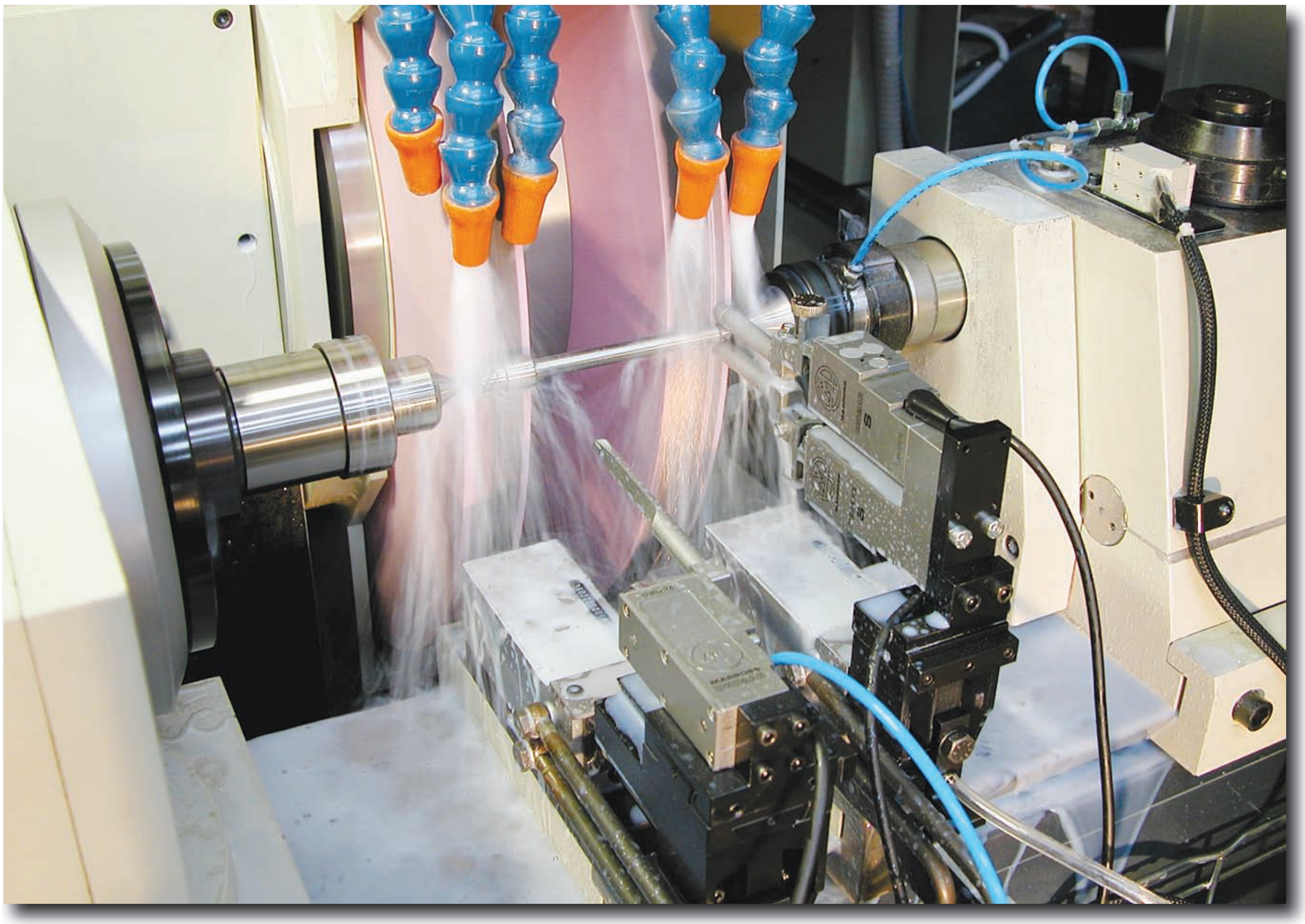
Reprinted from the November 2010 Editions of

SW SOUTHWEST · SE SOUTHEAST · NE NORTHEAST · MW MIDWEST

MANUFACTURING NEWS

Practical Applications Of Automated Precision Part Manufacturing Using Process Control Technologie



Two Unimar-S gauges are employed for in-process gauging of a family of cylindrical parts. A third Unimar-S gauge installed on the O.D. grinder is used to locate the part prior to starting the grinding cycle.

