CNC MACHINING

VOLUME 2
NUMBER 4
WINTER '98

COVERSTORY

Triton Engineering makes waves with Haas CNC technology

FEATURES

Soaring into the future with Mikana

From dry lakes to the winner's circle with Edelbrock

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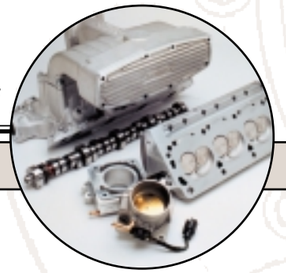

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THE MASTHEAD:
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On the Cover

Belgarda Yamaha rider Vittoriano Guareschi won the final race of the Supersport World Series, and finished second in the championship, aboard a yamaha YZF 600 Thundercat sporting sidecovers and shifter parts manufactured on a Haas VF-3 by Triton Engineering of Boulder, Colorado.

Photo courtesy Yamaha Motorsport

EDITORIAL

Formulating a Budget

By Denis Dupuis, General Manager, Haas Automation, Inc.

It's that time again, time to formulate a budget for next year. It seems that no matter where you work, these dreaded words raise their head every November and December.

During preliminary meetings with department managers, I found myself explaining that the budget for 1998 is just a more clearly defined plan to help us achieve the goals we set for the company years ago. It spells out the "whats" and the "hows" necessary to reach our target. Without the budget, we would just continue doing what we're doing today, and maybe at the end of the year we would be better off than last year. Or maybe not. I knew that if we actually decided "what" we wanted to achieve next year, the "hows" would jump out at us. Or at the very least, going though the process would make the questions about the "hows" clear, so we could prepare to meet our '98 goals.

After that first budget meeting, I began wondering why we work so hard at planning in business, when it appears we don't plan much at all in our personal lives. Everything still works out okay – doesn't it? The more I thought about this, the more I realized that we actually plan more than we ever realize on a personal level. We plan our day by setting the alarm the night before. And we plan our weeks, our months and our lives through memberships, vacations and the people we spend time with. Heck, most of us plan our children's lives. After all, starting that college fund is planning for their future.

A budget is really just a business's New Year's resolution. So, since we all have so much experience at planning our own lives, why do we so dread the budget process?

I think there are a couple of reasons. First, we all fear that we will come up with a great plan and someone will inevitably shoot it down. We've become accustomed to a "head-office" telling us, "No, we can't spend that much money," or "We can't hire that many people," and so on. We seem to know instinctively

that all the work and creativity we put into the budget plan will probably get a glance, at best, and then be reworked to fit someone else's vision.

Second, I think the corporate management style we all grew up with taught us that "if we budget for it, we had better do it." If we budget X dollars in sales, we will have to explain any variance. If we budget X dollars in expenses, we had better spend it, or do an awfully good job of explaining the discrepancy, in order to get the budget we want the following year. We have been taught that an annual budget is something that companies, departments, even careers, live and die by.

In reality, our budget defines our annual goal in monthly segments. It is just a plan. Staying the course, even when there's a brick wall in our way, doesn't make a lot of sense to me. A budget should give us a guideline to follow, a way to keep our sense of direction and focus. It should not be so rigid and cast in stone as to preclude taking advantage of opportunities that arise during the year – opportunities that none of us could foresee. A good budget should be flexible enough to allow for adjustments throughout the year – for whatever reason.

So, if you are dreading the task of finalizing your budget for next year, relax – it's just a plan. If you've never done a budget, or usually don't, then you should. Even if it's only a few lines jotted down on a piece of paper, that's okay.

Make a short outline showing what you want your business to achieve next year, how much you are willing to invest to make that happen and maybe how big (volume or number of employees) you want the business to grow. Even those few lines will set in your mind what your goals are and give you a direction. Then next year at this time, compare what you wrote with what actually happened. If nothing else, it will be a good start on the following year's budget.

Jeff Gordon and Hendrick Motorsports Snag Another Championship

Jeff Gordon looked like he was out for a Sunday drive as he crossed the finish line to win his second Winston Cup Series championship in three years at the newly renovated Atlanta Motor Speedway. Needing only to finish 18th or better to clinch the title, Gordon opted for patience and a leisurely race, rather than putting the championship on the line. After all was said and done, Gordon crossed the line in 17th position, three laps down from race winner Bobby Labonte and 14 points ahead of Dale Jarrett, his nearest competitor for the title.

"When I crossed the finish line, it was the biggest sigh of relief," Gordon told reporters after the race. "I don't think we really wanted to cut it that close." But sometimes that's what it takes to win a championship. Despite losing the race in Atlanta, Jeff Gordon's dedication and consistency, along with 10 victories and 22 top-5 finishes, allowed him to take home the championship. Fellow Hendrick Motorsports drivers Terry Labonte (who won the championship in 1996) and Rickey Craven finished the season in 6th and 19th position respectively.

But winning is nothing new to Hendrick Motorsports. This year's win marks the third consecutive Winston Cup Series championship for Hendrick, with Gordon winning in '95 and '97 and Terry Labonte taking the title in 1996. It's this winning combination of top drivers and cutting-edge equipment that keeps Hendrick Motorsports coming out on top.

One of the companies helping Hendrick stay on top is Haas Automation, which provides high-quality CNC machine tools for their machine shop. Currently, Hendrick uses five Haas machines to manufacture a multitude of engine and chassis components for their race cars, including cylinder heads, pistons, wrist pins, pulleys, engine mounts, brake cylinders, steering components and suspension parts. "They've really helped our program get ahead," said Ray Evernham, Jeff Gordon's crew chief. "We make a lot of the parts we use with their equipment." Quality parts and quality drivers are what it takes to win races. Such a winning combination is hard to beat.

The 1998 NASCAR Winston Cup Series kicks off February 15 at the Daytona 500. All eyes will be focused on Hendrick Motorsports to see if they can repeat their 1997 performance with another 1-2-3 finish. Stay tuned! It's guaranteed to be an exciting year.

Haas-Sponsored Race Team Sprints to 8th Place

The dust has settled and the 1997 Sprint Car Racing Association season has come to an end. For John Scott Motorsports it has been an exciting year. After months of tearing up the dirt throughout the West, drivers John Scott (#83) and Joe Custer (#30) are breathing a collective sigh of relief as they look back on a successful season.

Going into the final race, John Scott was solidly positioned to roll into 6th place for the season. Unfortunately, a piece of debris from someone else's crash resulted in a slashed tire, forcing him to miss the restart and not finish the race. The team closed out the season with a very respectable 8th place finish out of 74 race teams. On a brighter note, fans voted John Scott the 1997 "Most Popular Driver" in the SCRA.

"It's been our best season as a team," said John Scott, "and I'll never forget it. A lot happens during a season of 39 races, and not all of it is good. But I wouldn't trade this year for anything. We've had wins, flips, rolls and everything else you can imagine, but the Haas Automation sprinters just kept going."

Haas Automation is the featured sponsor for the pair of sprint cars campaigned by John Scott Motorsports. Based out of Perris Auto Speedway in Southern California, John Scott Motorsports is one of the premier teams in the SCRA, and one of the only teams campaigning two cars in '97.

The 1998 season, which begins in January, promises to be even more exciting as John Scott Motorsports ups the ante with the addition of a third car to the team.

Haas Goes to Europe

Celebrating their second successful EMO together in Hannover, Germany, Haas Automation, Inc., and Mikron Machining Technology reaffirmed their strong marketing partnership for Continental Europe.

Haas CNC products are marketed in Europe under the Mikron name as their VCE, HCE and TCE lines of machine tools. However, EMO Hannover '97 is the first time Haas products have been displayed bearing both the Haas and Mikron logos. Gene Haas, President of Haas Automation, explains: "EMO is the largest machine tool show in the world, drawing people from around the globe. We wanted to fully support Mikron in all markets where our products are sold under the Mikron name. But, we also wanted to support our distributors throughout the world who sell our products under the Haas name."

Mr. Haas went on to say, "We are very pleased with the efforts Mikron gives our products. Sales have doubled annually, and our partnership continues to grow stronger every year. We consider the show a complete success for us."

