volume 5
number 16
winter 2001

# CNC MACHINING

## The road from prototype to reality

# CNC MACHINING

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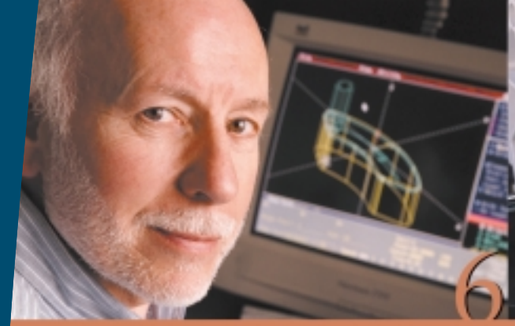
**cover photo:** Randy Lorentzen / Planet R Inc.


**THE MASTHEAD**

*CNC Machining* is published by Haas Automation, Inc., 2800 Sturgis Road, Oxnard, CA 93030, 805-278-1800, Fax 805-988-6918. Postmaster: Return invalid addresses to Haas Automation, 2800 Sturgis Road, Oxnard, CA 93030-8933 postage guaranteed. *CNC Machining* is distributed free of charge by Haas Automation, Inc., and its authorized distributors. *CNC Machining* accepts no advertising or reimbursement for this magazine.



*CNC Machining* is distributed through a worldwide network of Haas Automation Distributors, and by individual subscription request. Contact Haas Automation headquarters via mail or fax to be added to the subscription list. Published quarterly. © Haas Automation, Inc. & *CNC Machining* Magazine names. Designed and printed in the U.S.A. CPC # 1563572. www.HaasCNC.com

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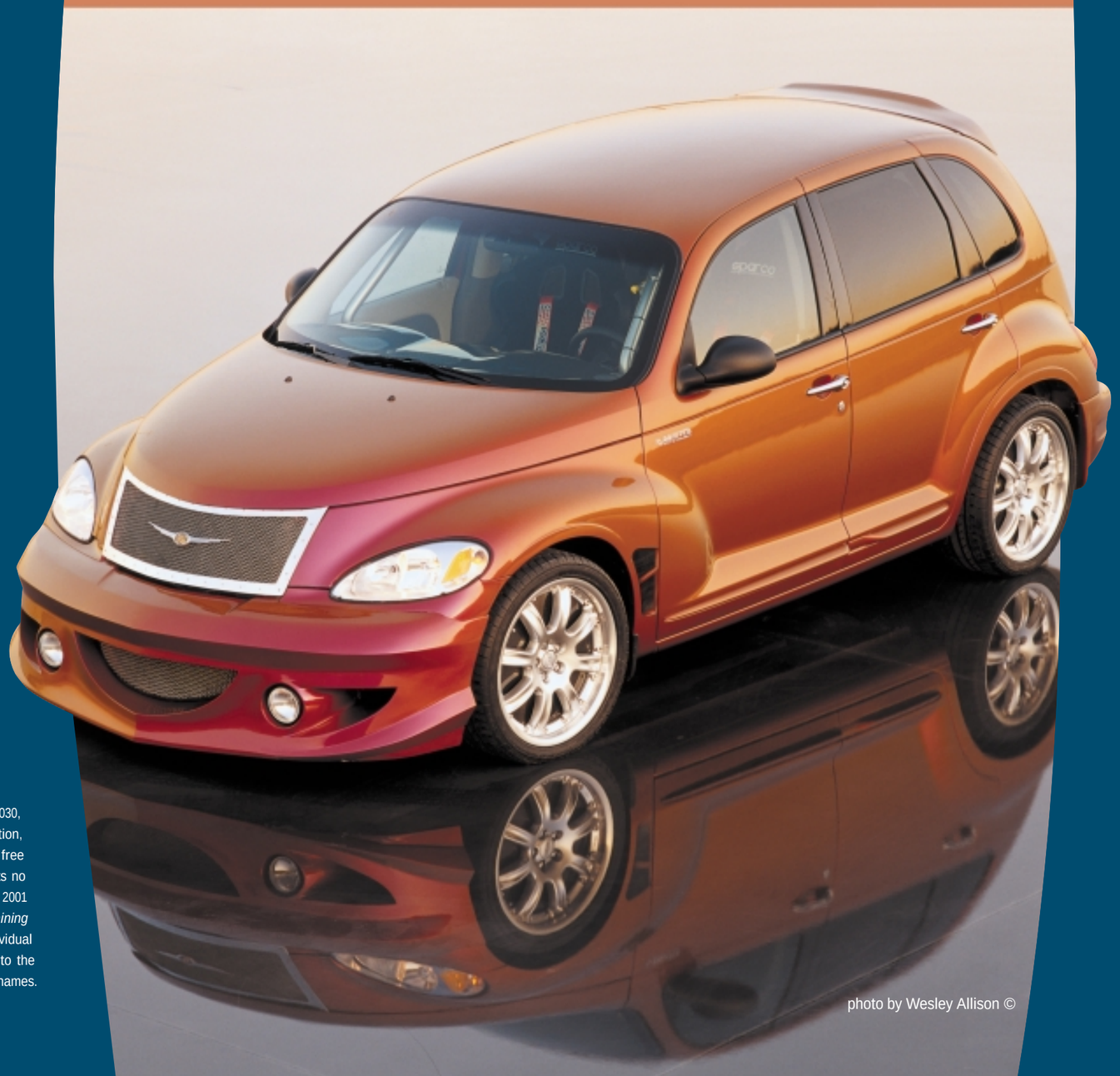


photo by Wesley Allison ©

# in this ISSUE

Yes, it's another year, and, depending upon which millennium camp you belong to, it is the real first year of the 21st century. The fact that you're reading this is a good indication that the world has, once again, escaped Armageddon (unless, of course, you consider the whole presidential election fiasco as being the end of the world as we know it).

On the whole, the year of the double zero was pretty good for the metalworking industry – sales were on the rebound from the serious slump that was 1999, and the continued strength of the economy spurred plenty of new products and renewed growth. For Haas Automation, 2000 was the best year ever.

It was also a very good year for the Driscoll family of Hamilton, Michigan. They were the lucky winners (actually, Mindy Driscoll was the official winner) of the Mini Mill giveaway at IMTS 2000. The Driscolls run a small job shop that services the plastic injection molding industry. We paid them a visit to see Mindy's Mill in action.

Since we were already in Michigan, we stopped by Ranger Tool & Die, an automotive prototype shop that services the Big Three auto makers. Over the years, Ranger has machined parts for some of the coolest vehicles to come out of Detroit – the Viper, the Prowler and the PT Cruiser, just to name a few – and Haas VMCs have played an essential role.

Precision machining is just as essential in the automotive aftermarket. Our story about OE Quality Friction in Toronto, Canada, shows how founder Norman Abbott took his company from startup to profitable concern by machining his own tooling for disc brake pads in-house.

And there's much more in this issue: We spoke with several women in the manufacturing industry to get their views on working in a primarily male-dominated business. We visited a shop in Northern California that successfully competes with metropolitan shops, while maintaining a higher quality of life away from the urban sprawl. And there's a piece on selecting the right CAD/CAM system for your budget and workload, while leaving the door open for future upgrades and expansion.

All in all, it's a great issue . . . so sit back, relax and enjoy!

# And next . . . the World

As we close out the real millennium (as opposed to the changeover from the 1900s to 2000) it is time once again to reflect on our past successes, almost successes and areas for growth and improvement. It is also time to say thank you to those who helped along the way. I want to pause in the past only for a moment to reflect on one of last year's biggest successes: the Haas Factory Outlets (HFOs).

As our distributors opened their Haas Factory Outlets, they took on a life of their own. Our customers immediately seized upon the benefits that the HFOs would bring them: dedicated sales people, dedicated service people, dedicated applications people, customer advocates and all of the attention paid to their needs. Service vans stocked with parts to maintain a 90% first-call repair rates have proven extremely effective in reducing downtime, and proven cost effective for the HFOs. The HFO concept has proven more successful for everyone than could have been anticipated. For that we have to thank our customers and the owners/operators of the Haas Factory Outlets across the country.

As we look forward, where are we going? With the globalization of all markets, we are taking control of the export markets with a clear vision. The new Haas Automation distributor in South Africa opened his new facility in 2000 to resounding success. The changes that have come in South America over the past year are starting to take root, and the new millennium will see the fruit of the labors of all involved in this market opportunity.

We will open Haas Automation Korea in January in partnership with our current Korean distributor, to offer all of our products through the Factory Outlet model. Our new facility will house a showroom, classrooms, spare parts inventory and a turnkey area to meet all of the customer's needs.

The opening of Haas Automation Europe marks the launch of Haas branded products in Europe, beginning with Germany, Scandinavia, Spain and Portugal. The new Haas Europe head office in Brussels will open in February, with five Haas Technical Centers opening in Germany in the same month. The rest of Europe will follow on a scheduled basis until all of the markets have access to locally owned and operated Haas Technical Centers.

All of this activity begs the question: What do we want to be when we grow up? The new millennium is a time to set new sights, open new doors, look for new opportunities and form new relationships. We have only just begun down that road, and we are cautiously optimistic that it leads to a renewed beginning for U.S. manufacturing. That renewed beginning will only be possible if we choose to travel that road together.






# Mini Mill from Heaven

by Olaf Wolff

Timing is everything. Perhaps a trite and often overused cliché, but just try to convince the founder of Haas Automation, or Tom and Mindy Driscoll, that it isn't true. Tom runs a small job shop set up in his converted barn in Hamilton, Michigan, a few ticks of the odometer outside of Grand Rapids. Tom's a third-generation machinist.

The Driscolls' two sons – Zeb, 16, and Charles, 15 – are home schooled, and more times than not the four of them work together in the barn shop. The Driscolls, pictured at right, are devoutly religious and uncompromisingly family oriented. They radiate warmth and generosity – the manifestation of a Norman Rockwell family portrait.

The home schooling appears to be working well for them. Between Zeb and Charles, they play about 15 musical instruments (we lost count). They also rebuild their own high-performance truck engines, they are both computer literate and Dad says they're getting the hang of operating a CNC machine tool.

So what's any of this have to do with timing? Everything. Last September, Tom and Mindy had planned to drive their sons to Chicago for IMTS, figuring it would be interesting for the entire family. As fate would have it, right before the planned departure day, Zeb got sick, postponing the trip for a couple of days, a delay that would perfectly align the structure of circumstances for what was to happen next.

Visitors to the Haas booth at IMTS 2000 had the opportunity to register to win a brand-new Mini Mill. By swiping their attendance cards at the booth, they were automatically entered in the contest. The winner was selected after the closing of the show from a total of 10,998 entries. The entries were compiled into a database and each was assigned a number from 1 to 10,998. Gene Haas then used a random number generator to personally select the winner. Who's to say for certain if it was the Driscolls' delay that positioned Mindy's card swipe in the winning order, or if Gene's uncanny touch for timing made the difference – the point is, Mindy Driscoll won. Driscoll Machine Shop now has a shiny new Mini Mill – affectionately and appropriately renamed "Mindy's Mill."

Tom has been involved with CAD/CAM and 3D milling for more than 9 years and is quite the whiz at it. His primary source of income is machining for the plastic injection molding industry, but he also works part-time at a local company called JCI, programming and milling headliner tooling parts for the automotive industry.

Please see DRISCOLL page 34

## New Mini Mill Far Exceeds all Expectations

From its inception, the new Mini Mill (16" x 12" x 10" travels) from Haas Automation has been a very popular machine. With its unique combination of big features, compact footprint and small price, the diminutive VMC appeals not only to small shops, but large shops as well.

For smaller shops, or those just starting out, the Mini Mill provides an affordable first step into CNC, or a way to increase capacity without breaking the bank. For large shops, and those firmly established in the industry, the Mini Mill is a capable small-footprint (6.5' x 6.5') machine that's perfect for performing second operations, or for machining smaller jobs that would otherwise tie up a bigger machine.

