Welcome to* Revolutions*, the column that brings you the latest, most up-to-date and easy-to-read information about the people and technology of the gear industry.* Revolutions *welcomes your submissions. Please send them to* Gear Technology*, P.O. Box 1426, Elk Grove Village, IL 60009, fax (847) 437-6618 or e-mail* people@geartechnology.com. *If you'd like more information about any of the articles that appear, please circle the appropriate number on the Reader Service Card.

New Name for the NASA Lewis Research Center

The place was built in 1941 as a research facility working on aircraft engine design. At that time, the governing authority was the National Advisory Committee for Aeronautics (NACA) and the facility was called the Aircraft Engine Research Laboratory. In 1947, the Cleveland, Ohio, facility was renamed the Flight Propulsion Research Laboratory to mark the expansion of its research activities into flight propulsion. A year later, in September, 1948, the facility was again renamed. This time it became the Lewis Flight Propulsion Laboratory in honor of George W. Lewis, the late director of aeronautical research for the NACA. When NACA was dissolved in 1958, the center was taken over by NASA and renamed the NASA Lewis Research Center. Now, forty-one years later, this historic laboratory has changed its name again. The Cleveland, Ohio facility is now the John H. Glenn Research Center at Lewis Field.

"We are honored that the center will now bear the name of two great men, John Glenn and George Lewis," says center director Donald Campbell. "The blending of names reflects the pioneering research in aerospace technology that employees have performed throughout the center's history, and will continue to perform in the future." Some of that pioneering research is directed toward questions of gear design and manufacture with both military and civilian applications.

There is a great deal of analytical and experimental gear research being conducted in the areas of gear tooth shape, geometry, material, thermal behavior, lubrication, noise and vibration, and manufacturing techniques. This work, which primarily addresses the needs of both the U.S. Army and NASA, emphasizes aeronautical applications such as helicopter transmissions, and is geared toward reducing weight, noise and vibration while maintaining high mechanical efficiency. Some of the research projects at Glenn include investigations into gear crack propagation, studies of gear dynamic forces, and face gear technology for aerospace power transmission.

The name change was the idea of U.S. Senator Mike DeWine (R-OH), who proposed it in the FY 1999 VA-HUD Appropriations Bill last October in recognition of Glenn's contributions to science, space and the State of Ohio.

Glenn was the first American to orbit the Earth, piloting his Mercury-Atlas 6 "Friendship 7" spacecraft through three orbits on February 20, 1962. Part of Glenn's training for that mission took place at Lewis in the Multiple Axis Space Test Inertia Facility (MASTIF), also known as the Gimbal Rig. This was used to teach astronauts how to bring a capsule, tumbling through space, under control. Thirty-six years later, on October 29, 1998, Glenn became the oldest astronaut in history when he returned to space as part of the crew of the space shuttle Discovery (STS-95). During the mission he participated in experiments on the effects of space flight and the aging process.

The designation of the historic site upon which the Center is built as Lewis Field celebrates the legacy of accomplishment and innovation left to us by George W. Lewis (1882-1948). Among a multitude of accomplishments in the fields of aviation and engineering, Lewis became the NACA's first executive officer in 1919. Five years later, in 1924, Lewis was named the NACA's director of aeronautical research, a post he held until 1947.

John Glenn in his space shuttle space suit.

"I cannot think of a better way to pay tribute to two of Ohio's famous names—one an aeronautical researcher and the other an astronaut legend and lawmaker—than by naming a NASA research center after them," says Daniel S. Goldin, the NASA administrator who made the name change official.

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Wormgear Predictions by Computer

Imagine sitting down at your PC and being able to predict the contact patterns and other details vital to the design and manufacture of wormgears quickly and easily. Dr. Michael Fish, formerly of the Department of Mechanical Engineering at Huddersfield University and now a research engineer with Holroyd, created such a program as an offshoot of his research into wormgear transmissions. Holroyd, a subsidiary of Renold PLC and one of the largest manufacturers of screw machined products and precision gearing, is now using Fish's software for analyzing wormgear contact.

Known design parameters and manufacturing settings are fed into the computer. The program then calculates the clearance between engaging tooth flanks and the positioning accuracy (or transmission error) resulting from the given specifications. The analysis can also include influences that will result from the manufacturing process as well as from how the set will be used in its application. Factors such as machining quality, alignment of components and deformation of the contacting surfaces under load can also be taken into account.

The software then generates accurate representations of the final off-load contact conditions that will be achieved using the given parameters. An exact contact-marking pattern illustrating this information can, therefore, be generated beforehand.

