

Rebuilding a Legacy

BOURN & KOCH PROVIDES RETROFIT MACHINE FOR GEAR SHAPING
JOE GORAL, BOURN & KOCH

When Bourn & Koch purchased the Fellows Gear Shaper Company in 2002, there was considerable excitement about the possibilities for the little-known machine tool company from Rockford, Illinois. Though the purchase of Fellows wasn't their first foray in to acquiring a gear company, it had been 17 years since Bourn & Koch had bought Barber-Colman's machine tool division, acquiring their gear hobbing machine designs and repair parts and service business. The acquisition of Fellows offered numerous opportunities to expand Bourn & Koch's footprint into the world of gear manufacturing.

Since the acquisition of Fellows in 2002, Bourn & Koch has developed new models of Fellows gear shapers and has been awarded patents on designs that have been incorporated into these machines, most notably the use of flexure plates to increase stiffness in the cutter spindle housing, removing the need for hydrostatic pads. Though their new machine designs offer a long list of cutting-edge technologies, Bourn & Koch has always had a strength in remanufacturing older Fellows gear shapers.

A typical remanufacture process will not only bring the machine up to today's standards for CNC controls and machine systems but will also restore the machine's alignments or original factory specifications. In essence, it is a new machine using very well-seasoned castings. As one might imagine, the process is time consuming and costly, but typically results in a machine that is two-thirds the price of new. On specialty machine tools, such as gear manufacturing equipment, this can mean considerable costs savings to the customer.

Understanding the increasing need for many companies from job shops to OEMs to update their gear manufacturing machinery or to outright add this to their capabilities, Bourn & Koch took the time to rethink their offering to the market for gear shaping machines, focusing on the Fellows 10-4 in particular.

Lloyd Koch, co-founder of Bourn & Koch and machine tool guru,

Fellows 10-4 Retrofit by Bourn & Koch.



headed up the effort to provide a more cost efficient and adjustable version of the Fellows 10-4 to the market. Koch, a former engineer at Sundstrand Machine Tools, knows the rebuilding process like the back of his hand; it is how Bourn & Koch got started in 1975, rebuild and retrofitting Sundstrand's machines. Larry Bourn & Loyd Koch started rebuilding machines in 1971, eventually forming Bourn & Koch in 1975.

Starting with an original Fellows 10-4 serial number 34807, Loyd and the team of gear technicians at Bourn & Koch disassembled the machine, painstakingly inspecting the parts as they were removed to determine if they met OEM tolerances. The parts that did not pass inspection were discarded and replaced with new, manufactured per Fellows OEM prints.

Once disassembled, the bare castings were now a blank canvas for Loyd and

the engineering team at Bourn & Koch to start anew, attempting to balance the delicate task of reducing cost while maintaining quality. Any gear shaper whether new, remanufactured, that leaves Bourn & Koch must produce AGMA class 10 gears on all measured features. The goal for the rebuilt machine was to be able to provide a minimum of AGMA class 9 gears. The result was a class 10 gear produced at run-off.

Two of Bourn & Koch's current engineering staff, Wayne Densmore and Steve Ray, started their careers at Fellows, accepting positions with Bourn & Koch when the company was acquired. Densmore is a mechanical engineer by training, responsible for numerous designs both at Fellows and Bourn & Koch that have stood the test of time. Around the office, Densmore has a reputation for designing machine tools that are of an equivalent duty to those made in the heyday of American



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Machine Tools. Ray, a software and controls engineer, has been responsible for development of Bourn & Koch's human machine interface (HMI) software over the past 16 years. He's been an integral part of many new software features on both gear hobbing and gear shaping machines during that time. Both Ray and Densmore were integral to the effort to bring this "new" product to market.

While Fellows produced a reliable, stout, gear shaper, the controls on the machines, much like any electronic component, become obsolete. Bourn & Koch

primarily uses Fanuc on their machine tools, from gear hobbers and shapers, to cylindrical and surface grinders. The standard for Bourn & Koch gear machines has been the Fanuc 0i-MF with a PC front end to host their gear manufacturing HMI. Understanding that the needs of the gear manufacturing market vary, Bourn & Koch designed a new CNC package with Fanuc Macro Executor on the 35i CNC control. Bourn & Koch already had a leg up on using this control for their new Blanchard grinders, so the transition from 0i to 35i was a relatively

AGMA 10 gear cut on the 10-4 Retrofit.



painless process. This also provides a familiar programming option to those familiar with Fellows original programming via Macro Executor.

