

Speed Matters – In Racing and in Hobbing

RCD Engineering's switch from manual to CNC hobbing operations breaks gear manufacturing lead time records with Bourn & Koch 100H in their gear production pit crew

Joe Goral Sr.

RCD Engineering (Race Car Dynamics) is a 50-year-old Northern California manufacturer of starters, blower drives, crankshafts, camshaft drives and other components used by National Hot Rod Association drag race teams and other racing circuits to move at speeds of 300+ mph.

For many years, RCD relied on an old manual Barber-Colman 6-series gear hobbing machine (built in the 1960s) to create idler gears used in their camshaft drives; but they were experiencing long lead times with their finish grinding operations and wanted to make a change. Jason Leach, Production Manager at RCD, explains the old process: “We cut blanks, machined the gear blank front and back, roughed the teeth in, milled the holes (they need to be clocked to the teeth), deburred manually, sent the gears out to heat treat (4 days shipping there and back), recut bore and faces of the gears to true up after heat

treating, sent out for finish grinding (4 days shipping there and back), and finally applied finish coating.”

This long, nine-step process took about eight weeks, but it could go even longer if their finish grinding source was backed up. After bringing the Bourn & Koch 100H gear hobbing machine on to their team in 2016, though, RCD has cut the process down to just four steps and has eliminated the need for finish grinding services altogether.

The key to changing the process was being able to cut heat-treated blanks (Rockwell 46-48) and clock the gear teeth to the timing marks or mounting holes on the new equipment while achieving the same AGMA 10+ quality as RCD's customers had come to expect.

“Since purchasing the 100H, we have changed our process,” says Leach. “We now cut blanks, heat treat the blanks, machine gear blanks front and back on our turn mill complete with holes and timing dots, then rough and finish the teeth on our Bourn & Koch 100H. We

have cut our lead time on these gears by 50%.”

50% Faster Overall Production AND 30% Faster Gear Cutting Cycle Times

“In addition to eliminating finish grinding operations,” explains Leach, “we have noticed about a 33% faster run time on the hobbing operation alone versus our old mechanical hob.” And because RCD tricked out their 100H with the optional deburring attachment, they found they could eliminate manual deburring operations as well. They were able to bring the deburring process inline on the 100H and complete it in one setup.

The 100H is part of Bourn & Koch's line of H-Series horizontal gear hobbers. H-Series machines are designed to produce AGMA Class 10+ quality external spur and helical gears in a compact footprint. The machines are manufactured and assembled in Bourn & Koch's Rockford, Illinois facility by precision machine tool builders with decades of experience.

Each machine is CNC-controlled with servo-motion on precision linear roller ways, hand-scraped bearing surfaces and accurate ball screws for easily achieving high tolerances. Bourn & Koch's conversational HMI with full touch-screen control panel guides the operator through the gear cutting process, reducing the need for specialized training to operate the machine. In fact, the HMI on the 100H allowed a new user with just one AGMA basic gear manufacturing training class and less than 40 hours of training and gear hobbing experience to cut a sample gear at least 25% faster than an operator with 40+ years of experience could cut the same gear on an old, manual Barber-Colman (see details of the time study in the sidebar).

Leach confirms that the transition



Standard Bourn & Koch sample hobbled on Barber-Colman 6-10.



to the CNC machine was smooth. “We bought the 100H to replace our old Barber-Colman 6-10 mechanical hob, and the learning curve was not nearly as steep as I expected. The CNC control is very user friendly and easy to learn. The process for creating the programs is simple.”

RCD enlisted Bourn & Koch’s help to create the program that ensured the gear teeth were clocked to their mill work in the same place for each gear. This service got RCD’s CNC program on the right track. But one of the biggest advantages for RCD of moving from Barber-Colman to Bourn & Koch was the compatibility of the tooling.

100% tooling compatibility between the old and new

Workholding can be very expensive to replace. So, the fact that Barber-Colman 6-10 model tooling is compatible with the new Bourn & Koch 100H means companies can benefit from a lower investment moving from manual to CNC operations.

