Economic impacts of ORNL's 20th century achievements

(As published in The Oak Ridger's Historically Speaking column on August 11, 2014)

Recently Gordon Fee approached me with a question. He said, "How many technological breakthroughs that have occurred at Oak Ridge can you name?" Before I could answer, Gordon continued by saying that most people he asked could usually name the discovery of medical isotopes, and of course, separating the uranium 235 for the Little Boy bomb and often the first plutonium in an industrial sized reactor, but they could not usually go beyond that.

I thought, what a shame. I know there have been many substantial and significant technological advances that emanated from Oak Ridge and have had tremendous worldwide impact. But, I soon realized that Gordon was right, I could not name the specific technological breakthroughs either.

This really had an impact on my thinking about Oak Ridge. I immediately wanted a poster, an elevator speech, a short list of significant things coming from Oak Ridge that I could pull out of my billfold should I need to show anyone what Oak Ridge had accomplished.

Gordon was frustrated by the fact that he had recently been in Nashville when he noticed that some of the people with whom he interacted in various state organizations where he served only saw Oak Ridge as a contaminated cleanup site. I did not realize it was that bad...I do know that when you get 25 miles away from Oak Ridge, most people know very little about what is going on here.

Recently, Fanny and I were privileged to visit Hanford, WA, where I make a presentation about the history of Oak Ridge and we toured the Hanford site to see the elements that will be included in the Manhattan Project National Historical Park. Then we spent 10 days on a vacation touring the Washington, Oregon and California area. Great vacation.

I made it a point when the opportunity presented itself to tell people we were from Oak Ridge. I never said, Oak Ridge, TN. Just Oak Ridge. They knew exactly where I meant and they could tell me the basic history of Oak Ridge and some even knew about medical isotopes. So, maybe we are better known outside Tennessee than we are in our own state!

Gordon also wondered what might be done to promote a better understanding and appreciation for Oak Ridge. Surely something could be tied to the upcoming 70th anniversary of the end of World War II. Or maybe the slogan "Science City" might be used to promote the idea of the many things that have come from Oak Ridge.

I agreed that something should be done as I felt that we in Oak Ridge were failing at getting the positive accomplishments into the common language of the people sufficient enough for them to recall and to recite them with pride to others.

The next thing I did was to contact Jim Campbell and ask him the same question Gordon asked me..."Can you name the technological breakthroughs that have been accomplished in Oak Ridge." Jim immediately gave me a list Jim Roberto had created and that was being used in a study the East Tennessee Economic Council was conducting about Oak Ridge.

Imagine my delight when Carolyn Krause sent an email saying she had attended a presentation by Jim Roberto while Fanny and I were gone and had written a Historically Speaking column about the significant accomplishments of Oak Ridge! So, enjoy Carolyn's summary.

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A multibillion industry was born at what became Oak Ridge National Laboratory, but ORNL never received a dime for its research results and technology developments. Nor did it patent the technology and license it to a private firm.

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Jim Roberto, associate laboratory director for partnerships at ORNL, recently spoke about the radioisotopes produced at the Graphite Reactor after the completion of its Manhattan Project mission.

In 1946 a radioactive carbon isotope, a product of the Graphite Reactor, was shipped to a St. Louis hospital to treat cancer patients. "That was the laboratory's first example of technology transfer," Roberto told Friends of ORNL.

As sources of radiation, radioisotopes are also used to diagnose, as well as treat, diseases such as cancer. "Over 100 million medical procedures involving radioisotopes are performed each year," Roberto said.

ORNL inventions and research results in the 20th century have had an important economic impact on the United State and the world, he added.

Roberto reviewed ORNL technologies that sprang from work at the Graphite Reactor, the world's first continuously operated reactor.

Eugene Wigner, research director at Clinton Labs (1946-47) and winner of the Nobel Prize for Physics (1963), "had the vision to build a national laboratory around the Graphite Reactor," Roberto said. Besides the production and distribution of radioisotopes, two other important missions arose from work at the reactor.

The first was science and engineering for nuclear power. "That area was the source for ORNL's materials science, nuclear engineering, separations chemistry, and reactor technology," he said.

The second was the development of neutron scattering at the reactor by Ernest Wollan and Clifford Shull, who shared a Nobel Prize for Physics in 1994 for his use of neutron scattering to analyze the structure of materials.

