Today's machine shops must operate more efficiently and at a higher level of quality and precision than in years prior, as the latest equipment is designed to help businesses deliver top-quality results.

Photo courtesy of Centroid

**FROM PORTING** to surfacing to final assembly and testing, cylinder head preparation has become more sophisticated, more challenging, and more competitive than ever before. It's still a good business to be in—if you're able to keep pace. "There are not as many shops today," observed Tim Whitley of T&S Machines and Tools, Gainesville, Texas, "but the ones that have survived are busy."

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**Honing In On Improved Productivity** 

Even so, Whitley continued, to remain competitive in cylinder head preparation, today's machine shops must not only operate efficiently, but at an elevated level of quality and precision. "In the past, an adequate surface finish was OK," he said. "Today the machinist must achieve near-perfect finish and flatness. The new engines operate at higher combustion pressures due to the expanded use of superchargers, turbochargers, and multi-layer steel-shim gaskets—so they need smoother, flatter surfaces than more forgiving naturally aspirated engines sealed with composite gaskets. Today, there is no such thing as too smooth a surface finish."

Additionally, new materials have brought new challenges. "Engine builders expect machine manufacturers and tool companies to keep up with evolving technology," noted Erik Shepard of Goodson Shop Supplies, Winona, Minnesota. "They need to be able to machine newer, harder materials and repair newer engines." And they also need "equipment that makes the job easier and faster, to be worth the engine builder's hard-earned dollars."

John Cowher of Centroid CNC in *PerformanceRacingIndustry* | *January2017* 

### By John F. Katz

Howard, Pennsylvania, summarized the situation: "Our customers have to keep up with the demands of their customers," which means they have to be able to "produce and not out-source. Because if they can't do that, then their competitor is going to eat their lunch and hand them the bag. So our customers expect—they demand a more user-friendly, reliable and efficient machining center. And along with that they want excellent customer service and support."

From cutting blades to complete CNC machining centers, the industry has responded with a parade of new products. We'll offer an overview of several of those products before examining some specific head-prep challenges, and how these products have helped to solve them. We'll also take a deep dive into how automation continues to revolutionize the industry. And in a sidebar (page 68), we'll examine how advances in flow bench technology are helping engine builders evaluate both the effectiveness of their engineering and the quality of their work.

#### The Profitability of Efficiency

"It has become mandatory for profitability to make surfacing fast and efficient," Whitley stated. "So T&S has focused on CBN (i.e. cubic boron nitride) milling machines. If a shop can turn around surface jobs quickly, with a superior finish and very little frustration in producing this finish, the resulting cash flow can even cover for the less-efficient processes in the shop."

So T&S set out to build "the absolute best surfacer that can be built in terms of surface finish, flatness, versatility, and speed. This is not an inexpensive process, nor is it easy; in fact, it's very difficult to design a machine that's simple to use." It was deemed important, also, that the machine be manufactured entirely in the US.

"Our S-3000 series of surfacers all incorporate features not found on any other machine, at any price—such as the versatile cradle/head fixture that first solidly clamps the head, and then aligns to within a thousandth of an inch using a proprietary sliding indicator that runs on the linear ways of the machine," explained Whitley. "We've also developed a precision spindle to rigidly support a 15.5-inch cutter plate, so we can easily achieve finishes down to 8 Ra. And our design takes up the least possible space on the shop floor."

Feedback from customers has been positive. Whitley recalled the owners of one Virginia machine shop who were "ecstatic about the profitability of our





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surfacing machine," when they visited the T&S booth at the 2015 PRI Trade Show. "That was after owning it for only three months. I spoke with them again about four months later, and they were still excited, because they anticipated having the machine paid off six months after that."

#### **ProblemSolvers**

Goodson manufactures a wide range of shop tools that solve specific problems. Shepard told us that he hears quite often from engine builders who, while rebuilding modern high-performance heads, find that their spring compressors won't compress the valve springs



Cylinder head preparation has become more sophisticated, more challenging, and more competitive than ever before, requiring today's machine shops to operate at the highest levels of efficiency. Plus, according to one source, "engine builders expect machine manufacturers and tool companies to keep up with evolving technology." Photo courtesy of Goodson.

far enough to remove the keepers. The solution is "our MTI pneumatic spring compressor (PN CF-3000B), which delivers 1500 pounds of force at a line pressure of only 90 psi. It's the same spring compressor that's used by many Top Fuel and Funny Car teams, yet it's versatile enough to work on any heads.