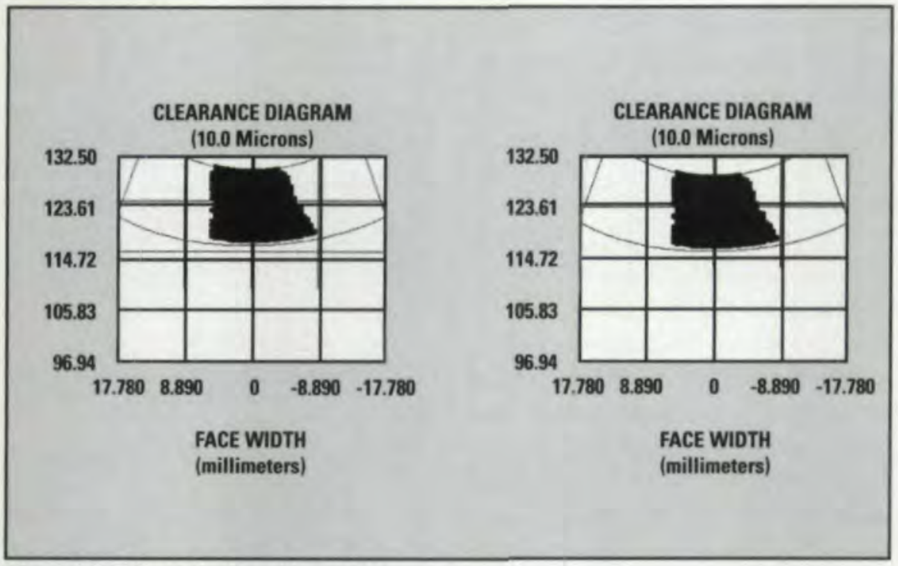

Figure 1 — Theoretical marking pattern.

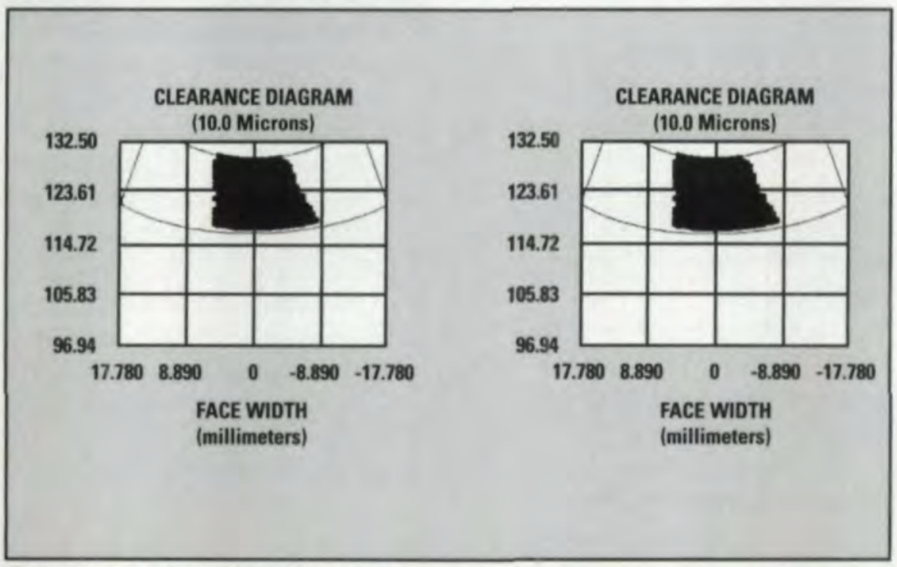

Figure 2 — Synthesized marking pattern.

"We have learned that the dynamic behavior of worms is not as unpredictable as was once believed," says Fish. "Provided that sufficient accurate data is known about the manufacturing process, it is possible to simulate contact to a high degree of accuracy. The new software is enabling Holroyd to identify critical factors in the design and manufacturing process and therefore impose closer controls on the quality of the final product."

This simulated contact pattern for a sample gear set is seen in Figures 1 and 2, which show the theoretical marking pattern for two gear designs and then the synthesized contact pattern generated by the computer, which includes error sources found during the manufacturing process defined as deviations from the theoretical conditions.

The new system enables the required contact conditions to be achieved more quickly than with existing iterative processes, which involve cutting then marking the worm and wheel set, followed by inspection and assessment. Used as an integral part of manufacturing and servicing processes, the software can allow the operator to:

- Give fast analysis of theoretical designs to find the optimum contact conditions.
- Compensate for the effects of manufacturing tolerances on theoretical contact.
- Assess the tolerance of a design to operating conditions.

According to Fish, "The software has the capability of simulating potential sources of variation in contact, which may occur in manufacturing or operation. Such sources include worm thread and wheel tooth surface generation, tooth pitch spacing, axis eccentricity, axis alignment, and component deformation. Adding these elements to theoretical contact conditions can significantly improve the accuracy of the synthesized contact predictions. This is a significant result, as the ability to accurately control quality and performance is critical in most modern customer specifications."

The software also has a troubleshooting role. It can model the changes in linear and angular shaft alignments, which happen during assembly, or which sometimes take the form of slight deflections under load in operating conditions. The gear set design can be modified to compensate for this effect as a result. This gives the option of investigating and removing sources of unacceptable operating errors in existing sets.

Holroyd believes that this new program has far reaching implications for the gear industry in that it represents a significant tool with which to quickly release the expertise held within the company. The operator can draw on existing working design and manufacturing knowledge, which recognizes criteria necessary for any intended application, and then apply this through the software to produce an optimum design.

When asked if Holroyd would be marketing this software, Fish said, "There are no plans to market the software, as it is essentially a tool to be used by a qualified worm gear designer. Output data can only be utilized through experience, and the knowledge of what represents a satisfactory result is still dependent upon the operator. Since there are so many factors that determine suitability, it is essential to keep the human element when entering design data."

Holroyd sees the development of this program, as well as its overall software development efforts, as essential parts of the company's drive toward higher quality products produced more efficiently and cost-effectively. According to Fish, "A better understanding of contact will enable maximum product suitability for any given application. Proven applied knowledge for customer benefit and reduced delivery times will consequently increase demand." ✪

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