

## Y-12 advances machine tool accuracy

In 1964 the first Air Bearing Spindle, a totally new concept in holding a part so as to minimize machine vibration and thus increase accuracy, was manufactured at Y-12 for a production tape-controlled turning machine. T. G. Lewis of the E. I. Du Pont Company was the consultant.

From this first prototype, six more with even greater accuracy capabilities were produced. Five were installed at Y-12 and one sent to Rocky Flats, Colorado, to the nuclear weapons manufacturing facility there.

This culminated two years of design and experimental efforts between Du Pont and Y-12 on air bearing spindle technology. According to Ed Bailey (as recorded in Bill Wilcox's *Overview of Y-12 History, 1942–1992*, beginning in 1962, development engineer Dick Sladky learned of Du Pont's experiment using diamond knives, interferometers, and air bearings to solve problems in placement of sprockets for motion picture film.

Even small errors in machining sprockets could result in sufficiently large errors over long lengths of film to cause alignment problems. It was during this experimental work that the use of porous graphite was found to be a good bearing surface. However, adding a thin film of air between the bearing surface and the spindle made an even more effective bearing. It was so much improved that it was called a "super bearing surface."

Du Pont agreed to machine some shapes using materials other than uranium similar to what Y-12 was required to make and to hold the tolerance of a few micro-inches. By 1967 this technology was proven successful and was in routine use at Y-12 for machining weapons parts. It remains a mainstay of such precision machining processes today.

Contracts were placed with Excello and Heald to produce the air bearing spindles to Y-12's specifications. This was the method used to transfer this technology to private industry. Laser interferometers were introduced in product certification applications for making high precision measurements in the micro-inch range.

Here is what Joe Ryan had to say about diamond turning at Y-12, one of the highly precision machining techniques developed in the 1960's.

"My recollections of the Du Pont diamond turning machine are that it was brought into Y-12 in the late 1960's by Leonard Whitten and set up in the G3 development lab of Building 9998. Tommy Lewis of Du Pont and Whitten were the developers of this project.

"The machine was driven by a seamless sheave (belt) from an electric motor at fairly high speeds, 500 rpm or more. The seamless sheave was necessary so that the seam didn't show up in the surface finish of the part.

"The vertical spindle was air bearing and floated on 60 psi of dry, filtered, instrument air. A fixture was mounted on the spindle and the part attached to it by cap screws through a flange from underneath. A diamond knife (tool) was mounted in a rigidly built sweep arm.

"The depth of the cuts were from 50 to 75 millionths of an inch. I recall one part was 20 millionths over, and we went back and got it, that's a 10 millionths depth of cut! The nominal part size was four inches and many aluminum spheres were made to that size with a mirror surface finish. We also made a lot of 1-inch-thick discs of the same size. These were nickel-plated stainless steel. Sometimes a segment was cut from these, so that you had a four-inch segment of the disc with a mirror finish.

“The measuring system was a white light interferometer mounted on air bearing slides. We would master on a four-inch gage block, slide the system to the waist of the part, "0" the fringes and read the difference on an amplifier.

“Temperature is always a prime issue, even though this was in a temperature controlled clean room. Alcohol was used as a coolant for cutting. As it evaporated, the part became colder. We devised a quick connect system into the fixture to circulate 68-degree coolant through the fixture and part to avoid a long normalizing period.

“Ray, this certainly was interesting work and I did enjoy it. Let me add something here. Leonard Whitten, now deceased, was a real gentleman, a pleasure to work with and had one of the three best ‘minds’ that I came in contact with in 35 years at Y-12.”

What Joe describes serves to give some insight into the often technical yet highly practical atmosphere of work at Y-12. Joe’s delight at getting to work in the era of advancing machine tool accuracy has stayed with him all these years. He is not alone when it comes to folks at Y-12 who have had such rewarding careers.