"Another issue," Shepard continued, "is finding the right cutter to machine valve seats for maximum airflow." But again, "Goodson offers a huge selection of high-performance seat cutter blades—140 in all—including our Black Smoke series for the most popular diesels. We also offer a single, threepiece blade set that works very well on

#### continued on page 70



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#### continued from page 66

everything from an everyday re-build to a race engine. And if an engine builder wants a profile that we don't stock, we can have a cutter made to their specifications—and we won't duplicate that profile without that customer's signed approval," he added.

#### AdvancesinAutomation

Still, perhaps no other factor is changing the cylinder head prep field more rapidly than advances in automation. Centroid, for example, is actively promoting its new A560 machining center,



Among Performance Trends' latest products is an electronic probe, pictured in use here, that can be mounted on almost any valve to measure velocity around the entire circumference of the valve opening; it can also be easily installed and removed without any special tools or special valves.

which is available in standard and XL size. (The latter features a larger work envelope, which can accommodate, say, a large six-cylinder diesel head.) "What's important to note," Cowher emphasized, "is that this is a three-in-one machine." The fixture stays in the machine, accepting cylinder heads, blocks, or a multipurpose T-slot table.

"And that's something that no one would have expected 10 or even five years ago," added Centroid's Keith McCulloch, although even then "custom-

## The Custom Advantage

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Designed for the professional and sportsman racer Erson FSP valve springs use super-clean, ultra-strong specially blended steel alloy of the highest quality to provide longer life. Specially formed structural process provides the highest levels of performance and durability by any steel spring.

ers were telling us that they wanted the ability to change from cylinder heads to blocks without having to re-indicate or re-align equipment."

Port matching has come a long way too, said Cowher, "meaning that from the port side to the bowl side you have no transition. That's a critical step in cylinder-head preparation. And it has been very laborious, time-consuming and inconsistent when done by hand."

"When you machine an intake from each side," McCulloch further explained, "the two machining operations are going to meet somewhere along the port. But we designed the A560, with its tilting head and rotary table, to minimize that transition. Tilting tables were pretty popular five or 10 years ago, but now you don't see them as often because these newer designs have replaced them. And in addition, we've devised software that very nearly makes the transition disappear—so no handwork on the head is required afterward."

And according to McCulloch, the A560 port-matches manifolds and heads with equal precision. "That, also, was commonly done by hand. But with our machine you can CNC the head and CNC the manifold, and when they come out of the machine they are perfectly matched. Five or 10 years ago engine builders were using gaskets to draw lines, and then [would] die-grind both the heads and the manifold by hand until they matched."

Cowher also described advances in Centroid's autonomous digitizing, which is now "50 to 60 percent faster than it was before. And with our new enhanced data capture, it's also more accurate and more user-friendly as well."

"The best part is how easy it is to set up, and how quick it is," added Mike Stevens, also from Centroid. "Once you've put the cylinder head on the machine, you can start digitizing in five to 10 minutes. And a common-sized intake port can be completely digitized in an hour and 45 minutes. The machine is completely automatic: It starts digitizing at the entrance to the port, and when



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## CYLINDER HEAD PREP EQUIPMENT

it has reached as far as it can it flips the head over and starts digitizing from the other end—just like you would do when you were cutting.

"And then you can bring that data into your CAD package, where you can smooth it out and clean it up and design a tool path. And the great thing about digitizing and cutting on the same machine is that you don't have to worry about shifting the work pieces to match up. What you digitize is exactly what you are going to cut."

Part of the "clean-up" involves a slight adjustment of the actual dimensions. Because the probe makes contact with the inner surface of the part, the computer has to "offset the data outward," Stevens explained, to determine the actual dimension of the cavity. Having that planar offset speeds up tool pathing in the CAD package.

"And when you have digitized a handshaped port," McCulloch added, "a lot of times, once that data is on the computer screen, staring you in the face, you can see things that you could not have seen in the hand-shaped port, no matter how much you rubbed your fingers inside of it. And then you can manipulate the original hand-shaped port directly onscreen, for even better flow properties. Once you become accustomed to doing that, it becomes another powerful tool in the engine builder's arsenal."