This year's booth attendance was up nearly 200% over EMO '93, and many new and existing customers chose to purchase machines at the show. In addition to displaying a selection of standard machines, Haas also debuted their new VR-11 five-axis profiling VMC at the show. Aimed primarily at the aerospace industry, this versatile machine provides travels of 120" x 40" x 30" (xyz) and ± 32 degrees of rotation on the A and B axes.

Wilfried Creten

In other European news, Haas has appointed Wilfried Creten as their European Sales Manager to provide expanded service to this rapidly market. Working out of Belgium, Mr. Creten will act as liaison between Haas, their European partners and their customers.

"Our goal is to expand our worldwide market for Haas machine tools and provide the same kind of service in Europe that has made Haas the best-selling machine tool in America," said Al Nodarse, Director of Sales for Haas Automation. "Mr. Creten's reputation and extensive experience in the market will help us achieve these objectives."

Mr. Creten's extensive experience marketing American machinery in Europe, including Eastern Europe and Russia, will strengthen the effectiveness of Haas and their partners in Europe. Mr. Creten has a college degree in mechanical engineering and is fluent in Dutch, German, French and English.

1998 Haas Trade Show Calender

Name of Show / Location	Dates
HOUSTEX in Houston, TX	Feb. 10-12
WITS in Wichita, KS	Feb. 24-26
IMTEX in New Delhi, India	Feb. 24-Mar. 3
APEX in Charlotte, NC	Mar. 10-12
Arizona Manufacturing Expo in Phoenix, AZ	Mar. 10-12
WESTEC in Los Angeles, CA	Mar. 23-26
EMAQH in Argentina	April 18-25
Greater Cleveland Machine in Cleveland, OH	April 21-23
SIMTOS '98 in Seoul, Korea	April 22-27
MACH '98 in Birmingham, UK	April 27-May 1
Eastec '98 W. Springfield, MA	May 19-21

WESTEC '98

As North America's largest annual metalworking and manufacturing exhibition, WESTEC has traditionally been a showcase for Haas Automation to reveal its latest wares. This year is no exception.

Although rumors have Haas working on a myriad of new products, officials are as yet unwilling to reveal the exact details of what's in store for attendees at the Haas booth. You can be sure, however, that there will be some impressive new machines.

WESTEC '98 will feature more than 600 exhibitors and is expected to draw more than 30,000 attendees from Southern California and the Western United States. As the first major machine tool exposition of the year, WESTEC is the perfect opportunity to take an early look at the latest innovations in equipment and technology, and get a jump-start on making those purchasing decisions early in the year.

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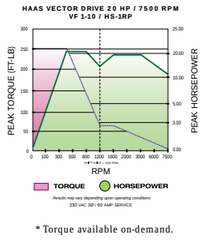
Ongoing design Advancements...

20 hp vector spindle drive



* Torque available on-demand.

Using the same closed-loop technology as our brushless servo motors, this Haas-designed vector drive optimizes the slip angle between the rotor and stator of the spindle motor to double low-speed torque and acceleration, resulting in the fastest and most powerful spindle output ever.

Improved gearbox

The Haas-designed and manufactured gearbox now employs wider, redesigned gears with 50% higher load capacity to handle vector-drive performance of 250 ft-lb of torque at 300 rpm. This new design is also more crash resistant should an accident occur.

Improved chip removal

By raising the height of our chip auger chute to 24 inches, chip swarf is dispensed at a higher level, leaving the coolant behind and dispensing a much dryer chip.

UP-TIME 98% GUARANTEE

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* Actual published torque charts available on request.

Electronic thermal compen

When ballscrews rotate they generate heat. Hea ballscrews to expand. With high duty cycles, like thc mold making, the resulting ballscrew growth can le ting errors. Our new ETC algorithm accurately mod heating and cooling effect and electroni compensates for screw position, providing near gla scale accuracy.

The smartest jog handle you've ever seen

The jog handle on the Haas control can be used to edit programs, override spindle speeds and feedrates, single-block-scroll through programs, and so much more that you'll wonder how you ever got along without it.

Get up to speed faster

The dual, 32-bit architecture of the Haas control allows for a new typ acceleration and dec have been doubled o older system, allowing axis drives to get up to speed faster with less shock to the system. Molds are cut faster and more accurately than ever before.

HaasValue

Ongoing engineering and design advancements with no price increases! How can we do it?

At Haas, we have two simple guidelines for engineering:

(1) Make the machines better, and

(2) Get better at making machines.

Our engineers understand the economic rewards these two principles provide for our customers.

Considerable effort and resources are invested to continuously upgrade our machines, while improving the overall manufacturing process.

Simply put: we make the investment, you get the benefits.

Change Everything But Our Prices.

HAAS

Ede brock

Precision Production Keeps Edelbrock in the Winner's Circle

When Vic Edelbrock bought his first project car in 1938, he had no idea he was about to revolutionize the world of hot rods. He just wanted to make his '32 Ford roadster the fastest car around.

Story by Clint Crowell

photo courtesy Edelbrock

Vic Edelbrock Sr. and crew with his 1932 Ford Roadster at Muroc Dry Lake.

Working out of his small garage in Los Angeles, he designed an intake manifold called "the Slingshot" for his flathead Ford. After strapping the manifold and a pair of Stromberg 97's to his engine, he headed to Muroc Dry Lake (where Edwards Air Force base is today) for testing and racing . The "Slingshot" propelled the little deuce roadster across the desert at 121 mph, and into the winner's circle, signalling the beginning of the Edelbrock dynasty.

Today, Edelbrock Corporation remains in the winner's circle as the premier manufacturer of high-performance aftermarket automobile components. The Torrance, California-based company produces more than two thousand different products, all designed to give their customers proven performance and maximum horsepower.

Top NASCAR teams, including Hendrick Motorsports, rely on Edelbrock components in their race cars. On the street, they set the standard by which all other parts are judged. Every time a driver starts his or her engine, Edelbrock's reputation is put to the test. And time after time, their intake manifolds, cylinder heads, camshafts, water pumps and other performance products meet the challenge and come out on top.

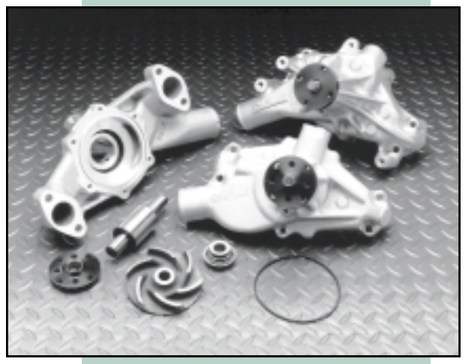
With so much riding on the line, the 500-plus-employee company leaves nothing to chance. "Controlling the process from start to finish is the best way to guarantee our products do what we say," says Scott Herrmann, Automation Systems Specialist at Edelbrock. "And having the most up-to-date tools to design and manufacture these products assures they are the best they can be."

Herrmann arrived at Edelbrock fifteen years ago to manage the quality aspects of manufacturing, from initial product development through shipping the parts out the door. His engineering degree in aerospace and background in computers and automation made him the ideal candidate to guide Edelbrock into the high-tech era of machining.

"When I first started working here," said Herrmann, "there were only 65 employees and no CNC machines. I began at the bottom doing the programming, then trained other people to program and do setup. Now, we've got a PC-based network linked to 25 precision machines, and we have a half dozen setup guys and manufacturing engineers."

Today, the 135,000-square-foot Torrance facility houses a gamut of CNC machines, including a five-axis Haas VF-6 vertical machining center used exclusively for porting cylinder heads. A Haas VF-2 and two VF-3 vertical machining centers equipped with 4th-axis rotary tables are used for completing practically every product Edelbrock makes, from cylinder heads and intake manifolds to water pumps and carburetors.

According to Herrmann, they use the VF-2 and two VF-3's for all the secondary operations they can't do on their two Mori Seiki horizontals, either because they don't have enough tools, or because the cut is located on the bottom of the part and would require refixturing. "The Haas machines fit our production flow nicely and finish the parts to a high quality," said Herrmann.



A selection of high-performance Chevrolet water pumps that Edelbrock machines on Haas VMC's.

Edelbrock components have been a perennial favorite with hot-rodders and racers for 59 years.

photos courtesy Edelbrock

Manufacturing is about getting product out the door, and Edelbrock has it down to a science. They produce about 5000 intake manifolds a week (10 to 20 different models), 200 sets of cylinder heads (various models), and 200 water pumps, again, three to four different models. For Herrmann, this translates into dealing with 20 to 25 setups a week.