According to Bob Murray, Haas' operations manager, the demand for the Mini Mill has been tremendous. "We knew it would be a popular machine," he said, "but the response has been even better than we expected."

This exceptional response, however, has posed no problems for the Haas production facility, says Murray. "We anticipated the demand," he explains, "and established a separate production line exclusively for the Mini Mill. We have an automated FMS (flexible manufacturing system) set up

Please see EXPECTATIONS page 34

To view the Trade Show Calendar for 2001, log onto www.HaasCNC.com

Haas Automation is entering its fifth season of technical sponsorship in motorsports competition with several prominent winning teams running the Haas logo in 2001.

Relationships between team owners and sponsors are as healthy as ever. Team owners are quick to recognize that machine tools with the precision to support NASA's space shuttle program are clearly capable of supporting precision driving efforts. We have plenty of reasons to feel enthusiastic and encouraged by the upcoming season, and by the fact that Haas equipment will continue to create the parts that win races and championships.

## Hendrick Motorsports

### WINSTON CUP

It was a long time coming, but the first time is always the sweetest and worth the wait – just ask Hendrick Motorsports driver Jerry Nadeau (#25, below). The final Winston Cup Series race of 2000 brought Nadeau's first-ever visit to (Winston Cup) Victory Lane. Carrying the Haas logo, the 30-year-old Connecticut native bested Dale Earnhardt by 1.3 seconds to win the NAPA 500 at Atlanta Motor Speedway. Nadeau's first victory in NASCAR's elite series came after several close calls this season, and in his 103rd career start. Competing in the #25 Michael Holigan Chevrolet, Nadeau also became the fourth first-time winner in 2000, helping tie a modern era record. "The car was flawless and the guys did an awesome job on the pit road," Nadeau said. "I gotta thank Hendrick Motorsports, and all the guys at the engine shop."

In fact, the Hendrick trio of Jeff Gordon, Terry Labonte and Jerry Nadeau showcased an exciting 2000 season, making their mark on the Winston Cup Series with a stat book of facts and figures that includes NASCAR records, come-from-behind victories and career-best finishes. With Nadeau's season-ending victory, the trio combined to bring Hendrick Motorsports and Haas to Victory Lane four times.

AP/Wide World Photos

### CRAFTSMAN TRUCK SERIES

GMAC, a longtime member of the Hendrick family of racing sponsors, announced a comprehensive sponsorship agreement with Hendrick Motorsports for 2001 that includes involvement in NASCAR's Winston Cup, Busch Grand National and Craftsman Truck Series. During the new racing season, GMAC will be the primary sponsor of the #17 Chevrolet Silverado driven by Ricky Hendrick in the Craftsman Truck Series, as well as a major associate sponsor of the #24 Chevrolet of Jack Sprague, who closed out the 2000 series in 5th position. Dennis Connor, the all-time "winningest" crew chief in Craftsman Truck Series history, will oversee the new GMAC racing operation, which will operate out of its own separate facility.

NetZero.com will assume primary sponsorship of the truck now driven by Sprague. Sprague has finished in the top 10 a whopping 89 times in his 145 Series starts to date. NetZero says it's looking to take the #24 Chevrolet Silverado, with a lot of work and luck, to a third NASCAR Craftsman Truck Series championship.

## PacWest Racing Group

### CART CHAMP CARS

Even though Mark Blundell didn't finish the Marlboro 500 at the California Speedway, he did go out "in style" in his last race for the PacWest Racing Group. After starting the race in 21st place, Blundell worked his #18 Motorola Mercedes-Benz through the pack to the front. On lap 128 of the 250-lap contest he executed a stunning pass to take the lead, only to suffer a major mechanical problem that ended his day. The elation in the Motorola pit as Blundell took the lead lasted only a few seconds before a plume of smoke came gushing from the back of the car and the Englishman was forced to take a line which would not leave oil in the path of his opponents.





Photo by Dan R. Boyd

Mauricio Gugelmin (above), driver of the #17 Nextel Mercedes-Benz, was also leading the race on lap 92 when his crew decided to keep him out under yellow flag conditions after a major accident in turn one which eliminated three cars. The Brazilian eventually made a stop six laps later, but just three laps further into the race he was again forced back into the pits with a mechanical problem – which saw his race go out the window.

### CART INDY LIGHTS

Scott Dixon gave PacWest Racing its first title when he led all but one lap to clinch one of the most dramatic Dayton Indy Lights Championships ever at the California Speedway in Fontana. Dixon, driver of the #17 Invensys/Powerware PacWest Lights entry, went into the season finale with just a four-point lead over Dorricott Racing's Townsend Bell, but was able to dictate the race after taking the lead on lap one.

During the lead changes on laps 37 and 38, Tony Renna (Dixon's teammate, running second) actually lost three positions, and Bell moved up to second place to put pressure on Dixon. Bell tried a desperate move on the inside of Dixon as the two approached the start-finish line for the last time, but it wasn't enough to beat the 20 year-old New Zealander.

## All American Racers (AAR)

### ATLANTIC SERIES

The 12-race, highly competitive Formula Atlantic season ended in the streets of Houston with mixed results for the young AAR team. Alex Gurney finished 8th in the Championship. He wasn't blessed with the best luck, being knocked off the track on the first lap at Homestead and the first lap at Toronto; he also suffered four mechanical DNF's, depriving him of gaining points toward the championship.

However, there were also plenty of highlights: a pole position in Cleveland; a podium finish (3rd place) at Trois Rivieres, PEI, Canada; a brilliant come-from-behind race (from 21st to 5th) in Elkhart Lake; 3 top-five finishing positions (7 top-ten); and 7 top-five qualifying spots. The team, which was only formed a few months before the first race in Miami, worked together all year and is proud of what it has achieved in a very short time.

## PPI Motorsports

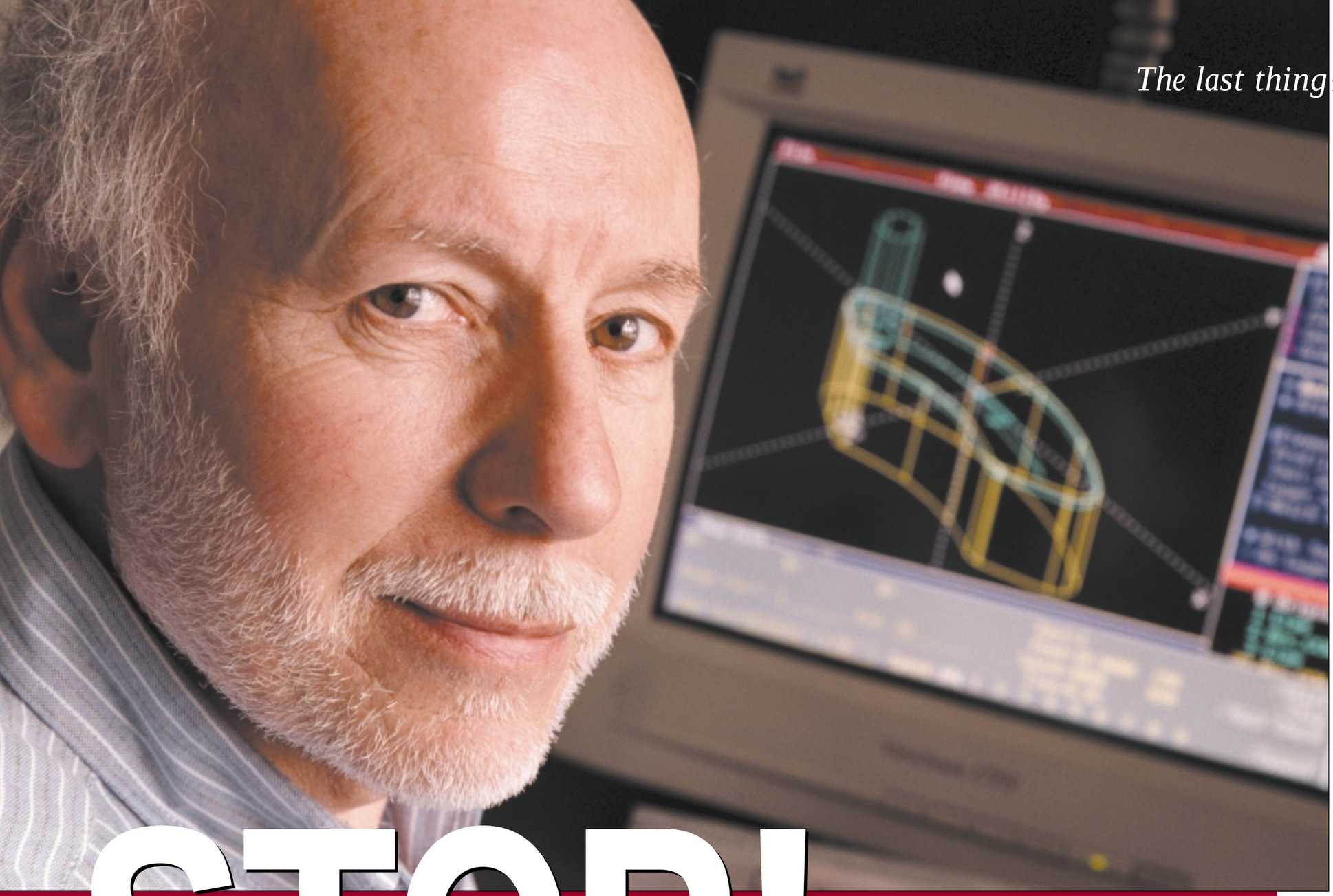
### CART CHAMP CARS

PPI Motorsport's 2000 Champ Car season came to an early end at the very long Marlboro 500, as both Cristiano da Matta and Oriol Servia crashed out by no fault of their own. During Sunday's portion of the race, da Matta's season ended after debris smashed his front suspension and the Brazilian careened into the wall. When the race was halted on Sunday, teammate Oriol Servia was running 12th – up four spots from his 16th place start. As the Monday portion of the race began, the Spaniard started his climb to the front. His charge topped out at 6th when the engine of Tony Kannan gave up the ghost and clouded the track with thick white smoke. Lost in the cloud, Servia and Michael Andretti touched wheels, ending Andretti's day and sending Oriol hard into the wall. The Telefonica car was totaled but Servia was unhurt.

### ATLANTIC SERIES

Many Haas accolades for the final PPI Motorsports Atlantic Team! After finishing the year with rookie sensation Dan Wheldon second in the championship and Andrew Bordin third, the final PPIM Atlantic team was recognized at the Atlantic year-end banquet for the Greg Moore Legacy Award. A surprise honor was bestowed on PPIM's veteran Atlantic driver, Andrew Bordin. The Canadian was selected as a finalist for the first Greg Moore Legacy Award. The 24-year-old from Woodridge, Ontario, Canada, finished third in the Toyota Atlantic Championship for PPI Motorsports in his third season in the series. He collected two wins and two poles in 12 starts. Both wins came from the pole, going flag-to-flag at Toronto and the season finale in Houston.

**Please see RACE REPORT page 35**



# STOP!

story and photos by Scott Rathburn

*The last thing* most people think about while driving down the freeway – usually at speeds in excess of 70 miles per hour – is whether their brakes, or those of the vehicle behind them, are any good. Until, that is, they have to slam on those brakes to avoid hitting the vehicle in front of them. The one they are rapidly approaching because they were too busy – talking on their cell phone, reading the newspaper, shaving, putting on make-up, eating, yelling at the kids, or just plain not paying attention – to notice that it was slowing down.

In that brief, but very intense, moment of panic, most people spend as much time watching the car behind them getting closer in their rear view mirror as they do watching themselves getting closer to the car in front of them. It's a fine line: Do you trust your own brakes and reflexes, or trust the brakes and reflexes of the person behind you?

What's it take to stop a 7,000-pound SUV traveling at 80 miles per hour, anyway? Well, consider this: it takes about twice as much as it does to stop the 3,500-pound vehicle for which its brakes were probably designed. Now *that's* scary.