One reason for the compatibility? In 1985, Bourn & Koch, Inc. acquired the machine tool division of Barber-Colman. And since then, Bourn & Koch have continued the tradition of manufacturing world-class gear manufacturing machines in Rockford, Illinois, just a few short miles from where Barber-Colman once did the same.

Another reason for the compatibility is that when approaching a new machine design, customization or re-engineering challenge, the Bourn & Koch team can draw from the years of time-tested engineering know-how available to them in

their OEM archives. 125+ years of parallel OEM records (from 1889 to present day) are being carefully preserved in the climate-controlled Bourn & Koch facility.

The valuable archives consist of all original assembly drawings, bills of material, electrical diagrams, hydraulic schematics, detail prints, and spare parts inventories from over 30 American-made classic machine tool brands — including Fellows, Barber-Colman, Devlieg, Bullard, Motch, Jones & Lamson, Acme-Gridley, Blanchard, Brown & Sharpe and many more. Add up the number of years each machine tool company existed and you arrive at 2,500 years of combined engineering know-how.

In keeping with Bourn & Koch’s philosophy of retaining the best features on legacy machine tools, the company had the foresight to retain compatibility with spindle bolt patterns so that customers would have an easier time making the transition to Bourn & Koch’s 21st century machine tool offerings.

The same bolt pattern used on the spindle of the Barber-Colman 6-10 model gear hobbing machines is used on the new Bourn & Koch 100H hobbing machines. And the larger Barber-Colman 16-16 and 14-15 models are compatible with new Bourn & Koch 400H gear hobbing machines’ bolt patterns as well. This compatibility allows RCD and other Bourn & Koch customers to use their existing collet chucks, face drivers, and other workholding devices on brand new equipment.

RCD is a Fan of Bourn & Koch’s Adjustable Speeds and Feeds

“Our Barber-Colman was doing eight gears per hour... rough cut only,” explains Leach. “On the Bourn & Koch 100H, we initially set up the machine to rough *and* finish cut one gear in four minutes (which is 15 gears per hour).” RCD was impressed with that speed, but also with the fact that they could use the “Speed and Feed Change” feature to tweak the speed-to-quality ratio. “We slowed the finish feed down a little to reduce the distance between scallops and improve the AGMA rating.” They now run 10-11 gears per hour with rough and finish passes resulting in an AGMA 12-14. This was the perfect balance of speed and accuracy for the idler gears.

“The great thing about this machine,” Leach concludes, “is the range you have to adjust feed and speeds easily to fit your needs.” The 100H gear hobber with Bourn & Koch HMI is available with a standard Fanuc 0i-F CNC — other options for CNC controls are available as well. The control includes the Automatic Single- or Double-Cut Cycles (with speed and feed change between cuts) as well as Crown Hobbing or Taper Hobbing Cycles, Automatic Hob Shifter (with parts per shift counter), and Power-Programmable CNC Hob Swivel for accurate setting of hob slide.

Beyond the Machine — Custom Workholding, Cutters, and High Quality Service

“Having good fixtures is paramount in manufacturing quality gears,” states Leach. “We purchased one workholding fixture from Bourn and Koch to elimi-



Photo of hobbed RCD Engineering 48T 10 D.P. 11 hole Vernier cam gear in Bourn & Koch engineered face clamping fixture.

nate any issues during the part run-off prior to machine delivery. We were provided a print with our fixture so that we were able to design and make our own work holding fixtures for our other gears.”

“We also purchased all of our PM6 and carbide cutters from Star-SU,” Leach adds. “And we use Star-SU’s resharpening services. We have found them to be fairly priced with good return times.” Star-SU has been Bourn & Koch’s trusted partner in distributing their gear manufacturing machinery for over a decade. Star-SU also supplies the hobs and shaper cutters for all of Bourn & Koch’s gear manufacturing machinery.

In addition to custom-designed workholding fixtures and cutters, the expert Bourn & Koch Customer Care and Field Service Groups can provide engineering support, custom-tailored preventive and predictive maintenance programs, operator training, and field services such as machine leveling/alignment; tool installation; recertification; rebuilds/retrofits; and diagnosis and repair of mechanical, electrical, hydraulic issues.

