Oak Ridge's history illustrates what America can do when we work together

(As published in The Oak Ridger's Historically Speaking column the week of August 24, 2020)

This *Historically Speaking* column first appeared as a personal FaceBook post by David Keim on Aug. 5, 2020. It seemed to me a really well written summary y of the history surrounding the Manhattan Project and Oak Ridge. I asked my friend, Dave, if I could publish it here for you readers of *Historically Speaking* and he agreed. Enjoy a brief and concise summary of our history:

August 6, 2020 marked 75 years since Paul Tibbets piloted the B-29 Enola Gay over Hiroshima, Japan, and dropped the first atomic bomb used in war. Uranium for that bomb came from the Y-12 plant in Oak Ridge, Tennessee, where I worked before moving to Oak Ridge National Lab, which had its own role in the Manhattan Project.

Stories exploring the development of nuclear weapons, their devastating use, and their ongoing existence continued to be published through the 75th anniversary week. Sober reflection and public policy debate are necessary, and I'd encourage you to read and watch stories and commentary of interest to you.

Linked <u>here</u> is the television special aired by Knoxville's NBC affiliate, WBIR-TV, in 2018 to mark the 75th anniversary of the founding of Oak Ridge. If you have 20 minutes, it's a great overview of the "Secret City" that evolved from World War II. (Robin Wilhoit interviewed me among many others, including Ray Smith.) In addition, I offer the following primer to explain Oak Ridge's remarkable role in the war:

First, there are three main Manhattan Project sites in Oak Ridge: the Y-12 National Security Complex, Oak Ridge National Laboratory (formerly the X-10 site), and the East Tennessee Technology Park (formerly the K-25 gaseous diffusion plant).

The fact that there are multiple sites within Oak Ridge underscores one of the most interesting aspects of the Manhattan Project: The science and engineering were so new that the U.S. didn't know which process would yield a bomb the quickest, so they built facilities for all the processes in parallel. Y-12 used electromagnetic separation to capture the fissile uranium-235 isotope, K-25 used gaseous diffusion, and a separate plant near K-25, called S-50, used thermal diffusion, although it didn't operate long. ORNL began as a reactor, built on the X-10 site to show how to produce plutonium, another fissile material.

Almost all Oak Ridge's work relating to the bombs that were dropped at the end of World War II centers on the Y-12 National Security Complex, which produced uranium used in Little Boy (Hiroshima).

The K-25 plant (now the East Tennessee Technology Park) assisted with enriching the uranium, too. K-25 was the largest building under one roof when it was constructed and has since been torn down, along with many adjacent buildings, to make land available for new commercial and industrial development.

After the war, K-25 and Y-12 were both central to U.S. weapons production throughout the Cold War, K-25 in producing enriched uranium and Y-12 for precision machining of uranium.

The X-10 site (now ORNL) did not produce any material used in the bombs dropped on Japan. X-10's role during World War II was to build and operate a nuclear reactor to produce plutonium. While Glenn Seaborg produced plutonium at Berkeley in microgram quantities prior to the Manhattan Project, larger quantities were needed for use in a weapon. The X-10 reactor and adjacent chemical processing facility served as a pilot plant to model how large reactors constructed at the Manhattan Project's Hanford, Wash., site would work. Hanford produced the plutonium used in Fat Man, the bomb dropped on Nagasaki.

The X-10 reactor was the world's first continuously operating nuclear reactor. That means that once it "went critical" — began sustaining a nuclear chain reaction — it kept going. It was modeled after the "Chicago pile," which was the first reactor but which was disassembled after it proved that the proper configuration of uranium and a graphite moderator could sustain a reaction.

Oak Ridge's history illustrates what America can do when we work together

(As published in The Oak Ridger's Historically Speaking column the week of August 24, 2020)

The Chicago pile was built from graphite blocks and uranium, stacked in a configuration (a pile) that would allow neutrons to penetrate and split other uranium atoms. Workers slowly removed neutronabsorbing control rods to allow the reaction to grow, then dropped them back into the pile when it was time to stop the reaction. It amazes me that physicists theorized that this would all work, and that Enrico Fermi and a few dozen of his colleagues stood around while Fermi's slide rule confirmed that, yep, nuclear fission behaved just like they predicted.

