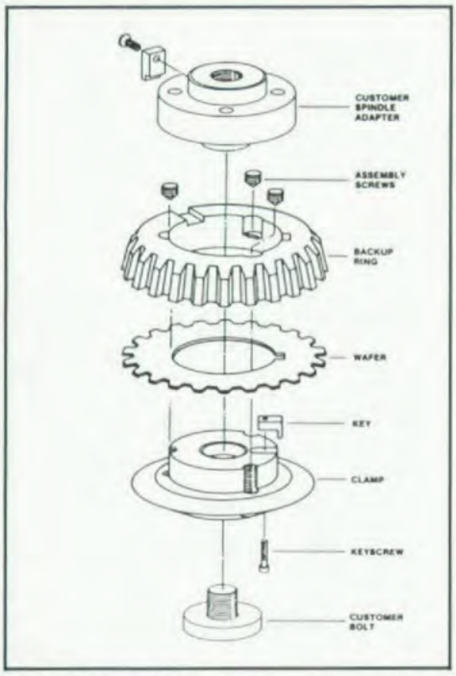

Fig. 1 – Exploded view of wafer cutter assembly.

The Wafer Shaper Cutter

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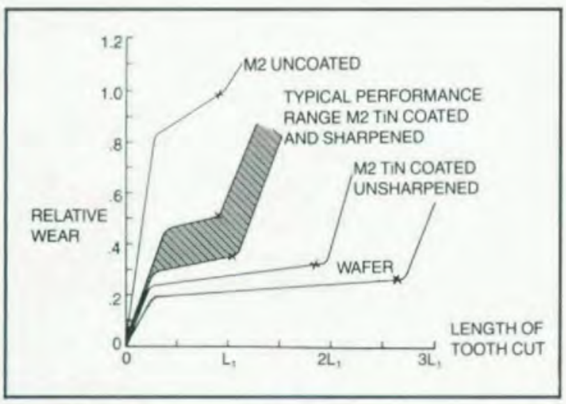

Fig. 2 – Comparison of wear characteristics of uncoated, coated and sharpened, and completely coated shaper cutters to a wafer shaper cutter.

