CNC MACHINING

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On The Cover

Designed for paramotoring, this 3-cylinder compact radial engine weighs approximately 37 pounds and pumps out 20 horsepower.

Photo: Scott Rathburn

In This Issue

The first step to recovery is admitting you have a problem.

Damn. Another year is gone, and what do I have to show for it? Well, I have fewer hairs on my head – and more where they don't belong (what's the deal with ear hair, anyway?) – and what's left is decidedly shifting toward the gray end of the spectrum. The bathroom scale, while not yet screaming in submission whenever I step on it, definitely groans a bit more than in years past, signaling the addition of more than a few extra pounds. And my daily exercise regimen consists primarily of sitting at my computer and working myself into a carpal-tunnel frenzy with the keyboard and mouse. I don't smoke, so at least I've got that going for me.

Sounds like it's time to make some New Year's resolutions – but I've never been much for resolutions. The way I figure it, despite all my good intentions, I probably wouldn't keep them anyway, so why bother? Sure, this may sound a bit defeatist, but I've got a pretty good track record of knowing what I will and will not do, and the first step to recovery is admitting you (I) have a problem, right?

I tell ya, it's a good thing I'm not trying to run a business. With an attitude like that, I probably wouldn't get very far.

Yet, a similar defeatist attitude seems to exist in the manufacturing sector these days. Pundits claim there are fewer jobs in the industry – except those that have gone where they don't belong (what's the deal with offshoring, anyway?) – and the jobs that are left are decidedly shifting toward the service end of the spectrum. They claim their pocket books, while not yet screaming whenever the end of the month roles around, definitely groan a bit more than in years past, signaling the addition of more than a few extra expenses. And the daily business regimen for many companies seems to consist of working themselves into a tunnel-vision frenzy about how hard it is to survive in the world economy. The smoking thing doesn't really work in this comparison, so I'll just leave that out.

Now, from a personal standpoint, I could easily do something about my individual shortcomings listed above. But if I choose not to (because it *is* a choice), I have no right to complain about it. If it really mattered to me, I'd get off my ass and take some action.

In my view, the same rules apply to the manufacturing industry. There are plenty of companies out there that are not only surviving, but they are thriving. They've chosen, in one form or another, to get off their asses and take some action.

We'll show you some of those companies in this issue of *CNC Machining*, and perhaps you'll find some useful information that can help *your* business thrive.

For our cover story, we visited a contract engineering firm in Canada that boosted its efficiency by investing in high-value, easy-to-use machine tools, and employing a flexible approach to machine utilization to avoid production bottlenecks.

Flexibility also is key for NextGen Aeronautics in Southern California – one of three companies tasked by the U.S. Government to develop morphing aircraft structures for the Defense Advanced Research Projects Agency (DARPA). Small-business agility, flexible thinking and flexible fabrication methods have NextGen competing favorably with industry heavies Lockheed Martin and Raytheon Missile Systems.

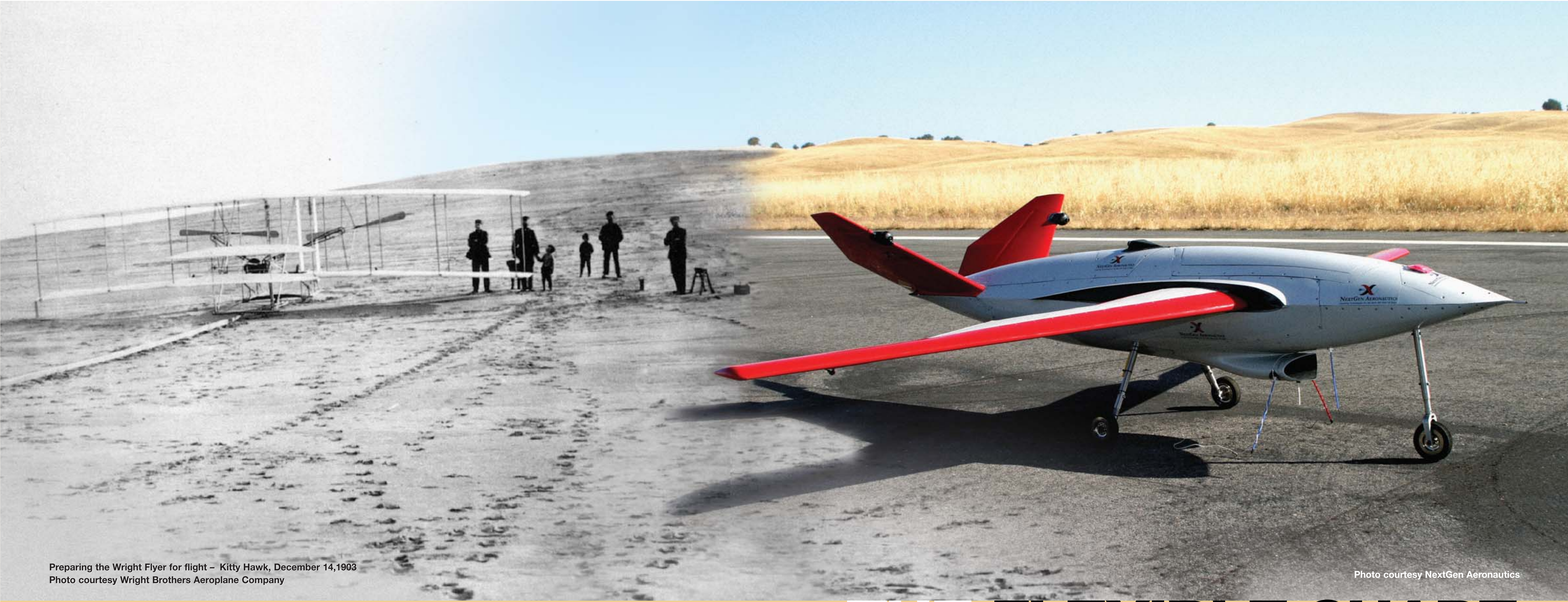
Another aerospace company, Mikana Manufacturing, faced with skyrocketing materials costs, formed a synergistic relationship with a tooling supplier and a machine tool builder to increase material removal rates in titanium, Inconel® and other exotic materials. The "three-way marriage" has proven beneficial to all parties.

Across the pond, we visited Brompton Bicycle Ltd. in the UK, the sole remaining quantity bike manufacturer in the country. The company builds high-end folding bikes that rival their non-folding counterparts for rigidity, safety and responsiveness. Working closely with their local machine tool supplier, Brompton was able to develop the most efficient and cost-effective methods to produce the precision-machined hinges that are the key to the bikes' success.

As always, there's much more. Be sure to check out Cycle Time for the latest industry news, and the Answer Man for a dose of applications solutions.

It's a great issue. So sit back, relax and enjoy!

– Scott Rathburn, Editor



Preparing the Wright Flyer for flight – Kitty Hawk, December 14,1903
Photo courtesy Wright Brothers Aeroplane Company

Photo courtesy NextGen Aeronautics

The next generation of airplanes will look radically different, and so will the companies that create them.

THE FLEXIBLE SHAPE OF THINGS TO COME

Story and Shop Photos by Richard Berry

Flexible Wings

It's certainly not a new idea. More than a hundred years ago, two clever bicycle mechanics from Ohio used the concept to pioneer powered flight – and, admittedly, they stole the entire notion from the birds.

To the Wright Brothers, it seemed the only obvious plan: make a flexible airplane wing and change its shape to control flight. The idea worked, and made the Wrights successful where all others had failed. Yet, as aircraft speeds and wing loads increased, subsequent builders chose different means to control flight, and somehow, over the ensuing years, generations of aeronautical engineers forgot this earliest lesson.

But now, as if to celebrate the ironic spiral of technical evolution, this long-overlooked idea has been given an engaging new name – *morphing* – and christened today's hottest topic in aviation research.

In defense of the great aircraft designers who have come and gone in the century since Orville and Wilbur, the task of constructing a modern airplane wing that is both strong, and flexible enough to change shape in flight, has been all but impossible . . . until recently. Thanks to advances in smart structures and active materials, the idea of significantly flexing and changing the shape of a working wing is finally becoming practical. While the materials and mechanisms to accomplish meaningful morphing are barely off the drawing board, the aircraft designer's palette has undeniably changed forever.

As you might expect, the U.S. Government's aptly named Defense Advanced Research Projects Agency (DARPA) is pushing the boundaries of this research. In its recent Morphing Aircraft Structures program, the agency contracted three immensely talented aeronautical companies to design the technology and build proof-of-concept prototypes to pave the way.

DARPA was looking for flexible, shape-changing wings that could efficiently adapt to widely varying flight conditions – something even the best of today's unbending wings can't do.

Almost from the beginning of manned flight, hinged or sliding rigid panels, such as ailerons, flaps, spoilers and slats, have served as substitutes for a bird's more subtle way of doing things. They're adequate for the job, but far from aerodynamically perfect. Swing-wing concepts introduced in the '60s offered a cautious step toward morphing, but the technology has remained tentative, and nowhere near as useful as hoped.

Essentially, the government was asking for a totally new technology. The Wrights managed "wing warping" back in 1903 to control steering in their first flyer. But in 2003, DARPA wanted a craft able to completely change its physical characteristics on the fly: transforming itself from an efficient, wide-winged, slow-soaring ranger into a narrow-winged, spectacularly maneuverable, high-speed bird of prey. Expected by-products of the technology, such as finer control, greater fuel efficiency and improved stealthiness, were anticipated as "research gravy." If only DARPA could find the right group of researchers . . .

3D illustrations by Dorn Kennison

Flexible Companies

The talented contractors chosen to tackle this radical research were industry giants Lockheed Martin and Raytheon Missile Systems – along with a new and nearly unknown startup from Torrance, California, called NextGen Aeronautics.

Tiny by comparison, NextGen was nevertheless awarded a multi-million-dollar contract, roughly on par with the others, and expected to perform in the same stellar league. DARPA was definitely thinking outside the box, but it knew what the pedigreed new team could bring to the table: flexibility.

"NextGen was formed for a reason," says Fabrication Manager John Flanagan. "When you approach revolutionary research from within a big company, there's no way to avoid getting caught up in the bureaucracy. You can't stretch fast enough and you can't jump far enough. You just can't move as quickly as your brain works." Research requires responsiveness. A small group is naturally more agile, and in NextGen's case, deliberately more flexible.

Flanagan points out that the principals who formed the company were previously industry consumers of the same type of research products they now produce. "Our CEO was head of the flexible-wing project at Northrop Grumman. One of our board members was the first commander of the International Space Station, and another was a former NASA Administrator's right-hand man."

From past experience, NextGen's managers understand the flexible approach required to give a client what he really needs – even if that client doesn't always spell it out. "We know the surface finish the assembly guy expects; we know the extra steps needed to prep a model for wind tunnel tests," says Flanagan. "We've been there. We bid the job that needs to be done, not just the minimum work required to meet the print. In the process, we save the customer time and money by eliminating the re-work that would inevitably follow. We become more than just a fabricator, we become a trusted team member."