"We've selected the right combination of machines, so now it's a question of reducing setup time. And the Haas units have helped us do just that. Each time I bring a Haas machine on-line, I notice an immediate increase in productivity. I attribute this to their ease in setting up, and because they are easy to teach people how to operate.

"A feature we find especially helpful," continues Herrmann, "is the jog handle scrolling. It allows our

photo by Scott Rathburn

Roy Salas sets up a cylinder head finish operation on a Haas VF-3.

This off-road pre-runner features a complete Edelbrock engine package as well as shock absorbers. Edelbrock recently purchased another Haas machine for their shock absorber facility.

setup guys to zip down the program on the control screen to make changes. It is a lot quicker than using arrow keys. We wish other CNC machines had that feature."

Herrmann purchased Edelbrock's first Haas machine, the VF-2, in 1994 to replace an existing machine that was getting old and worn out. For the application, he looked at Mori Seiki's small line, Cincinnati Milacron's small line, Fadal Engineering and Haas. "I chose the Haas," said Herrmann, "because it fit our application and tight space requirements. For the money, it was the best and most reliable.

"We run 24 hours a day, 5 days a week, so reliability is a big issue with us, along with service and support. If a machine goes down, we need responsive service to prevent lapses in production. I know Haas will be there to respond if I call."

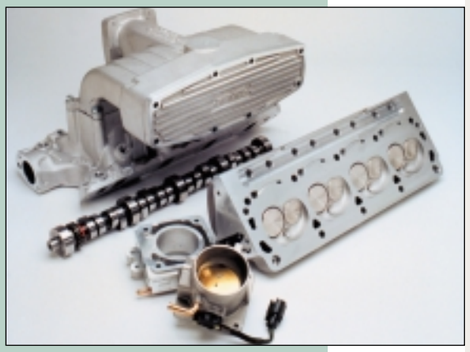
Last year when Herrmann needed a 5-axis vertical machining center to perform one of Edelbrock's most critical machining functions – porting aluminum cylinder heads – he returned to Haas and purchased a VF-6 equipped with high-speed machining and inverse-time options for 5-axis operation, and extended memory to handle their huge files.

"When a customer buys a product from Edelbrock, they are looking for bolt-on performance," said Herrmann. "It is important that the cylinder heads in production generate the same amount of power as the prototype. This requires precision accuracy and repeatability."

The more consistent the cylinders are the better. On a V-8 engine there are two cylinder heads, which means eight cylinders. When the cast-aluminum heads arrive from the Edelbrock foundry in San Jacinto, California, the cylinders can vary up to 30 thousandths of an inch. According to Herrmann, this would work fine for the average engine, but for true performance, each cylinder needs to have exactly the same parameters.

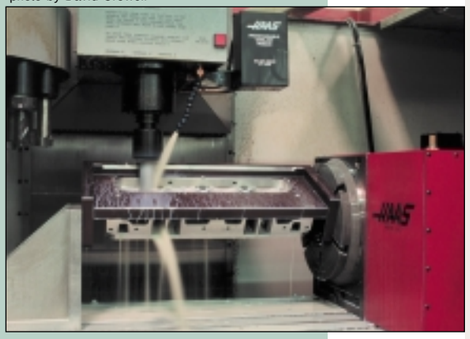
Herrmann said, "Craftsmen can grind cylinders by hand, which makes them close to perfect, but when you port them with a CNC machine, every cylinder is perfect and exactly the same. Each cylinder is going to flow the same and the distribution is going to be equal to all cylinders. That type of precision and consistency is critical to our customers."

And it's critical to the continued success of Edelbrock. Like Haas, they are an American company that is thriving because they engineer good products, manufacture good products and support their products. "Our company is based on guaranteed performance," said Herrmann. "We sell nothing less and expect nothing less from the companies we work with. That's the secret."



Nearly every product Edelbrock makes – cylinder heads, manifolds, throttle bodies, etc. – is completed on a Haas VMC.

photo by David Crowell



Edelbrock uses Haas VMC's and 4th-axis rotary tables for machining cylinder heads.

photo by Scott Rathburn

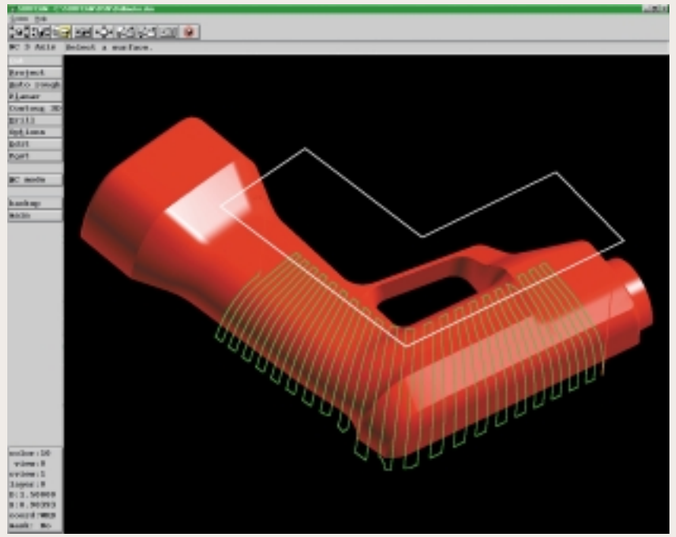
Scott Herrmann, right, looks on as Roy Salas checks the accuracy of valve-guide holes in a small-block Chevy cylinder head. Many of the finish operations are performed on Haas VMC's.

Edelbrock Corporation 310-781-2222

PC Modeing

By Larry Diehl

Part Two: Machining Methods



A flow cut traverses multiple surfaces within a set boundry.

Part one of the series talked about constructing solid and surface models in the computer.

Part two tells the ways you can machine the models using mid-range PC-based CAM systems.

You can cut imported CAD models two ways: Generate the tool path from the surfaces and tool geometry, applying edge protection to the surfaces, or generate the tool path directly from the solid, using Boolean operators and accounting for the sweep volume of the tool.

The second requires lots of calculations based on the intersection of the solids because it has to be continuously calculated as the tool moves along. Because the math is complex, risk of error is high and the probability of gouging is much increased. It's common to generate 10,000 to 100,000 individual tool path moves, and an error in a single move stops solids machining altogether. Any compromise gives a bad finish.

No software or hardware wizardry can speed up NC programming if the CAM system uses an inefficient technique to generate tool paths. The most robust method tessellates the part into polyhedrons consisting of numerous triangles (facets or planes), where user-defined accuracy determines the number of facets. Finished part accuracy is typically between 0.0005 and 0.0001 inch, so the math solution to the intersection of tool shape and facets is quicker and more reliable than the formulas to generate tool paths directly from solids.

It's easier to plan, organize and reorder cutting routines if your CAM system includes a module that lets you graphically cut and paste into an efficient operations manager. This sort of feature lets you view and reorder NC parameters associated with tool paths, and provides a history of machining strategies for family of parts programming. Tool, material and stepover settings used for one NC operation can be applied to different geometry for new tool path generation.

Cutting Features

Good math is only half of what a CAM system is about. The other half is good machining practice. Following are some features and methods for machining.

Gouge-Free Tool Support: Today's CAM systems should offer support for squarenosed, bullnosed and ballnosed end mills, with full gouge avoidance on each. 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.

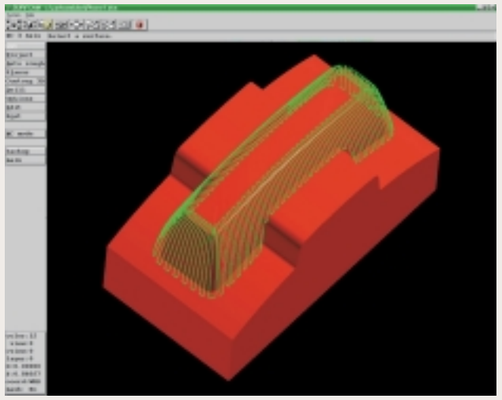
Surface Edge Protection: Individual shapes that make up a free-form surface or solid model may have gaps, and how they're handled differs among CAM systems. Some will simply add a straight line between the surfaces on either end of the gap, but this risks gouging. The more reliable method is to "edge protect" each of the individual surfaces. With this method the tool path is guaranteed not to gouge the interior or edges of the surface.