Cost reduction has been the primary driver for manufacturing automation applications for as long as those applications have been available. That is not to say that collateral benefits such as improved quality aren't important, but the fact is that if automation did not reduce costs there would be a lot less of it used.

One of the unintended consequences of widespread automation is the relative ease with which many repetitive machining and assembly tasks have been offshored to areas of the world with less sophisticated infrastructure and much lower labor costs. As companies work their way up the manufacturing food chain to increasingly precise parts, however, the "automate and offshore" strategy often runs into some serious problems.

There is a huge difference between automating a simple "plus or minus a couple of thousandths" machining operation, and a sophisticated "plus or minus a fraction of a micron" application. Many manufacturers discovered just how much difference there is when the offshored "precision" parts started showing up in their products.

That left them caught between the proverbial rock of high onshore manufacturing costs and the hard place of unacceptable product quality. The situation is made even more difficult in the current economic environment where capital expenditures are difficult to justify and even harder to fund.

Frankly, it's no accident that precision manufacturing operations historically have tended to incorporate a lot of manual functions performed by skilled operators. Until quite recently machine tools, material handling systems, and process control technologies simply have not been up to the job of efficiently automating high precision manufacturing operations.

That's changing very quickly, however, with new generations of machine tools and material handling systems being coupled with advanced gauging and control technologies to produce precision components with significantly less manpower. We can see the leading edge of what promises to be a trend toward on-shoring of precision part manufacturing in a range of industries including hydraulics, fuel controls, automotive, over-the-road diesel, aerospace, and even medical devices.

For example, a large domestic hydraulics company had offshored production of one of their lines of hydraulic motors, and almost immediately began experiencing product quality "challenges". After making the decision to bring production of a critical steel shaft "home," the company invested in a new machining line for the shaft. At the same time, they created a second line using existing machines with added automation and gauging.

The goal was to be able to grind the high-precision shafts in batches of one, with minimal part-to-part changeover time. Each line includes two OD grinders, a plunge grinder, a peel grinder, a centering machine, material handling automation, and a full complement of in-process, inter-operation, and post-process gauges.

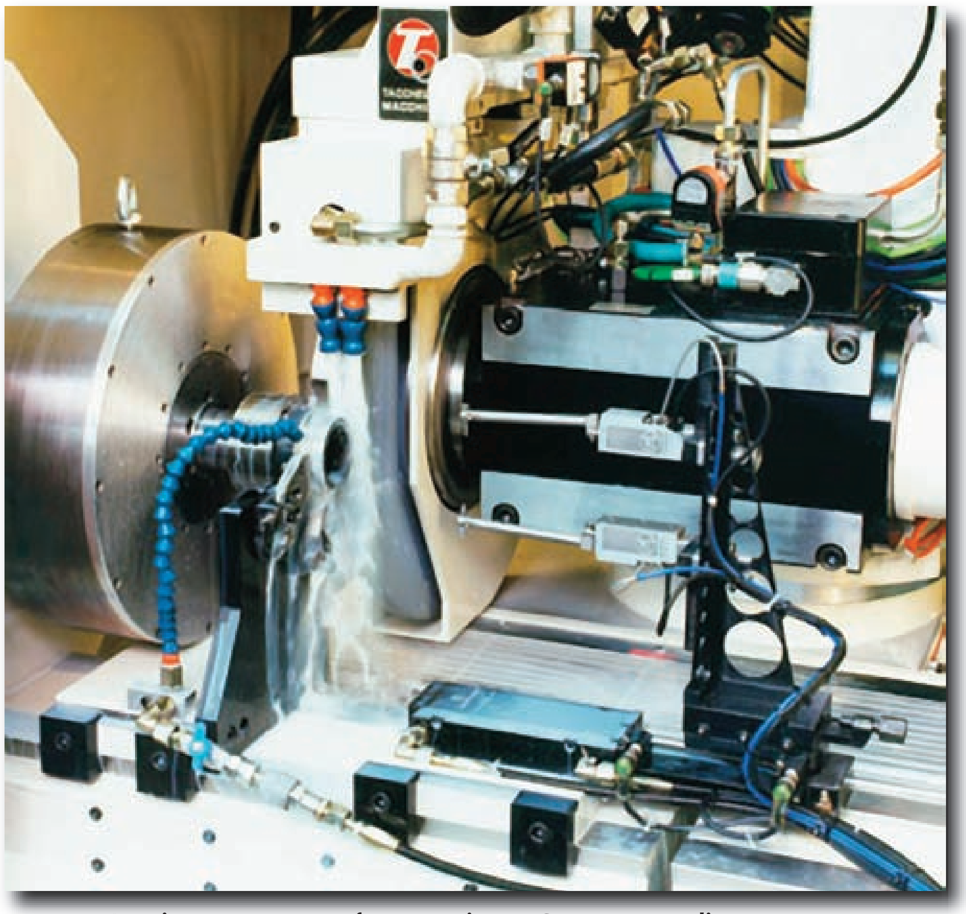
In operation, both lines meet the customer's goal of producing 128 different part numbers in batches of one as needed. The parts range in diameter from 1.063" to 1.312" and in length from 3.077" to 3.268" Total tolerance is plus or minus 0.0002" and both lines run at 1.67 CpK consistently.