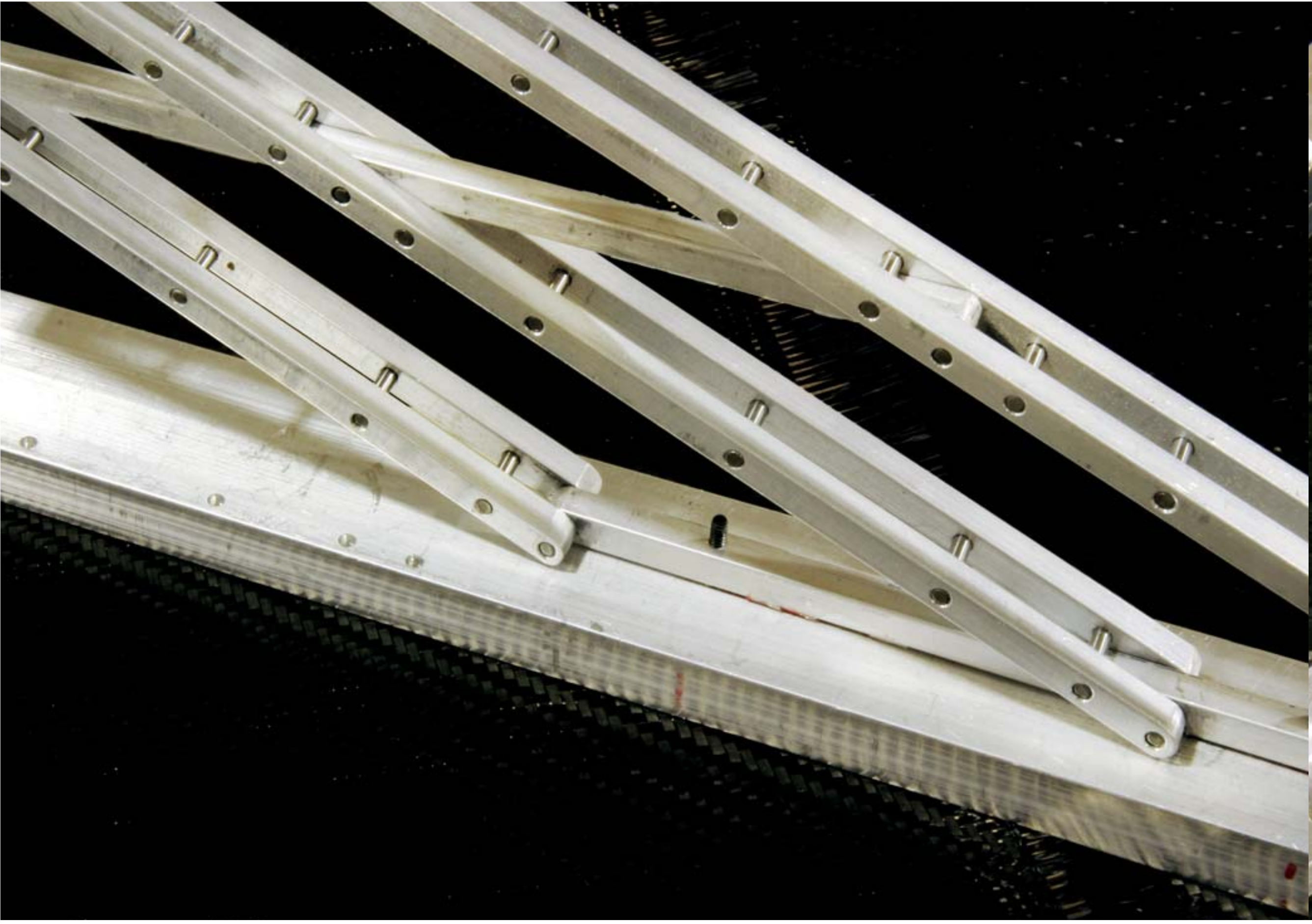
Flexible Thinking

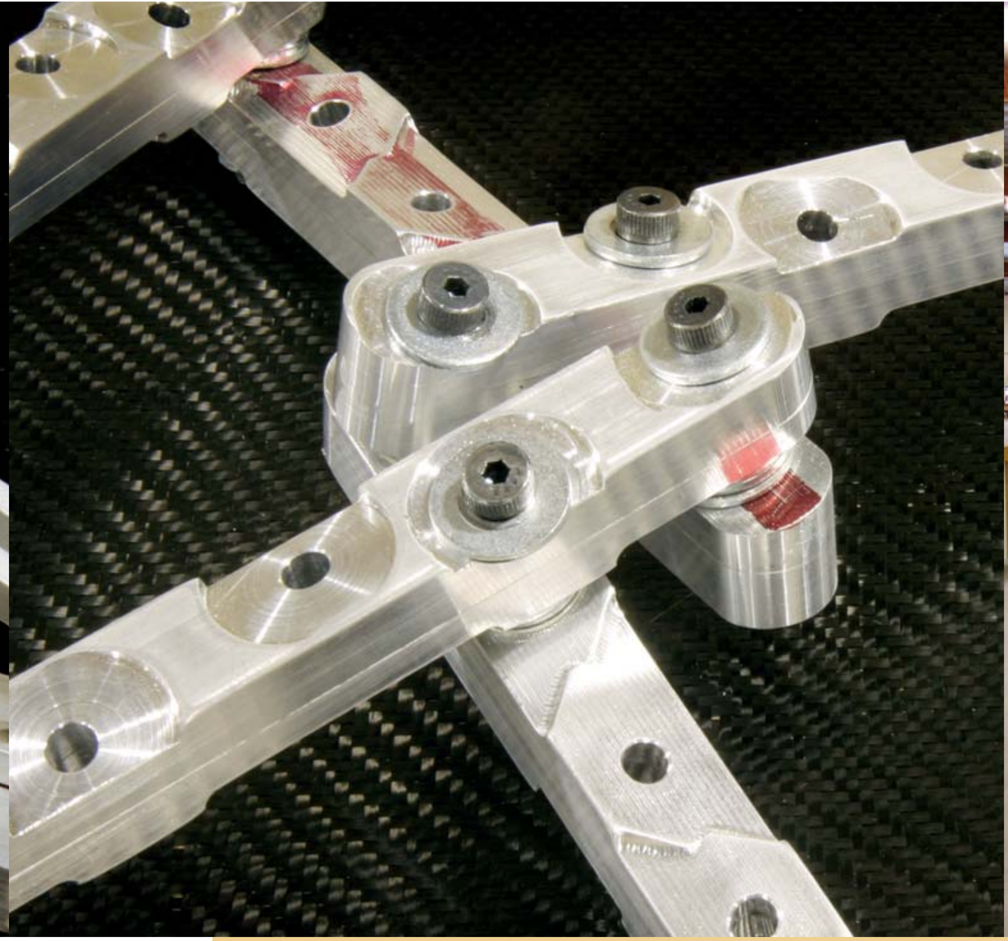
"We're successful in research for a reason," observes Flanagan. "In this type of work, you have to use your brain all the time; and from the beginning, we were committed to doing exactly that.

"Our goal was to have everyone on the team capable of doing everything. We set out to attract open-minded people, because that was exactly the type of company DARPA wanted. Then, and now, everyone here is used to their fullest capability." If a machinist needs a special fixture, Flanagan expects him to design it, program it and make it himself. In short, everyone's expected to be flexible and adaptable to any situation.

"Down the road, we'll be doing production," he continues, "and we'll expect those people to be as smart as the research guys. If a machinist can look at a part and figure out a better way to build it, he's thinking to his fullest. That's what we want."

The goal of morphing technology is to use integrated sensors and actuators to their optimum capabilities, so a wing can sense its environment and flexibly adapt its shape in flight. Does this mimic the birds? "Well, that's the goal," admits Flanagan, "but we've got a long way to go. Birds are intelligent; they can sense a lot and they can adjust quickly. We humans are also very intelligent, and we have a lot of sensors, too. There are thousands of hairs on our arms, and every one of them is a sensor, but they're obviously not as useful as a bird's. We've figured out how to fly; now we have to figure out how to use machine sensors as fully and effectively as the birds use theirs."





Prototype work at NextGen extends to articulated wing structures, high-strength stainless-steel wind-tunnel models, load-bearing antenna systems and complete proof-of-concept flight-test vehicles. For the majority of their standard polyester and graphite skin fabrication, they machine molds from ordinary medium-density-fiberboard (MDF).

Flexible Fabrication

While flight sensors and actuators drive a lot of NextGen's primary research, they represent only a fraction of the company's range of activities. Prototype work extends to articulated wing structures, high-strength stainless-steel wind-tunnel models, load-bearing antenna systems and complete proof-of-concept flight-test vehicles. While day-to-day shop work seldom follows a set routine, all the fabrications routinely begin on Haas Automation machine tools.

Highly adaptable Haas VF-4 and VF-7 vertical machining centers handle a remarkable range of milling jobs, and an unpretentious Haas TL-2 Toolroom Lathe sustains the turning. "These are good, solid machines that do everything we want them to do – without costing a fortune," says Flanagan. "The whole point of using Haas machines is that we can quickly upgrade them as our requirements dictate." He demolishes the myth that cutting-edge work demands ultra-elaborate machines. "Flexibility trumps complexity every time!" he exclaims. "Technology changes quickly, and will pass by the expensive built-for-30-years-of-production machine in the blink of an eye."

NextGen seeks machine flexibility because the materials they use will surely change as the technology advances. Their current collection runs the gamut: from absolutely astounding to oddly ordinary. Specialized skins that can stretch and move, yet withstand flight loads, are probably the project's biggest challenge. In response, NextGen has experimented with rare materials such as shape-memory alloys and memory-retention polymers. Yet, for the majority of their standard polyester and graphite skin fabrication, they machine molds from ordinary medium-density-fiberboard (MDF), better known as particleboard at the local Home Depot®.

"It's a very rapid moldmaking technique," says Flanagan, "and that's what counts." The shop laminates multiple 4 x 8 foot, 3/4-inch-thick sheets of MDF into whatever size blocks they need. Treating the block as a uniform solid, prototype designs are drawn in SolidWorks™, and toolpaths are generated in CAMWorks™.

The highest possible spindle speed and feedrate are used during the initial runs in the soft material, followed by a final pass at a slower feedrate with 10-thou' stepovers for a perfect finish. Securing the MDF block to a vacuum table and carefully monitoring the humidity allows the shop to consistently maintain a 5-thou' or better tolerance in the material.

"Some traditional guys tell us: 'You're crazy to cut that kind of stuff on your machines.' But that's the very reason we have these machines," stresses Flanagan, "to be able to do everything we need to do, without worrying. We're not a production shop. We don't need to make a hundred copies a day. But we do need the capability to machine whatever we want, whenever we want it, however we choose to do it."

The machinists control dust with a simple vacuum removal system, and turn out large, precision molds in a fraction of the time required by other approaches. After MDF work, they routinely switch to metal cutting with flood coolant on the Haas VMCs, with no problems whatsoever.

Since NextGen makes a lot of one-off items or matched left- and right-hand pairs, "Most of our stuff needs some kind of weird fixture for holding or matching," says Flanagan. "We've developed lots of innovative, fast ways of doing that. Whether it's vacuum tables, existing-bolt-hole jigs, adhesives, Bondo® or even barbells, we do whatever it takes to get the job done."

While they carefully consider the cutting loads a part will see, they seldom worry about how they'll mount it. It's out-of-the-box thinking at its best – a non-traditional but flexible approach to solving an age-old problem. Flanagan remembers: "One of our new machinists said, 'I wish I'd thought about glue-mounting before. It could have saved me half my work-time in the past!'" If talent and genius are givens, flexibility is what it's all about. Flanagan feels that concept will be the future hallmark of the industry.

"It's certainly not a new idea, but being able to react more quickly than the competition has gotten us the interesting work," he says. What could be more fun than making morphing structures and flying like the birds? "There are a lot of fun projects out there," he reminds us. "And, isn't that the point of life?"

NextGen Aeronautics, Inc.
www.nextgenaero.com

TIME IS MONEY.

Coin photos courtesy Daniel Van Rossen, Van Rossen Photographics

By John Shanahan

Time.

There never seems to be enough of it in manufacturing. That's the primary reason Folcroft, Pennsylvania-based Keystone Mint, a division of Leefson Tool and Die Co., recently brought in-house a process it had been outsourcing for the past five years. A manufacturer of coins, medallions and collectibles, Keystone relied on a contract shop to CNC machine its coining dies until late 2005, when the company decided to bring the process in-house.

"When you're dealing with an outside vendor, you're put in line based on the other jobs he has," says Dave Singles, a design engineer with Keystone Mint. In an industry like his, says Singles, which is driven by tight deadlines, getting plopped randomly into the queue can mean not getting a job done.

"The minting division is a very time-oriented business," he says. "We'll get a call on Monday saying a supplier needs 500 pieces coined by Friday, which doesn't give you a lot of time to machine up a die, heat treat it, coat it with chrome and then stamp out the parts. There were occasions where we lost jobs because our outside vendors couldn't turn them around in the time required."

The solution was to do the jobs themselves, which required an investment in equipment. The company needed a high-rpm CNC machine that wasn't going to take up a lot of space. They found that machine in the OM-1 Office Mill from Haas Automation in Oxnard, California.

"We needed something that was low-cost," says Singles. "At $35,000, the OM-1 seemed like a nice fit. It had the rpm and the amount of memory we needed, it was easy to run, and it didn't take up a lot of floor space." Measuring 60" wide by 76" high by 40" deep, the OM-1 offers a 50,000-rpm spindle, and has travels of 8" x 8" x 8" (xyz).

To generate the toolpaths needed to run the OM-1, Keystone also needed a CAM system. After seeing samples of artwork produced by MasterCAM® Art, the company bought the software for $14,000, bringing the total investment to $49,000.

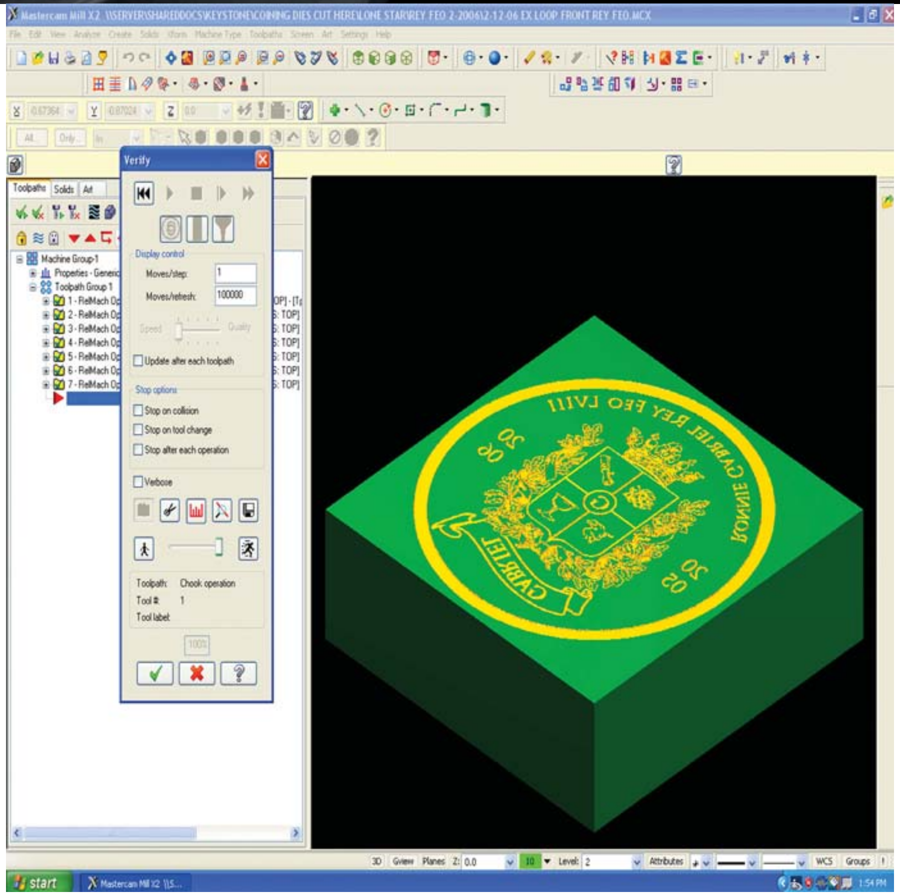
Calculating ROI

For Keystone Mint, calculating the ROI prior to purchasing the Haas OM-1 and the MasterCAM software was not as easy as plugging numbers into a formula. "There were so many variables to consider in our production process, that calculating the ROI was a challenge," says Singles. Weighing key factors such as production volume, staffing requirements, equipment housing needs and technical capabilities, Keystone's management deduced that the system would pay for itself in a year. The company's budgeting thought process is described below.

Production volume. The logical place to start when calculating ROI is with production numbers. Prior to purchasing the OM-1, the company outsourced the production of its die sets, which cost approximately $300 per set.

To calculate the ROI of the new equipment from a volume standpoint, Keystone took an average of its die production over the previous three years, arriving at a total of 365 die sets per year. At $300 per set, the company was paying a contractor $109,500 per year to make the dies. By investing $49,000 in the OM-1 and MasterCAM software, the company would save approximately $60,500 in one year – money that

The coining die above (shown with the finished product) was designed and programmed using MasterCAM Art software (right), and machined on a Haas OM-1 Office Mill (facing page).



would need to be invested in labor and overhead costs to operate the machine.