Furthermore, the ability to store specific port shapes and experiment with incremental changes "is yet another powerful tool that engine builders did not have in the past," McCulloch continued. "It was not only very hard for them just to reproduce that great engine they had built last week, but to actually improve upon that engine was somewhat of a hit-or-miss operation. Now they can store those port shapes in the computer. They can cut a new prototype and see how it works. Is it better? Well, if it is better then it's easy to move forward along that path. And if the change didn't give you the properties you wanted, it's easy to back up, see where you were, and branch out again from that point in

another direction." Overall, the technology "helps reduce the R&D cycle, and gets you to the goals you are trying to achieve," he added.

Cowher cited the example of D&J Precision Machine of Cambridge, Ohio, which specializes in the 5.9- and 6.7-liter Cummins diesels. "Prior to their investment in our product, it took them 40–50 hours to hand-port their cylinder heads," Cowher reported. "Now they can do it in 5–10 hours, and with consistency they

"The great thing about digitizing and cutting on the same machine is that you don't have to worry about shifting the work pieces to match up."

could not achieve before. They have also reduced their lead time from 12 weeks to one week, because instead of porting one head a week, they can port five or six. And since they can finish blocks on the same machine, they've freed up their other CNCs, which they used to use for block work, to do other machining jobs."

#### ShowTime

As this was written in early November, we asked our manufacturers what they planned to exhibit at the 2016 PRI Trade Show, then just weeks away. We also asked about delivery times for customers who had not ordered at the Show, but who may now be spurred by this article to consider new equipment.

Goodson, said Shepard, expected to have "all of our latest products on display at the PRI Show, for our customers to see, touch, and feel. We'll also have our hot-off-the-press, full-product catalog for 2017, which our customers

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can take home on paper or on CD."

Among the products Goodson expected to feature is the Hyper-Finish Diamond Valve Guide Sizing System, "a versatile hone that helps engine builders fine-tune valve-guide clearance for their individual applications," said Shepard. The Hyper-Finish Diamond hones cast iron, bronze, and hardened chilled guides, as well as bronze liners-"whether you want to remove a tenth, or two thousandths. That really appeals to race engine builders, as each likes to adhere to their own set of tolerances. Another benefit is that the diamond abrasives on the larger mandrels are over three inches long-so there is literally more abrasive honing the guide, to reduce tapering or bell-mouthing."

Centroid, said Cowher, planned to "display turnkey systems that are not just for CNC machining. Our live demos are going to show real parts being cut from billet, and port and block work being done just as if it was in a customer's shop. This is the real deal: actual work, being completed on the best turnkey systems available, and backed by the best service and support staff in the industry. And we're going to have equipment in stock within 30 days for delivery-that's the forecast at this point in time."

T&S is currently delivering surfacing machines about six months after they are ordered. And Whitley asked us to help clear up a persistent misconception: "We find it a little frustrating, after all the effort we put into manufacturing our machines entirely in the US, to read in online forums and other sources that we are importing our machines from China. The only metal we import is in the machine frames for our CNC blockboring equipment. Our new surfacer, all of our electronics for CNC and balancing, the balancers themselves, our fixtures and our seat-cutting tooling are all manufactured in Gainesville. And we hope, with the support of our customers, to generate enough cash flow to develop our own US-made CNC frames."

#### **TimetoReplace**

One question we always like to PerformanceRacingIndustry | January2017 address, when dealing with products that represent fairly large capital investments, is how to know when it's time to purchase new equipment rather than continuing to repair and/or upgrade what you already own.

"It doesn't make sense to continue to invest in old technology that doesn't offer the benefits of the latest technology," Cowher answered. "Investing in new technology and reducing or eliminating outsourcing is the way to go so you work smarter, not harder, and in better control of your shop."



The PRI Trade Show's Machinery Row is one of the few places engine builders can observe and test cylinder head preparation machinery in action before purchasing. Hundreds of companies use the Show as a platform to debut their newest equipment, giving attendees an up-close look when considering equipment upgrades.

"In the case of surfacing equipment," added Whitley, "it is imperative to spend the necessary money to have the most efficient machine possible. This is not an option with today's high-performance engines." He cited a surfacer as "the most profitable machine in the shop."

Perhaps more to the point, said Shepard, "When a piece of equipment is worn out past its life expectancy, it will no longer do the job it was designed for correctly or safely. You may keep on repairing it, but your work will not be up to standard, and it will take more time than it should to do each job. Also, you will be spending valuable time repairing a tool when that time could be spent working on billable hours."







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