Operations performed include a plunge OD grind controlled by a Marposs Unimar in-process gauge, and a peel grind after which the part is checked by a Marposs Unimar post process gauge that is mounted on the machine. After the grinding processes, the part is placed into a Marposs M57 automatic post process gauge which checks all of the processed features of the part and guarantees parts that may be out of tolerance do not go to the assembly area and maintains the SPC data independently on each part run. The Unimar and M-57 gauges were selected for this application primarily because their wide measuring range supported the goal of minimal part-to-part downtime while delivering the necessary precision and robustness to function in the in-process and on-machine environment.

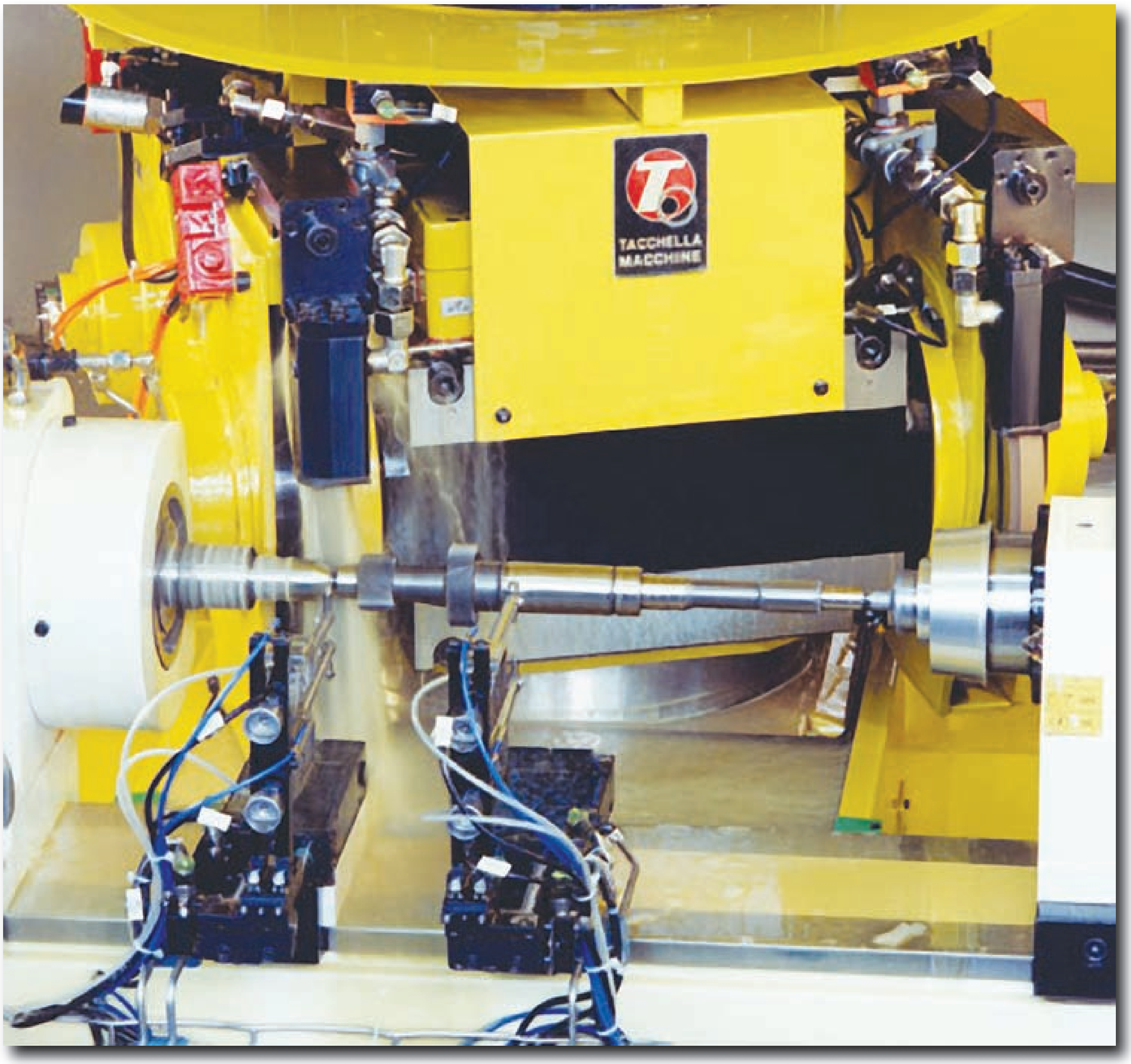
The grinders are equipped with Marposs P7ME amplifiers to process the gauge data and interface with the grinder's Fanuc controls. The Marposs M57 post-process gauge performs the final part inspection. This gauge also provides compensation data to the grinder controls based on finished part dimensional trends.

