NEW TECHNOLOGIES PAY MAJOR DIVIDENDS
Machine designs focusing on mass production, batch and small-lot processing, as well as providing ‘Closed Loop’ feedback increase throughput and improve the quality of the finished part.

By BILL MILLER

In order that productivity can be realized, gear producers need systems designed for simplifying and automating common tasks so that less experienced workers can perform reliably. This article outlines the strides made in simplifying and automating tasks for generating grinding. This includes:

- Exchange of tooling such as abrasive, dresser and clamping arbor.
- Quality maintenance.
- First time and repeat setup.

Gear grinding times continue their evolutionary improvements through faster direct drive spindles, abrasives designed for high material removal rates and machine designs with twin work spindles (Chart 1).

However, nowadays elements of non-grinding time represent more significant opportunities for most gear producers. Today, the intelligent gear grinding machine has more than just advanced software and an intuitive user interface.

Features to effect complex modifications have been a main frontier the last decade and hence significant mathematical calculations and control software differentiate the leaders from other suppliers. Parallel development to simplify the non-grinding time is a technology requiring advanced machine design. This is a strength and mission of Kapp Niles. Kapp Niles introduced entirely new models specifically to meet the demands addressing these opportunities. The “Dynamic” series is one example of this effort. The concept is primarily for mass production passenger car gears coupled to internal combustion engines as well as electric drives. The workpiece scope includes planet systems and final drive gears up to 260 mm diameter.

One innovative feature is fully automatic exchange of the clamping arbors enabled by an overhead spindle which has a vertical stroke axis (Figure 1).

The onboard probe then measures the accuracy of the arbor to verify the mounting (Figure 2).

This feature requires no tools so pays dividends by allowing less experienced workers to exchange arbors with precision. An RFID system assures the arbor and other tools are correct for the part number (Figure 3).

Kapp worm dressing tools are mounted on an expanding arbor so mounting precision is simply assured when the arbor is expanded with a simple T-wrench. The abrasive grinding worm is pre-installed on a flange with RFID identification of the tool number. Exchanging the tool is virtually automated after placing the tool in a cradle and rotating to load position (Figure 4).

The RFID system in addition assures the data is correct for achieving tooth size. After grinding the first part, the on-board probe can check a single tooth in 30 seconds and determine if the profile result is within specified limits. A correction is calculated and implemented if acknowledged on the touchscreen of the HMI. Although the KX100 and KX260 Dynamic machines are for mass production, these intelligent gear grinders also pay dividends when an alternate gear must be ground on the same machine. Complete setup is accomplished in less than 20 minutes.

The normal daily tasks are handled simply with the same advanced features described, which results in
fewer chances for errors and a higher operating efficiency (Figure 5). Maintaining profile quality in continuous production is also now practical with the latest probe and software. Through innovation, technology simply pays dividends.

**SMALL LOT OR BATCH PRODUCTION APPLICATIONS**

While mass production is a large business, those machines are not optimum for other applications or customers. Kapp Niles serves all branches of the gear market and offers many sector specific machines such as for industrial gear boxes, machinery, and aerospace. The new KNe3G is such a solution for typically small lot commercial gear production for up to 320mm diameter gears (Figure 6).

This technology simply pays dividends by incorporating basic functions necessary for simple and reliable operation but without twin spindles for mass production described above in the Dynamic series. There is significant investment savings that is welcomed by customers, especially those replacing very old, slow grinding machines and by companies entering grinding for the first time. The spindles, overall construction, and software assure maximum grinding speed with multi-thread worms.

Dressing technology is available, as on our widely proclaimed
KX300P series even including the option for topological dressing for infinite profile modifications. On-board inspection is included with full capabilities as on other Kapp Niles machines (Figures 7-8).

An innovation introduced with the KNe3G is a touch screen enabled HMI that is more intuitive especially for less experienced (and younger) workers. Think smart phone. Tasks that previously required a keypad or soft keys are replaced by touch and drag gestures, and an on-screen keypad pops up when a data field is touched (Figure 9). Numerical variables and modification amounts are entered into the on-screen pop-up keypad upon touch.

Further enhancements of the machine intelligence include common tooth modifications that can be selected by touch of an image, for example. More checks for correct input values and reader-friendly messages make it quickly usable by less skilled workers (Figure 10).

When setup time is reduced substantially to a fraction of the lot size production time, robot loading normally pays dividends; however, it is seldom implemented due to cost and integration challenges. A simple secondary door with common robot interface allows integration to be done simply and locally (Chart 2).

**QUALITY CONTROL**

The most popular and demanded topic in our gear schools is the ability to interpret and determine a corrective action when quality is not to specifications. Technology introduces a feature that enables a feed-
back “closed loop” between the grinding machine and the analytical check from the measurement lab. It is not a revolutionary idea as calculations for correction are simple when considering each characteristic individually such as helix and profile angle, helix crown and bias. These corrections are calculated from on-board measurements but of course the lab measurement is more precise.

This serves to shorten setup time by aiding the technician towards the correct parameters (Figure 11).

Experience tells us that grinding gears still requires monitoring of the process and quality, especially as normal process variables begin influencing the stable process. Machine, arbor, tool, and dresser condition will each present a signature result. Gear stock removal and hardness may degrade the abrasive prematurely. The real world doesn’t usually present a single variable cause of quality deviations. It is frequently multiple variables that have a compound effect. In repetitive gear production, the closed loop system would more quickly interrupt production. The effectiveness of such a closed loop would have to be judged on a case by case basis.

**SUMMARY**

- New machine designs for mass production incorporate electro-mechanical features previously unavailable for gear grinding machines, for example to automate arbor changing and eliminate the need for hand tools and manual indicators.
- New machine designs for batch and small lot production provide compact high-performance solutions that simplify the setup and management of the process in part through a touch screen enabled intuitive HMI for faster and more reliable setup.
- “Closed Loop” feedback from gear measuring devices is a technology shortening the time to first good piece and especially helpful to less experienced technicians and process managers. Production quality control will benefit as complex contributions to errors can be determined by calculation.

**Figure 11:** Corrections screen on the HMI.

**About the Author**

Bill Miller is VP Sales with Kapp Technologies. Learn more at www.kapp-niles.com.