Staffing requirements. The amount of training and time needed to effectively integrate a new piece of equipment into a manufacturing operation is another critical consideration. Although the OM-1 and CAM system require a knowledgeable operator, Keystone had a clear edge in this area. Its operators were already trained in CAD/CAM, so learning the new software took only three days of training. "We were fortunate to have the basics needed to get this machine up and running in a few days," says Singles.

In addition to the shallow learning curve the machine afforded Keystone's staff, the OM-1 does not require full-time operator attention. According to Singles, the input time per job is approximately 20 to 30 minutes. Once the job is set up, the system can run unattended for 3 to 12 hours, depending on the complexity of the project. During that time, the operator is free to run other machines. "Because the machine doesn't require constant supervision, we are not dedicating one person's salary to its operation," says Singles. "Even if a worker who makes $15 an hour spends three hours a day with the machine five days a week, that still comes out to only $10,800 per year in labor costs."

Housing needs. Integrating a new piece of equipment into an existing operation can sometimes prove challenging, requiring movement of existing equipment, shuffling of workflow or the addition of space to house the new machinery. Fortunately for Keystone, bringing the relatively small OM-1 into its current operation was fairly easy. "We were able to fit the OM-1 in an area where we had other equipment," says Singles. "Because the footprint is less than four square feet, it doesn't take up that much space." Nor was it a replacement for any of the systems already in place. The OM-1 integrated neatly with Keystone's operations.

Technical capabilities. Along with the impact a of new piece of equipment has on current production needs, companies also must consider the potential for new business it affords. According to Singles, the OM-1 and MasterCAM system enable Keystone to offer its customers 3D artwork at an affordable price. "In the past, in order to get a 3D raised profile on a coin – think of the bust on a quarter – the customer would hire an artist to make a sculpt in clay, which would then be used to create the die," says Singles. "To make the die from the sculpt and then manufacture the coins, we would need to charge about $1,200 per side for this labor-intensive process. Now, with this new system in place, we can offer our customers sculpt-like coins for a fraction of the price – $400 to $600 per side."

Because many of these art coins are created as giveaways, customers don't have the budgets needed to do an artist's sculpt. In these situations, the system has enabled Keystone to save its customers money on their projects, and in some cases has meant the difference between getting a job and losing it to another company.

With its Haas OM-1 in place, Keystone Mint has been better able to manage its time and shuffle jobs as needed. With careful planning and budgeting, the company ensured that its move to bring the manufacture of coining dies in-house, and the equipment purchase required to effect this change, has clearly resulted in a return on investment. Time is now firmly on Keystone Mint's side.

www.keystonemint.com

888-776-5915

This article first appeared in the October 2006 issue of *MJSA Journal* www.mjsa.org.

CNC and Jewelry

CNC technology is certainly not new to the jewelry industry. The machines have long been available, and with systems becoming smaller and providing greater efficiency in time and materials, they're making a definite inroad with large and small manufacturers. But the question is: Is it really necessary?

"Some of the designs that can be machined are extremely time consuming to do by hand," says Dave Hayes, product manager for Haas Automation. "Some manufacturers spend meticulous hours trying to make a mold for a coin die, for example. When they're done, they've got the mold, but what if something happens to it? Are they going to spend another two days making it again?" As it tends to be with most high-tech tools, the value of CNC shines through when it comes to multiples of an item, or the need for repeatability.

"If you're making only one of something, it could take longer with CNC," Hayes says. "But as soon as you make more than one, that's where the payoff comes. Let's say you're making a coin, and on every 20 coins you want to change the date. With CAD/CAM and CNC, it's a breeze. You spend a few minutes changing the date, and everything else stays the same. You send the program to the CNC, and it cuts the new one just as fast as the last one. If you want to make the exact same design as one you made four years ago, you just call up the program from a library and cut it."

CNC also allows some freedom in how designs are created, and can save time in the process. "Some specialty and high-end manufacturers are bypassing the mold process, and even bypassing die-making, and cutting the precious metal directly," says Hayes. "A jeweler can come up with a design, and cut it directly out of billet titanium or gold or silver. Investing in CNC equipment and learning the technique is a commitment, but once you've mastered it, the sky's the limit."

CUTTING TIME

By Brad Branham
Photos by Scott Rathburn

Break the Tool – then break the Rule.

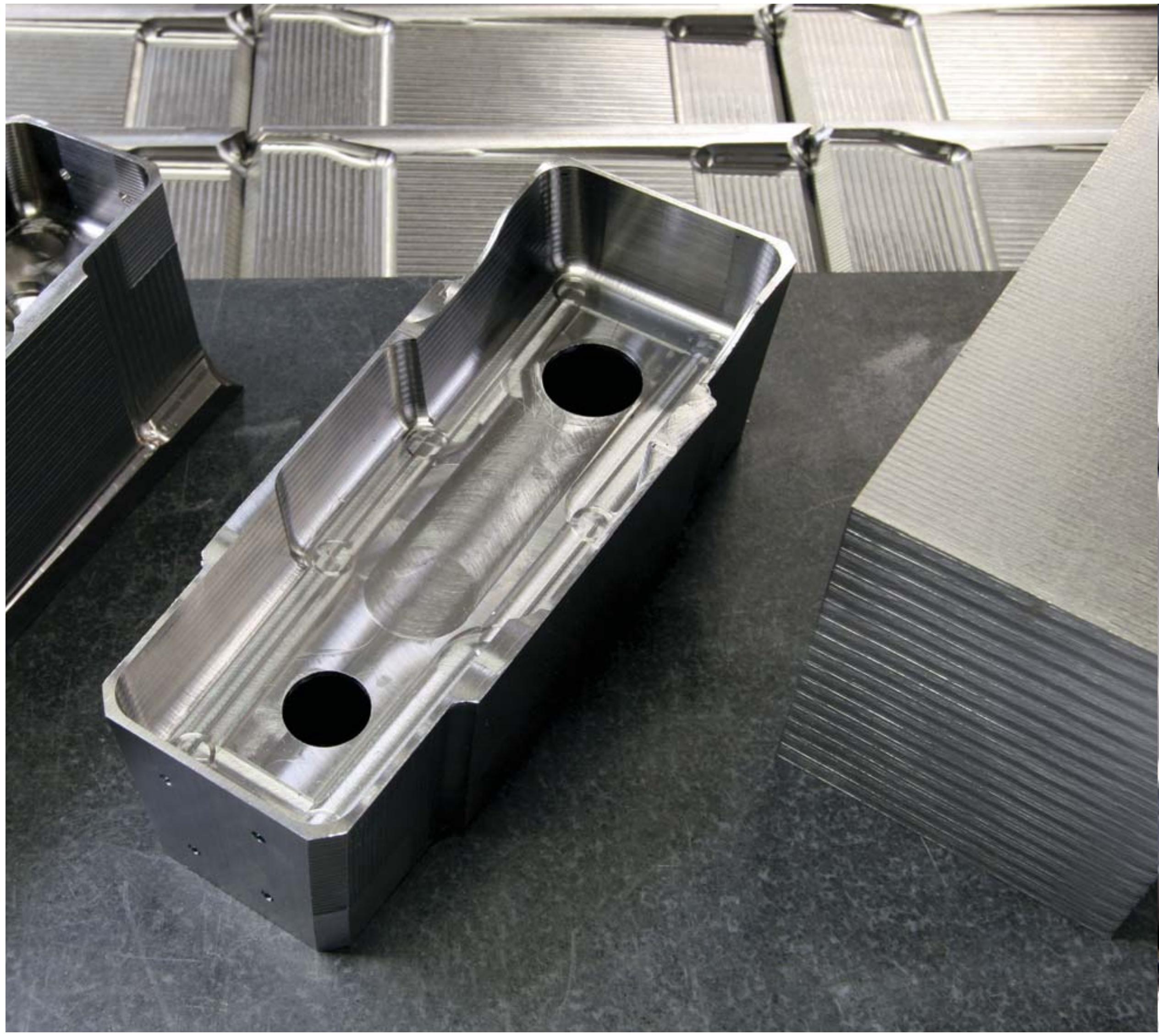
While this maxim may seem counterintuitive, it reveals a successful path to faster removal rates in titanium. To realize the highest gains, you first must determine the limits of a new tool design – and pushing a large endmill to its point of failure can get a little scary.

Titanium is used extensively in aerospace and military applications, as are Inconel® and other exotic materials. Michael Allawos, President of Mikana Manufacturing Company of San Dimas, California, knows this all too well. “We started in 1985, primarily in the aerospace industry,” he remarks. “We are sought out for the one-of-a-kind stuff that we do, and the hard-to-produce parts we make from hard-to-machine metals.”

In the past few years, however, prices for aerospace metals have skyrocketed, making material costs a much larger factor in the profit-and-loss equation. To cut costs and remain competitive, Allawos realized that Mikana would have to increase production speed. He would have to cut titanium and Inconel faster, and that meant he had to innovate.

Knowing that the machine and the process were only parts of the solution, he searched for a tooling company that would assist his effort to pioneer a new method to cut titanium. He eventually found a perfect partner: Jonathan Saada and Associates of Thousand Oaks, California, distributors of Hanita® cutting tools.

“This is a three-way marriage!” Jonathan Saada exclaims, referring to the cooperative relationship between his company, Mikana and Haas Automation, Inc. Saada supplies innovative cutting tools and Mikana provides the arena and expertise to test the new ideas. Because of its stability – and the thorough support provided by Haas service engineers and the Haas factory – a Haas VF-2 with a high-tension drawbar is the preferred test machine. The results of their combined innovation defy many theories about cutting problematic metals.



Most of the parts Mikana produces are made of hard, abrasive Inconel or titanium, which traditionally are subjects of slower feedrates. "Everything in machining is measured in cubic inches per minute [of material removal]," explains Allawos. "It is often the measure of profit or loss. Faster removal rates and longer tool life mean more production, and some of the parts we produce here require large amounts of material removal. It's all about cutting the cycle time."

How much material removal? Allawos holds up a large block of titanium 6-2-2-2-2 and a thin-walled, hollowed-out titanium box. "See this?" he asks. "This thin part was made from a block this size. As you can see, 90% is gone, and six-quad-two titanium is harder and more abrasive than other types." What's amazing is that most of the material was removed at feedrates that would unnerve most machinists. Much of the really heavy hogging was done at a feedrate of 80 to 90 inches per minute!

Saada and Allawos decided to address the problem of slow feedrates with a practical approach. "When we first started this project," says Saada, "I assured Michael that he would not pay for a tool unless it proved itself to be cost effective. But we wanted to know the actual limits of the new tool, so we took it to Mikana's production manager and told him to break it. We did this for each new tool we tried, documented the results, and finally achieved some very impressive feedrates."

"I encourage my employees to develop ideas and experiment," explains Allawos. "If we make one good discovery, the cost savings will pay for it all. We document everything, and we've done some amazing things here. We now have techniques that allow us to get good results using speeds and feeds significantly beyond the cutting tool manufacturer's recommendations, especially in Inconel and titanium."

(Above Left) These thin-walled structural fittings for the F-22A fighter are machined from titanium in two ops on Mikana's Haas VMCs. Pictured from left are op 1, op 2 and the raw titanium billet.

(Above) Aluminum components for the thrust-reverser assembly of the Boeing 787 await their third and final machining operation. The lofted surfaces of the part require 3D machining with lots of kellering. Rather than use small ball endmills and tight stepovers, which require more machining time, Mikana opts for larger ball endmills and small scallop heights. The parts are then hand finished, which, in this case, is more cost-effective.

(Left) Mikana's quality manager (left) and production manager inspect a finished part, while other employees take care of business on the remaining Haas machines.

"There are three things that work together to produce good cuts in titanium," Saada reveals. "First is the tool. To help eliminate chatter, we use a tool with uneven geometry, called a VariMill®, to break up the harmonics. It's coated with titanium aluminum nitride to dissipate the heat.

"The second factor is the use of kellering," Saada continues. "We use the tip of the ball endmill and work out around the radius. And thirdly, we use the chip-thinning effect." Chip thinning refers to the technique of using light engagement with a larger section of the tool's cutting edge to achieve the depth of cut.

"With the coated tool, we can cut 80 to 90 inches per minute in 6-2-2-2-2 titanium," explains David Buchberger, Saada's associate. "When you tell someone who is used to machining titanium at 4 inches per minute that he can cut at 80 inches per minute, he kind of steps back and shakes his head in disbelief. When you show him that it actually can be done, he is impressed."

Saada addresses the problem of work hardening the part, which causes brittleness. "Work hardening, most of the time, is a result of dwelling," he says. "People are afraid in titanium, so they take a cut of ten thou', and when they get into a corner they slow down. Where does the heat go? Into the part! Work hardening becomes localized, so you must be continuously moving the tool, always cutting. We use chip-thinning calculations so the heat goes into the chip and not the part!"

Titanium 6-2-2-2-2 is very hard and abrasive, and is no picnic to cut. But neither is 635 Inconel. It is arguably the most difficult metal to machine; cutting tools die quickly in Inconel.

Saada brings out a convoluted plate and a block of Inconel and puts them on the table. "For this part, you can see how we hog out this block," he points out. "About 95% is gone in chips. We tried endmills of carbide, ceramic inserts and cobalt. They dulled quickly – no life. We finally tried a powdered-metal tool, 12% cobalt, 6% vanadium, coated with titanium aluminum nitride, and that was the right combination."

"All the other endmills had very short lives, and carbide was so brittle that the cutting edges chipped," says Buchberger. "They were lasting about 20 minutes in 635 Inconel. Now we're cutting more than an hour per tool resharp, and we do not recoat between sharps. Here at Mikana, we get three hours of cutting in Inconel with the same 1-inch cutter, and much of that time is spent in a full slot with a 250 thou' depth of cut – at a full 4 inches per minute!"

But tooling and feedrates alone do not make the process profitable. "One of the most important factors is the Haas VF-2 with the high-tension drawbar," explains Ed Lujan, Mikana's production manager. "The drawbar tension took any chatter variable out of the equation. When you cut hard metals, chatter is the machinist's nightmare. It doesn't exist on this machine. If you are going to cut a variety of metals, it's good to have a versatile machine, and I can put any kind of metal I want on that Haas."

