



# gear tooth honing: Economical and Flexible

**T**he need to increase operational efficiencies is a daily requirement in the highly competitive global automotive manufacturing environment. This is clearly seen at the transmission development and manufacturing facilities of Getrag Ford Transmissions in Köln, Germany, and Halewood, England. At those factories, high volume production is required, but so is flexibility.

Originally, the Köln plant was set up as a high-volume, fully automated manufacturer. However, the increasing size of the Getrag Ford customer base—Ford, Jaguar, Mazda and Volvo, to name a few—along with ever-changing volumes and product mixes between five- and six-speed manual transmissions as well as automatic transmissions create the need for greater flexibility.

Today, Getrag Ford's plants in Halewood and Köln are set up in manufacturing cells to make transmissions in smaller volumes—approximately 50,000 units per year. But getting to that point required changes in philosophy as well as machining processes to allow Getrag Ford to manufacture a spectrum of parts with up to four part changeovers daily.

## A New Direction for Flexible Shop Floor Manufacturing

Because flexible manufacturing presented a new challenge to Getrag Ford, the company was willing to try new concepts. After extensive studies of the possible manufacturing methods, the specialists at Getrag Ford decided to test and implement a new combination of shop floor processes—modern CNC gear shaping and gear honing—to replace the processes that had been in place—gear hobbing and gear shaving. In order to test this new strategy, the concept was implemented in both the Köln and Halewood facilities.

As it turned out, one gear shaping machine and one Präwema precision gear honing machine were sufficient to produce the 14 different gears of the MT82 six-speed transmission, a manual transmission used on Ford rear-wheel-drive light trucks and minivans, such as the Ford Transit vehicles.

The gear shaping and honing machines allowed similar flexibility in Köln, where they are being used to manufacture the MMT6 six-speed manual transmission for front-wheel-drive vehicles such as the Ford Mondeo.

According to Dr.-Eng. Christoph Schulte, leader of the gear research department at Getrag Ford, "This is revolutionary."

"The technology provides the quietest gears possible, excellent surface finish with increased residual stresses, making the gears much more resistant to pitting and premature failure," says Scott Knoy, vice president of sales for American Wera, which represents Präwema in the United States.

Knoy adds that the cycle times and costs of gear honing are equivalent to gear shaving, but honing produces a higher quality gear.

Choosing this course of action was a relatively high-risk proposition for Getrag Ford, considering the tenacity of today's global competition. In the current market, the basic prerequisite for a partner is 24-hour service with guaranteed product reliability.

Despite those demands, there have been no significant problems since the installation of these processes in January 2004, according to Schulte.

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In fact, the new setup has piqued the interest of many potential customers. According to a Getrag Ford spokesman, the combination of shaping and gear honing enables the company to have a tighter control on delivery and allows it to be more competitive in the world market, even with a product being manufactured in high-cost countries like England and Germany.

#### A Direct Comparison Proves the Point

Schulte says he is generally reserved in the comparison of different gear production processes. All relevant technical criteria have to be taken into consideration. Those criteria include the amount of material removed, production quality and manufacturing-induced deviations, tooling costs, personnel costs, machining costs and scrap costs.

Keeping all that in mind, Schulte says, “The modern gear shaping and honing processes—carried out as individual stepped processes—are comparable on the cost side to the costs of conventional shaping [alone]. Chiefly, the high precision Präwema honing process makes for a very logical compromise between quality and cost. The Präwema honing machines’ remarkably high process stability and robustness of the machine construction provide a convincing argument for this case.”



Getrag Ford sees high precision honing as the most economical hard gear finishing process available at this time, as evidenced by the increasing number of parts being honed at Köln and Halewood.

One of the keys to achieving high quality with honed gear teeth is the quality of the incoming part. At Getrag Ford, flank-form modifications generated by the gear shaping process are controlled by statistical process control (SPC).

Josef Siebler, Präwema sales director, sees the advantage in the details: "The high quality of the incoming gears relative to the bore and the faces are essential and can improve the overall quality that can be achieved by the Präwema honing process."

Currently, Getrag Ford is working to improve even further the surface finish of the gear flanks in the shaping process. As they do so, Getrag Ford engineers expect shorter cycle times for the Präwema honing machines and a marked decrease in tooling costs, making the company even more competitive, Siebler says.

#### Training and Process Efficiency are Key

Since honing is a completely new manufacturing strategy for Getrag Ford, the company requires even greater expertise out of its workforce. "Our new manufacturing strategy will demand more qualified personnel to obtain optimal process capacity," Schulte says. "It is necessary in the manufacturing planning, for the plants in England and Germany, to place a greater emphasis on the training of the workforce. In addition to process training, we have identified plant layout, logistics and automation planning as areas where future training needs to take place."

Another area where training and expertise come into play is automation. The optimization of part-to-part changeover times and standardization of tooling take high priority in automation. The workforce in Köln has amazed the engineers at Präwema with a number of good ideas for process improvement, Siebler says. Examples of this ingenuity include the error-proofing of incoming parts using a sheet metal profile gage and combining the diamond dressing gear and diamond dressing roll into a single tool.

The transmission specialists in Köln have relied on support from Präwema and its tooling partner, Tyrolit-Reineke, to continue improving the productivity of this new manufacturing concept. With the help of these experts, Getrag Ford has been able to shorten the average process times for honing parts. Improvements made to the original system have included a faster Indramat CNC controller, the use of linear motors in the X, C, B and Z axes and software designed to identify the shortest possible axial travel distances.

Furthermore, Tyrolit-Reineke has developed a dressable ceramic tool for the Präwema honing machine that makes it possible to shorten the cycle time per part an additional 8–11 seconds.

Combined with the improvements mentioned above, this has allowed Getrag Ford's average cycle time to be reduced from 60 seconds to 30 seconds during the time period from 1999–2005.

Despite these improvements, the expectations of engineers and management at Getrag Ford Transmissions are high, and they are convinced that there are many more possibilities for process optimization. ■

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