Tool Path Bounding: You want to be able to arbitrarily limit the extent of the tool path so that only a portion of the model is cut. For quick tool path generation, the bounding needs to be done at tool path creation time rather than waiting until after the full tool path is generated. This is especially significant if a portion of the model is all you want to cut anyway.

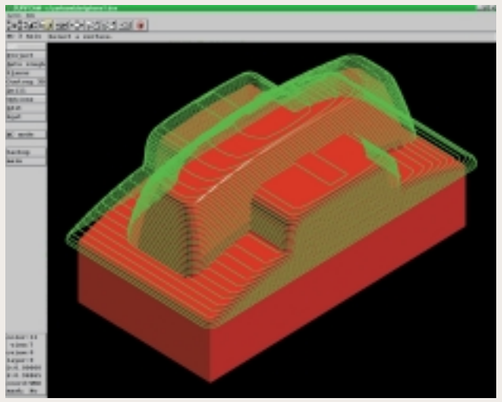
Fixed-Distance Step-Overs and Scallop Height Control: CAM software should allow the user to specify a fixed distance between each cut, and specify the maximum scallop height and maximum surface tolerance. Then the software will calculate the proper step-over to develop the shortest possible NC code and fastest machining cycles.

Feed-Between Moves: Tool path generation usually follows rows as it cuts the parts. When the tool comes to the end of a row, the CAM system 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 can gouge if the software doesn't check first. To avoid gouging, better systems will offer the option of following the part shape in the transition to the start of the next row.

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 to engage and to leave the part gently, such as spiral, arc, and ramp motions, to guarantee they won't gouge.



Constant Z-level finishing is the best way to cut near-vertical slopes.



Multi-surface flow cutting can be used to optimally machine a part, following various bends.

Cutting Methods

Cutting techniques for both solid or surface models are z-level roughing, z-level finishing, planar, single surface flow, multi-surface flow cutting (includes radial cutting), and project cutting. The machinist should have the option to specify various cutting methods for any portion of the model.

Z-level roughing is the most efficient way to remove the majority of excess material when cutting a part. It slices a model with constant z-level planes to generate paths which can then be spiral or zigzag cut. If there are overhanging areas on the part, you want the CAM system to avoid gouging with the shank of the tool as well as the tip.

Z-level finishing is the best way to finish areas of a part that are almost vertical. It is important that the operator can apply a boundary curve to limit the area of path generation.

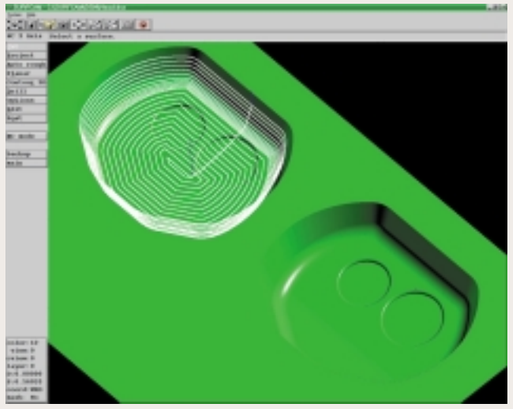
Planar cutting is the oldest and most well-known method of cutting complex models. It allows the operator to generate parallel planar tool paths over any number of underlying surfaces. Current systems vary widely in the speed and quality of the tool paths generated. Even systems that claim to generate gouge-free tool paths may gouge on complex shapes. If you are choosing a new CAM system, be sure to test it on the most complex part you're likely to cut.

Single surface flow cutting leaves the best surface when a part's geometry is defined by only a few surfaces. It cuts only a single surface at a time, but the CAM system must be capable of gouge checking that surface against any number of surrounding surfaces.

Multi-surface flow cutting is a powerful feature. For machining a boomerang shaped part, or any part with a bend or a lot of bends, it is important that the CAM system is able to generate tool paths that flow along or across a specified flow surface while remaining essentially perpendicular to it. On a round, oval or odd-shaped part, mold or die, this feature lets you cut perpendicular to the shape around the part's periphery regardless of its shape. The machinist can control tool-path direction to produce the finest detail.

Project cutting is useful when machining an irregularly shaped part with a particular 2D tool path, as for engraving. Your CAM system should be able to create this tool path, project it onto the complex model and cut – all with full gouge avoidance.

About the author: Larry Diehl initially developed SURFCAM in the 1980s. He continues to program daily as Surfware's chief software developer, and oversees SURFCAM product development. 818-991-1960



A spiral toolpath is projected, with gauge avoidance, onto multiple surfaces.

Mikana in aerospace

Mikana Uses Haas CNC Technology and Soars Into The Future Beyond the Speed of Sound.

Story by Clint Crowell

When the Blue Angels streak through the sky demonstrating the aviation excellence of the U.S. Navy, they are piloting the most versatile aircraft in the nation's front line of defense – the F/A-18 Hornet. It was called upon during Operation Desert Storm to fight opposing aircraft and destroy ground targets on the same combat mission.

photos by Gerard Burkhart

Mikana President Michael Allawos displays a ramp mid-former they machined on a Haas VMC for Northrop Grumman.

McDonnell Douglas F/A-18 Hornet.
photo by James Bean

McDonnell Douglas F/A-18 Hornet.

The twin-engine fighter/attack aircraft, also used by the U.S. Marine Corps and eight allied nations, showcases the capabilities of modern manufacturing while setting new records in reliability, maintainability and mission performance. At the roots of its success are the combined efforts of not only large contractors like McDonnell Douglas, Boeing, Northrop Grumman Corporation, General Electric Co. and Hughes Aircraft Co., but also essential job shops like Mikana Manufacturing Company, Inc., located in San Dimas, California.

Danny Hennig, left, and Michael Allawos check a 4th-axis set up for an aluminum rib assembly Mikana manufactures for McDonnell Douglas.

It is fitting that Mikana machines parts for the F/A-18, because the company and aircraft share many of the same traits. Both are on the cutting edge of technology and successfully pushing the limits to reach higher levels of achievement. "We are asked to do the impossible," said Michael Allawos, president of Mikana, "which translates into providing precision parts on quick turnarounds. The way we achieve this, is by being aggressive with our machines."

Mikana's philosophy has been working for them since opening their doors in 1985. They specialize in the aerospace and medical industries, using the latest manufacturing and business systems to remain competitive in the high-tech arena. As testament to their success in managing technology, during the recent glut in the aerospace sector, Mikana not only survived, but positioned themselves for growth.

"We have proven our abilities to our clients," said Allawos, "and are being rewarded for our efforts with a backlog of projects extending into the next century. As a result we are expanding – buying new equipment – but not without control. Maintaining control of our growth enables us to continue doing the jobs we are best suited for, instead of having to do work that doesn't fit our expertise."

With Mikana's growth came the purchase of their first Haas unit, a VF-4 vertical machining center (50" x 20" x 25" travels) equipped with a chip conveyor and programmable-coolant nozzle. "We've found that if you buy the best and most technically advanced equipment for your company," Allawos said, "the people will rise to the occasion and perform miracles. That is why we thoroughly investigated our machining options before selecting Haas Automation for our shop."

Richard Borowski, Mikana's general manager, added, "We went to Westec and looked at the different manufacturers, then toured several facilities to see the machines in action. The more we saw of Haas, the more we were impressed."

Allawos, a strong advocate of teamwork, has empowered Borowski to run the shop. "We were certain our volume could support several new machines," Borowski continued, "but we remained cautious with our purchasing until we could put the VF-4 to the test. The machine started paying for itself the minute we flipped the switch on, and within a month it had proven itself to us."

Allawos added, "We realized a 60% savings with the first machine, so we bought more."

They had their second VF-4 VMC delivered within 6 months, and within a year and a half had two more Haas units running in the shop, both VF-2 VMC's (30"x16"x20" travels). "There are three things a machine needs if it is going to make you money," Borowski said, "versatility, repeatability and accuracy – crucial factors for maintaining good productivity. Our Haas machines come through in all categories."