The ability to machine a variety of metals is critical to Mikana's production and future. "Although we make parts for the F-18, the F-22 and the Joint Strike Fighter, things are now getting a lot more commercial." Allawos points out. "We work with commercial clients like Lockheed, Boeing (on the 787 program) and JPL. We have about 108 Rover parts that are still running around on Mars. A lot of them were made on our Haas machines."

Fifty percent of Mikana's production is titanium and Inconel, but they also machine plastic, foam and aluminum. "This is the tool that rips through aluminum," says Buchberger, holding up a large, three-flute serrated endmill. "Sub-micrograin carbide. Some people don't think it's necessary for aluminum, but it will pay for itself ten times over in tool life and cutting speeds."

"We even use this tool for cutting floors," adds Lujan. "We can finish cut unsupported floors up to 6 inches square and 0.045" thick – and hold 0.005" tolerance with no problem. Some of the other tools tend to rip up the floors. This is my 90-inch-per-minute, lights-out-running tool."

About half of the Mikana shop is dedicated to machining titanium. "We want to use our Haas machines for those jobs, because we get better results on them," Allawos remarks. "It's a more rigid machine, and better for the harder material."

One of the big advantages, says Lujan, is that "the Haas machines are all the same. If you can run the VF-2, you can run the VF-4, or the VF-8. The controls are all the same. The things that really make a difference in what we do are feedrate and look-ahead. The Haas control makes difficult jobs easy."

"We push the limits here, and learn the truth about how fast we can cut, and what the limits are of the tool, the machine and the process," observes Saada. "We support one another, and we all profit from the other's ideas and innovation."

Allawos agrees. "Our innovative spirit generates benefits for all three companies – and, ultimately, for the industry itself."

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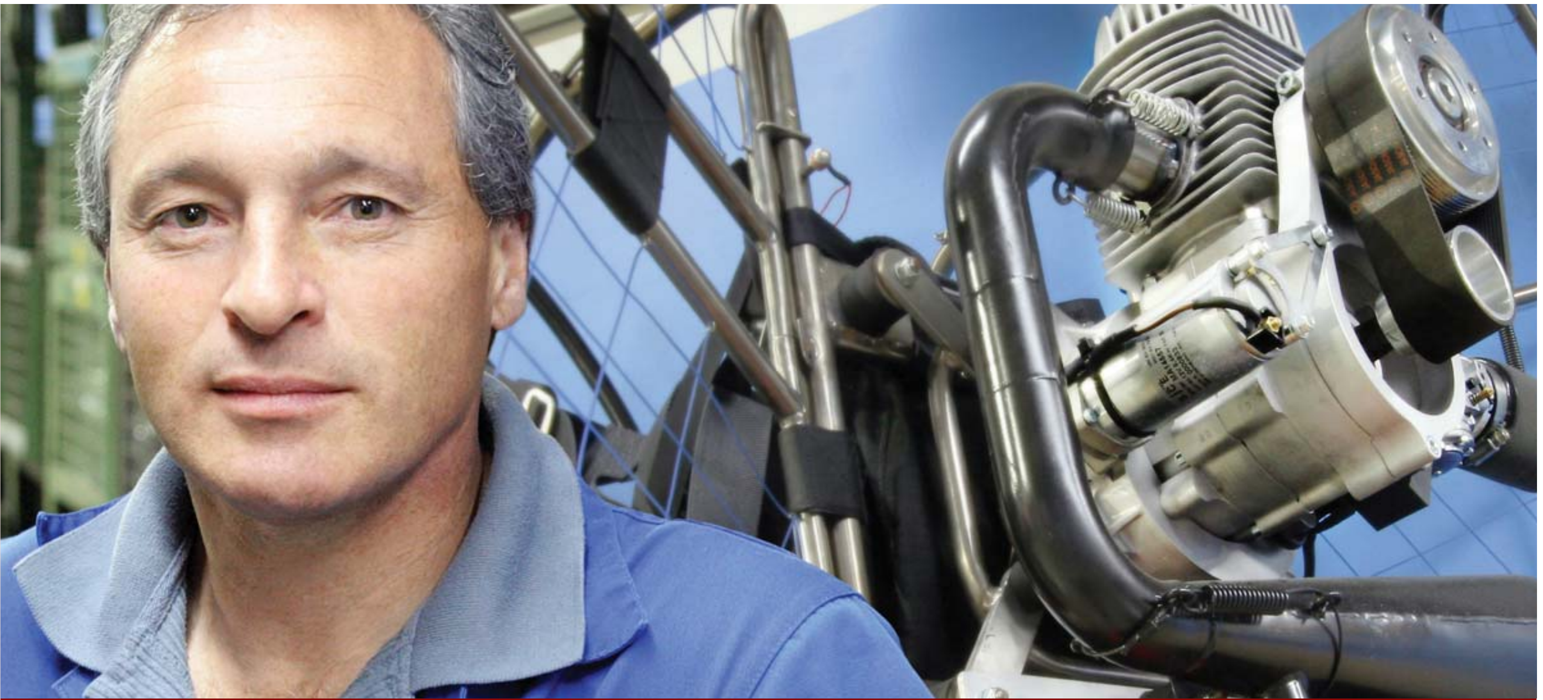
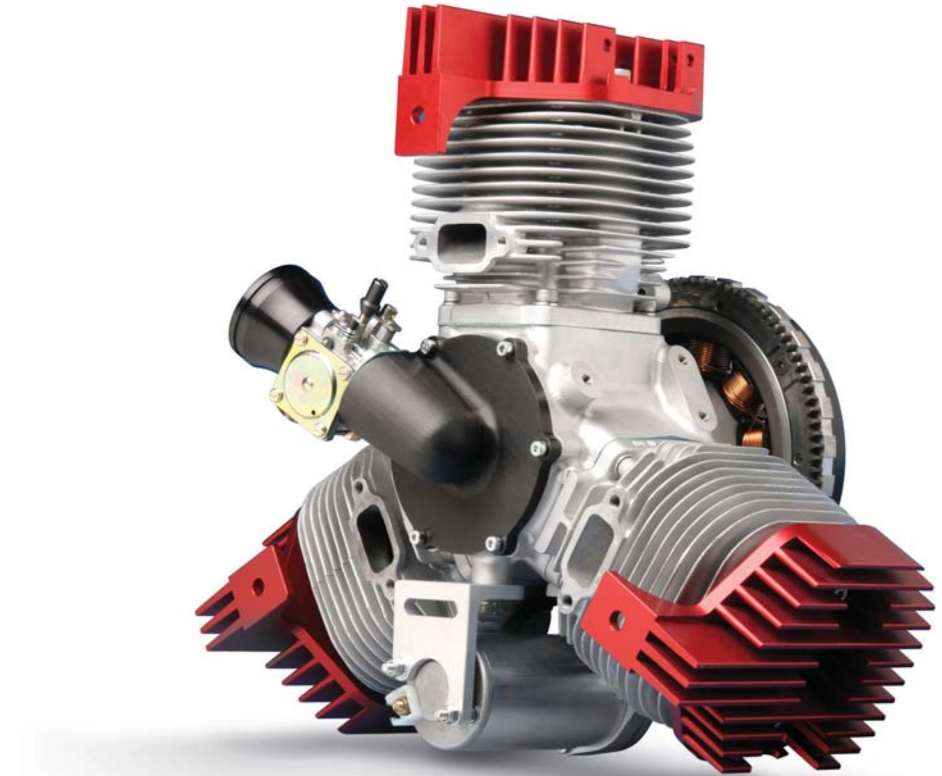


"When the only tool you have is a hammer – everything looks like a nail."

Compact Radial Engines – Matching the Machines

Story and photos by Richard Berry

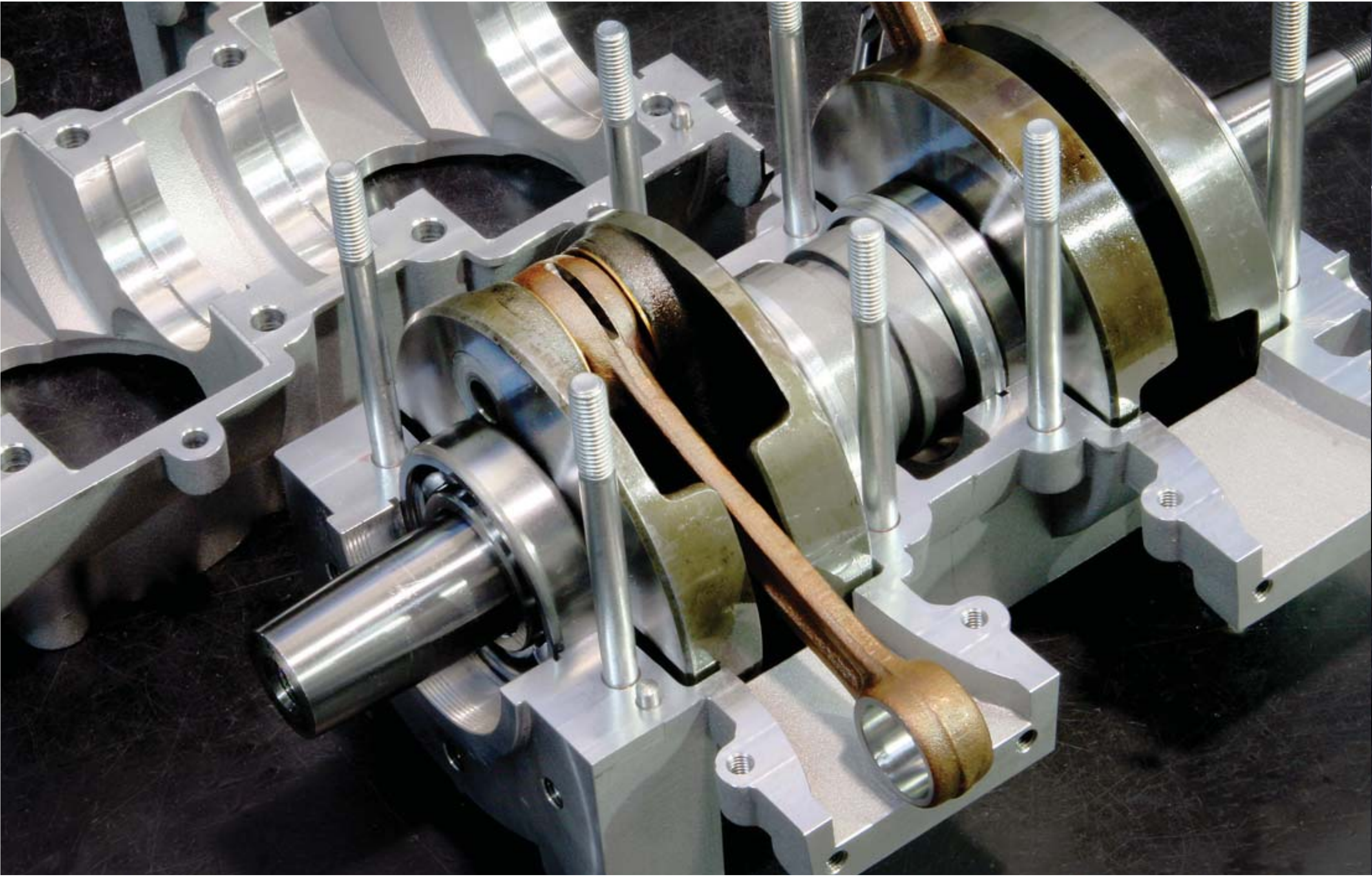


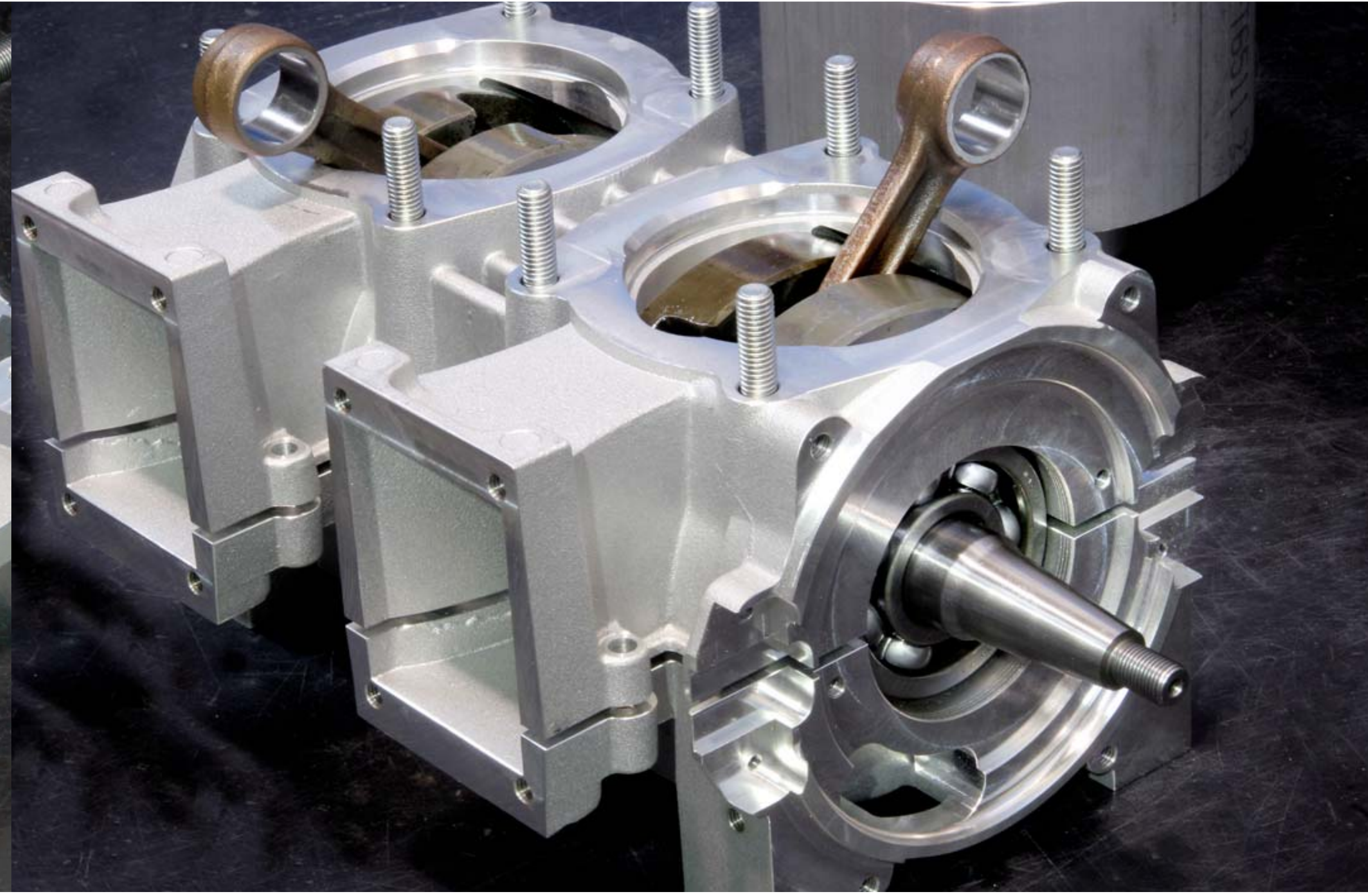
Like it or not, life is full of paradoxes. What often appears perfectly simple can, out of the blue, become much more complicated – unless you're smart.