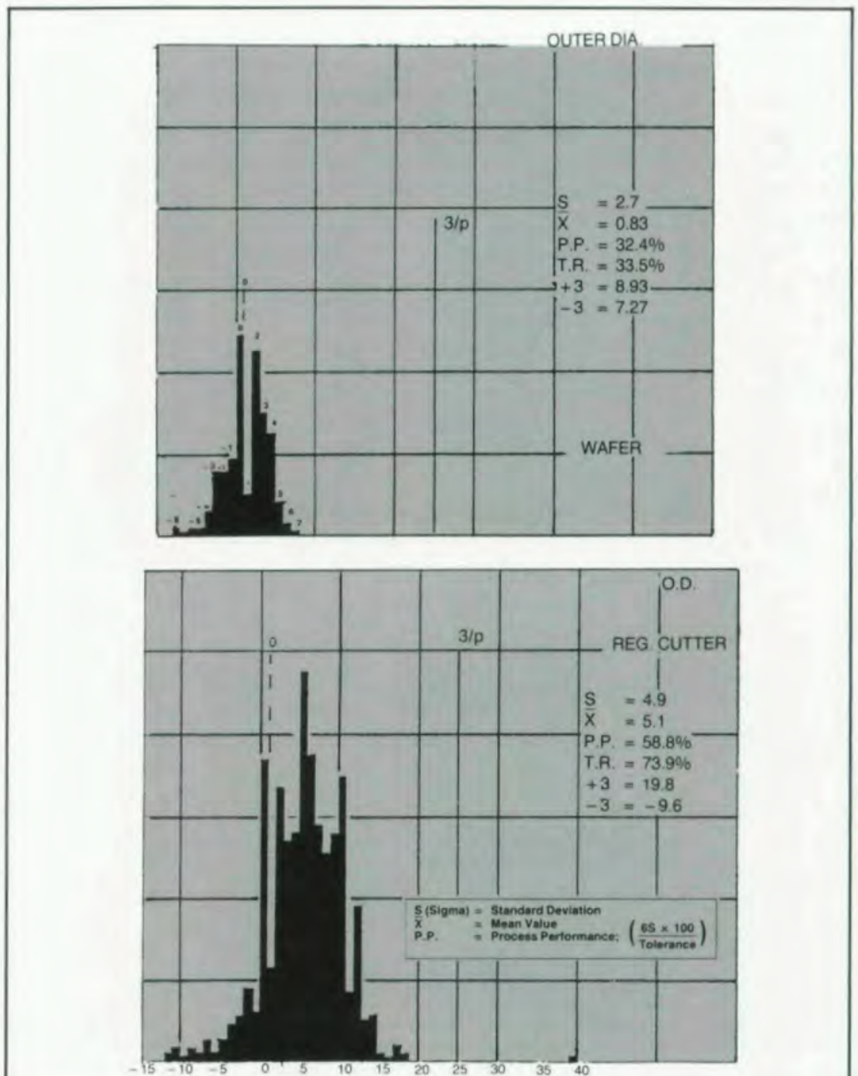

Fig. 3 – OD variation of shaped parts during the life of one wafer and during the life of a conventional shaper cutter.

In 1985 a new tooling concept for high volume gear production was introduced to the gear manufacturing industry. Since then this tool, the wafer shaper cutter, has proven itself in scores of applications as a cost-effective, consistent producer of superior quality parts. This report examines the first high-production installation at the plant of a major automotive supplier, where a line of twenty shapers is producing timing chain sprockets.

What is a Wafer Shaper Cutter?

It is a shaper cutting tool assembly, (Fig. 1) which directly replaces a conventional shaper cutter. One of its main features is that it does not have to be resharpened when worn. Rather, its cutting face is reconstituted to its original accuracy by replacement of a gear-like cutting wafer; consequently, tool mainte-

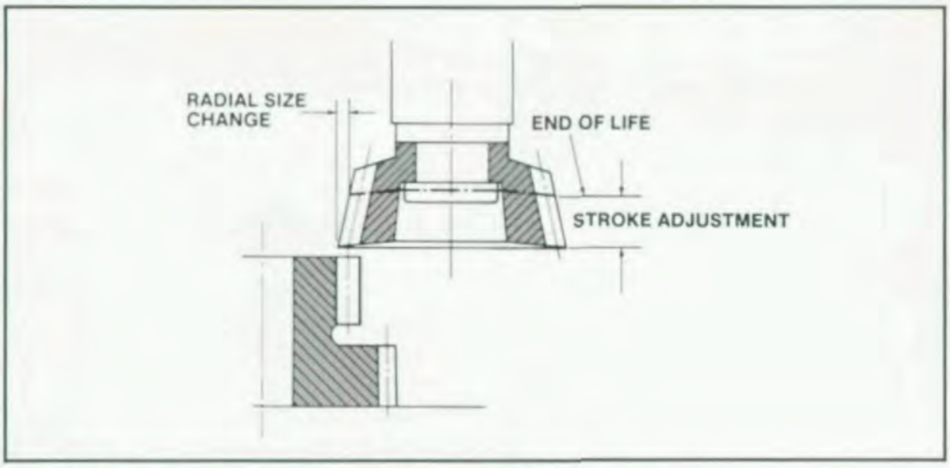

Fig. 4 – Adjustment requirements in the use of conventional shaper cutters.

Fig. 6 – Easy assembly and disassembly using three screws.

Fig. 5 – Reblading area in clean environment.

nance costs are reduced and sharpening errors are eliminated. In other words, the quality of the tooth cutting edge remains the ongoing responsibility of the tool supplier.

While the geometry of conventional shaper cutters has always been a compromise between tool sharpening life and cutting clearances, no such restrictions apply to the design of cutting wafers. This latitude permits the development of the optimum wafer tooth geometry with the most favorable cutting clearance angles tailored to every specific application.