Productivity has skyrocketed. "We realized a 50% increase in productivity when we switched to the Haas VF-4 to manufacture the titanium Fitting Cover for the F/A-18," said Borowski. "And at the same time," he continued, "we were able to increase the life of the carbide inserts on the cutting tools 12-fold."

He attributes these accomplishments to the rigidity of the machines (provided by the heavy cast-iron base), the ability to run at higher rpm for longer periods of time, and the ability to maintain constant speed during bigger and deeper cuts.

These same characteristics are vital in machining the Lateral Cam Mikana produces for McDonnell Douglas' MD-80 and MD-90 commercial aircraft. These parts are what Borowski calls "a titanium nightmare." Starting with a 16-pound block of titanium measuring ¾" x 14" x 16", they use three setups to machine it down to a 3-pound finished part. "It's a multi-angle type of cut, and we have to hold critical dimensions to 0.0005", " Borowski said. "It's a nightmare because of all the cutting and hog out. The titanium is tough and dense, and it requires more power to maintain the feed rate and keep up the rpm. The Haas machines have allowed us to more than doubled our output."

Danny Hennig, left, checks a part while Programmer Tom Anderson, center, and General Manager Richard Borowski work at the Haas control.

Mikana has realized similar results in aluminum. A rib-assembly part they manufacture for McDonnell Douglas starts as a 3600-pound plate of aluminum measuring 4' x 12' x 3". The plate is cut into 300-pound blocks measuring 24" x 30" x 3", which are then machined on the VF-2s into a pair of 15-pound parts. Keeping up with the production schedule means taking big cuts. "We really push our equipment, but never sacrifice accuracy," Borowski said. "The rigidity of the Haas machines gives us the accuracy we need to maintain tolerances and meet quality control inspections."

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Mikana keeps a busy production schedule, completing 15 to 20 setups a week with runs of 1 to 30 parts each, so saving time in setup is crucial for staying on track. It begins with programming, where it is fascinating to note that Tom Anderson, one of their programmers, wrote posts for one of the first Haas units ever made, serial number 6006. The programmers use the latest CAD/CAM software to generate posts and incorporate a digital camera to create packages for the setup guys.

"Haas cut our setup time by over 30%," said Borowski, "which is important to us, because some setups are 9 hours with 1 hour runs, while others are 3 days with 2 hour runs. Guys can do dry runs to check for tool paths and see the part being machined on the control panel screen without actually running the part. The control panel is very user friendly and our guys can get a lot of information right from the screen without having to go anywhere. They can make changes, proof the part, archive the program and run the job."

Borowski continued, "We can run the same program over and over and not worry about whether it's going to be close. The repeatability is always top notch and the Haas machines always do what you tell them to do.

"There are a lot of other things we like about the Haas units, for instance the way they come underneath the machine with the coolant instead of from behind. But the bottom line is we had a need for machines and Haas filled it admirably. And in doing so, helped us increase our delivery schedules, our relationships with our customers, and our ability to work in different situations."

Michael Allawos displays a rib assembly Mikana makes for McDonnell Douglas while operator Danny Hennig prepares to run another part on the Haas VF-2.

In accordance with their mission statement, Mikana set out to create a greater presence with their customers and influence the shape and direction of industry. They have made great strides in achieving their goals and have assembled the ideal combination of equipment, management and craftsmen to continue on their path of growth and financial stability.

Mikana, 909-592-2117.

Making Waves

If it has an engine, you can trick it out and make it faster.

Ron Gitlin has applied this theory most of his life: first to his race bikes, and later to personal watercraft, motocrossers, road-racers and Go-Peds. Fortunately, thousands of other speed-addled individuals share this penchant for hopping up whatever motorized machine they have at the time. Otherwise, Gitlin would still be hating life, chasing contracts in the endless dance of feast or famine that is the traditional job shop business.

For more about Ron Gitlin see Racer to Riches on page 21.

Story and photos by Scott Rathburn

Rick Quelch, above, is one of many top competitors who rely on Triton for high-performance watercraft parts.

photo by Heather Selwitz

Today, Gitlin is president of Triton Engineering & Manufacturing of Boulder, Colorado, a machine shop founded by his father in 1946. He took over the reins in 1989 when his father decided to retire... but he refused to dance the same old dance.

He wanted a steady dance partner for Triton – one that wouldn't run off with another shop at the drop of a low bid. To temper the ups and downs of the business and add some stability, Gitlin decided to manufacture his own products.

Triton now specializes in manufacturing high-performance parts for personal watercraft, motorcycles, Go-Peds and the occasional motorcycle race team. They are the largest manufacturer of billet cylinder heads in the personal watercraft arena, producing a full line of performance products for just about every craft on the market.

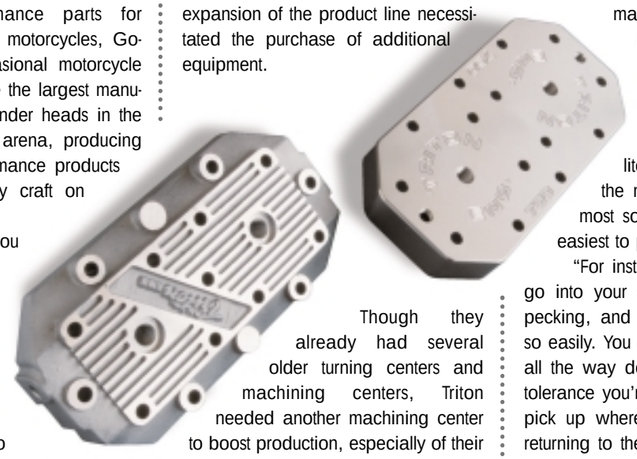
So, how do you make the transition from traditional job shop to full-blown manufacturing? Well, it doesn't happen overnight. First, you have to have products to manufacture. Then, you have to have the market to sell them.

Gitlin had the products: He had prototyped his first designs in the late 80's via UPS, penning the designs while working at a Florida motorcycle shop and sending them to his father for machining. Upon taking the helm at Triton, he was able to implement these designs and jump-start production.

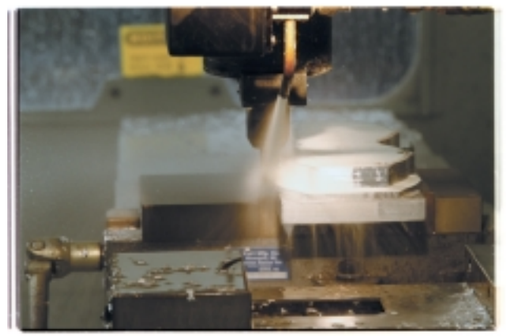
And he had the market: Extensive experience in the motorcycle and watercraft industries gave Gitlin an immediate in-road – he knew what to make, who to sell it to, and the weaknesses of the competition. He found distributors in short order.

David Weaver sets up to machine a water rail for a Yamaha 700 triple snowmobile.

Almost immediately Triton began production of Gitlin's original designs. Soon, increasing demand and rapid expansion of the product line necessitated the purchase of additional equipment.



Though they already had several older turning centers and machining centers, Triton needed another machining center to boost production, especially of their larger cylinder heads. They wanted a machine that was larger and faster and would allow them to set up multiple fixtures quickly and easily. After thorough research, they selected a VF-3 vertical machining center (40" x 20" x 25" travels) from Haas Automation, Inc.



Triton burns the perimeters of their cylinder heads at 10,000 rpm and 130 ipm on a Haas VF-3 VMC.

According to David Weaver, Triton's head machinist and second in command, many things contributed to their decision to buy the VF-3, including the big table, large Z travel , value, price and speed. But, "It was the control that really sold us," he said.

Gitlin agreed. "We read about the Haas machines and they sounded good, but what really sold us was taking a test drive and finding out how good the control is. All my machines have Mitsubishi, Fanuc or Yasnac controls, with the exception of the Haas. As far as I'm concerned, the Haas is literally the best control on the market. It's definitely the most sophisticated, and it's the easiest to program.

"For instance, the way you can go into your canned cycles, like for pecking, and change the parameters so easily. You can make the mill rapid all the way down to within whatever tolerance you're comfortable with and pick up where it left off, rather than returning to the zero point and slowly feeding down. That's incredible, because on our cylinder heads, half the machine time is a drilling cycle. We were able to take parts and literally reduce the machine time by 40 percent. It was amazing."