For Norman Abbott, however, that SUV rushing up in his rearview mirror is like money in the bank. Every time that driver slams on the brakes, it's another chunk out of the life of that vehicle's brake pads. And brake pads are what Norman Abbott is all about.

Norm is the owner and president of OE Quality Friction of Mississauga, Ontario, a company that manufactures original-equipment-quality disc brake pads for the automotive aftermarket. His specialty is brake pads for light trucks, vans and, you guessed it, SUVs. Of course, OE manufactures pads for passenger cars, as well; but when Norm put together his business plan to start the company a few years back, he saw a growing trend toward light trucks and SUVs. Betting that trend would continue, he chose to concentrate his efforts on that market. It's a bet that paid off: Light trucks and SUVs currently account for more than 50 percent of all new vehicle sales.

Brake pads – or friction materials as they're known in the business – are nothing new to Norman. For years he worked for Allied Signal Friction Materials, a major supplier of original equipment brake pads to the automotive industry. "I was vice president of engineering at one time, and I was responsible for developing a bunch of OE (original equipment) formulas that are still in production today with the vehicle manufacturers," he explains. "I ran the operation here in Canada up until about 1992."

That's when Allied Signal decided there was too much production capacity in North America and Europe.

So, because the Canadian dollar was worth about 87 cents at the time and going in the wrong direction, they closed down the Canadian plant. Norman Abbott found himself out of a job.

"Systematically, I let 450 people go, got out of the business, got interviewed for a few jobs, decided that age discrimination was alive and well, did a bit of consulting for a few friction companies, then decided that what I needed to do was start a company," Norm explains.

That company is OE Quality Friction. "I got a bunch of people around me – some other guys who had worked at Allied Signal put some money in – I wrote a business plan, went to the banks, borrowed a lot of money and started the company," he says.

Though Norm makes it sound easy, he knew the only way he'd be able to compete with the "big boys" was to make his own tooling. Gone are the days of simply riveting pucks of friction material to backing plates and calling it a day. Today's disc brake pads are integrally molded: The friction material is formed to size and bonded directly to the backing plate under extreme heat and pressure in a single operation. It's a method that requires dedicated tooling for each unique pad.

"The way original equipment manufacturers now make brake pads," Norm explains, "is much more complex, and obviously more costly, than, say, 20 years ago. Typically, the tooling is purchased from outside suppliers. We had started going this direction at Allied Signal, and each set of tooling was costing us about $10,000, and we would wait six to eight weeks for delivery of one part number. Well, in the aftermarket, there are five or six hundred part numbers that are active, and it doesn't take too much math to say, 'Hey, if I'm going to have 500 part numbers, and it's $10,000 a hit, and each one takes six to eight weeks to make, I just can't get there from here.' You're talking millions of dollars worth of tooling investment up front, and probably waiting three or four years while the stuff gets made. You can't start a business under those conditions."

Nabil Khanania, above, checks the dimensions of a punch for a set of disc brake tooling. The matching cavity plate is shown at right on the machine.

Opposite page: A completed set of tooling for disc brake pads – a bottom plate, cavity plate and punch plate. OE Quality Friction machines all of its tooling in-house out of 4140 HT alloy steel.

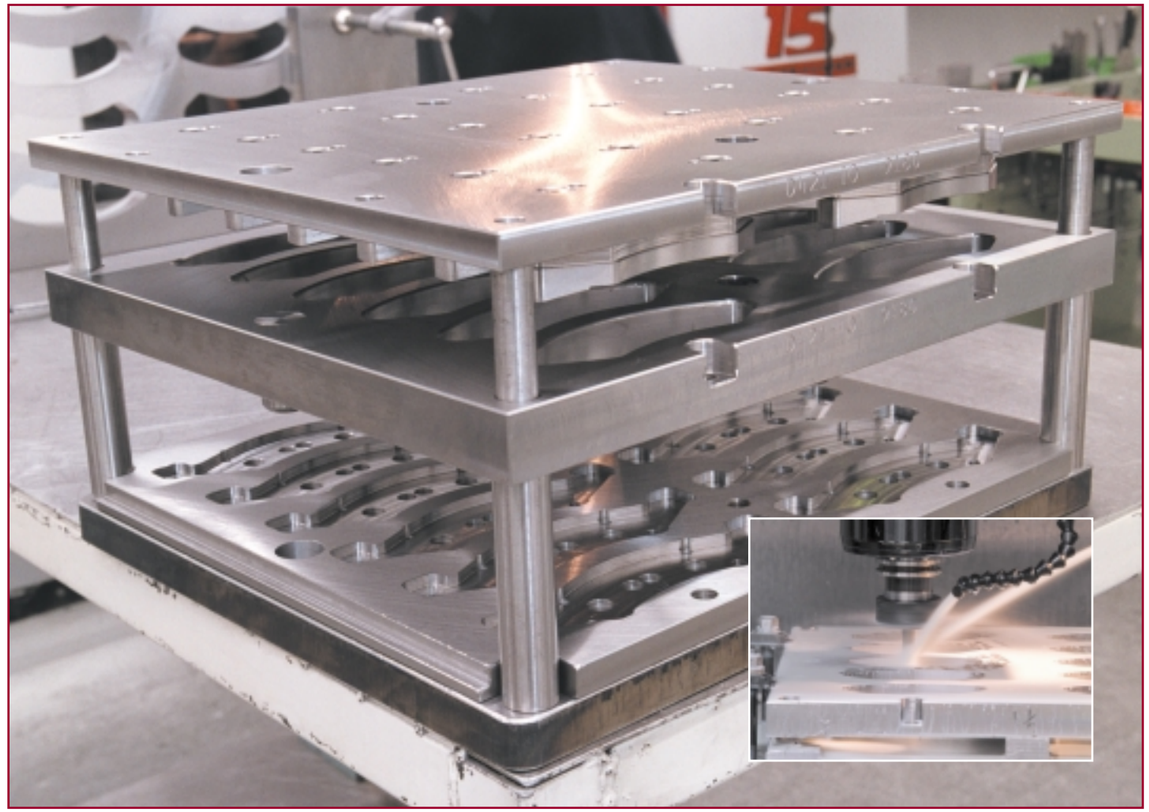
Rather than fight the math, Norm decided to change the conditions. The key, he says, was to make the tooling in-house, but he didn't understand anything about NC machinery. "I knew I was going to do this company, but the missing link was the tooling. I decided to get myself educated."

During his consulting days, Norm had run across a small company in Florida that made some of its own tooling; he decided to pay them a visit. "They had a Haas VF-3 tucked in a corner which made a little bit of tooling," Norm says. "I spent three months standing by the operator's side, basically learning about CNC machines. The Haas was a very nice machine – it performed beautifully. So I convinced myself absolutely that I was going to come back, take a course in NC programming and buy a Haas. It was very simple. I didn't look at any other machine."

Norm's intent was to get a VF-3, just as the shop in Florida had. But when he contacted the local Haas distributor, he found they only had a VF-4 on the floor, and they thought *that* might be sold. If he really wanted it, they said, then he ought to come down with some money.

Though his financing still hadn't come through, Norm bit the bullet and bought the machine. "I didn't have a facility to put it in," he laughs, "so I had it delivered to a friend's facility, where we got it wired up and running. At the same time, I was taking my CNC course, and I set up the machine and played with it. I had a few scary moments, but finally got to the point where I was proficient," he says. "In the meantime, we'd found a facility, the bank had given us approval to start the business, the other shareholders came in and we got started."

That was back in 1997. By September of 1998, the company was seriously



producing parts, and by 1999, OE Quality Friction was a profitable concern.

Today, OE Quality Friction manufacturers more than 220 different part numbers of disc brake pads, and that number continues to grow. "We are right up to date on domestic light truck and sport utility applications," Norm says. "We've got a full line of domestics, and we're branching into the import car. We're tooled right up to the 2001 model year vehicles."

The ability to make tooling in-house and react quickly to the needs of the market have been critical to the company's success. OE is one of only two brake pad manufacturers in North America that makes their own tooling.

"We churn out about five sets of tools a month," Norm says, "and it costs us about $2050 Canadian to make a complete set, which is very, very inexpensive." That's a far cry from the $10,000 per set and six- to eight-week delivery time they could expect from an outside supplier.

A complete set of disc brake tooling consists of a bottom plate, a cavity plate and a punch plate. The bottom plate holds the steel backing plates for each brake pad, the cavity plate sits on top of that to mold the outer profiles of the pads and the punch plate carries the punches that fit exactly into each cavity to form the pad's top surface. A cavity plate may have as many as 20 cavities, or as few as 8, depending on the size of the pads, and the punch plate will hold a corresponding number of punches.

Since each punch has to fit exactly into a corresponding cavity, the typical manufacturing method, Norm says, is to use wire EDM to cut the slugs out of the cavity plate, then machine those slugs and use them as the punches. But OE Quality is far from typical: They machine all of the tooling out of 4140 heat-treated alloy steel plate.

"We turn the cavity plate into Swiss cheese by very aggressively milling out these cavities," says Norm. "Then we take another chunk of steel and cut it up to make all the punches that fit perfectly inside these cavities." When asked why he doesn't use wire EDM, he replies: "If you look at the time it takes to wire EDM, we'd have the cavity plate sitting on the machine for a week. And as much as it seems sacrilege to take all that expensive tool steel and turn it into chips, the Haas does the job in about a quarter of the time – and time is much more expensive than the tool steel. We knock out a cavity plate in about a day."

OE further reduces costs and speeds turnaround by "production-izing" their machining processes. "We've commonized the external features of all of the tools," Norm says. "We have canned cycles for all three plates, so we can knock those off probably in a tenth of the time it would take the average jobbing shop.

Dan Beaudin sets up to machine another punch out of 4140 HT alloy steel for a set of disc brake tooling.

Really all that's left, then, is reverse engineering an OEM sample."

From the OEM sample, Norm creates the toolpaths in SmartCAM: one to cut the bottom plate, one for the cavity plate and another for the punches. The bottom plate and cavity plate require only two-axis pocketing to cut the profiles of the backing plate and the friction pad, respectively. The punches, however, often require 3D work, because many modern disc brake pads have chamfers on their leading and trailing edges to reduce squeal and chatter.

Most manufacturers cut these chamfers after the pads have been molded, but OE takes a different approach. "We mold in the chamfers," Norm says, "which is unique in our industry. We take advantage of the 3D capabilities of the Haas to cut the chamfers into the tooling."

Since all of the cavities in a particular set of tooling are identical, as are all of the corresponding punches, Norm only has to create the toolpaths for one location. This done, he hands off the programming and machining duties to Nabil Khanania and Dan Beaudin.

Nabil has been with OE Quality from the start; in fact, he was the company's first employee. "I met Norm when I was taking the CNC course at Humber College" (a local community college), he explains. Dan is a graduate of Humber College, as well, who was recruited by Nabil. The pair currently split their time between making tooling and providing support for the rest of the plant.

Nabil takes the toolpaths Norm has created in SmartCAM and turns them into complete machining programs for each plate. For example, if a set of tooling has 12 cavities, he will write a sub-program to cut the profile of a single cavity. "It's one profile, one layer," Nabil says. "I make that layer three or four times depending on the thickness of the part, then I pick up that sub-program and give it another work offset to cut each of the remaining cavities. All of the pockets are measured from the center of the fixture," he explains. "We specify an X, Y coordinate for each of the pockets and run the same sub-program at each location." In essence, the machine just cuts the same profile over and over at different depths and locations.

Before the expensive tool steel goes into the machine, however, a single cavity and matching punch are cut out of aluminum and checked against the print. "We always take the trouble to make an aluminum mock-up of the punch and the cavity plate," says Norm, "just to make sure we haven't made any programming errors." Once dimensions are verified, they switch to steel.