In an interesting way, a progressive and well-respected machine shop in Western Canada illustrates this point to a "T." A lot of people tell us Southern Cross Machining is one of the smartest small-parts fabricators in the Vancouver area. Loyal clients rave – and even a few loyal competitors concede – that it's arguably the most respected job shop in British Columbia. Apparently, the reputation is well earned.

With a sharp eye on quality control, intelligent workflow and efficient machine-utilization, this busy shop consistently turns out exacting, tight-tolerance work – on time and to spec. For nearly two decades, an enviable parade of high-end customers has relied on Southern Cross to deliver precision parts, and these very particular purchasers haven't been disappointed. But surprisingly, in recent years, the most demanding customer has become the shop owner himself.

The name on the building – Southern Cross – is presumably borrowed from the down-under hemisphere's version of the Big Dipper, the prominent constellation of bright stars near the South Pole. It's your first hint to the shop's heritage. But even if you miss the celestial clue, you'll immediately grasp from owner Leon Massa's engaging accent that he's a transplanted Aussie. "Well, you're dressed up like a dog's dinner!" he'll taunt, with a solid handshake and a wry smile.





Next you'll notice an abundance of sport-aircraft pictures competing for space among the framed awards adorning the wall. That's your second giveaway. Sharing the same roof with Southern Cross Machining is a separate company christened Compact Radial Engines: a manufacturing venture turning out 2-stroke engines and reduction-drive gearboxes for ultra-light sport aircraft.

As you might guess, Leon Massa's machining background has deep roots in aviation. He admits to a formative 10-year stretch with Qantas Airlines in Sydney, then a stint at Air Canada, before buying a lathe and setting out on his own. Massa shrugs off the notion that this aeronautical experience makes his shop more obsessed with precision, but his customers might disagree with that assessment. To a large degree, the shop's stellar reputation stems from its ability and know-how to deliver high-precision parts.

"Qantas never called us machinists," he remembers, "we were referred to as 'fitters and turners'. So we not only made the stuff, we also had to put it together." That interesting aspect of his past – building complete assemblies – has remained a constant in Massa's business, as have the Qantas-blue coveralls that he and the shop staff (still) wear today. Bolstered by his long extracurricular interest in sport aviation, Compact Radial Engines appears to be a perfectly natural business match for Massa.

"Interesting story there," he relates. "Down at the local airfield a few years back, I spotted a beautiful little 3-cylinder radial engine, and eventually convinced the guy to tell me where he got it. I really just wanted to buy one for myself. But then, as they used to say in that old shaver commercial, 'I ended up liking the product so much, I bought the whole bloody company!'"

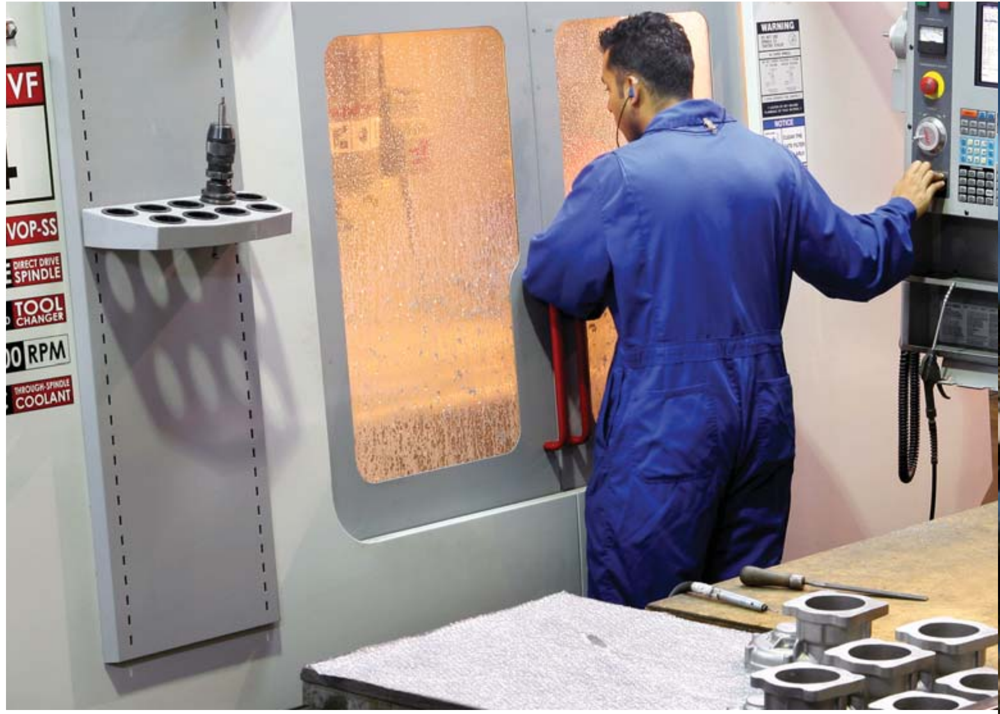
The company Massa acquired was Italian, and though their small engine designs were spectacular, their market success was not. It was a tough market to crack.

In a world full of internal-combustion engines, the ultra-light aircraft community has traditionally had a hard time finding a power plant it could wholeheartedly embrace. The sport's demand for reliable high power in an exceedingly lightweight package has driven many engine manufacturers out of business – even in Europe, where the small engine is king.

Massa set out to change things, redesigning components to improve the product's performance and appearance, and moving much of the machining to Canada. Since there are a lot of European fabricators who specialize in small engine parts, Massa buys the pistons, cylinders and crankshafts from these specialty companies. "They're all our own design," he stresses, "intended specifically for these engines. They're not just a generic part off the shelf." The crankcases, clutches and gearbox reduction drives, however, all are machined at Southern Cross.

The unusual reduction drive is often a necessity for high-rpm 2-cycle engine applications. Rotating a prop too fast will cause its tips to reach supersonic airspeeds that lead to turbulence and destructive vibration. The gearbox is an engineering and manufacturing challenge all its own: In spite of the complexity and high stress loading, its dependability must be unquestionable. "I sell the gearbox to a lot of other companies who adapt it to their engines," says Massa, "engines that are often much bigger than mine. They're being tested to 130-horsepower, but I know they can take a lot more."

Under Massa's new direction, Compact Radial Engines offered paired engine and reduction drives. These complete units matched the newest ultra-light airframes



far better than the heavier, adapted-from-other-use 4-cycle power plants that had become the sport's affordable staple. Builders of ultra-lights suddenly found they had many more choices to match the machine to the job.

But as Compact Radial Engines became a demanding new customer of Southern Cross Machining, Massa faced some machine-matching challenges of his own. "When I bought the company, I figured it would be a good fit with what we already did," he continues. "I thought I had all the equipment I needed to make the parts, but actually, I didn't.

"We couldn't let the engine company work interfere with the regular job-shop stuff for the established customers. So I decided early on that, whenever I needed parts for my engines, I'd put in a purchase order – just like any other customer." The devil, it turned out, was in the mix.

Massa has always maintained a wide range of equipment in his 10,000-square-foot shop, but it was initially stocked with expensive Japanese machines. The demands of the modest, new "just like any other" customer, though, began putting pressure on Southern Cross. The shop's underpinning of complicated machines required more effort to set up and more attention to run than the medium-price-point engine parts warranted. Things were getting complicated.

Virtually screaming for higher cost-efficiency, the shop's modest new customer had unwittingly become its most outrageously demanding.

Prior experience, however, was again in Massa's court. Besides investing heavily in complex, expensive equipment over the years, Massa had also been one of the first in his territory to incorporate simpler and more-affordable Haas Automation machines in his shop. This was back at a time when few Canadian shops had even heard of the new name Haas. Now, to meet the increased demand from the engine company, he bought more.

"I'd had a number of Haas machines over the years," says Massa, "and I always liked them. I kept my first VF-2 for more than seven years, then sold it to a friend who used it for another three years. I later bought it back from him and used it again

"I'd had a number of Haas machines over the years," says Massa, "and I always liked them. I kept my first VF-2 for more than seven years, then sold it to a friend who used it for another three years. I later bought it back from him and used it again for a couple more years before finally trading it up to a bigger one. That machine is still going in a local shop today, doing work just as accurately now as when I first had it here."

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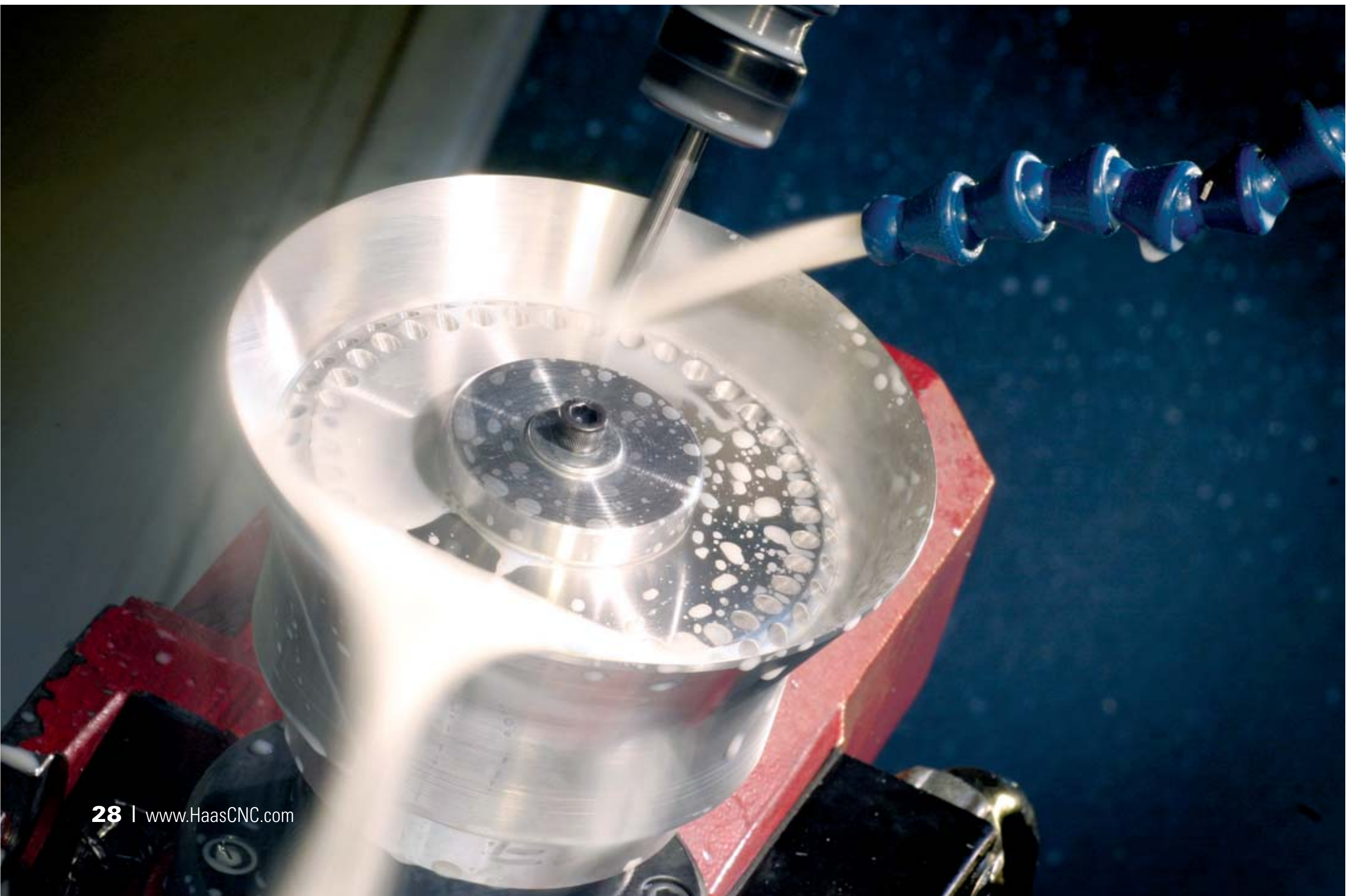
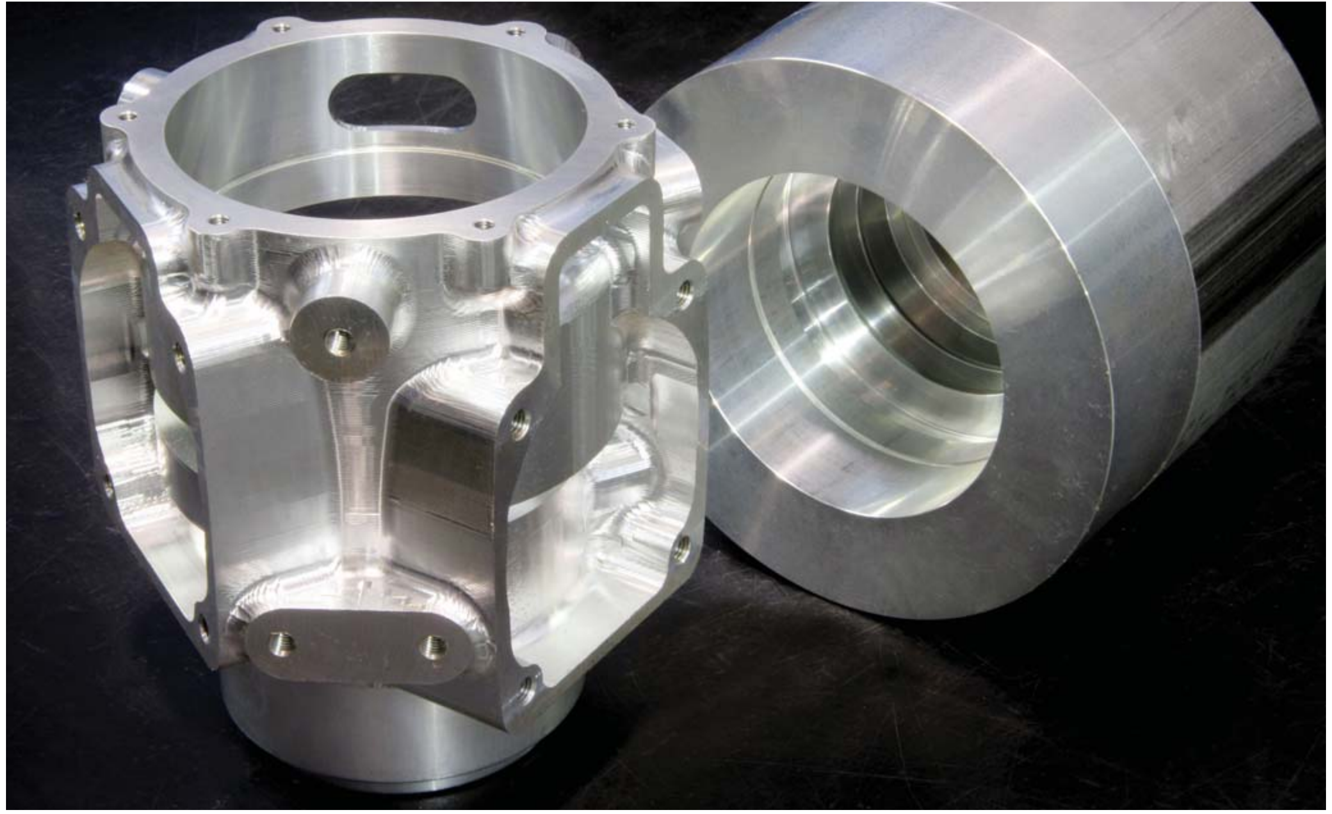
"I don't need to use a complicated Japanese machine that costs three times as much as a Haas, to do what a Haas will do," says Massa flatly. "It's not just the cost and complexity of running the high-end machines when the work doesn't warrant it – it's the time you waste that makes no sense."