Triton uses the Haas VF-3 primarily for machining billet cylinder heads for personal watercraft. "We build 701, 760, 1100 and 1200 (cc) Yamaha heads; 750, 900, and 1100 Kawasaki heads; and 720 and 800 Sea Doo heads," Gitlin said.

Typical batch sizes are 50 to 100 pieces, depending on the model, and Triton uses multiple fixtures to hold up to four heads at a time on the table. The Yamaha 1100 triple is a good example of a typical cylinder head operation on the VF-3.

photo courtesy Yamaha Motorsports

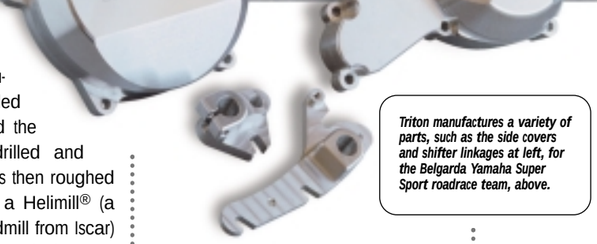
Wayne Sturm measures the combustion chambers of a Yamaha triple cylinder head machined on Triton's Haas VF-3.

The head starts as a 2" x 6" x 16" block of 6061-T6 aluminum. The block is drilled for mounting holes, and the sparkplug holes are drilled and tapped. The periphery is then roughed to within 0.025" using a Helimill® (a high-speed, inserted endmill from Iscar) at 10,000 rpm and 130 inches per minute. Two clean-up passes take the part to its finished size, then the bottom of the head is machined and the combustion chambers cut. The head is then refixtured to finish the top.

Total time for all operations is about 1 hour, 15 minutes.

"I would say we probably took 10 to 12 minutes off the Yamaha triple with the Haas," Weaver said. That's a big savings on a run of 50 heads, and Triton has achieved similar results on their other products.

"We build these things called ski bridges," Gitlin said, "a repetitive part. The fastest we were able to build that part on our other machines was a little over nine minutes. With the Haas, we got it down to a little over five minutes." That's a reduction in cycle time of nearly 45 percent.



Triton manufactures a variety of parts, such as the side covers and shifter linkages at left, for the Belgarda Yamaha Super Sport roadrace team, above.

Gitlin went on to say, "We were able to take a lot of our existing programs and speed up the processes tremendously. Via the 10,000-rpm spindle and the torque of the servo motors, we were able to run much heavier chip loads; and the size of the machine (48" x 20" table) enables us to run more vices and more parts at one time for faster turn-around times. If somebody wants billet side covers for a [Yamaha] YZF 600, we can run 100 of them on the Haas and be out of there and onto another job faster than we can on any of our other machines."

And, "The Haas produces a much nicer looking product," Weaver added. "A lot of our products are aesthetic. It's not so much a matter of

Triton Engineering is the largest manufacturer of billet cylinder heads for personal watercraft. They manufacture a variety of other products as well, such as velocity stacks, intake manifolds, fuel-injection systems, couplers, knobs and gas caps. What they call spruce-it-up or speed-it-up type products.

function, but does it look cool? That's what a lot of the Go-Ped kids and the Jet Ski world want: to look cool."

In addition to reducing Triton's cycle times, the Haas VF-3 has also been very reliable. "It hasn't even hiccuped," Gitlin said. "We literally have not had even a minute of downtime."

"I wish we had discovered Haas a lot sooner," commented Weaver. "I've never seen a machine come into any shop, anywhere, that didn't have some kind of problem right off the bat. The Haas is the only machine I've ever seen where it was, 'Come in, drop it on the floor, turn it on and here you go.' No problem."

And it's accurate. "We probably hold plus or minus two-tenths (0.0002"), although it's not really required for most of what we're doing," Weaver said. "But occasionally I'll get into a bearing surface and the Haas will hold a tenth all day. Whereas my other machines will take an hour or two to stabilize out, the Haas just seems to be close right from the beginning. And it doesn't change."

"But occasionally I'll get into a bearing surface and the Haas will hold a tenth all day. Whereas my other machines will take an hour or two to stabilize out."

Gitlin agreed, "The Haas does not change at any point in time during the day; and it does not change regardless of how much down time there is between cycles. For instance, if we're running parts all day and the operator takes a 20-minute break, the next part he makes after the break will be exactly the same size as the part before the break. That's not true for our other machines; the part will change a few tenths."

This accuracy, repeatability and reliability allows Triton to maintain the superior quality necessary to meet the demands of the high-performance motorsports industry. Their ability to produce quality products and quickly react to market fluctuations has provided the stability they need to dance the dance in today's competitive marketplace.

Ron Gitlin, front, and his father Ed Gitlin with a selection of Ron's toys. Ron took over the reigns of his father's machine shop in 1989.

Racer to Riches

Growing up in his father's machine shop, Ron Gitlin saw first-hand the volatility of the traditional job shop business. So when he left home to pursue a career of his own, he had no intention of subjecting himself to that type of life. Little did he know that one day he would end up as president of his father's company.

by Scott Rathburn

Ron Gitlin measures the combustion chamber volume of a Yamaha twin watercraft cylinder head. Heads are machined on a Haas VF-3.

Triton Engineering & Manufacturing Company, Inc., of Boulder, Colorado, began life in 1946 primarily as a job shop, with their main focus being aerospace and defense contracts. For many years, lucrative government contracts provided a very comfortable living. But such contracts required tremendous energy to procure and were apt to disappear without warning.

Triton didn't really start dealing with the public or other companies until the early 70s, when several national research & development facilities moved to Colorado. Being the oldest continuously run machine shop in the area, these facilities naturally gravitated to Triton for their machine work.

But Ron Gitlin didn't want any part of the job shop environment.

He vowed not to follow in his father's footsteps, but he still learned all the ins and outs of the business. Naturally, he learned to be a machinist and how to rebuild equipment, but he always used this knowledge toward his own interest – building trick parts for his race bikes.

Race bikes were his passion.

At the tender age of 19, Gitlin headed to California to seek fame and fortune as a professional motorcycle racer. Plying the dirt oval was his life's ambition – but working at a motorcycle dealership paid the bills. For two years he chased his dream. But alas, a professional racing career was not to be. Despite reaching AMA expert level, the number-one plate and factory sponsorship remained out of reach. "I realized I was never going to be good enough to be anybody," Gitlin explained." So I headed back to Boulder."

Though he returned without a championship, the connections he made and the experience he gained, both on the race circuit and in the motorcycle shop, would serve him well down the road.

For the next several years, Gitlin worked at his father's machine shop while also working as parts manager at a local motorcycle dealership. It seems machining and motorcycles were destined to remain intimately entwined in his life. Despite this full plate, he also pursued a college degree during this time.

Degree under his belt, Gitlin once more left the crisp, clean Rocky Mountain air of Boulder in search of fame and fortune. Well, at least fortune.

Alighting in Florida as general manager of a motorcycle dealership, his interest in motorcycles quickly expanded to include the growing arena of personal watercraft – Jet Skis, Sea Doos, Wave Runners and the like.

As with his race bikes, Gitlin was always searching for ways to make his new toys faster. At that time, however, the performance aftermarket for personal watercraft left a lot to be desired. "Being a customer myself of the existing companies, I saw the crap they were turning out and the prices they were charging for it," he explained.

Realizing the potential the market held for quality products, Gitlin combined his manufacturing know-how with his experience in the motorcycle and watercraft industries and began formulating designs for his own product lines. Working long-distance with his father, he prototyped his own performance cylinder heads and accessories for personal watercraft.

About this time, Gitlin's father decided he wanted to retire. There was talk of paring down the business and selling it as a job shop, or just liquidating the business entirely.

Gears began to turn in Gitlin's mind, forming an idea.

He said to himself, "Wait a minute! We have an existing base – Triton Engineering – that is very strong, very knowledgeable and very capable. I think we can get into this industry and be a serious player right from the get go." So back to Colorado he went to relieve his father and become president of Triton Engineering.

But what about the volatility of the traditional job shop business?

"I had no desire to come back and be solely in the job shop business," Gitlin emphasized. "I didn't want to sit there waiting to see if, and when, we were going to get a big aerospace package; or spend a lot of time and energy bidding huge projects only to miss the bid by $100 on a $40,000 contract. But I saw a tremendous opportunity to provide some stability by manufacturing aftermarket parts for personal watercraft."

