ARTIS Monitoring and Control System

OFFERS THE LATEST IN HOBBING PRODUCTIVITY

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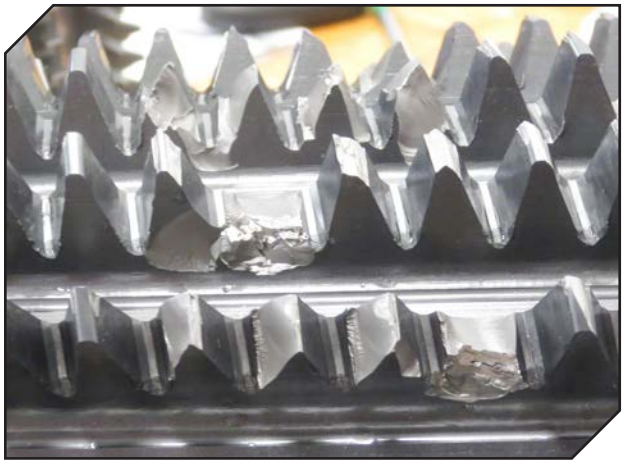
A modern six- or eight-speed automatic transmission can contain 25 or more precision gears, a fact that makes hobbing a prime target for productivity-improving technologies. For some perspective, a well-known transmission builder produces one million transmissions annually for two lines of luxury automobiles. The eight-speed gearbox contains four planet wheel sets containing a total of 25 gears in two sizes.



The larger gears are hobbed in 40 seconds while the smaller are produced in 4.3 seconds. Advances in tooling and machine technology have quadrupled the productivity of these operations in the last 10 years.

But that performance comes at a price. Today's hobbing tools are considerably more expensive than those of 10 years ago, so users need to optimize the process to achieve the greatest possible number of parts per tool before re-sharpening. Of equal or greater concern, however, is the need to avoid breaking these costly tools.

Traditionally, manufacturers have relied on "rule of thumb" guidelines and hob supplier's expected tool life recommendations to avoid catastrophic failures. But, this approach works by building in extremely conservative safety margins at the expense of productivity, and is paid for in unnecessary machine downtime for tool changes, unnecessary tool maintenance costs and parts not made.

The solution is a process monitoring system with the ability to detect and track tool wear, account for workpiece variations without generating false alarms and instantly stop the process in case of chip welding, damaged or broken teeth, or other conditions such as peeling coatings. Since an individual hob may be re-sharpened up to 15 times, and each re-sharpening changes its diameter and, therefore, its operating parameters, the monitoring system also needs to be self- calibrating to accommodate this factor.

Various attempts have been made to adapt existing process monitoring technologies to hobbing operations, but due to the complexity of the process none have been completely satisfactory. Based on a track record of successful monitoring solutions for other processes, ARTIS—a Marposs company— worked in cooperation with a major transmission builder to develop a hobbing-specific application that would allow the user to achieve maximum output along with maximum tool life.

The project began by collecting real-world data from operating hobbing machines in the customer's plant. The end result was an algorithm representing the life cycle of a hobbing tool that can be used to identify the optimum time to take it out of service for re-sharpening based on its actual condition.

ARTIS then created a system of machine-mounted sensors to monitor process parameters including spindle torque, spindle vibration, power consumption and a number of others depending on the specific application. Using these inputs the system then captures the exact signature of each operation in the process and automatically generates a "good" tolerance band for the process based on that signature.

While the concept of monitoring process inputs is not unique, the ARTIS system couples it with powerful software specifically designed to detect the exact kinds of anomalies produced by worn and/or damaged hobs. This data was generated during the in-plant monitoring project which revealed that normal wear, welded chips, peeling coatings and broken teeth all generated distinct signatures before and during the ultimate failure of the tool.

The software can identify and quantify each of these signatures to generate either an approaching end of life warning for normal wear, or an automatic machine stop in case of actual tool damage. In the case of normal wear, the ARTIS system notifies with ample time to schedule the downtime required to minimize the impact on production.

Another unique aspect of the system is the ability to detect and automatically compensate for tool diameter changes after re-sharpening. This is very important in a high-volume environment where individual tools may be used on different machines before and after re-sharpening. A smaller diameter tool changes the operation's power consumption, so the ability to detect diameter changes and re-calculate the optimum process signature without re-mastering the tool eliminates a great deal of machine downtime.