A few “Mods” take RCD from Classic to Modern Hobbing...and supercharge gear production

Bourn & Koch is proud to be able to have helped Race Car Dynamics (RCD) Engineering transition to a more accu-

rate, modern 100H gear hobbing machine that had the ability to rough and finish cut heat-treated blanks for their crankshaft and camshaft gears; match the gear teeth to timing dots; and eliminate the need for finish grinding outsourcing. RCD is happy to have made the successful move from manual to CNC gear hobbing operations with AGMA 12-14 quality gears as the result. And RCD customers are cheering at the drastically reduced gear set lead times.

RCD plans to move other gear production tasks over to the Bourn & Koch

100H gear hobbing machine in the near future, including some gear sets for starter motor gear heads and helical bronze gears for their magneto drives. The Bourn & Koch crew say they will be ready to help RCD light ‘em up! 

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Joe Goral Sr. started working for Bourn & Koch in September of 2013, providing support service for Bullard & other vertical turning machines. Since then, he has moved into a technical support & applications role for Bourn & Koch, specializing in gear hobbing and vertical grinding applications. Joe attended the AGMA Basic Gear Training in April of 2017 to supplement the training he has received on the shop floor at Bourn & Koch.



Bourn & Koch Electrical Engineer Kenneth Braswell programming a Bourn & Koch 100H with full touch screen display.

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Gear Hobbing Time Study: Old vs. New

To test and validate the speed with which an inexperienced operator can cut a gear using the new HMI control on the 100H Gear Hobber, Bourn & Koch conducted a detailed time study in May 2017. The study compared the setup, workholding, programming/gear change, and cutting times required to cut a standard sample gear on a Barber-Colman 6-10 Gear Hobber (fully restored to OEM specs) and a brand-new Bourn & Koch 100H Gear Hobber. The gears from each machine were inspected, and detailed quality results are available by request.

The operator of the Barber-Colman had 40+ years of experience running Barber-Colman gear hobbers. The operator of the Bourn & Koch 100H had less than 40 *hours* of training and operating experience and had merely completed the AGMA Basic Training for Gear Manufacturing class in March 2017.

The sample gear was a 30-tooth helical with a 2-inch face width. The operator with 40+ years of experience cut the sample gear on the Barber-Colman 6-10 Gear Hobber in 34 minutes, 31 seconds total time to complete the first gear. The inexperienced operator cut the same sample gear on the Bourn & Koch 100H Gear Hobber in 25 minutes, 43 seconds total time to completion—a 25% time savings on the new machine vs. the old. The time savings was accumulated across all stages of the operation—from set up of the hob and workholding (10% faster on the Bourn & Koch 100H), programming/setting up and changing gears (50% faster on the Bourn & Koch), and cutting time (which was 25% faster on the Bourn & Koch).

The sample gear was hobbled using a single cut on the Barber-Colman and took 15 minutes, 39 seconds to complete. On the Bourn & Koch, a 2-cut cycle (climb & conventional) was used to achieve a speed of 11 minutes, 57 seconds total cut time. This shows the newer, Bourn & Koch machine to be approximately 25% faster than the old school hobber.

Surprisingly, the greatest time savings was in the CNC programming step of the test. The inexperienced operator with just one training class under his belt, was able to program the Bourn & Koch 100H machine to run the 2-cut cycle in just 4 minutes, 11 seconds. The experienced operator spent a total of 8 minutes and 20 seconds setting up change gears on the Barber-Colman. These results show the old Barber-Colman to be 50% slower in this phase of the time study.

The sample gear cut during this time study on the Bourn & Koch 100H was measured to



Finish hobbled automotive pinion on Bourn & Koch 100H.

AGMA Q-9 on the lead and involute, with an AGMA Q-11 on the index. Not bad for the inexperienced operator's first gear! The old Barber-Colman achieved quality scores of 7 for Index, 0 for lead, and 3 for involute. With a bit more training, the inexperienced operator could easily increase the quality of his results in subsequent tests, leaving the Barber-Colman even more solidly in the dust.

For the full report of this time study, please go to www.bourn-koch.com/timestudy or call 815-713-2367. 