Putting his industry contacts and experience to quick use, Gitlin found distributors for his first designs and new products. "I already knew who to market the parts to, how to market them and what the shortcomings of the competition were."

The products were an instant success, prompting Gitlin – and Triton – to branch out into other areas of motorsports. His contacts from racing and the motorcycle industry gave him a fast inside track to additional customers. Many of the people he used to race with – or against – were now team managers needing parts for their race bikes. They naturally came to

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Story and photos by Scott Rathburn

Rip Snortin' Scooters

Back in the good old days, before the advent of skateboards and in-line skates, a kid needed a little ingenuity when it came to developing modes of transportation. Sure there were bicycles, but they were for big kids, and you had to convince the elders you were deserving of such a purchase. And what if you were in that awkward in-between stage: too big for a tricycle, but too small for a bicycle? There just weren't many options

Until the discovery of the handy-dandy, home-built scooter. You found yourself an old orange crate and some scrap wood, appropriated an old pair of metal roller skates, borrowed your dad's hammer and a selection of nails and assembled everything into the coolest vehicle in the neighborhood. Well, it seemed pretty cool at the time, and it let you rip up the sidewalks with abandon until you were big enough to justify that Schwinn Stingray with the blue-metalflake-vinyl banana seat.

Over the years, the orange-crate scooter evolved in a couple different directions. Southern California saw the birth of the sidewalk surfer, a variation of the board and roller skate combination, but sans handlebars. This was the precursor to the modern skateboard.

Another branch of the family tree yielded the metal scooter. Basically a mass-produced version of the old crate and roller skate contraption, these featured a single rubber tire fore and aft, a stamped-steel foot deck, chest-high handlebars (at least they were chest high if you were eight) and multi-colored streamers dangling from the hand grips. For the most part, these were merely stepping stones between three- and two-wheeled mobility, eventually handed down to younger siblings or banished to the garage to collect dust.

Until, that is, an over-zealous gearhead named of Steve Patmont strapped an old Weed Eater engine to his scooter's rear wheel, thus creating the Go-Ped. A far cry from the self-propelled contraptions of yore, the Go-Ped is not just for kids anymore.

At first considered a novelty, Go-Peds soon developed a cult-like following. As with any vehicle, motorized or not, get a couple testosterone-addled owners together, and the next thing you know, there's a race. And where there's a race, there's a loser. And where there's a loser, there's an overwhelming need to vanquish the loss by returning to beat the winner. Thus begins the endless cycle of spend money, modify, race, spend money, modify, race. The end result? A dual-overhead-cam, fuel-injected, 16-valve, twin-turbo, nitro-burning, 450-horsepower scooter that'll do flamin' burnouts two miles long at 150 miles per hour.

Well, maybe that's a little extreme. But the reality is, people actually do race the darn things! Powered by a 22.5 cc two-stroke engine, a stock Go-Ped will reach top speeds of about 20 mph. In full-race trim, a Pro-Modified Go-Ped will crank out about 10 horsepower and hit speeds up to 35 mph. As with other

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Ray Kite and Gunnar Geenemeier of Toy Shop Racing in Denver, Colorado, tear it up on a pair of tricked out Go-Peds.

Scooters, cont...

A pair of modified Go-Peds fully decked out with Triton products.

racing, set up is crucial, with different tracks requiring different set ups. Short, technical tracks loaded with tight turns, require a Ped that's quick off the line and has lots of low-end grunt to squirt from apex to apex. A course heavy on straights, however, requires more top-end power and the speed to cover the most ground in the least amount of time. It's a fine line to walk, and its always a compromise. Get the mix wrong and you'll be left behind.

In the endless battle to come out on top, owners were quick to grab anything that would make their rides faster or better looking. A tremendous demand soon developed for high-performance parts. And where there's a demand, there's an aftermarket.

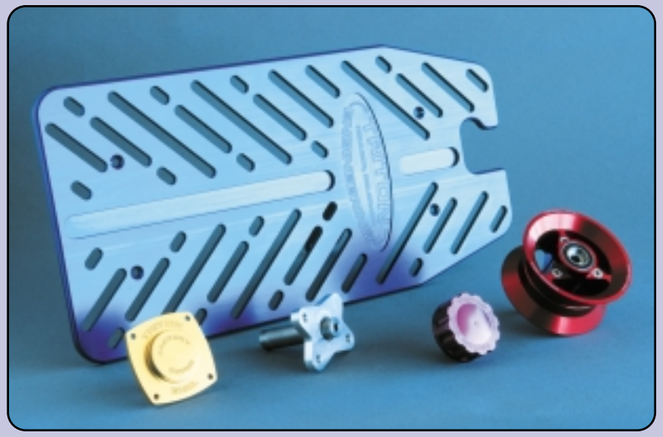
Through a rather chance encounter, Triton Engineering & Manufacturing (see main story for more about Triton) stumbled into the Go-Ped culture. David Weaver, the number-two man at Triton, explains: "Two kids came through the shop and asked if we could make some parts for them. We said, 'Sure,' and it just went from there. All of a sudden, from those two kids alone, we got probably 100 sales. When we originally designed some of that stuff we thought, 'Yeah, right, trick parts for Go-Peds.' But since then, business has grown tremendously."

Seeing an obvious untapped market for Go-Ped trickery, Triton stepped into the void and soon found themselves machining a myriad of parts. They are now the number one manufacturer of aftermarket Go-Ped products in the world. "We build billet wheels, billet foot decks, billet side covers for the engine, turbo cones, miniature forks, all kinds of weird stuff," said Ron Gitlin, Triton's president. "Pretty much anything you can replace on a Go-Ped, we make it; and we private label for several different companies."

At the recent Go-Ped Nationals in Omaha, Nebraska, about 100 competitors gathered to battle for top honors in Pro, Amateur, Junior and Women's divisions. Triton products adorned the rides of nearly every top competitor, including Denver's Toy Shop Racing, which descended on the event with a collection of ten racing Peds fully decked with Triton parts. Ray Kite, TSR's owner, crew chief and engine builder, referred to his team as "the Indy crew of the Go-Ped world."

From a piecemeal wooden contraption to a full-on racing machine. Talk about evolution.

Some of the Go-Ped trickery manufactured by Triton Engineering. Clockwise from upper left: Foot board, billet wheel, gas cap, rear axle support and bearing, and engine side cover.



The monstrous 22.5 cc Go-Ped power plant, complete with Triton parts.

someone they knew for their machining: Ron Gitlin and Triton Engineering.

Soon Triton was making parts for the likes of Belgarda Racing, Yamaha's European roadrace team, and Team Kawasaki's motocross effort. Contacts from Gitlin's dirt track days yielded customers like Bartel's Harley-Davidson and riders Jay Springsteen, Chris Carr, Terry Poovey and Steve Moorehead. Seeing these parts, other teams and racers would ask who had made them.

The word spread. Individual customers led to entire markets. One-off parts grew into full product lines.

Triton currently is the largest manufacturer of billet cylinder heads for the personal watercraft market, producing their own lines as well as private labelling for other vendors. They manufacture a variety of other products as well, such as velocity stacks, intake manifolds, fuel-injection systems, couplers, knobs and gas caps. What they call spruce-it-up or speed-it-up type products.

"By bringing on our own product lines, and also building my competitors' product lines – which are our design, we just private label them – we added a tremendous amount of stability to our business," Gitlin explained.

Now, 75 percent of Triton's business is motorsports, with the remainder being high-tech job shop work. "We still do a lot of work for the national labs," Gitlin noted. "Our true specialty, if we said we had to have one, is high pressure and high vacuum. We specialize in designing and building vacuum chambers and systems, and pumping stations, as well as cryogenic valves and systems."

For Triton Engineering the combination of manufacturing and high-tech contract work has been a very profitable endeavor. But where do they go from here?

"That's a difficult question," Gitlin says. "I think a lot of it is based on my personality, and on what I do and don't want out of life. I mean, living in Boulder is bitchin'. And at 37-years-old, I've leveraged myself into a position where I earn pretty good money. I live in a nice house, and I have more toys than there's time to play with. Between my motocrossers and my dirt trackers and my shifter go-carts and my Go Peds and my watercrafts, I have a lot of toys and a lot of fun.