During the design stage of the project, numerous considerations were made as to how the machine could be more accurate and adjustable, while reducing cost. Starting with the machine's x-axis, the team at Bourn & Koch looked at how to simplify the design while increasing infeed accuracy during the gear shaping operation. The decision was made to convert the machine's x-axis for infeed and positioning to direct drive with a ball screw and servo motor. Employing a Fanuc Beta-I 12 servo in lieu of their standard Alpha-I 8 servo, the new design for the x-axis on the machine now has more torque and higher accuracy due to the removal of the gearing in the original design. This also resulted in reduced costs as fewer moving parts are now required.

The same philosophy was applied to the machine's c-axis for the work spindle. Typically, a new or remanufactured 10-4 gear shaper would have a drivetrain through a spline shaft to rotate the table. The machine now has a direct drive work spindle, which improves accuracy and reduces backlash in the drive train. The original design incorporated a gear train and spline shaft to drive the table. With the direct drive design, those components are eliminated, reducing cost both at the time of machine build and during machine ownership. This also offers a mechanical advantage over typical belt drive systems.

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At the heart of a gear shaper is its spindle. The stroke and rotation of the spindle are the driving force behind the generation of the gear teeth. Particular attention was paid to how to improve this area of the machine while reducing cost in the rebuild process. To further reduce cost, a Fanuc servo motor was used in place of a Fanuc spindle motor. This also reduces the number of components required to retrofit the machine to CNC including the disc brake but provides the added benefit of programmable quick return stroking.

Floor space is a large concern in many shops these days. With square footage being at a premium, compact machine designs can have a distinct advantage in process to determine what machine

will ultimately be selected for purchase. To reduce the footprint, Bourn & Koch considered many aspects of the machine, most notably the guarding package and the hydraulic unit.

A simplified guarding package was designed for this new offering to reduce both cost and required floor space. While the new guarding package is less costly, it does not sacrifice the required safety features and ergonomics requirements that many companies have. The guarding package allows operators easy access to the machine's workzone for setups.

With the removal of the hydrostatic pads and use of a mechanical guide in lieu of hydrostatic, the hydraulic requirements of the machine were greatly reduced. This allowed for a smaller

hydraulic unit to be incorporated to the build, further reducing floor space. The new hydraulic unit also runs intermittently, saving on energy costs.

The new guarding package and smaller hydraulic unit reduced the overall required machine footprint by 16.5 square feet.

Maintainability is a focus of many companies in the machine selection process these days. Extended service contracts and extended warranties are all a sign that companies are looking to ensure the machine can be maintained by experts from the factory. That being said, a gear shaper is not in the same class as a milling or turning machine. They require fine adjustments and specialized knowledge to continually produce high class gears. With that in mind, Loyd and the team at Bourn & Koch worked toward developing methods to easily adjust the machine.

The cutter nut on the spindle was modified to allow it to be adjusted via set screw. The guide attachment is now adjustable via set screw as well.

Further improvements to the c-axis were made through retrofitting the table bearing cap to allow for preload adjustment without disassembly. Typically, a Fellows 10-4 gear shaper requires that a spacer be ground to fit in order to set the preload of the table bearing. This step is eliminated in the rebuild process and for future maintenance by incorporating the cap design. Table bearing preload is necessary for producing an accurate gear. With this step simplified, the machine's ability to continually and reliably produce accurate gears over its lifetime is greatly improved.

Overall, the "new" Fellows 10-4 retrofit offers companies a cost-effective way to add or upgrade their gear shaping capability without sacrificing quality. With Bourn & Koch's OEM support and technical expertise on Fellows, companies can be well assured that they are getting a quality machine backed by a team that knows their gear shaping machine inside and out.

For more information:

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10-4 Retrofit machine workzone.