Another reason for the superior wear characteristics of wafers is the titanium nitride (TiN) coating, which is applied to all the cutting surfaces and which has to meet stringent adherence and thickness specifications.

It is this combination of premium coating, optimum tooth geometry and cutting edge preparation, which enables a wafer shaper cutter to outperform even a new, completely coated conventional shaper cutter. It is common knowledge, of course, that a further tool life decrease occurs once the conventional cutter has been sharpened and the TiN coating has been removed from the cutting face. (Fig. 2)

The wafer material is M2 high speed steel, hardened to 64-66 Rc. Tests have shown that using premium high speed steels is of little benefit, since the superior wafer performance is the result of the TiN coating applied to all the cutting surfaces. The typical cratering wear, prevalent on the cutting face of sharpened shaper cutters, is either eliminated or greatly inhibited on wafer cutters through the high hardness and the low coefficient of friction of the TiN coating.

Part Quality

The original wafer shaper cutter development was based on the assumption that the elimination of sharpening and the increased tool life were going to be the two major benefits the new tool had to offer. The results after extensive testing lead to the conclusion, however, that consistent and improved part quality and the elimination of scrap are the most important factors for wafer cutter justification.

Statistical process control (SPC) studies have shown that wafer tools consistently produce parts with smaller deviations within the statistical population than do conventional tools. (Fig. 3)

There are many reasons. One is the tight size tolerance and accuracy to which all wafers are manufactured. There are no tool diameter and tooth profile variations, as is the case within the sharpening life of conventional cutters, and there are no sharpening errors.

A second reason is the elimination of all machine adjustments, which are usually required after a conventional cutter has been sharpened, and which traditionally have been a major source for part variations and scrap. (Fig. 4) In this first production application the fact has been substantiated that once a job is set up, wafer tools produce the correct part size on an ongoing basis. There is no longer any downtime for part qualification, usually required after the change of a conventional cutter.

Economics

Before this first production line was committed to wafer shaper cutters, extensive cost, SPC and method studies were conducted during a pilot program. Over a four month period it was documented that the wafer shaper cutter would

- reduce tool costs by 39%
- reduce scrap by 70%
- reduce manpower in the shaping department by 60%
- save 4 man-hours per day by eliminating the sharpening operation.

One of the major underlying factors for these savings is the increased machine uptime brought about by fewer tool changes. While a conventional cutter yields 250 sprockets per sharpening, a wafer cutter at the same speed and feed rates on the average produces 1200 parts before it has to be replaced.

Producing Superior Quality and Meeting Production Requirements Through a Systematic Tool Maintenance Procedure.

Soon after the pilot program was initiated at this production facility, it became evident that the reblading operation of the wafer tools was incompatible with the hostile environment of the shop floor. After all, the purpose of remounting a new wafer is to reconstitute the tool to its original accuracy, which is difficult to guarantee in an area where contamination with chips and cutting fluids is a real possibility. For this reason, a reblading station was set up in the area of the inspection lab. Here wafer cutter assemblies ready for reblading were throughly washed, disassembled and then rebladed with a new wafer. (Figs. 5 & 6) Each assembly was then checked to verify proper mounting and seating of the wafer. A ball check was routinely performed to document wafer runout before the cutter assembly was returned to the production floor; thus, assuring the operator that all tools would produce quality parts from the first to the last piece without any machine adjustments.

Range of Application

To date the wafer shaper cutter is being successfully used in a wide range of applications up to 5DP, both for internal and external gears and splines. Non-involute forms benefit particularly from the consistently accurate tool geometry of the wafer, which is always compromised with conventional shaper cutters, since they are designed to accommodate the maximum usable cutter life. Helical applications with helix angles of 20° and above are being developed and are under test in selected production applications. Economics studies are also being conducted to establish the most efficient use of wafer tools. They are being applied more aggressively with higher feeds and speeds, thus realizing lower machining cycles and lower machine costs. Based on present production results, we predict that the wafer shaper cutter will evolve as the gear cutting tool of the future, providing both superior quality and economy in high volume production. ■

AUTHOR:

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