On the test machine, the ARTIS system resulted in a 17-percent increase in tool life without changing any of the process parameters. The increase represents the difference between tool changes based on "rules of thumb" or arbitrary part counts, and tool changes based on actual tool condition as reported by the monitoring system.

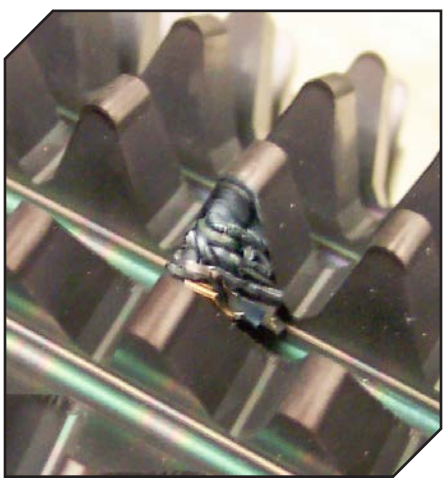
During the testing, this customer used the data generated to identify and optimize the coating used on the hobbing tools. While not a direct benefit of the ARTIS system per se, the coating selected on the basis of the process data delivered a 60 percent increase in tool life, an increase that almost certainly would not

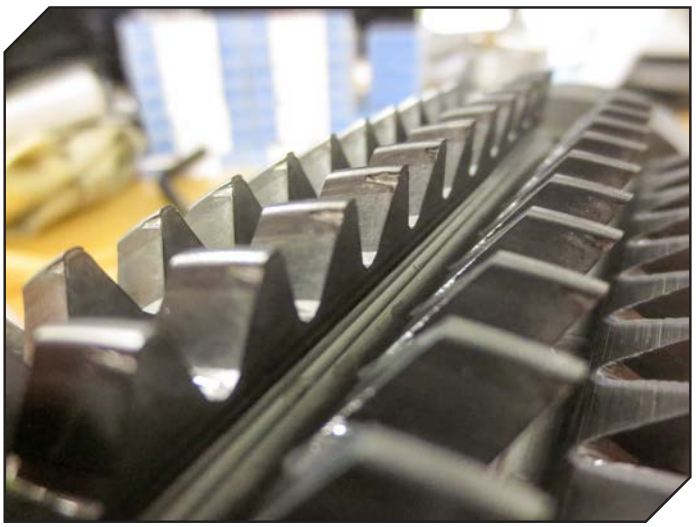
have happened had the data not been available.

In another application, a gear manufacturer reported that their ARTIS system, which had been running for some time without incident, suddenly began triggering alarms, but the hobs showed no signs of wear or damage when inspected. As the manufacturer was preparing to call for service on the ARTIS system, the hob head bearings failed and the machine was immediately taken out of production. The customer credits the ARTIS system for minimizing both repair cost and downtime by allowing them to react promptly to the bearing failure predicted by the repeated alarms.

It is important to note that the initial ARTIS system described here was developed in cooperation with a customer for a specific set of application parameters for gears with a module of 14 or less. Since that customer used only Siemens CNCs and Liebherr hobbing machines, the ARTIS application was developed for that specific combination.

Software with the ARTIS CTM-FP-Gear Hobbing option can be integrated into Siemens 840D controls and is also is available pre-installed in the control. The ability to automatically compensate for tool diameter changes after re-sharpening, and the adaptive control constraint of the feed rate where cycle time can be reduced automatically, are currently available only with Liebherr gear hobbing machine tools.





However, the ARTIS software has also been added to other control systems such as Fanuc via a dedicated PC and control interface. The Artis monitoring components can be applied to virtually any new or existing hobbing machine including those from Liebherr, Gleason Pfauter, Felsomat, MAG-Samutensili, Kashifuji and Mitsubishi, and many others.

ARTIS software is available for soft material applications on gears with module up to 100 and cutting times up to a few hours. All implementations are application specific. Better tools, more capable machines, and improved controls have quadrupled the productivity of the hobbing process in the last decade, just in time to meet the growing demand for precision gears in the transportation and other industries. Now, real-time monitoring and control systems are ready to help gear makers set even higher benchmarks for productivity and quality from the equipment that's already on their production floor.

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