Each tooling plate starts life as an 18- by 16-inch piece of hardened tool steel that has been squared and ground flat by the supplier (the added expense

Rupinder Dhaliwal fills a set of disc brake tooling with a loose mixture of friction material before putting the tooling into a 400-ton curing press.

is well worth the reduction in machining time). Plate thickness varies from about 5/8 inch to 2 inches, depending on the size of the brake pads being made, and whether it's a base plate or cavity plate. All of the external features and common locating holes in each plate are machined using canned cycles, and then the features specific to each plate, such as cavity profiles, are machined.

The punches start out as pieces of tool steel 20 inches long by the width of the punch. "It's like a rack of ribs," Norm says. "We do all the drilling and reaming in that strip while it's still in one piece. Then we chop it up into sections that go straight onto a fixture. That way we don't spend time unnecessarily facing and squaring pieces of steel. As long as we've got one ground flat surface that's drilled and reamed for dowel pins, it just drops onto the fixture." Each punch takes about 45 minutes to cut, and comes off the machine as a finished part. "We do a slight bit of deburring," Norm notes, "and it's finished – no hand work at all."

Once completed, the tooling moves to the production side of the plant to begin the manufacturing process. There, each cavity is filled with a loose mixture of friction modifiers, lubricants, dry phenolic resin and catalysts. Once filled, the tooling goes into a 400-ton cure press. "It gets squeezed between heated platens at about 350 degrees Fahrenheit," Norm explains. "During that period, the resin melts and flows around the other ingredients, then the catalyst works and everything hardens to form the finished friction material.

"These are five-daylight cure presses, so we're cooking four part numbers at a time, and the fifth daylight is used as a heat-up daylight for the next set of tooling. Because all of our tooling is common," Norm adds, "when the tools are closed, you can't tell one from another. It could be running a three-cavity truck part, and underneath it would be a 20-cavity rear brake for a Beretta. The tooling is constantly going in and out of the press, and every six minutes, or so, you get a set of parts."

Once molded, the brake pads are ground to a uniform thickness, painted, assembled with any additional hardware required and boxed for shipping.

OE currently runs two shifts per day on the production side and a single shift in tooling. Their 14,000-square-foot building is now filled, and they've added a third cure press to keep up with demand. According to Norm, Nabil and Dan have become so proficient at producing tooling on the Haas that the "machine now outpaces the organization. We could pump out a lot more tooling, and the machine could run more, but our infrastructure couldn't handle it," he says. "We'd have to double our people in the office!"

That's an enviable position to be in for such a young company. And though age discrimination may be alive and well, in the case of Norm Abbott, it looks like this old dog is teaching the industry some new tricks.

**OE Quality Friction**
**905-564-9500**



# Working in EXTREMES

Story and photo by Scott Rathburn

## So, what's so special about the friction business?

People ask this question of Norman Abbott all the time, and rightly so. After all, he manufactures disc brake pads for a living, so it's a question he is eminently qualified to answer. But rather than going off on a technical treatise about friction modifiers, fillers, resins and catalysts, like some experts might, Norm usually responds to these queries with a simple story.

"Brake pads are one of the few products that have to work over such a wide temperature range," Norm explains. "I'll give you an example: Two cars come off the production line, let's say built at Ford Taurus in Atlanta. The first car – and they're identical vehicles, they come off the line one after the other – the first one goes north. The guy lives in Alaska, and he's off to Japan. He's a business man, so he parks his car in the airport in Anchorage and flies to Tokyo and comes back a month later. His car has been sitting outside – I've never been to Anchorage, but let's assume it's sitting outside – at minus 20 degrees Celsius (–4° F) for a month. So the whole car has been soaked right down to minus 20. He gets in it, and, assuming it starts – it probably wouldn't, but assuming it does – he drives to the kiosk where he pays his parking fee. When he puts his foot on the brake, he doesn't expect to have any peeps, or murmurs, or pulls or judders. He expects the brakes to work absolutely perfectly at minus 20 degrees Celsius.

"The next car that came off the production line goes south. This guy decides that none of his family has visited Mexico, so they're going to get the children, and they're going to get the neighbor's children, and they're going to get the dog, and the skis, and they're going to put a boat on the back. And, oh, by the way, they want to take the scenic route, so they go across the Rocky Mountains. The car now weighs twice as much as Ford intended it to weigh, and he's going to come down the other side of the Rocky Mountains, and his brakes are going to be running at 1,000 degrees. Similarly, he doesn't expect to have any peeps, or groans, or squeals or judders out of the brakes. So, our product has to work over this enormously wide temperature band – invisibly to the end user."

Therein lies the challenge. Today's vehicles, especially SUVs, put much higher stresses on brake pads and create higher levels of heat than in years past. Yet, drivers still expect their brakes to work flawlessly – every time, under every condition and regardless of the type of vehicle they drive.

Vehicles seem to get larger every year, but because of significant increases in the performance of friction materials, manufacturers have not necessarily increased the size of the brakes. Some of the latest SUVs weigh upwards of 7,000 pounds, yet "the brakes don't appear to be any bigger than on a 3,500 pound car!" Norm exclaims. "So that means even more so that a sub-standard aftermarket material is going to show up more quickly than it would have done historically, where the brakes weren't used so hard."

Now, that's something to think about the next time your brake pads need replacing.

# Bucking the Status Quo: Women in a Man's World

**Story**
Linda Dorr

**Photos**
Scott Rathburn

Machine tools are manly pieces of equipment. They're big, they're powerful, they cut metal, they make things. Walk through any machine shop, manufacturing facility or distributorship where machine tools are in use or being sold, and you'll notice one thing: most of the workforce consists of men.

Women in the machine tool and metalworking industries certainly aren't unheard of, but they are definitely in the minority. Those who have chosen to challenge the status quo, however, hold a wide range of positions, from assemblers to machinists to managers to salespeople. We talked with a few women, at Haas Automation and elsewhere, to find out what their day-to-day experience is like. As you might expect, there are many things these women have in common – mainly, that each likes her job.

Valerie Knupp is a production manager at Haas Automation, responsible for several sub-assembly departments, including tool changers, gearboxes, spindles and, until recently, rotary products. The latter department she just handed over to someone else, so she could take on large VMCs and small and mid-size HMCs. "I've done all the sub-assemblies, and now I'll be doing the actual machines – rounding off my machine tool education, if you will," she says.

Valerie's first position at Haas was traffic manager – she didn't know a lot about machine tools when she arrived nearly four years ago, but, having been a general manager for a trucking company, she knew how to ship anything. After running the shipping department for a year and a half, she was asked to manage the rotary department. "I was floored," Valerie says. "I didn't know anything about it! But Bob [Murray, operations manager] said, 'You can do it, Valerie. You've shown us you can do it.' So I was a little scared." This didn't deter her, however. "I'm never quite satisfied with where I am," she notes. "I'm always looking at what's next."

At the time, the rotary department was in fine shape in terms of quality, but it needed work in the areas of process control and scheduling. "That's what I'm really good at – measuring efficiencies, measuring the labor standards, and putting processes in place," she says. Next up was tool changers – and her responsibilities have been increasing ever since.

Angelica Cardona is a mechanical assembler who started at Haas a little more than three years ago, bringing with her many years of experience in manufacturing. Angie started out building sub-assemblies for lube panels, then went on to building the lube panels themselves. Next came the tool-release pistons plus most of the assemblies that go in that area – filters, check valves, through-the-spindle coolant pumps. She loves her job: "This is one of the best experiences of my life, working here."

Valerie Knupp, Production Manager

For the last 10 months or so, she's been building the cam boxes for the Haas side-mount tool changers (SMTCs). Valerie Knupp, her supervisor, says, "If I didn't have Angie doing that job already and somebody asked me whether a woman could do it, I'd say it was a man's job. It's very heavy, it's a difficult assembly – and she does it hands-down. We never have quality failures on those units." The fact that the quality is consistently top-notch "speaks volumes for the design," Valerie points out, as well as for Angie's assembly skills.

The stainless steel component that is the foundation of an SMTC cam box weighs about 60 pounds. It has to be heated for the first step in the assembly process, so Angie lifts it in and out of an oven. Building five units at a time, she takes them out of the oven in succession, lays them out and does the first step in the process for each one. She checks the quality at every stage, and when each cam box is complete, she inspects it again. "By the time it's finished, I've gone through everything twice," Angie explains. The cam boxes then move to the tool changer area, where the SMTC assembly is completed and hooked up to a test box. Ultimately, each one gets mounted on a machine where it runs for 36 hours to make sure it works. It always does.

Angelica Cardona, Mechanical Assembler

Norine Peters, Haas Automation's trade show manager, is known in the industry as the "Trade Show Goddess" – a nickname, she says, that "reflects my attitude about working in a male-dominated industry." She's been at Haas for nearly five years, and in "show business" for more than 20. Before coming to Haas, Norine worked for various computer and printer manufacturers, managing their trade show and public relations efforts. She managed booths that were in the 7,500-square-foot range and two stories high, with a staff of 150 to 200. This helped her make the transition to working with machinery that requires a large amount of exhibit space. "Previously, my focus would be on how to make the booth stand out in a very sophisticated and glitzy show environment," she says. "The product was secondary. The machine tool industry is different in that the focus is on the product."

Norine Peters, Trade Show Manager

Norine's biggest adjustment was learning how to take a much larger product line on the road and get it set up. She used to spend a week building a booth and then just place the products and plug them in. CNC shows, however, require forklifts, plumbing, coolant, air, raw materials, extensive electrical requirements, scrap removal and more – all of which was new. "I am not mechanically inclined, but I have a natural curiosity about how things work, and I am not hesitant to ask questions or doggedly track down the information I need," she says. "Also, my background was being able to multi-task and keep track of millions of details."

The team spirit at Haas is another thing that made the transition easy. “There’s a great support team around here,” Norine says. She’s learned what questions to ask, and the people she asks are usually very patient and will explain things in detail. “One of the great things about working at Haas is that the people designing, supporting and selling the products are generally excited about what they’re doing, and more than happy to share that excitement and pride with you.”

Ana Cruz is a machinist at Repair Tech International (RTI) in Van Nuys, California. She started learning the trade about five years ago, while still in high school, because the recruiter for the Machine Tool Partnership Academy at the school was quite convincing. “I thought, it’s not going to hurt me a bit to try something new,” Ana says – and she found that she liked machining.

In the first year of the Academy program, Ana learned how to operate manual machines, and by the third year she was taking CNC classes at Los Angeles Valley College in Van Nuys. She started working part-time for RTI in 1996, and has been full-time since July 1998. Ana still has a few more CNC classes to complete – she loves programming, and is looking forward to learning more about how to write programs for the parts she runs.

At present, Ana mostly runs manual machines on the job: lathes, mills and a drill press. She also supervises several students who came from the same Academy program she did. This is a group of boys who were initially reluctant to listen to her – she’s not much older than they are, and she’s a woman. This wasn’t a problem for long, though, as it quickly becomes obvious that Ana knows what she’s talking about. Her aim, she tells them, is to make them self-sufficient, so they can work without needing her supervision. “I tell them it’s all about teamwork,” she says.

Isaura Miranda, who goes by her last name, has been a machinist for Prompt Machine Products in Chatsworth, California, for three years. Miranda happened upon the machine tool trade because she was looking for work, and her brother-in-law, who also works for Prompt Machine, told her the company needed machinists and that they would train her. Although she didn’t know anything about machine tools when she arrived on the job, she now runs two Haas lathes. At present, she works mostly on setting up and running parts. “She’s very good at it and very reliable,” says her supervisor, Tim Sullivan. “We can give her a shop order and she takes it from setup to running parts off.” Miranda is particularly interested in programming. She knows how to modify existing programs, and has asked to learn more about it, so Prompt Machine plans to send her to school. “She likes to learn,” Tim says.

Joyce Hayes has been a machinist for more than 20 years, and has also been teaching machine shop classes at Simi Valley Adult School for nearly 10 years. As a young widow with six children, she went to the Adult School to learn a trade so she could support her kids. The machine shop class was new – and she was the first student to sign up for it.