Part programs and gauge set-ups are stored in memory and called up by the machine and automation controls as required. Cycle time is 15-seconds per part.

The manufacturer reports a 40% reduction in overall production costs in-



A Unimar gauge set up for measuring an O.D. on a coupling type part. The gauge is mounted on a slide that advances the gauge prior to beginning the grinding cycle. The gauge is then retracted following the grinding cycle to permit unloading and loading the parts.



Two Unimar in-process gauges are used on this twin spindle O.D. grinder for controlling size in grinding of shaft type parts. Contacts on the gauges can be easily adjusted to accommodate measuring parts from 8 to 131 mm diameter.

cluding a manpower reduction from the previous 30 operators per line to two. The cost savings paid for both lines within six months, and the parts are now Made in the USA.

The really interesting aspect of this application is not the productivity of the new equipment, that's hardly a surprise, but rather the fact that the customer's existing equipment could be equally productive when equipped with modern process control technology. Here is another example of what can be accomplished.

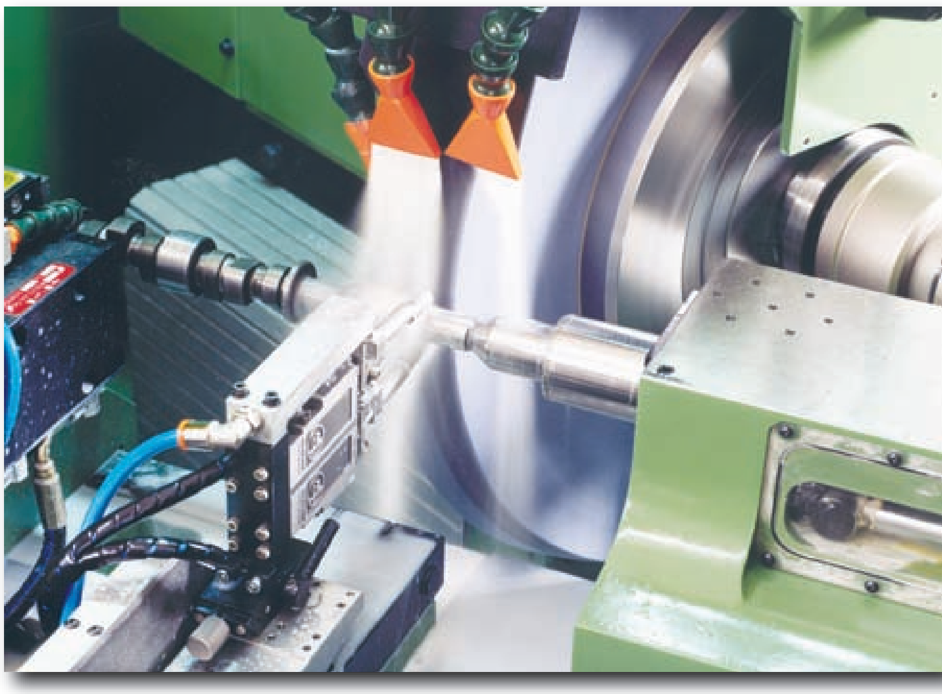
A competitive hydraulic pump manufacturer produces a family of parts on a Weldon AGN4 grinder. The parts range in size from 4.5 to 8.75 inches and are typically produced in batches of less than 50. Tolerance on the part is plus or minus 0.005-in., but the customer could no longer hold that while meeting cycle time requirements with the aging Weldon machine.