Haas VF-4SS Super Speed vertical machining centers are used for much of Southern Cross's 4-axis work. "But," Massa explains, "they've also proved to be a good match for a lot of my engine parts, because they're quick to set up. I can get on a Haas and get going quickly, then move on to something else.

"I chose the VF-4SS Super Speeds because they give me so much table length and high-speed cutting capability for the price. We have a lot of fixtures and stuff set up to go straight on the Haas, and we like to leave those machines configured for 4th-axis work. It saves a lot of time to have the rotary always mounted on the end of the table – its quick to set up, and away we go. Some customers have recurring requirements that we can re-fixture and machine with a minimum of effort this way. What I'm saying is, the VF-4SS is big enough to put lots of stuff on it.

"Sometimes, I'll set up one of my engine parts on the end of the table and use the rest of the machine to do other jobs. The crankcase for the 3-cylinder radial is a good example," he notes. "For most of our engines, the crankcases are machined from Almag 535 permanent-mold injection castings. But now, for the radials, it's different.





They, too, were originally made from castings, but after buying the company, we discovered the patterns had gone through a fire. They weren't destroyed, but because of the heat, they were distorted. I didn't want to pay a fortune to have new ones made, so we took a good casting and reverse engineered it. We now make the whole thing out of a solid 2024 aluminum billet," he reveals.

"It takes two operations on the lathe and three on the mill, the longest being a 4th-axis op that takes about four hours. It's 4th-axis indexing, but it's also 3-D contouring on each surface. The finished appearance is great, and that's important," say Massa. "I have the little radial parts anodized so they look nice and sexy once they're put together. When items like this are made well and look good, you've really got a winner.

"If a VF-4SS is free, I can put the billet in, walk away, come back four hours later and there's a crankcase. But when I need the machine for different work, I can just interrupt things. I don't have to tear down the engine setup; I can leave it on the end of the table and do something else. I can work on two things at once, so to speak – a few hours here, a few hours there."

Without this flexibility, long combined operations like the three required for the radial crankcase could cause a real bottleneck in Southern Cross's shop operations. "This way, the engine doesn't steal all the machine time," notes Massa. "It lets us work around it.

"I'm always careful to not let my engine company step on my machine shop's toes. It's get it in, get it done and get it out." But that aggressive production is tempered with an important caveat: These engines have to be well made. After all, some guy might buy one, strap it on his back and go jump off Mount Robson.

"We can't just bang 'em out," stresses Massa. "They're going to fly; they've got to be bulletproof." And while crankcases don't have to be extremely accurate, – holding half a thou' is no problem – things like bearing bores do. So Massa has to trust his machines to deliver the quality he needs, every time he needs it, but without stealing too much of his shop resources.

"My engines remain a separate company from my machine shop," says Massa, "but I depend on the shop to machine them." So, a precision-obsessed job shop is tasked with turning out his consumer-oriented products. Massa can't sell those products at anything near commercial aerospace prices, so how does he make it work?

"There's no need to reinvent the wheel," declares Massa, "but smart shop management is what's demanded here. A big part of that is having the right machines, and matching the right machine to the job."

An old adage warns: When the only tool you have is a hammer, everything starts to look like a nail. We all tend to make-do with what we have, often without realizing the paradox of problems that doing so can cause. "There's definitely no need for that," concludes Massa. "It's the CNC age, mate. We're much smarter now."

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small wheels BiG PROGRESS

Story by Matt Bailey
Shop photos by Scott Rathburn
Studio photos courtesy Brompton

Thirty years ago, a young engineer and cyclist named Andrew Ritchie designed and built a prototype folding bicycle in the back bedroom of his home overlooking the Brompton Oratory in London. Little did Ritchie know at the time, but 30 years on he'd be running Brompton Bicycle Ltd, and overseeing production of 14,000 folding bikes a year: a £5 million turnover business.

For those who have never seen one of the company's small-wheeled marvels, the Brompton bicycle is one of those brilliantly conceived and unrivalled step changes in engineering design that comes along once in a blue moon.

When the three frame parts are folded, it's no bigger than a small suitcase and can weigh as little as 9 kg. It unfolds in 10 seconds, clicking into place with a rigid precision that reveals why Brompton offers a five-year warranty on its machines – all of which are still built in the UK, at its Brentford factory.

"We are the last quantity bike manufacturer in the country," says company project manager, William Butler-Adams. "In the past five years, our sector has grown by 15 percent."

Much of this growth is undoubtedly due to the general increase in bike sales. Part of it is almost certainly due to growing costs and restrictions for motorists, especially in congested areas such as South East England and central London. Prompted by the rail companies, many Brompton users carry their bicycles on the trains – assembling them at the station to complete the last part of their daily commutes.

In years gone by, the bike was the reserve of the die-hard Brompton enthusiast – a slightly eccentric, often besuited figure derided by mainstream peddlers. These days, more and more frustrated commuters are seeing the light.

"For a long time, the bike wasn't well understood by the cycling fraternity," admits Butler-Adams. "Hinges can lead to difficulties regarding front and rear wheel alignment, rigidity, safety and responsiveness," he says. "The accurate machining of these hinges is crucial to avoid rock and movement. The cynics considered hinged bikes a flawed concept."

An unfortunate state-of-affairs for the company – one that did little justice for what has ultimately proved itself to be an inspired innovation.

"A bike hinge may sound like a simple component," states Butler-Adams, "but on our latest revised hinge we are using cutting-edge technology, such as 3D CAD modelling, rapid prototyping with resins and a state-of-the-art CNC machining centre. All of this means that we can produce components to very tight tolerances, giving us increased quality and longer product life."

The new Brompton hinge is the biggest change on the bike for 15 years, and technically one of the most challenging ever. As part of its development phase, Brompton spoke to a number of possible machine tool suppliers. According to Ritchie, it was the positive attitude of Norwich- and Leicester-based Haas Automation UK (sole UK distributor of the U.S.-built machine tools) and their enthusiasm for the project that prompted Brompton to place an order for a Haas VF-1 40-taper vertical machining centre.

"We'd heard very good things about the standard of engineering on the Haas," says Ritchie, "plus we spoke to another company that was using a Haas machining centre and they gave us the thumbs-up. Of course, price was also a factor. All in, the VF-1 was exactly what we were looking for."

Before the arrival of the Haas, all of Brompton's hinges were manufactured on a machine tool designed and built in-house by Ritchie himself.

"The bespoke machine is fairly inflexible," he says. "So it was time to replace it. However, the problem wasn't finding a machine to do the job, it was finding a solution to the technical aspects of the project, such as the workholding, methodology and the ergonomics. It seemed there were a million ways of making the components, and we needed someone to help us find the most efficient and cost-effective. We had enough to worry about with engineering the bike, so it was time to call in machine tool professionals."

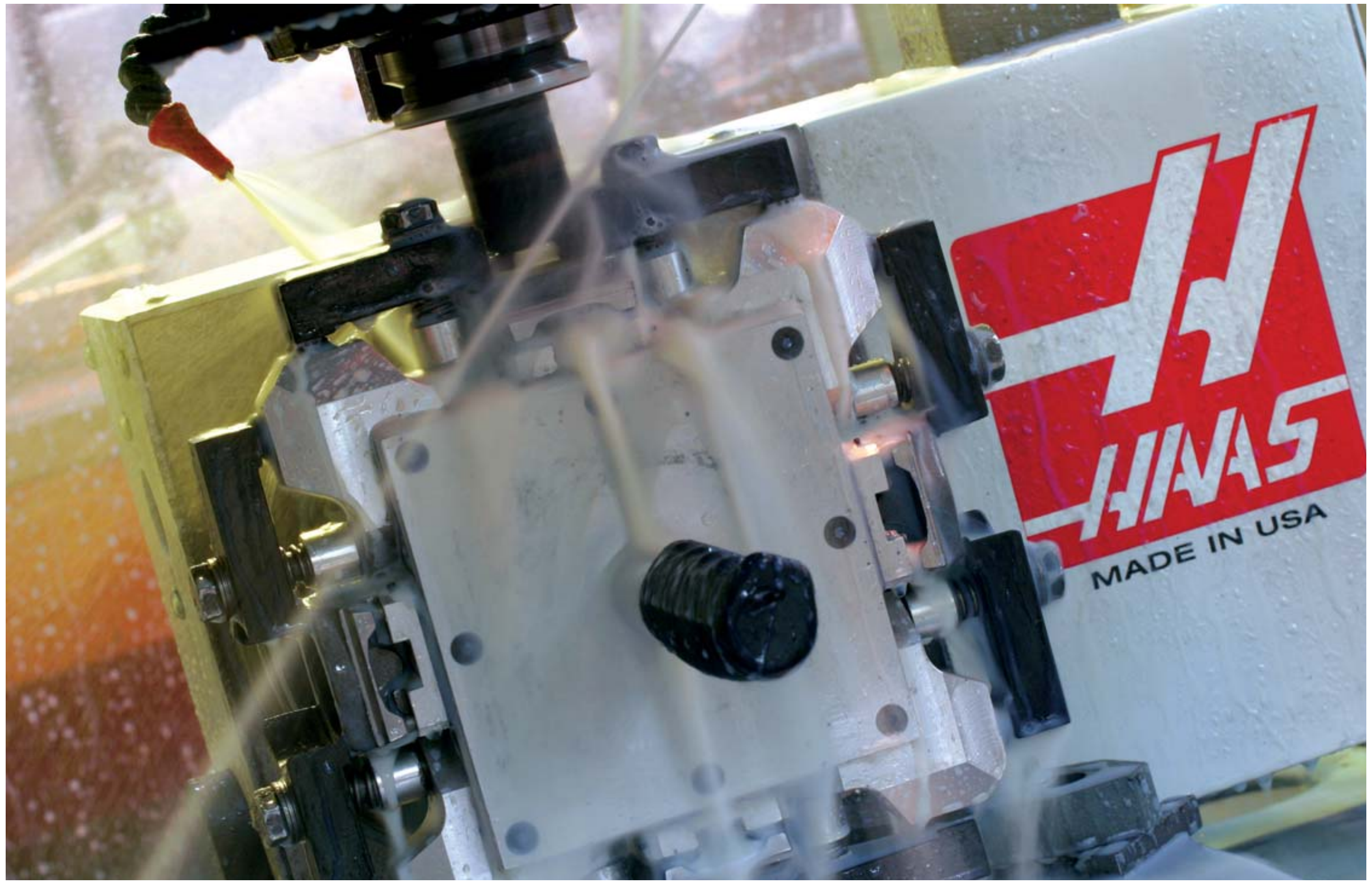
Realising they were going to have to work hard to reach Ritchie's standards and expectations, Haas UK set about designing a method for clamping the cast-iron hinge, including a solution that would be able to compensate for the irregularities of the cast faces.

The solution is based on a Haas QuikCube multi-fixture system, where a hinge casting is loaded using an innovative locating/aligning mechanism. This is repeated four times – on the four faces of the cube – and the whole QuikCube is loaded on the VF-1. The rotary table and right-angle heads on the VF-1 mean that the hinges are completed in a single setup – four at a time – something that Brompton was never able to achieve previously. Tolerances are ± 0.05 mm on critical dimensions.

"While this project was originally conceived to improve the fatigue life of the hinge, the Haas VF-1 gives us so much more," says Butler-Adams. "It improves our efficiency, reduces our cost base and increases our productivity by 20 percent with the same workforce. We now have enough capacity to tackle important new markets. It also provides better accuracy than we ever hoped for, and we now have total flexibility to make different types of hinges. In fact, when it comes to versatility, it's brilliant," he enthuses. "We simply pick up a different cube, load the parts, press the Cycle Start button and away we go."

And it seemed that the engineering department at Haas UK's Leicester Technical Centre – like the machine itself – exceeded Brompton's expectations.