Joyce attended school full-time for a year and then started working for Fairchild Industries in Chatsworth. She became lead person after 6 months, and then was promoted to “factory specialist,” which meant she set up all jobs, did inspections and supervised other people in her area. She’s also worked for Rocketdyne and the Jet Propulsion Lab (JPL) in Pasadena. As a full-time machinist, Joyce ran CNC mills, lathes and EDM machines. She now teaches all of these, sometimes working 14-hour days.

The Adult School offers morning, afternoon and evening classes so that students can attend no matter what their work schedules. About 98% of Joyce’s students have full-time jobs and take classes part-time, mostly in the evenings. Students with no experience start out in her conventional machine shop class, where they learn all the manual tools – lathes, mills and grinders. Her CNC offerings include a class on MDI (manual data input), one on PC-based Mastercam and Gibbs CAD/CAM software, an advanced class on tool and die making, and a class on CNC controls that covers Haas, Fanuc, Fadal, Acu-Rite and Dynapass controls, among others.

Ana Cruz, Machinist

Isaura Miranda, Machinist

“We know you can do it.” “We never have quality failures.” “She likes to learn.” “It’s all about teamwork.” Such comments are common where these women are concerned. And though they entered the world of machine tools through different paths, each of these women shares a common conscientiousness – every one takes her job very seriously, and does it very well.

Their consensus is that women are very well suited to work in this industry, because women tend to be detail-oriented, good at having back-up plans and “winging it” when nothing goes as planned, and they’re team players. Now, we could argue all day and into the night about whether characteristics such as these are inherent or learned – or both – or neither. One thing is clear, though: these women all possess these particular traits!

To them, being female in a mostly-male business has not been a disadvantage – reactions from men in the industry have generally been unbiased. “They might have reservations at first,” Valerie Knupp observes, “but then they learn, guess what, she has a clue. She’s doing a good job.” Variations on this theme came from every woman interviewed. Although there have been rare instances of true male chauvinism (one woman was actually told, 15 or so years ago, that she should go home and let a man have the job she was not entitled to), in general no one feels that she’s had to deal with much gender discrimination. “You have to earn respect no matter who you are” was an oft-repeated motif.

So, despite being dominated by men, the machine tool and metalworking industry appears to be an equal-opportunity profession. As Norine Peters noted, “Women have a lot to offer this business. As long as you’re willing to work hard in a fast-paced environment and you’re not afraid to stand out in a crowd – you’ll fit in quite nicely.”

# CONCEPT to CONCEPTION

story and shop photos by Olaf Wolff

photo by Randy Lorentzen / Planet R Inc.

# We are a nation
comprised of individual free thinkers,
free to succeed or fail
by the choices we make,
and by the opportunities we are presented with,
recognize and take advantage of.
That individuality, diversity of ancestry and freedom,
although often taken for granted,
is what keeps and makes us powerful.
When faced with the prospect of losing who and what we are,
though, we unite with a will and ferocity
unmatched in this universe.
We are, after all,
"One nation under God."

Michigan, the heart of America's automotive industry, is far too familiar with having its lifestyle, its entire economy, threatened by outside forces (as was the machine tool industry at generally the same period of time). It wasn't that long ago that the foreign car manufacturers were building cars faster, at lower production costs and with greater dependability – backing that with a first-rate dealer support system. We (as a nation) weren't prepared for the onslaught of foreign distribution and we couldn't keep pace. Every quarter, losses increased alarmingly. We'd never faced this sort of attack before. Once we recognized that finger-pointing was not only futile, but adolescent, Detroit and the workers of Michigan unified to meet the formidable challenge head-on.

There were lessons to learn from the import makers. Pride and ego had to step aside – we would need to re-evaluate not only ourselves, but the methods used to build American cars. Simply put, the situation would necessitate a change in our traditional ways of thinking – in essence, forcing us out of our comfort zone, and forward to a new level of doing business. It was a wake-up call not only for the auto industry, but for many American corporations in general.

The automotive industry was backed into the corner but never hit the canvas. Sticking with that analogy, they got lean and mean, learned to counter their competitors' moves, and successfully fought back, regaining the title that rightfully belonged to them – to us. One such company that has not only survived since 1953, but has played a role in getting the automotive industry back on track, is Ranger Tool & Die of Saginaw, Michigan. Ranger is a relatively small operation by corporate standards, creatively positioning considerably more small to medium-sized machine tools inside their 15,000-square-foot building than would appear possible from the outside. The largest is a Haas VF-3 and the smallest a VF-1, although word has it a Mini Mill looms in the very near future.

**Machinist Zorina Beckman discusses a completed prototype part with Ranger co-owner Jim Kuhnle. The 1993 Haas VF-1 it was machined on is still a reliable favorite around the shop.**

Ranger is now, and has always been, a prototype shop, a unique and essential part of the industry, producing components for concept cars. Concept cars provide the industry an opportunity to exhibit the shapes, level of comfort and performance characteristics of potential production vehicles. Generally, these vehicles are displays of design boldness, tamed to a high degree when and if they make it to production.

A concept vehicle begins with a simple clump of clay, molded and shaped by the hands and imagination of designers. Engineers configure the specs and dimensions and generate blueprints, which are then distributed to specialized companies such as Ranger.

John Kuhnle and Tom Schick are the co-owners of Ranger Tool & Die. Based on the nature of their business, we asked if they ever attended car shows and

Ranger is now, and has always been, a prototype shop, a unique and essential part of the industry, producing components for concept cars.

Many of the parts machined by Ranger are prototype components for steering systems. Above, a reservoir body for a power steering system is machined using a 4th-axis rotary table.

snooped around to see if any of their parts are on the vehicles. “Oh sure. We’re both car guys from way back when,” volunteered John. “In fact, I recently bought a hot rod about two months ago, and I’m 57 years old. It’s a classic 1932 Ford Cabriolet. It was completely done; professionally built entirely out in California. All I have to do is drive it, maintain it and, of course, polish it.

“The majority of our work, probably 80 percent, is for the Big Three auto makers,” John continued. “The thing is, we don’t always know who or what the parts are for.”

That’s a portion of what makes their company unique – there’s a level of hush-hush that is a necessity in this facet of the industry. Does this present any particular challenge? “No,” John says, “we pretty much have to satisfy the blueprint’s requirements, so it really doesn’t matter what they’re used on. In the old days, before CAD systems, I think we probably used to be a little more involved, as far as interaction with engineering. But that doesn’t seem to be the case as much any more. We used to have to make more decisions as to areas of the part that did or didn’t have to be to print. Now, with the modern machinery and tighter tolerances, the prototype pretty much has to conform completely to the print.” Ranger is a certified Boeing supplier as well, which makes up the other 20 percent of their business. They also produce plastic injection molds – prototypes and production tools – using Haas machines to cut all of the cores and cavities.

“The Haas machines are a big part of what we do here,” John states, “because we rely on them not only to make parts, but also to make electrodes, and to do secondary operations for our stamping business; we trim a lot of our stampings on them. We machine prototypes from solid billet. I guess if there’s any single machine that we couldn’t do without, it would be the Haas machining centers. They are clearly the largest part of our machining center package.”

Ranger has been involved with many very popular and successful projects, prototyping components for vehicles such as the Dodge Viper and the aggressively styled Prowler. They can also claim credit for creating the prototype power-steering pumps for *Motor Trend* magazine’s Car of the Year – the very hot, retro-styled PT Cruiser. “A lot of the things we work on never go to market,” John points out. “That’s not uncommon in this business. Not everything that the product development people undertake comes to fruition.”

It’s this aspect that makes the prototype business so challenging, and why we were interested in how Haas machine tools fit in. John had already given us a strong indication of how he feels about Haas machining centers.

John mostly runs the office portion of the company and Tom the machine shop (although they have a complete understanding of each other’s job, and if called to do so, each can fill in for the other). It was only natural for Tom to chime in when the questions regarding Haas machines came up. “When I get to talking with someone about the Haas

> “The majority of our work, probably 80 percent, is for the Big Three auto makers,” John continued. “The thing is, we don’t always know who or what the parts are for.”


Tony Martin sets up a job on a VF-1 with 4th-axis rotary table. Many of the prototype parts Ranger produces require machining on multiple sides. Haas rotary tables help reduce the number of setups.

machines, or showing them off, I always say, 'Look here, made in America.' Then I continue by telling them they're the best bang for the buck we've ever gotten. That's how I honestly feel about them. We've shown them to many customers, and I always tell everyone that you can't go wrong buying them. For the money and the value, it's the best buy I've ever gotten. That's the way I honestly feel about them and that's how I advertise them."

Ranger's oldest Haas machine is a 1992 VF-1, although up until very recently they had a 1991 model. "Incidentally, we had no problem selling it. I didn't even put it up for sale – there were plenty of people asking for it," Tom was quick to mention. "We basically sold it because we needed the new technology, not because it wore out," he added. It's a move they may soon repeat with another older Haas machine. In Tom's words, "Once you get used to the new stuff, it's hard to go back."

By John and Tom's estimation, they service somewhere between 35 to 40 customers, some on a daily basis, others only once or twice a year. It requires a good deal of flexibility and resourcefulness on everyone's part to handle the often one-run, specialized needs of customers. At times they work from blueprints, but now mostly from CAD files. On the rare occasion, someone may bring in a part, stating that they're having a problem, and ask for Ranger's input. Other times, components are brought in and the customer simply says, make a part that fits this and does that – and that's when the ability of the machines and the requirement for real versatility comes into play.

Tom told us about one particular occasion when they had a short production run requiring some hard milling (around 60 Rockwell). The job necessitated the use of two Haas machines running 24 hours a day, seven days a week. They operated the two machines under those taxing conditions for six to eight weeks, without experiencing any difficulties. Ranger is also capable of producing the actual solid models in-house for their clients when necessary, doing all the programming in Mastercam.

One of the most prominent and consistent Ranger clients is Delphi Automotive Systems. "We recently did some large castings for the Delphi Quadrasteer. On this one we knew what it was for, because they brought in the truck to show us," said Tom.

Quadrasteer is a revolutionary steering system that combines the performance capabilities of full-sized vehicles (such as the new Chevy truck that will come equipped with it) with the maneuverability of much smaller cars. In addition to maneuverability, there's noticeably improved high-speed stability that drivers will clearly appreciate. It's also a more responsive and smoother steering system when trailering. This system is not to be confused with four-wheel and all-wheel drive technology. Quadrasteer is unique in that it is a four-wheel steering system that electronically controls the direction of the wheels at different speeds for optimum control.

Contributing to these kinds of vehicle enhancements, which not only make cars easier to drive but also safer, is one of the highlights of a prototype shop. It's what keeps John and Tom enthusiastic about going to work each morning, even if they don't always know what they're creating at the time.

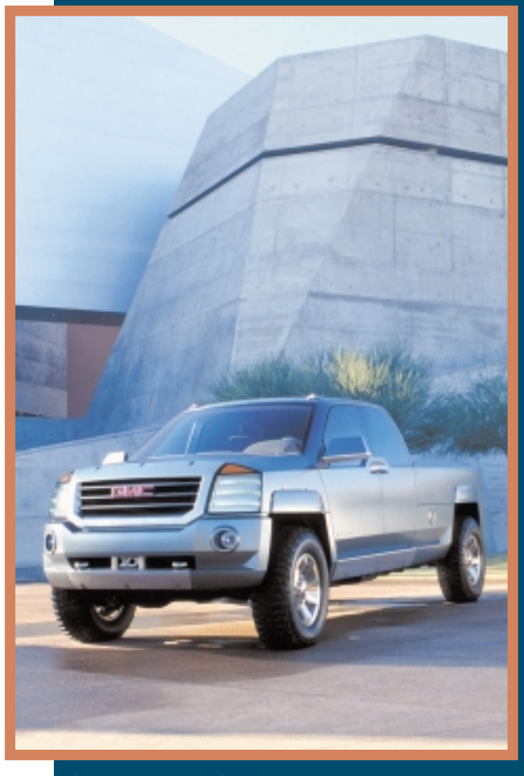


photo courtesy General Motors

Michigan is indeed, and aptly so, the home of Motown (legendary record label named after the Motor City). The predominant portion of the population is either involved with or knows someone in the automotive industry – whether they work in a massive production facility, a mid-size company such as Ranger, or in their own barn converted into a small job shop. There are an unimaginable number of automotive-related niches that have been created and continue to sustain the livelihoods of a great portion of Michigan's people.