Rather than invest in a new machine, the customer chose to install a Marposs Unimar S26 in-process gauge on a quick-adjusting bracket and an E9 gauging amplifier on the existing machine. A simple relay-based I/O device interfaces the gauge with the machine's Fanuc control which was modified to accept gauge data inputs. For a fraction of the price of a new machine, the Weldon is now meeting both quality and cycle time goals while delivering an overall part cost reduction.

In-process gauging plays a key role in both of these applications, but it isn't always the best solution to a productivity problem. Sometimes it's better to take the gauge off of the grinder. Here's an example.

A small engine manufacturer match grinds a pair of features on a crankshaft. The challenge here was to reduce cycle time to improve productivity and lower cost.

The original set-up used a Marposs Unimar S26 in-process gauge to both locate a critical dimension used to position the part prior to the grinding cycle and then to control the grinding operation. Doing the pre-measurement on the machine significantly increased the cycle time for the process.



Unimar gauges are designed to function flawlessly in the grinding hostile environment. In this photo, a Unimar in-process gauge is applied to an angle head O.D. grinder for controlling size on shaft type parts. The machine also incorporates a Marposs automatic wheel balancing system.

The solution was to pre-measure the part with a second Unimar S26 gauge before it's loaded using a fixture that duplicates the machine's tooling. This allows the grinding wheel to be pre-positioned before the part is loaded, removing the traverse time from the machining cycle. This cuts the time spent moving the wheel into contact with the workpiece to an absolute minimum, while eliminating the danger of a crash.

Each of the gauges is equipped with a Marposs P7 amplifier. Communication between the positioning gauge, machine control, and in-process gauge is fully automated, and the parasitic time spent positioning the part is eliminated. No special control software or grinder modifications were required, and the grinder itself remained in the standard configuration.

This solution was initially implemented on a new grinding line, and then duplicated on an existing line to improve its productivity.

A similar approach has been used successfully by bearing manufacturers to cut cycle times in match grinding operations. Most bearings are ground on shoe-type grinders which support the OD of the race with pads resembling those used on a steadyrest. Variations in the OD can move the centerline, so the grinding wheel has to be infeed relatively slowly to avoid crashes.

These are extremely high-volume operations with typical production of a half million or more bearings per day, so any reduction in cycle time has an extremely high payback. By pre-measuring the OD of each race before it's placed in the grinder the machine control can precisely place the wheel for minimal movement to contact with no danger of crashing.

The resulting cycle time reduction is not typically very large, perhaps 0.1 second or so, but over a production run of 500,000 parts per day it generates a substantial cost reduction. Properly executed, this approach can also eliminate the need for an ID in-process gauge on the grinder further reducing costs.

Here again, the productivity of existing machines can be improved for a relatively small capital investment in gauging hardware and control software. In some of these examples 15 year old machines were able to match the productivity and precision of brand new equipment with the simple addition of contemporary gauging hardware and control technology.

In a time when capital budgets are tight to non-existent the approaches described here offer a low-cost, proven way to improve productivity through the creative application of process control technologies. Add them to the machine, move them off the machine, or integrate both approaches into a beginning-to-end process control system and you can add precision parts to the long list of automation success stories.

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