"The project support from Haas UK was superb," says Butler-Adams. "I think many suppliers would have walked away when they saw what we were asking, but Haas kept working at the problem until we had what we wanted; it really made all the difference. We developed a good relationship and we got through to the end."



According to Butler-Adams, the operator has found programming the Haas as easy as, well . . . riding a bike. Quoting the training operation as a "real success," the operator is regularly shaving time from machining cycles. Important time savings, when you consider that working flat-out, the Haas VF-1 will process 45,000 hinges a year with plenty of capacity for more. However, Brompton is the first to admit they are not in the "volume" market.

"My aim is not to pick up production and move it to Asia, especially with high-technology components such as the hinge, which make the Brompton what it is," says Butler-Adams. "We don't and can't operate in the £300 bike market – that's not where we are. We make high-quality bikes that are capable of thousands of miles and last for years. Our standards are very high, and our customers are people who have done their research and realise they are buying the best. Most of our components are bespoke, such as the brakes and the gears."

Incredibly, even the tread on the tyres is a Brompton design.

"In terms of the VF-1, if we as a company are not prepared to invest in the sort of technology that makes us more efficient and improves our products, then the competition will have us for breakfast!" exclaims Butler-Adams. "The machine has been a revelation. We couldn't have taken the new hinge into production without it and the support from Haas UK."

As for Ritchie, with the air of a vindicated man he concludes: "I always thought it was a good idea to have a bike you could carry around with you."

For all the cynics out there: a salutary lesson in patience, perseverance and engineering creativity.

www.bromptonbicycle.co.uk

ROMEO UNDER ICE

STORY BY BRAD BRANHAM
PHOTOS COURTESY OF JEFF BLAIR

ANTARCTICA – THE PERFECT SPOT FOR A MANUFACTURING ENGINEER!

ROMEO

NOW, I REALLY BEAR NO ANIMOSITY TOWARD ENGINEERS, and I don't propose that we should send 'em all to Antarctica. But for Jeff Blair, Antarctica has some distinct advantages. Blair, an engineer at Magee Scientific, is the developer of ROMEO – the Remotely Operable Micro-Environmental Observatory. The unique environment of the Antarctic sea floor provided the perfect conditions to test his creation.

Blair designed and built ROMEO to help marine scientists study the plentiful, but mysterious, single-celled sea creatures known as foraminifera (for-AH-min-IF-era). Most of these amazing tiny organisms live on the deep ocean floor, but some large species live beneath the Ross Ice Shelf in Antarctica, where the water is cold and the sea floor is relatively near the surface. The large foraminifera, or "forams," found in Antarctica can be seen with the naked eye, which makes them easier to study than their microscopic cousins.

Fossilized forams provide researchers with clues to (among other things) prehistoric environmental conditions, and studying the glue they use to make their shells may lead to a wide range of industrial and medical compounds. Unfortunately, high winds, below-freezing temperatures and the need to use divers make studying Antarctic forams in-situ difficult.

The idea for ROMEO began as a discussion of these problems during a chance meeting between Dr. Tony Hansen, president of Magee Scientific (Berkeley, California), and Dr. Samuel Bowser, who specializes in the study of foraminifera. "I met Sam at a bed-and-breakfast in Christchurch, New Zealand," Hansen recalls. "We were both in transit from McMurdo Station (Antarctica's largest research community), and he told me about some of the difficulties he'd encountered during his research."

Dr. Bowser wanted to be able to study the organisms year round, but the 100-mph winds, indescribable cold and six months of darkness tend to make the Antarctic winters a little too uncomfortable to pursue outdoor scientific fieldwork. Observing forams was confined to the summer months, and could only take place during twenty-minute sessions by divers. What researchers needed was an underwater instrument that could be positioned to observe foraminifera 365 days a year – and transmit the images to scientists for study in a more reasonable environment.

"Dr. Bowser explained what he needed," Hansen continues. "Then I contacted Jeff Blair and asked him if he would like to take on the project." Blair was an engineering student at Worcester Polytechnic Institute (WPI) in Massachusetts at the time, but had previously worked with Hansen on an instrument for measuring airborne pollution.

Blair accepted the challenge to design ROMEO after discussing it with Dr. Gretar Tryggvason, head of the Mechanical Engineering Department at WPI. "I suggested he do it as a capstone, or major project," explains Tryggvason. "The student's major project must put all their skills together and have a practical result. It must be directly related to their major, and must be completed successfully as a condition for graduation. Blair could travel to Antarctica as part of the project, and receive credit without interrupting his course of study."

The arrangement was ideal, but the project presented Blair with some pretty tough issues. ROMEO had to survive for long periods of time in an extremely hostile environment, so its parts had to be made to a high level of precision. It had to be rugged enough to withstand low temperatures and elevated pressures, and the seals had to be absolutely watertight around the fiberoptic cables and the mating surface between the Lexan® dome and housing. The camera also had to be able to zoom and pan smoothly, and function well in near-freezing temperatures.

Blair worked out the designs around a Sony SNCrz30N™ webcam, and used WPI's Haas Technical Education Center (HTEC) for the prototype work. Haas Automation provides the HTEC with up-to-date Haas machine tool technology through the local Haas Factory

Outlet in Hartford. This relationship proved essential to the ROMEO project, allowing Blair to utilize the latest machining technology to prototype his designs, and integrate any modifications with minimal expense.

"With the Haas machine shop on campus, we were able to get the job done without long delays," observes Blair.

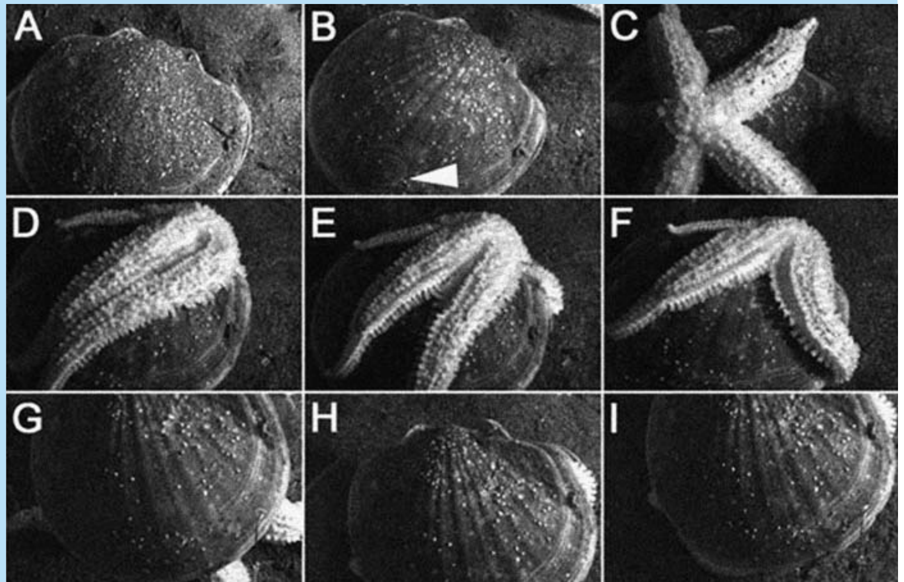
Dr. Bill Weir coordinated the machining portion of the project, and WPI graduate David Hyman fabricated the internal brackets and housings for ROMEO. "The housing cylinder was cut from an off-the-shelf 12" diameter Lexan tube," recalls Weir. "It was 22" long and 3/4" thick, with a Lexan cover plate. A precision plastics shop made the camera dome to our specifications.

"We used a Haas VF-3 machining center to make most of the internal parts. Many were small, intricate, difficult-to-machine brackets and components, mostly out of aluminum and stainless steel. Making brackets to hold parts and fit them into a tube with six military lithium-ion batteries was a challenge," Weir adds.

Once in Antarctica, Blair faced some unexpected problems with the device. First, a leak developed in the tube during testing. "The compound used to bond the stainless steel flange to the Lexan tube failed," Blair explains. "Fortunately, we were able to correct the problem with an additional O-ring on the baseplate and the dome."

Another problem came in the form of an unexpected intruder. ROMEO was focused on a captive scallop to observe the foraminifera on its shell. Soon after placing ROMEO, a sea star attacked the scallop, ate it and moved on – repositioning the shell out of the scan range of close focus, and hampering the study. "As engineers, we tend to focus on the technical challenges," concludes Blair, "but sometimes we don't really think about what biology can do." Regardless of your point of view, the sea star had an expensive snack.

ROMEO is now hard at work in Antarctica, observing foraminifera and sending real-time images to scientists for study in a more comfortable environment. In a sense, it is a brother to the Mars Rover: Both work in harsh conditions and send information to be studied remotely. And both were – to a significant extent – made on Haas machines.



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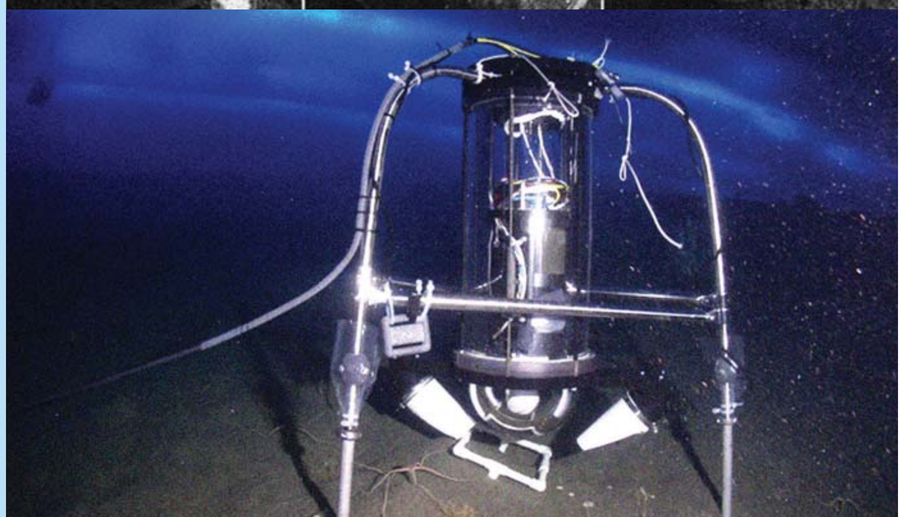

The Cruise of America
by Richard Berry

Route 66. The Mother Road. The Main Street of America.

Last October, 80 years after the legendary Route 66 was commissioned, a professor and a group of vintage-car buffs and students from Oakland University (Rochester, MI), hit the Mother Road on a 2800-mile odyssey to drum up interest in manufacturing careers. With the help of a movie-star muscle car, they set out to capture the imagination of a new generation of students, and encourage their interest in automotive manufacturing.

Dubbed “Cruise of America” – and led by a bright-red ’66 Dodge Charger previously seen in the top of a tree and at the bottom of a lake in the movie *Big Fish* – the journey followed old Route 66 from Chicago’s outer loop to Santa Monica’s famous pier. Along the way, the group stopped at high schools and community colleges to spread the word about modern American manufacturing.

The “Cruise” was organized by OU’s PDMC Motorsports student racing team, under the direction of Dr. Patrick Dessert. Dr. Dessert is associate professor of industrial and systems engineering at OU, and director of the school’s Product Development and Manufacturing Center in the School of Engineering and Computer Science.

“We wanted to reach out to technically-minded kids who maybe hadn’t thought much about an automotive career, or didn’t know how to go about getting one,” says Dr. Dessert. “It’s a familiar problem in education today. Students just aren’t being attracted to careers in manufacturing; they’re not being shown the opportunities and the rewards. So we set out to get their attention and change things. And I believe we did. Even if the excitement of seeing our student-restored ‘Big Fish’ Dodge just motivates a kid to enroll in Auto-Tech at the local community college, then we succeeded.”

OU’s PDMC Motorsports program lets students modify and tune a production car for professional racing. It’s a popular and successful program that has helped spawn a new Motorsports System Engineering Degree at Oakland – the first 4-year degree of its kind in the nation. Haas Automation, which actively promotes and supports education in the metalworking fields, is one of the sponsors for the program.

“Motorsports is the most popular phenomena on the planet today,” says Dr. Dessert, “and it’s the only sport that builds an industry. It’s the perfect platform for us to reach and motivate future manufacturing students. It’s these young people who are really passionate about cars, that we need to rebuild our industry.”

Photos by Richard Berry

Starting Early
by Brad Branham

Go to high school. Get college credit. Strengthen manufacturing. What’s not to like?

California recently enacted a bill that encourages public-school students to seek careers in manufacturing. Signed into law in 2005, SB 70 provides funding for “Quick Start Partnerships in Applied Competitive Technologies.” These partnerships encourage technical programs in public schools through cooperation with local community colleges.

Taking advantage of the new law, the North Orange County Regional Occupational Program at Western High School in Anaheim, Calif., is collaborating with nearby Fullerton College to teach students metal-cutting skills using a variety of CNC machines. The students receive college credits for the experience.

Photo by Brad Branham

Fullerton College Machine Technology instructor Dan O’Brien, left, discusses Mini Mill programming procedures with student Daniel Burris.

Beginning in February 2007, about 30 students from Western High School – along with other neighboring high schools – will participate in a five-week program, attending classes at Fullerton College on consecutive Saturdays. Steve Heck, Western High School machine and CAD/CAM instructor, could not be more enthusiastic. “It is crucial that we interest future machinists early,” he states. “They are a very important national resource.”

One of the challenges of getting high school students interested in manufacturing is overcoming public perception. “Some people have the idea that manufacturing is dirty, and doesn’t pay well,” Heck explains. “We must educate the public to change their stereotyped perception of machine operators to the image of today’s skilled, educated technicians.”

To counter the negative perception, Western High School has an aggressive manufacturing program. “We are updating our courses constantly,” Heck comments. “We have a new Design and Fabrication for Engineering curriculum, and we are working on other things –AutoCAD®, SolidWorks®, CNC and conventional machining.” Western has several manual machine tools and one CNC mill, a Haas TM-1.

The collaboration with Fullerton College provides access to additional CNC equipment, including four Haas Mini Mills and a Haas SL-10 lathe. Dan O’Brien, Fullerton’s Machine Technology instructor, agrees with Heck about the machinist image, and is enthusiastic about the partnership with Western.