Some are passed from one generation to another. Take, for instance the fellow who is the sole provider of a single electrical connector used by Chrysler. It's a small part used on the assembly line to test electrical hookups on the vehicle doors. For years he's been cranking them out manually on an old Bridgeport,

For the money and the value, it's the best buy I've ever gotten. That's the way I honestly feel about them and that's how I advertise them."




Long-term Ranger machinist Kirk G. Longuski produces first-rate fuel-pump reservoir screens on a Haas VF-2.

but the demand for the part has increased to the point were he's now in the process of purchasing a Haas Mini Mill. These sorts of scenarios are common throughout Michigan.

Once again flourishing, the American automotive industry continues to look toward the future, attempting to anticipate the wants and needs of fickle consumers, ensuring in the process that companies such as Ranger share in an extended bright future. And, in a twisted turn of corporate irony, in many areas, we now cooperate and share technology with the very competition that once posed a threat. In the corporate reality, after all, we are but one global marketplace, essentially unifying the world where politics and government alone have failed.

Concept vehicles and prototype makers will continue to play a key role in that future. Chrysler is currently contemporizing a classic form with the creation of a new concept car named Chronos. It's a vehicle that owes its inspiration to the 1953 Chrysler D'Elegance concept vehicle, featuring lines that flow cleanly from the front chrome grille and jewel-like headlamps to the steeply raked windshield. For all that John and Tom know, Ranger Tool & Die may already be machining some of the parts.

**Ranger Tool & Die**
**517-754-1403**

In the corporate reality, after all, we are but one global marketplace, essentially unifying the world where politics and government alone have failed.

# CAD/CAM a la Carte

## A modular approach to choosing machining software

**Story**
Bryan
Diehl

Buying the "right" NC programming system for your shop can be a nightmarish proposition, especially if you are more accustomed to dealing with machine tools than with the "foggy" language sometimes used by computer software sales representatives.

The purpose of this article is to help you cut through that "fog" by offering a few clarifying CAD/CAM definitions; it is also my intent to help you better understand what you can and should expect from any machining software package you decide to purchase for your shop.

### THREE CRITICAL QUESTIONS UP FRONT

First, there are three critical questions you need to ask about any software package you investigate:

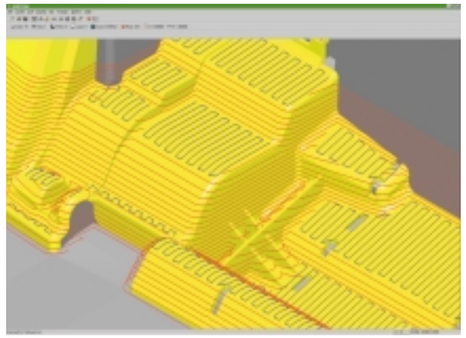
- Does the software do what I need to do now?
- Is it an expandable, modular system that will allow me to add on as my needs change and grow?
- Will this system pay for itself in a reasonable amount of time by increasing throughput and quality?

If you can't answer "yes" to all three of those questions, you probably ought to politely back out of the interview and look at another system where the answers are positive.

The concept of modularity in software is no different from that of hardware options or add-ons. A well-designed software package generally will offer certain basic capabilities to meet your current needs (question 1). But instead of forcing you up front to buy capabilities you don't need, a properly designed system will offer a series of upgrade modules that you can purchase as your needs expand (question 2).

Payback time (question 3) varies with each individual business, of course, and can only be analyzed using information that is highly specific to your own operation. This analysis is essentially the same as for any investment you make: Up-front cost versus dollars saved over the long haul.

*Bryan Diehl is the VP of Software Development*
*SURFCAM CAD / CAM Systems by Surfware*



**Case in Point** – Suppose your shop currently does only NC turning. That means that for the moment you probably could get by with a less expensive CAM module than if you were also doing NC milling. But suppose you plan to buy a mill/turn machine in a year or so. Will the software you buy today allow you to upgrade to support that newer, more complex equipment? Can you "trade in" your current system for its full value? Or will you have to start over from scratch at that point? Only an analysis of your particular business situation can give you an answer, but it's something to keep in mind before you jump into a software purchase.

**Windows Multi-Tasking** – Nearly all PC software is Windows-based these days, allowing you to use the same familiar interface in the shop that you are already using in your office. But, beware! With some CAM systems, the operation running in the foreground takes over the entire computer (CPU), which sabotages Windows' productivity by preventing background processing. The bottom line is that you want to make sure the system you choose delivers true Windows multi-tasking (the ability to open multiple windows, each capable of processing in the background while you work in the foreground).

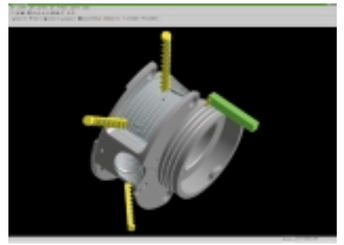
### THE BASIC NC PROGRAMMING SYSTEM

What capabilities should be offered by a "basic" CAD/CAM system? The answer to this is probably debatable, but in my experience there are certain capabilities that no one can dispute.

**Importing Part Data** – These days, a job to be quoted is more likely to arrive as an electronic file than as a blueprint. That means your software needs to be able to import the data file accurately. To do this it must have a built-in file translator, which can come in two types – neutral and direct (see next paragraphs).

**Neutral Data Translators: IGES and STEP** – An IGES translator is the most commonly used neutral data translator in North America. (Note: some CAM vendors charge extra for IGES, so it's a good idea to ask up front.) Some NC programming systems let you "tweak" an incoming IGES file to conform precisely to the originating CAD product. This valuable feature, called "flavoring," ensures that you will import and export the file exactly as the designer built it.

The next version of IGES is destined to be a new standard, called STEP (International STandard for the Exchange of Product Model Data). Since 1983, the International Standards Organization (ISO) in Geneva has worked to implement a global standard for transferring part information throughout a product's entire cycle.

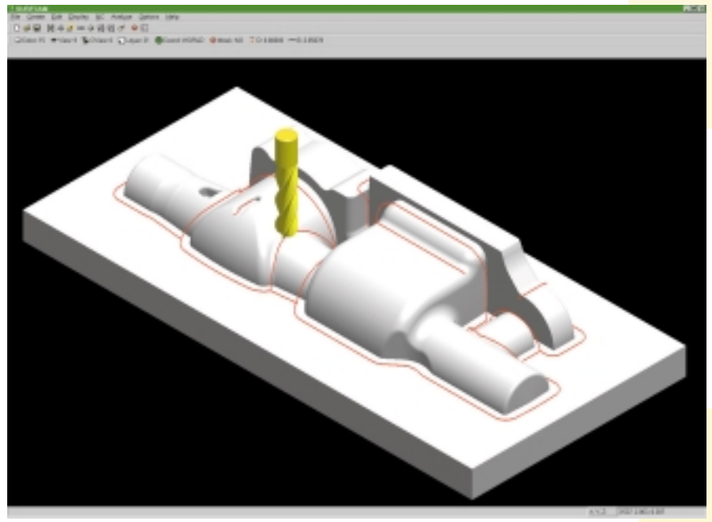


Data transferred will someday include not only geometry (e.g., curves, surfaces, solids), but also application protocols and testing procedures.

**Direct Data Translators** – A direct translator can contain complete geometry data because it uses the originating CAD/CAM system's database format. However, as each system requires a dedicated direct translator, they're expensive to write and update. Therefore you can expect the CAD/CAM vendor to charge extra for the latest direct translators. They may even charge separately for bi-directional capability, so I suggest you ask what's included up front so you won't feel nickel-and-dimed.

Nevertheless, a basic CAM system should include at no charge some older direct translators for common automotive, aircraft and aerospace data files. If you do reverse engineering, you will need to read-in digitized data, and you may sometimes need to transfer APT-CL (Automatically Programmed Tools-Cutter Location), NC code and toolpaths back into part files.

Regarding direct translators, you're likely to hear more about a new technology called "one-step data transfer," whereby a single mouse-click directly translates the CAD file to a particular CAM system.



### COMPUTER-AIDED DESIGN (CAD) FOR MANUFACTURE

It takes good CAD functionality to design products or tooling from a concept, blueprint or sketch. But if your NC programming software has an integrated CAD front end, your shop may not need a separate CAD system. You'll want productive modeling software that is fast and easy to use, so check the product reviews, or make sure your designer tries out the modeling and editing features. Powerful but flexible 2D and 3D construction and editing tools help you satisfy customers up front, and ultimately speed toolpath generation.

**Basic CAD Capabilities** – In my view, any major CAM system's lowest-priced module should include 3D wireframe design with NURBS curves, and fast shading (rendering) with light source control, plus dynamic 3D rotations, zooms, pans, redraws and view changes that are incredibly fast.

A basic system should give you OpenGL graphics card support to let you rotate shaded models with thousands of complex surfaces smoothly and without flicker. Superior visualization of all sides of a part's design will catch the attention of customers and management alike.

More sophisticated design features such as multi-surface trimming, text mapping to splines (for engraving), variable and rolling ball fillets will probably cost more.

**Solid vs. Surface Modelers** – Shops needing extensive design and assembly capabilities will want to check out the mid-range PC solid modelers, because they offer plenty of capability at a fraction of the price of UNIX-based packages. Solid models are composed of primary shapes like cylinders, cones, spheres and cubes, and contain volume as well as dimensions. A solid model consists of a surface model with topology data added, so a CAM system can import the underlying surface model from any solid model and machine it.

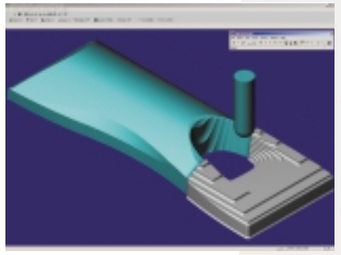
CIMdata, an independent technical service since 1983, said in a March '99 report that solid modelers are most appropriate for defining primary shapes, and surface modelers for complex free-form shapes. Thus, solid modelers are very useful at the conceptual stage of design, but when you're machining a mold or die, a surface modeler gives better control of sculptured surfaces.

## TRAINING TIME

Machinists and managers know that training time is down time, so the shortest possible learning curve saves money. Today's basic CAD/CAM system should be efficient for the expert, and self-instructional for the new user. When you click on Help, the software should coach you on how to complete the current operation. Context-sensitive online Help with hypertext linking is standard now. Some vendors offer a complete, hot-linked on-line manual, along with hard copy. Some CAD/CAM systems offer a built-in audiovisual component so users can view multimedia tutorial movies without leaving their current window. Internet-based training facilities offer access 24 hours per day and allow users to operate tutorials at their own pace.

## SMART PROGRAMMING

**Tools and Materials Libraries** – The best machining systems include extensive libraries of tools and materials even in their lowest-priced modules. A



"smart" NC programming system suggests feeds and speeds based on good machining practice. Of course, programmers can override by choosing all their own settings, and use the software's "built-in experience" merely as a check on their own preferences.

To organize part files and machining steps, the software's operations manager should provide a graphical drag-and-drop interface for ordering and reordering toolpaths, for viewing NC parameters associated with those toolpaths and for post processing.

If you are machining similar parts, you want to be able to copy machining processes and apply one NC operation's parameters and machining strategies to new geometries. This re-cut option saves programming time in family-of-parts machining.

When your program is ready to go to the machine, it should generate a setup sheet with cycle times and tool setup information. Make sure all shop reports can be exported to standard spreadsheet formats.

For mold shops, the parting line where the mold sections mate will usually be a complex surface. Because molds generally must separate at the widest section of the molded part, your NC programming software should automatically generate these parting lines.

