechanism and a receiving mechanism. This would work with only a single pass of the material.

To Lawrence the calutron must have been a simple physic machine. To others it obviously seemed highly complicated and to those who might know that only 0.7% of uranium was that precious uranium 235, the calutron must have been perceived as mighty slow. It would also prove to be extremely expensive to build and operate.

Vannevar Bush held a meeting on December 6, 1941 to organize an accelerated Uranium 235 research project managed by Arthur Compton. This program had Ernest O. Lawrence responsible to research and refine electromagnetic enrichment techniques and Harold Urey responsible for gaseous diffusion research. The centrifuge approach had already been discarded because of perceived difficulties rotating a cylinder as fast as would be required to obtain sufficient separation.

Lawrence must have seen this action by Bush as one that took him a giant step toward actually producing calutrons. He was now officially going to be working on the practical separation machines he knew would do the job. I am convinced he was a key figure in promoting the implementation of practical industrial machines to separate uranium 235 to be used to create a powerful bomb.

Then on December 7, 1941, Japan attacked Pearl Harbor. Four days later Germany declared war on the United States. On December 18, 1941, a meeting was held where the S-1 Project was dedicated to the development of an atomic bomb.

During early 1942, Vannevar Bush continued to push for accelerated research. He also continued to reorganize and pull all US uranium efforts under his control and oversight.

The S-1 Section or S-1 Project was dissolved on June 17, 1942 by Vannevar Bush with President Roosevelt's approval. It was replaced by an S-1 Executive Committee chaired by James B. Conant and members Lyman James Briggs, Arthur Holly Compton, Harold Clayton Urey, Ernest O. Lawrence and Edgar Murphee.

Again, Lawrence was solidifying his position of strength and ability to influence the decisions regarding technology to pursue to create the uranium bomb. The electromagnetic separation

method was beginning to be seen by all as feasible. It just required massive amounts of industrial effort.

Then on August 13, 1942 the Manhattan Project was created by the U.S. Army Corps of Engineers and General Leslie R. Groves was given command of the Manhattan Engineer District. The S-1 Executive Committee created secret sites in Tennessee (Site X) and New Mexico (Site Y). The transition from research overseen by the Office of Scientific Research and Development to the joint military and industrial effort to actually create the practical facilities and products needed for an atomic bomb had begun.

The S-1 Executive Committee soon became largely inactive yet, Bush, Lawrence, Conant, Compton and other key figures in the early decisions continued to influence development activities. Ultimately the Military Policy Committee consisting of Vannevar Bush, James B. Conant, General Leslie Groves, Rear Admiral William Purnell of the Pentagon's Joint Committee on New Weapons and General Wilhelm Styer – Chief of Staff of the Army's Services of Supply, had responsibility for the Manhattan Project's direction.

Y-12 figured prominently into this emerging and ever more complex situation. Next week we will begin a closer look at the activities in Tennessee and especially the construction of the Y-12 Plant.