“The intent is to interest and inform high school students about how products are made with modern manufacturing methods. The program is set up to show students that manufacturing is not the greasy, stereotypical machine shop that, unfortunately, is the perception held by lot of people,” O’Brien says. “It’s set up to show how we use computers and modeling software to design something, then take that design down to the CNC mill and make it.”

Steve Heck – Western High School – 714-713-7401
Dan O’Brien – Fullerton College – 714-992-7214

Major Expansion for Haas CNC Racing

The end of the 2006 NASCAR season saw the beginning of a new era for Haas CNC Racing. After residing for nearly 5 years in the shadow of Lowe's Motor Speedway, the organization moved its headquarters to a newly constructed $15-million race shop in nearby Kannapolis, North Carolina.

Along with a threefold increase in space, the spectacular new 140,000-square-foot shop includes technological advances that make it a world-class development facility. Among these are an R&D area filled with Haas Automation CNC machines for prototype production, and a seven-post, full-scale track simulator to model racetrack conditions.

The seven-post machine uses data gathered from test runs at specific tracks to accurately reproduce – in the shop – the dynamics of those tracks by pulsing huge hydraulic actuators (posts). The car sits on four of the seven actuators, which simulate up-and-down track stresses on the wheels and suspension. Three other actuators pull down on the chassis to simulate aero loading and weight-transfer forces. High-speed data measurements from the in-shop simulation are analyzed to guide suspension setups for each chassis on each tested track.

Only a handful of NASCAR teams have seven-post simulators, including perennial winners Hendrick Motorsports, Joe Gibbs Racing, Penske Racing and Richard Childress Racing. The Haas team will be NASCAR's fifth.

"We're looking to build competitive cars that win races," stated Joe Custer, general manager of Haas CNC Racing. "Another goal of the new technology," added Marketing Manager Carl Cline, "is to attract the absolute best engineering minds in the business."

The 2007 NASCAR season will bring a number of changes to Haas CNC Racing, including a 25% expansion in the workforce. The organization will field two Nextel Cup teams this year, along with a Craftsman Truck Series team. At press time, further details had not been announced.

Advanced Wind Tunnel

By Richard Berry

Aerodynamics has become such a critical aspect of modern motorsports that today's seriously competitive race teams must devote significant time to wind tunnel testing. Unfortunately, there are very few wind-tunnel facilities dedicated to auto racing, and even fewer built to accommodate full-sized NASCAR vehicles.

That situation will change dramatically in 2007, with the building of a $40 million wind tunnel in Concord, NC – the first 180-mph rolling road wind tunnel in North America for NASCAR racecars and other motorsports vehicles.

WindShear Inc., a company owned by NASCAR team owner Gene Haas, has contracted Jacobs Engineering Group Inc. to build the wind tunnel on a 5-acre site near Concord Regional Airport. Slated as the most advanced racing wind tunnel in the world, it will provide a 180-mph rolling road under the vehicle's tires to accurately simulate actual racing conditions. "This will be the most technically advanced wind tunnel in the United States," explains Joe Custer, General Manager of Haas CNC Racing. "It's the first of its type in North America, and only the third of this scale in the entire world."

The distinctive "rolling road" is actually a 1-millimeter-thick continuous steel belt about 11 feet wide and nearly 30 feet long. A revolutionary "thru-the-belt" sensing system will measure the aerodynamic downforce under each tire, providing handling data with greater accuracy than ever before. At the tunnel's top speed, the 22-foot diameter main fan will re-circulate 2.85 million cubic feet of air per minute, consuming 7 megawatts of power in the process.

WindShear Inc. will operate the one-of-a-kind facility with a staff of 10. The tunnel will be available for all motorsports teams and auto manufacturers to rent, complimenting other nearby research-and-development facilities in the heart of NASCAR country. When completed late in the year, the 40,000-square-foot facility is sure to become a magnet for high-tech motorsports companies the world over.

“After Thoughts”

By Brad Branham and Richard Berry

What happens* after *I buy?

For many products, this question rarely even comes into play. Rather, the key driver in the purchasing decision is price. But if you’re looking to buy a CNC machine tool, what happens after the sale is just as important as the brand or type of machine you buy – if not more so.

These days, it’s pretty much a given that nearly every machine tool builder makes a decent machine. It’s also a given that every machine tool – regardless of make, model, specification or initial cost – will, at some point, break down and require service.

The ability to provide that service – and the replacement parts that service entails – in a swift and affordable manner, is what distinguishes one builder from another. While the initial cost of a machine tool may seem significant in the short-term, the total-value equation must take into account the long-term service and support of that machine by the builder and its distributor network.

Haas Automation, Inc., is the largest machine tool manufacturer in America, and the company provides support for its products through a worldwide network of Haas Factory Outlets (HFOs). These HFOs are locally owned and operated, and dedicated exclusively to the sales, service and support of Haas machines. It is arguably the best service program in the machine tool industry.

The sales staff at each HFO is well trained, and engineers and specialists from the Haas factory in Southern California visit the HFOs regularly to address technical issues and update proficiency.

HFO service personnel are factory trained, and certified annually. They arrive at the customer’s shop in fully outfitted service vehicles, and are backed by the HFO’s extensive stock of replacement parts. If for any reason a part necessary to repair a machine is not in stock at the HFO, it is ordered from the Haas factory and shipped the same day (the Haas factory maintains a 99% same-day-shipment goal for service parts).

Haas distributors worldwide are embracing the HFO program, and setting up facilities dedicated solely to the Haas product line. These facilities feature demonstration areas equipped with the latest Haas machine tools – VMCs, HMCs, lathes and rotary products. Customers can even consult an applications engineer to help streamline their manufacturing processes. The concept has been so successful in North America that, eventually, all Haas distributors will become HFOs.

As the company’s international markets have grown, Haas Automation has spread the HFO concept throughout Israel, Asia, South Africa and the Asia-Pacific region. In the past three years, HFOs have opened in Seoul, Sydney, Shanghai, Beijing, Guangzhou, Tokyo, Kuala Lumpur, Pune and Bangalore. More HFOs will open soon in Tel Aviv, Delhi, Coimbatore, Johannesburg, Brisbane, Melbourne and at least five other cities in China, as the HFO concept proliferates.

The model is extending into Europe, too. Four new HFOs have opened in Germany, one in Spain and another in Portugal. More will open soon in Moscow, Prague and Vienna. That’s nine new HFOs in Europe, and plans are in place to have 20 more by the end of 2007.

In Latin America, a new HFO in Tijuana will join the other five HFOs in Mexico. Openings also are scheduled for Brazil and Argentina in 2007, and more HFOs are planned for Honduras, Chile, Peru and Columbia.

These international HFOs will join the more than 65 Haas Factory Outlets in the U.S. and Canada. All of these are dedicated to providing the best sales, service and support in the industry – whether the customer is in Honduras, China, Germany or the U.S.A.

Dürbheim, Germany

Lauffen am Neckar, Germany

Guangzhou, China

Quingdao, China

CNCMACHINING

the ANSWER man

Dear Applications:

I was wondering if there is a way to slow down the draw rate when running a program in Graphics mode on Haas machines. Right now, it is hard to see what is happening unless I use single-block mode.

Greg

Dear Greg

It is possible to slow down the speed of the Graphics display using single-block in Graphics mode. This allows you to manually control the draw speed of the graphics display via the jog handle. Change setting 104 (JOG HANDL TO SNGL BLK) to ON. Now, when in Graphics mode, use single-block and turn the handwheel in the minus direction (counterclockwise), one click will equal one block. With this feature you can quickly scroll through your program, yet have the control to slow down to one block at a time, when needed. If you have a very large program, you can start with single-block off and let it run at full speed. When you get close to a section of the program you need to look at closely, you can press the single-block button to halt the Graphics, and begin using the jog handle to control the speed. Setting 104 can also be useful during actual cutting or testing of a program. A turn to the left is like pressing Cycle Start, and a turn to the right is like pressing Feed Hold.

Thank you for choosing Haas as your machine tool provider.

Sincerely,
Haas Applications

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Dear Applications:

I am converting a program from another brand of machine to our Haas VF-3. The G81 canned cycle utilizes a "K19," which is the number of times to incrementally move in "X" to drill to the "Z" value. What variable does Haas use for this?

Steve

Dear Steve,

The Haas mill control has a G72 command. This command allows you to drill a series of holes in a straight line. The G72 command may be used with drilling, tapping and boring canned cycles. Use an I value to define the distance, incrementally, between holes, and an L value for number of holes. This line can also be at an angle. You specify the angle of the line of holes with a J command. The J value is the angular starting position, and is always 0 to 360 degrees counter-clockwise from the 3 o'clock position. Refer to your Operator's Manual for more information about using G72 with canned cycles.

Another way to do this is with a G91 (Incremental Positioning) command. Here is a simple program to drill 100 holes in a grid plate using G91, and an L command for the number of times to repeat the G81 drill cycle along the specified axis.

```
%
O3400 (Drilling grid plate)
T1 M06
G00 G90 G54 X1.0 Y-1.0 S2500 M03
G43 H01 Z.1 M08
G81 Z-1.5 F15. R.1
G91 X1.0 L9
Y-1.0
X-1.0 L9
Y-1.0
X1.0 L9
Y-1.0
X-1.0 L9
Y-1.0
X1.0 L9
Y-1.0
X-1.0 L9
Y-1.0
X1.0 L9
Y-1.0
X-1.0 L9
Y-1.0
X1.0 L9
Y-1.0
X-1.0 L9
G00 G90 G80 Z1.0 M09
G28 G91 Y0 Z0
M30
%
```

Sincerely,
Haas Applications

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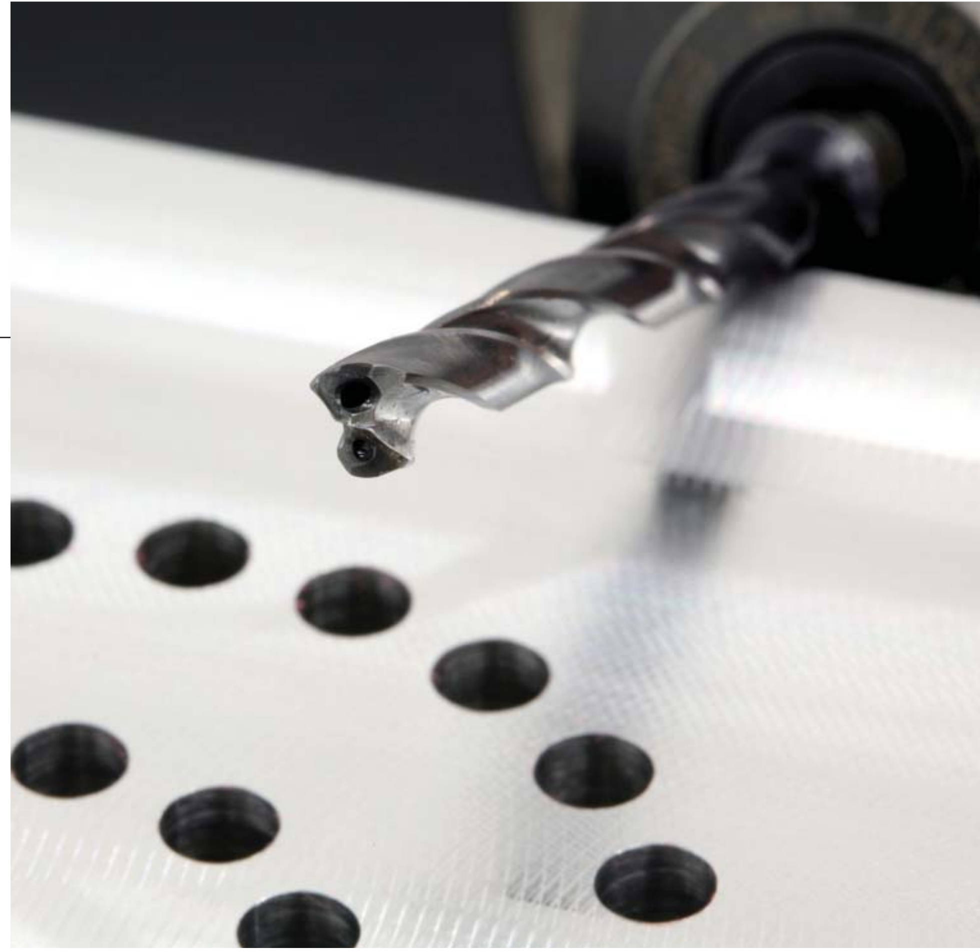

Dear Applications:

We are ready to order a machine and I have a question about the 300-psi through-spindle coolant option. We will be drilling 1/8" diameter holes with through-spindle coolant. The drills have 0.010" diameter coolant holes. Will 300 psi be enough pressure to provide sufficient coolant?

John

Dear John,

With small holes in the drill like you mention, 300 psi won't push the coolant out with enough pressure to clear the chips. Haas Automation does have an optional 1000-psi through-spindle coolant option, and your type of application is exactly what it was designed for. If you are drilling deeper than four times the diameter (1/2 inch in your case) this can be an extreme application. Because the drill diameter is so small, the chips may begin to clog the flutes of the drill. I highly recommend using the 1000-psi through-spindle coolant option with the G73 high-speed-peck canned cycle for drilling. This cycle will peck to break the chips, but will not retract all the way out of the hole on each peck. When the chips are broken, they are much easier to evacuate with the high-pressure coolant.

Sincerely,
Haas Applications

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Dear Applications:

We seem to have lost our Operator's Manual for our VF-4. How can I get another copy?

Andrew

Dear Andrew,

The current version of the Haas VF-Series Programming and Operator's Manual is available as a free download from the Haas Automation website. Go to www.haascnc.com and click on Customer Service. Then, click on Manual Updates. This section of the Haas website contains the latest updates to the Haas Operator's Manuals, as well as a host of other useful information. Here you will find the most up-to-date information about new machine options and features, details of the latest software updates and the most recent product addendums. These documents are in .pdf format for easy downloading and printing. You will need Adobe Acrobat Reader® to open the files.

Sincerely,
Haas Applications

• • •

Roll Credits.

Coldfire Processors

Built-In USB Port

40 GB Internal Hard Drive

Color-Screen Remote Jog Handle

15-Inch Color LCD Monitor

Intuitive Programming System

Wireless Probing System

Minimum Oil Machining System