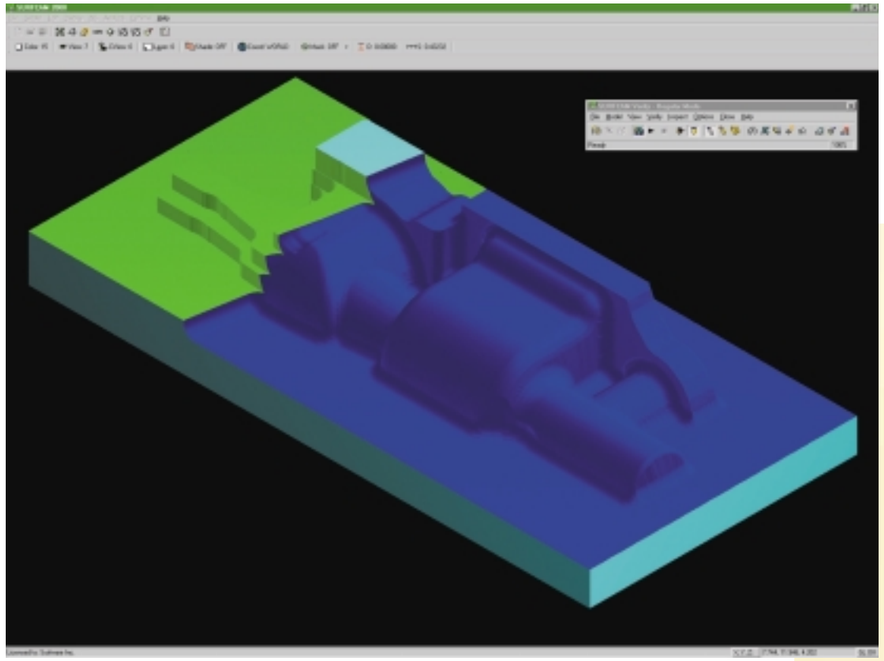
## CRITICAL MACHINING FEATURES

There are far too many important CAM features to cover them all in this article. Still, there are certain ones you definitely want to look for before you buy.

**Gouge Avoidance** – A shop cannot perform efficiently if rough and finish machining operations gouge the part or over-cut adjacent surfaces or nearby features. Therefore, to check the complete toolpath, the CAM system should consider the type of tool, its diameter and corner radius, shank diameter, flute height and fixtures and clamps. Even systems that claim to generate gouge-free toolpaths may gouge on complex shapes. So run your tests on your most complex parts.

**Supported Tools** – Today's CAM systems should support standard, bullnosed and ballnosed end mills with full gouge avoidance. Because each tool has advantages in machining various shapes, the better CAM systems don't limit the operator's choice of tools. Rough cutting with bullnosed tools is faster and, depending on the job, can also be effective for finish cutting.

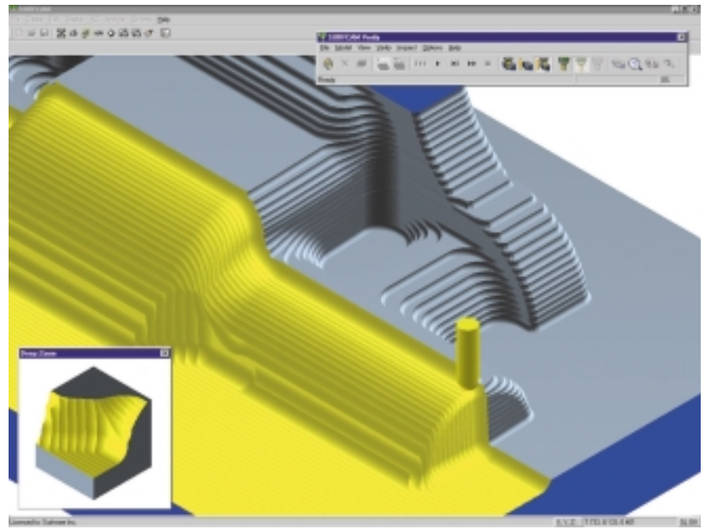
**Edge Protection of Less-Than-Perfect Models** – Various CAM systems handle the gaps between the individual shapes that make up a free-form surface by simply adding a straight line between the surfaces on either end of the gap. This method, however, risks gouging. In my view, the more reliable method, called edge protection, recognizes the edges of each individual surface and offsets the tool accordingly.



**Feed-Between Moves** – CAM systems usually generate toolpaths by rows. When the tool comes to the end of a row, the software decides how to position the tool at the start of the next row. Some use a simple "up-and-over" algorithm. But watch out, this approach can cause unnecessary rapid and plunge moves, adding to machining time and increasing the chances of gouging the part.

**Scallop-Height Control** – For the fastest machining times, the system should adjust each individual stepover distance to maintain the maximum, user-defined scallop height while taking into account the surface shape across the entire part.

**Gouge Checking of Lead-in and Lead-out Moves** – The lead-in move positions the machine tool to the start of the first cutting row. The machinist needs a variety of options for lead-in and lead-out moves – like spiral, arc and ramp motions – to engage and to



leave the part gently without gouging. Be sure your system has this basic feature.

**REST Machining** – This refers to the intelligence built into a milling system so that it recognizes material left over after a prior cut, the REmaining STock. This feature greatly speeds up the machining process, especially for a semi-finish cut after the initial roughing routine is completed.

**Steep/Shallow Machining** – Some systems give the user the ability to machine steep (near vertical) or shallow (near flat) areas of a 3-axis part. Then, as an option, the toolpaths can be sorted by region to minimize rapid moves (cutting air).

**Integrated Toolpath Verification** – With built-in verification software, the programmer can quickly rotate the part on-screen to view planned toolpaths from every angle. This virtually eliminates time-consuming dry runs on the NC machine, and speeds a product's time to market. Basic CAM software includes a "light" version of 2- and 3-axis toolpath verification. Upgrades to full-feature versions are available at extra cost, and some CAM companies offer upgrades to 4- and 5-axis verification as well.

## MACHINING MODULES

CAM vendors offer progressively higher-priced modules to support 2-, 3-, 4- or 5-axis machine tools. Usually, all the features of a lower-priced system are included in a higher-priced package. Current systems vary widely in the speed and quality of the toolpaths generated.

**Lathe Turning** – Two-axis turning is usually the lowest priced machining module, but still should support rough and finish turning and grooving with full gouge avoidance. Each operation should support completely user-configurable cut angles, retract angles, lead in/out angles, separate XZ stock offsets, spring passes and material boundaries. All lathe toolpaths should be gouge-free with complete tool insert checking, including front and back insert angles, unlimited element look-ahead and automatic undercut avoidance.

**$2^1/_2$ Axis** – Some CAM vendors offer a VERY productive $2^1/_2$-axis milling package at the same price as the

Please see CAD/CAM page 35

# Machining Goes Rural!

## Gateway to the Redwoods with Stan West CNC

**Story**
Gary Brient

**Photos**
Preston Gratiot

It is said that we are the product of our land: The environment in which we live inspires our behavior, and perhaps even our thought itself. If so, Stan West CNC in Willits, California, has made it practical and profitable for a metalworking business to be positioned far from urban sprawl.

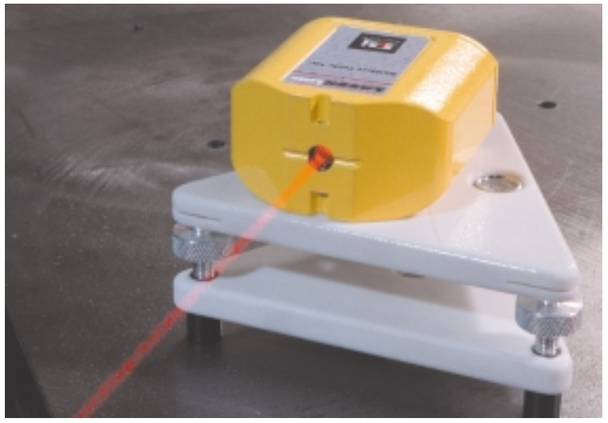
Amongst trees, streams and rivers, machining is enhanced by an environment of clean air, temperate climate and a strong sense of community.

Located 140 miles north of San Francisco, Willits is a community of homes, schools, businesses and churches that thrives in a tree-filled valley. Early settlers were a self-sufficient lot who grew their own produce, fruit and potatoes, and raised their own meat. If perseverance and toughness were traits to be admired, then citizens of Willits were special folk.

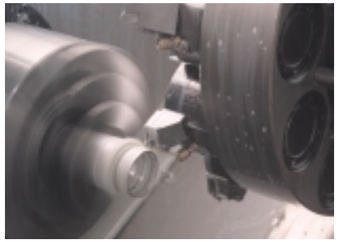
Mix this self-sufficiency with the fax machines, modems and telephones of the new era and you have a formidable recipe for success. Stan West CNC has used the new technology to good advantage, creating a successful job shop that has grown to sixteen employees and spun off two satellite machine shops: CEMCO Machining and Goforth Machining Enterprises. The three concerns – Stan West CNC, CEMCO, GME – operate a combined force of three Haas VF-1s, three VF-2s, two VF-4s, one HL-1 and one HL-4.

Stan West, father and founder of the company, recently passed away, but he left a legacy of successful operations to a son, Dave West, who now is owner and general manager. Dave has further expanded the company's machining base by designing and producing cabinet-manufacturing machines. As Dave states, "We live in the heart of a lumbering community . . . we service this local business by building some of the best cabinet-building machines anywhere." Always searching, always expanding, Dave has also introduced laser alignment tools, speed handles (for fellow machinists), chip tools for lumber milling, oil recycling machines and steam turbine parts for local utility companies. This diversity of product has propelled Stan West CNC into a growth mode for this new millennium. As Dave explains, "What I really need now is half a dozen tried and true machinists. With affordable homes, good medical, this community offers a special quality of life."

The cabinet machines have produced new margins of profit for the business, and account for almost 40% of the company's gross revenue. This is machining at its inventive and problem-solving best. Tolerances for the line-boring unit they make are exceptionally close when you consider that 46 drills are aligned in two 23-drill rows with 32 mm centers. A Haas VF-4 creates the gear heads that drill upward, creating a line bore machine that is self-cleaning by utilizing gravity to remove the shavings and particles.



Now if cabinet machinery sounds a bit stodgy, take a look at the Lazerline, which is in full production at Stan West CNC. This line-generation unit (a real laser) permits a user to create an instant perpendicularity to a surface while delineating accurate, straight lines.



Perhaps its greatest advantage is the ability to create vertical, horizontal and parallel lines on uneven surfaces. The casements for the laser are a particular challenge to machine, inasmuch as they require alignment of five different planes. All sides of the unit must be parallel or perpendicular to one another. The result of careful alignment of the planes yields a maximum deviation of only 1/8" over an 80-foot projection of laser. This is accuracy equal to any construction task, while reducing the number of people necessary to perform tasks. Stan West not only machines the casements for the units, but also provides space for assembling them after machining.

The act of machining itself led to another product for Stan West CNC. Tired of ripping the skin off his knuckles every time a speed handle broke on one of his vises, Dave West designed a speed handle that wouldn't break. Three handles from different manufacturers have all broken during use. Each was made out of 1/4" stock. So Dave decided to machine his out of 5/8" stock. He not only machines the new speed handles, but powder coats them in colors of red, black and blue. His original run of 150 pieces has now grown to 2000 speed handles in the hands of machinists around the country.

Another innovation of this shop is the Chip Compression Briquette Machine, a tool that reduces waste volume of metal chips – the by-product of the company's metalcutting operations – by turning them into briquettes. In the compression process, more than 95% of the coolant is removed from the chips, allowing the coolant to be recycled for the next job process. When you stop to consider that recyclers will pay almost twice as much money for solids versus chips, it is understood that this machine may well pay for itself.

The volume of the shop continues to grow. When asked about the future of Stan West CNC, Dave responds, "We've got about 16,000 square feet right now, but with the addition of Lazerline and a new oil recycling system that we'll machine right here, a new 25,000-foot facility is on my mind. It is conceivable that in five years we'll have a hundred employees." Though he wouldn't be specific, Dave is most interested in producing the oil recycler, which will provide every car owner an easy, clean recycling system that he can use in his own garage.

