Y-12 continues to push the state-of-the-art in machining —
Or: Machining technology helped give U.S. edge during Cold War (title used in *The Oak Ridger*)

The decade of the 1960's brought additional growth and increased innovation to Y-12 in all aspects of the growing assortment of missions. Not only was Y-12 supporting the growing nuclear weapons complex in general, with the addition of Lawrence Livermore Laboratory in 1952 to supplement the Los Alamos National Laboratory's nuclear weapons design work, now both laboratories were looking to Y-12 to manufacture ever-more-specialized components.

While dedicating substantial resources to the separation of lithium-6 for thermonuclear weapons, manufacturing nuclear and other specialized components for nuclear weapons testing, support for the new and ever-increasing demand for megaton-yield warheads for missiles began being requested from Lawrence Livermore Laboratory. Y-12 even began in the 1960's to bring in work from other government agencies such as the National Aeronautics and Space Administration.

Of special note is the transition to the first high-yield multiple warheads that were compact enough that several could be carried on each ballistic missile. This, again, required Y-12 to retool machines and to increase the capability for intricate designs and unusual mixtures of materials and processes.

Even tighter tolerances were required, and ultimately new methods had to be developed that enabled precision machining that just was not available using technology and machines available at the time. So Y-12 engineers working with machine tool companies made tremendous advances.

One such advance came from a joint effort with the Du Pont Company using diamond knives, interferometers and air bearings. The use of porous graphite in the air bearings where a thin film of air is created between the bearing and spindle made this leap in precision possible. Tolerances of a few microinches could now be routinely attained. This use of porous media for air bearings is noted in the Timeline of Air-Bearing Spindle history as "having had their genesis inside the National Labs" with no mention of Y-12!

Bill Barkman, of Technology Development, recalls, "The Ex-Cell-O series of T-base machines were delivered to Y-12 in the 1960's with air bearing spindles, hydraulic axes and spindle drives. They had hard-wired numerical control unites that accepted the part program instructions from a paper tape reader."

Bill notes, "Later enhancements to these machines included the contact ball tool setter and computer numerical control units (commonly called 'CNCs'). The early CNC system used Mylar tapes to input the part programs and had an internal part program storage capability of approximately 8,000 words."

The diamond cutting machine operations in Building 9998 and other specialized locations included such innovations as electric drive axes and spindles. Also, air-bearing technology was applied to Linear Variable Differential Transformers (again a common term used is "LVDTs") that were used for dimensional inspection. This inspection technology developed alongside the machining technology at Y-12.

If anything, the inspection machines required even more precision and controlled environments to assure accuracy and repeatability of measurements. Bill commented on this aspect of the advancing technology by noting, "Equipment such as the dual-arm sweep gage and the Moore series of inspection machines required tightly controlled environmental conditions and still represents the state-of-the-art today for many operations."

Bill concludes by saying, "Coordinate measuring machines are now used for the majority of work piece dimensional certifications needs." Y-12 today remains at the forefront of close tolerance measuring techniques and continues to push the technology forward.

An example of the use of the machines Bill mentioned above can be seen in an article published in the July−August 1977 issue of *Optical Engineering* magazine, where the University of Arizona published, "The diamond-turning development program at the Oak Ridge Y-12 Plant is currently involved in the fabrication of copper-plated mirrors for the CO_2 laser fusion experiments being conducted at Los Alamos Scientific Laboratories."

The article continues, “These mirrors—long-radius spheres being fabricated on the Moore diamond-turning lathe and short-focus off-axis parabolas being fabricated on the Excello lathe—must be inspected and certified for figure accuracy prior to delivery.” The article went on to describe the measurement of waviness of the mirrors as being fractions of a micron.

In October 1962, the Cuban Missile Crisis occurred when the Soviet Union attempted to stage missiles in Cuba, threatening the United States. It was in the tense atmosphere surrounding the Cold War and the race to build nuclear weapons that Y-12’s continuous improvements in machining provided the nation and the world a stabilizing situation. Without the huge production capacity of Y-12, our nation might not have had the strong bargaining position required and thus might not have been able to avoid nuclear war during the long and stress-filled Cold War years.

The Alpha-4 COLEX process was shut down at the end of 1962, having produced all the highly enriched lithium-6 needed for the thermonuclear weapons stockpile for the foreseeable future. The AEC reported to Congress in 1963 that “the Oak Ridge Y-12 Plant” had successfully separated the scarce lithium-6 isotope, and the nation now had a large stockpile of that important material.