Today ORNL is the world's foremost center for neutron scattering research, thanks to two superb facilities: the accelerator-based Spallation Neutron Source and the High Flux Isotope Reactor. In fact, research performed on magnetic and other materials in the 20th century at HFIR helped enable the development of credit cards, cell phones and small motors for automatically adjusting car windows and seats.

Roberto noted that nuclear reactor development at ORNL has had a long history of economic impact. Alvin Weinberg, director of ORNL for 18 years, was the first to publish and promote the concept of the pressurized water reactor. PWRs are used to power the Navy's nuclear submarines. PWRs are at the heart of most nuclear power plants that generate 20 percent of our nation's electricity.

And then there is the never-say-die molten salt reactor (and breeder) invented at ORNL and championed by Weinberg. The Alvin Weinberg Foundation, based in London, UK, promotes molten salt reactors as safer, cleaner and cheaper nuclear power and "a revolutionary advance in nuclear energy technology."

Although the U.S. government terminated the MSR work at ORNL despite the successful operation of two prototypes, preventing the commercialization of the technology, two U.S. companies are researching the MSR, as are entities in China, France, Japan, Russia and the UK. China has the largest MSR program.

Another ORNL technology that is used worldwide is nuclear fuel reprocessing. It is not being used in the U.S. because of fears of illegal diversion of nuclear fuel. But advocates of the technology

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say that it would extend the country's nuclear fuel supply and reduce the amount of dangerous nuclear waste that must be isolated.

In materials development, Roberto said, "South Korea is stamping out large reactor components made of an alloy developed at Oak Ridge."

The development of nuclear instrumentation for reactors at ORNL spawned the founding of ORTEC, a spinoff company in Oak Ridge that was bought by EG&G. Ronald Nutt pioneered the development of nuclear instruments at ORNL and then EG&G ORTEC.

He and David Townsend designed the first prototype positron emission tomography (PET)/computed tomography (CT) scanner, which was built and operated in 1998 by CTI PET Systems (now Siemens Molecular Imaging) in Knoxville. Nutt was president of the company at the time. Combined PET/CT scanners are having a far-reaching effect on medical imaging of cancerous tumors and other disease markers.

Centrifuge technology was tested at Oak Ridge's K-25 plant for the enrichment of uranium because it uses one-tenth the electricity of gaseous diffusion. ORNL's Norman Anderson and colleagues further adapted the technology for purifying polio and other vaccines. Removing impurities from vaccines reduces or eliminates unwanted side effects.

Ion implantation and ion channeling research at ORNL have had a major effect on the development of semiconducting chips for a variety of electronic devices. Using calutrons at the Y-12 plant, ORNL researchers demonstrated that electrical junctions can be formed in silicon by the direct implantation of boron and phosphorus ions. Thousands of semiconductor samples were implanted in Oak Ridge for industry in the early development of integrated circuits.

As commercial nuclear power plants aged, ORNL analyzed pressure vessels and other components of the plants for the Nuclear Regulatory Commission. ORNL researchers identified reactors whose 40-year life could be safely extended to 60 years, avoiding millions of dollars in replacement costs.

ORNL chemists led by Bruce Moyers synthesized novel molecules that selectively bind to highly radioactive cesium-137 and extract the troublesome fission byproduct from waste produced in the development of nuclear weapons during the Cold War. Eventually, the \$1.3 billion Salt-Waste Processing Facility at the Savannah River Site in South Carolina will use the ORNL technique to remove cesium from 34 million gallons of high-level radioactive salt waste so it can be disposed of as low-level waste, saving the U.S. government \$10 million.

Finally, Roberto mentioned the lab-on-a-chip device invented by Mike Ramsey in the mid-1990s at ORNL. The microfluidic chip, which can be used for chemical and environmental analysis, was licensed to a small company that was sold to PerkinElmer for \$600 million.

People have benefited in many ways and millions of dollars have been earned and saved, thanks to ORNL inventions and expertise.

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Now, thanks to Carolyn, you have a list of substantial accomplishments that have resulted in significant technological advancement as well as tremendous monetary gain. And they all came about because of the Oak Ridge National Laboratory...Oak Ridge's own!

Each and every reader of the above summary of Jim Roberto's talk can take pride in being a part of the place where this type of technological advancement is routine.

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ORNL Associate Laboratory Director for Partnerships