His interest in the automotive market probably accounts for his backing of a go-cart racing team. For the past two years, suspension mods, transmission pieces and brake parts have been machined for the race effort. Driver Mike McKoen competes at all of the regional events. Inasmuch as Mike is Dave's UPS driver, your reporter suspects a bit of blackmail on Mike's behalf to obtain his parts: No parts, no delivery! And of course we'll not talk about Dave's past involvement with high-performance jet skis, robotics, movie camera equipment and turbine blades. This shop has done of bit of everything.

A big fan of Haas equipment, Dave volunteered, "My father said the key to operating successfully in outlying areas is equipment capability and reliability. Because we are so far from our dealers, we depend on machine reliability to keep us running. Frankly, I wouldn't buy a Haas without the coordinate rotation, geared head and the 4th axis . . . with the 4th axis we're not just another guy machining. In fact, I write my own program generators in BASIC. I prefer my own programs to CAM packages because they contain features that suit the way we operate . . . they are tuned to feeds and speeds, which equal more profit." Using his own programs also allows him to modify and then optimize coding for specific jobs. This is especially important for jobs involving tool steel and titanium. In addition, Dave adds that knowing the programs makes features of the Haas control, such as the built-in calculator for figuring arcs and the graphic dry run, especially useful when it is necessary to adjust coding at the machines.

Today, Stan West's marketing area extends throughout Northern California and the San Francisco Bay area. But, as Dave's father once said, the truth is: "The fax, the phone and United Parcel Service put us 'next door' to customers anywhere. Therefore, we are able to compete with anybody; our geographical location becomes almost irrelevant."

**Stan West CNC**
**707-459-1206**

# Haas Builds 608 Machines in October

For the first time in the company's history, Haas Automation, Inc., of Oxnard, California, has built more than 600 CNC machines in a single month. In October, a total of 608 machines rolled off the Haas assembly lines, ready to ship. This tops the previous high of 521 machines achieved in January of 1998, and is estimated to be more machines than any other machine tool manufacturer in the world is currently producing.


Haas Automation is the largest unit-volume producer of CNC machine tools in the United States. To meet the growing demand for its products worldwide, the company is expanding its manufacturing facility by nearly 200,000 square feet – the second such addition since moving to Oxnard in 1997. The new building, which is expected to be complete by spring of 2001, will bring total footage of the Haas facility to more than 800,000 square feet.

This expansion will increase the capacity of the Haas plant to more than 1,000 CNC machines per month, making Haas Automation the largest unit-volume producer of CNC machine tools in the world, while increasing plant efficiency and productivity. In conjunction with the new building, Haas is expanding its workforce to an estimated 1,000 employees, and investing more than $15 million in new flexible manufacturing systems (FMS), automated CNC turning cells and robotic welding systems to further streamline production and expand lights-out operation.

At a time when many U.S. companies are moving offshore to reduce costs, Haas Automation continues to manufacture all of its products in-house at its facility in Oxnard, California. This commitment to quality is what makes American-made Haas machine tools the best value in the industry.

DRISCOLL continued from page 3

With Tom's experience, learning to operate the Mini Mill hasn't been much of a stretch. Before the new machine arrived, Tom did most of his machining on two older Fadals, but more than likely, that will soon change. "Looks like this Mini Mill will outwork my two other machines combined," Tom commented.

To help the Driscolls get the most out of their new Mini Mill, Tom Dawson, branch manager of the Grand Rapids Haas Factory Outlet (HFO), has made a standing offer for the entire family to attend any of the available classes taught at the HFO. The classes are free of charge and cover the basics of operating a CNC, up to and including more advanced subjects entailing programming and tooling. Mindy and Tom both feel the classes would benefit Charles and Zeb the most, guaranteeing a fourth generation of Driscoll machine tool operators.

I left Michigan the morning after meeting with the Driscolls. Negotiating the freeways from Farmington Hills to Detroit Metro Airport, I concluded that the Mini Mill could not have gone to a more appreciative family, or to a place where it would be put to better use. I missed one off-ramp, and the rental car return and shuttle to the terminal went slower then it should have. But, I made it to my plane with six minutes to spare – timing is, after all, everything.

EXPECTATIONS continued from page 3

to machine the castings, a robotic welding system to build the machine pedestals, a dedicated area for assembly and a staff of specialized employees whose only job is to produce the highest quality Mini Mills possible."

By October 2000, 120 Mini Mills per month were rolling off the Haas production line, with more planned to meet customer orders. With the completion of a new addition to the Haas facility in the spring of 2001, capacity for the small machines is expected to climb to 200 per month.





CAD/CAM continued from page 31

lathe module. However, for the next price up, you may be able to add premier surface design, multiple-height island machining, clamp avoidance and automatic spiral and zigzag pocketing. For greatest efficiency and fastest machining times, the system should adjust each individual stepover distance to maintain the maximum, user-defined scallop height while taking into account the surface shape across the entire part.

**3 Axis** – (Some 3-axis systems include free lathe turning.) Your machinists want to choose from a variety of cutting methods to use on any portion of a solid or surface model. Thus, you'll need 3-axis support for all of these methods: automatic Z-level roughing and finishing, planar cutting, single-surface flowline cutting, multisurface flowline cutting, pencil tracing, project cutting and 3D contour cutting.

**Simultaneous 4- and 5-Axis Machining** – Only a few CAM systems deliver true simultaneous 4- and 5-axis machining. Look for multiple surface 5-axis contouring with gouge checking. Flexible drive-check machining includes contouring, normal to surface, lead/lag and swarf machining, all with complete tool angle control.

**Mill/Turn** – Mill/turn machines combine turning and milling operations into a single multi-tasking machine that can reduce part handling and increase production. For most applications, 2-axis CAM systems with the lathe option are adequate for mill/turn programming, but for some mill/turn jobs, such as impellers, you will need a 3- or 4-axis CAM system.

## DEMONSTRATION SAVVY

It takes alertness to be able to sort out the hype from the bread-and-butter machining systems. It's only natural for vendors to want to impress you with their prepared demonstrations. However, as a savvy machinist, you should insist on cutting your shop's worst-headache parts, not the "canned" demo parts.

Finally, if you arm yourself with some solid CAD/CAM know-how and a battery of tough questions, you will be able to cut through the "fog" I talked about earlier. If this article helps you do that, I will have succeeded.

RACE REPORT continued from page 5

## C&C Motorsports

The longest non-stop, point-to-point desert race ever held – Tecate SCORE Baja 2000 presented by AutoZone – came to a surprising finish, with 70 percent of the 262 starters completing the torturous 1679.54-mile, brutal terrain of the Baja, California peninsula. The Haas Automation Ford Ranger won Stock Class 7S, piloted by drivers Joe Custer, Troy Cline and Darren York. In the process the Ford Ranger beat all mini-truck classes, with the closest finisher nearly 7 hours behind. Haas' own John Roth participated as a co-driver. For him, one big highlight was when the vehicle rolled over completely (John was aboard at the time) just past the half-way point. The rollover cost the team some time, but the truck and drivers were fine. Helping crew for the winning team was no other than Gene Haas himself.

# Haas Appoints New Director of Sales and HFO Business Manager

To support its rapidly growing national and international markets, Haas Automation, Inc., has promoted Peter Hall to the position of Director of Sales, and appointed Tim Brooks as HFO Business Manager.

Peter Hall

Tim Brooks

Mr. Hall joined Haas in 1998 as Director of Haas Factory Outlets (HFOs). In that capacity, he has been instrumental in establishing the HFO concept throughout the U.S. and Canada. As Director of Sales, he will expand that concept to the world market.

Mr. Hall's extensive experience encompasses nearly 30 years, working with such companies as Gleason Works in Rochester, New York, and Kearney & Trecker, GMBH in Stuttgart, Germany. He has a degree in Machine Tool Technology from the University of Manchester, England, and is also a chartered mechanical and electrical engineer (CENG) in the U.K.

Mr. Brooks joined Haas as HFO Business Manager last October. Working out of the Oxnard facility, he services eleven western states and western Canada, with primary responsibilities of providing support to Haas distributors and helping them improve productivity as needed.

Mr. Brooks' experience in the machine tool industry began in 1989, primarily on the cutting tool side, working for distributors, doing outside sales and working for the manufacturers. He most recently was manager at the Milwaukee Haas Factory Outlet, a Division of Productivity Wisconsin.

# New machines ready to make parts

## SL-20 APL Automatic Parts Loader

The new Haas SL-20 Automatic Parts Loader (APL) is a fully automated lathe parts loader with opposing two-jaw grippers. The APL is programmed directly through the lathe's control, and is available only with a new Haas SL-20 lathe. The APL operates in the background of normal turning operations and delivers near-continuous, unattended machining. The double-sided rotating gripper loads and unloads parts with a single trip to the spindle, or can be used to rotate parts for a second turning operation.

- Allows Unattended Operation
- Flexible Gripper Configurations
- Programmed via Haas Control
- Loads/Unloads Parts in One Trip
- Gripper Converts to Two-Clamp Shaft Style up to 16" Part Length
- Background Operation

## HS-1 Auto Bar

Machine complex parts from bar stock in a single setup on the new Haas five-axis bar machining center. Machine five sides, cut off the part, feed out the bar and machine the next part without interruption. Automatic bar loading and a built-in parts catcher allow for unattended operation.

- 40-Taper Spindle
- Built-in 4th- and 5th-Axis Rotary Tables
- Servo Bar 300 Bar Feeder
- Five-Axis Control
- Automatic Parts Catcher

## VTC CNC Vertical Turning Center

The VTC is designed to handle large, heavy parts that require multiple operations in a single setup. It combines the rugged foundation of our VF-8 50-taper VMC with a 48" turning T-slot table that provides speeds to 300 rpm. The platter is driven by a 30-hp motor and two-speed gearbox for turning, and a high-performance servo motor for very precise C-axis positioning and interpolation.

- 48" Diameter Platter
- 48" Max Part Dia / 28" Max Height
- 30-hp Vector Drive
- 300-rpm Platter Speed
- 2,000 ft-lb Rotational Torque (C Axis)
- 50-Taper Spindle (Live Tooling)
- 3 Turn/Bore Tools Standard
- Side-Mount Tool Changer
- Easy-Access Door Configuration

## TL-15 Twin-Spindle Lathe

The new Haas TL-15 turning center is a dual-spindle CNC lathe built on the very popular Haas SL-20 foundation. The TL-15 comes standard with twin spindles, a combination VDI/bolt-on tool turret and the ability to add options like live tooling and full C-axis capabilities to the main spindle.

- High-Production Oriented
- Double-End Part Capability
- 12-Tool Hybrid Turret
- VDI 40 & Bolt-On Tools
- Special Twin-Bore & Twin-Turn Toolholders

## VF-6TR Five-Axis Trunnion Machine

The VF-6TR is a versatile five-axis machining center based on the popular Haas VF-6 VMC platform. The standard table has been replaced with a dual-axis trunnion table that provides full simultaneous five-axis motion, or can be used for positioning workpieces to almost any angle for machining.

- Dual-Axis Table
- Side-Mount Tool Changer
- ±120° Tilt
- Full 360° Rotation
- 310 mm Platter

## Haas SL-10 Small Footprint Turning Center

The new Haas SL-10 lathe takes up only 6.5' x 4.5' of shop floor space, yet delivers a very generous turning capacity of 10" x 14" (max). This lathe features a 6" chuck, 6,000-rpm spindle and an extremely affordable price tag.

- Full CNC Turning Capabilities
- 10" x 14" (max) Capacity
- 1.75" Bar Capacity
- Bolt-On Tool Turret
- Brushless Servos
- Vector Drive Spindle
- Hydraulic Clamping

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HAAS AUTOMATION, INC. MACHINES & EQUIPMENT


AT

# THE RIGHT PRICE.

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