The Chicago pile went critical on Dec. 2, 1942, and construction on the X-10 Graphite Reactor at Oak Ridge began two months later, on Feb. 2, 1943. It went critical on Nov. 4, 1943.

Oak Ridge, Hanford, and Los Alamos, N.M., were the three main sites of the Manhattan Project. About 60 percent of the project's funding came to Tennessee. Oak Ridge and Hanford were production sites. Los Alamos was the scientific center and is where the bombs were assembled, using uranium produced at Y-12 and plutonium from Hanford.

After scientists at X-10 confirmed how irradiated uranium and chemical separations could yield plutonium, the site's bomb-related work concluded. Engineers and scientists recognized that they had an extremely powerful scientific tool in the Graphite Reactor, however, and determined to build a national laboratory for the Southeast: Oak Ridge National Laboratory.

They figured out how to use their one-of-a-kind reactor to pioneer nuclear energy (through reactor design and training of physicists and engineers), produce medical isotopes, use neutrons as probes for materials research, establish health and safety protocols related to radiation, and ultimately follow their discoveries and applications into environmental research, supercomputing, and other fields represented at ORNL today. The lab built a dozen more reactors after the X-10 Graphite Reactor and is working to 3D-print its 14th reactor today.

So Oak Ridge is one part—a pretty big part—of one of the most remarkable stories of modern times, apart from just how unusual it is that the town was created out of nothing by the U.S. government in a matter of months. The bigger picture is that German scientists had discovered nuclear fission as the Nazis rose to power. The scientific community recognized the potential of this discovery, both for the peaceful generation of energy and its deadly use in a weapon. Scientists debated the ramifications and how to proceed, and some—including ORNL's first research director, Eugene Wigner—worked with Albert Einstein to make President Franklin Roosevelt aware of the potential that Nazi Germany would harness this unprecedented power.

In the Manhattan Project, the U.S. brought together the scientific community (which was figuring out the nuclear physics of fission), industry (which built the plants and ran them under contract to the government), the military (which seized land for the sites and oversaw their construction and operation), and government (which paid for everything) in response to a true existential threat. Like, if they didn't get this right, they had good reason to believe we wouldn't exist anymore.

Basic science—in this case the behavior of the atom in heavy elements—was translated to both weapons and power generation incredibly quickly. The neutron was discovered in 1932 and nuclear fission at the end of 1938. Think about how rapidly those discoveries changed the world, not only in the terrible fact of nuclear weapons but for medical isotopes that have saved or prolonged countless lives, to create and power our nuclear Navy, as an emission-free source of 20 percent of the nation's electricity, and more.

For American science, after the Manhattan Project, the next big effort was the space race. What fields are in the same position today? Supercomputing? Quantum computing? Superconductivity? Another large-scale carbon-free energy source? A discovery none of us have heard about yet?

Oak Ridge's history illustrates what America can do when we work together

(As published in The Oak Ridger's Historically Speaking column the week of August 24, 2020)

Oak Ridge underscores the centrality of research and development to national competitiveness and national security, which are closely related in many instances. It's why I hope Tennesseans are proud of the contributions of Oak Ridge.

If you've read this far and you want more, pick up Richard Rhodes' "The Making of the Atomic Bomb," the definitive history of the Manhattan Project. Thanks for your interest!

I know you appreciated Dave's synopsis of our history. You should be reminded that in a previous career Dave worked as a reporter and then an editor for the Knoxville News Sentinel before coming first to the Y-12 National Security Complex and now with Oak Ridge National Laboratory. Thus, his writing skills and effective communications skills come through in this well written brief history. Thanks, Dave, for composing it and agreeing to share it with *Historically Speaking* readers.



David Keim, Director, Communications Division, Oak Ridge National Laboratory