"To be honest with you, on the one hand I'm pretty content where I'm at. But is the business anywhere near as large or successful as it could be? No. If I were serious about radically growing the company, I think I could pretty easily spin it off into a couple different divisions and spend more time focusing on the ice climbing stuff we make. But everything's a trade-off. The more successful you are in business, the more demanding it is on your time and the more stress it is. I don't know if I want that."

For now, Ron Gitlin is content to enjoy the stability of Triton's manufacturing success. It seems he finally has his number one plate.

Machining of a water rail for a Yamaha triple snowmobile.

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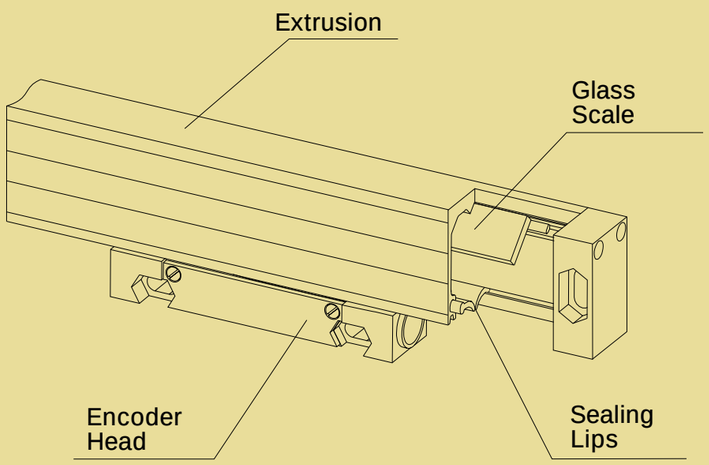
Zen and the Art of Positioning

Story by Al Werner, RSF Electronics, Inc.

Wherever you go . . . there you are.

IN a Zen kind of way, this makes complete sense. Because no matter where you end up, that's exactly where you are at that point in time. For a machine tool, however, this is not a good thing. Unless, of course, you know where you started and where you are in relation to that starting point. That's why God – or if you prefer, engineers – invented position feedback systems.

Figure 1



In order to machine a part accurately, the machine tool must know the exact location of the cutting tool at all times, both in relation to machine zero and to the part. The demand for improved machine resolution, accuracy and speed continues to push design engineers to utilize the latest technology. Thus, the use of linear encoders for machine tool position feedback is becoming more popular due to their performance enhancing characteristics.

Prior to the development of low-cost electronics, manual machine tool operators used a flat ruler and pointer system to obtain information about the position of the cutting tool and the work piece. The ruler quite often was an etched metal or glass scale attached to the stationary machine. The pointer was a simple arrow, with or without a magnifying lens to enhance visibility. A vernier scale, when used as a sophisticated pointer, was able to 'subdivide' the ruler pattern for greater accuracy. In the use of manual machine tools, the operator acted as the control system. He moved the machine, received feedback from the linear ruler, adjusted the feedback for known errors and tooling factors, and checked his work with hand-held micrometers and gauges. Machining of a single complex part was time consuming. Machining of many parts with high repeatability was difficult at best.

Advancements in the field of electronics made possible the first affordable digital readout systems in the late 1950s. Linear transducers converted machine motion to digital pulses, and a digital readout (DRO) displayed incremental motion to the operator. Back then, a typical two-axis DRO system for a small milling machine was quite expensive. It cost around $3000.00 – enough to buy a new automobile – for a system that developed 0.0005" resolution, had few features and was often unreliable. Despite all the advantages a DRO system provided, machining still required a highly-skilled operator with time and patience.

With the development of CNC controls for automatic machine tools came linear encoders designed for the task. Today's high-speed, high-resolution, high-accuracy, high-duty-cycle and high-reliability machines require these same features from the position feedback devices they use to maintain closed-loop servo motor control. Of all linear encoder technologies, glass scales offer the greatest advantages to machine tool manufacturers today.

Haas Automation now offers glass-scale linear encoders (linear scales) as an option on many of their machining centers. The technology being used by Haas was designed specifically for the rigors of CNC applications and has proven itself capable through more than 10 years of field experience. Following is a description of how these encoders work.

The linear encoder consists of two sub-assemblies: (1) an extrusion with internally mounted glass scale and (2) an encoder head with scanning carriage.

The glass scale is fixed within an aluminum extrusion to facilitate attachment to the machine and protect it from the elements [Figure 1]. The scale has a pattern of opaque chrome lines and transparent spaces of equal width. Included on the glass is an additional track for the Reference Index output signal, commonly used for the Home position. The Home position is repeatable within one encoder count regardless of the machine's direction of motion during the Homing sequence. This repeatable Reference Index location allows machine operators to set up machine programs and have repeatability of machining with fixtures even if machine power is cycled off and on.

The scanning carriage of the encoder head [Figure 2] "reads" the chrome graduation pattern. The scanning carriage includes a reticle that has the same grating pitch as the scale chrome graduation pattern, as well as a corresponding Reference Index pattern. Light from an LED is collimated to make the light rays parallel and transmitted through the reticle and glass scale graduation pattern [Figure 2]. The scanning carriage rides on the glass scale on roller bearings, which maintains a uniform air gap between the reticle and the scale, regardless of the encoder head mounting.

The glass-scale linear encoder operates on an optical 'photo-electric' scanning principle. [Figure 3] The four major components used to create a signal output are the LED, the reticle, the scale graduation pattern and the photocell elements. A chrome deposited pattern of equal lines and spaces is printed on the glass scale, with the lines perpendicular to the direction of travel. A similar pattern is found on the reticle within the scanning carriage. Essentially, light is transmitted from a light emitting diode (LED) through a collimating lens, through the reticle and scale glass, and is detected by photo elements. When there is relative motion between the scanning carriage and the scale, a moiré fringe pattern of light is converted into electrical micro-current signals by the photo elements. [Figure 4] These signals are converted into square waves and forwarded to the CNC control system. [Figure 5]

The direction of motion is apparent by the phase relationship (offset) between the two square wave trains called A and B. The number of square waves is directly proportional to the distance moved. With the inclusion of a Reference Index (RI) signal, essentially a repeatable HOME point found at one location along the entire scale travel, the control system is provided with complete positional information. Thus, the encoder fulfills its mission as a linear feedback device.

Glass-scale linear encoder technology developed for the machine tool industry has also found application in linear and X-Y stages for printed circuit board (PCB) drilling, electronics assembly, optical comparators and video inspection. Recent advancements in linear motor technology have created the need for glass-scale linear encoders wherever these 'flat' motors are used. Glass-scale linear encoders continue to be the standard for linear position feedback within closed-loop control systems

RSF Electrics, Inc. 916-852-6600

Figure 2

Encoder Head Scanning Carriage

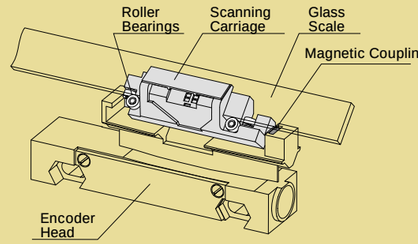


Figure 3

Transmissive Scanning Principle

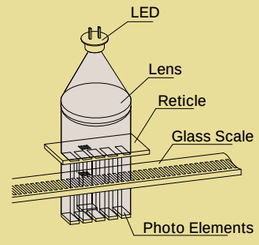
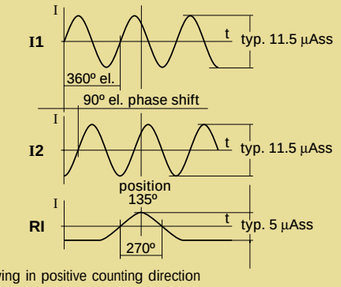
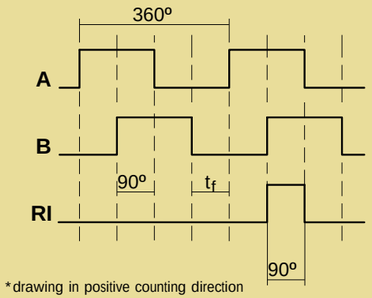


Figure 4



*drawing in positive counting direction

Figure 5



*drawing in positive counting direction

Simplifying Turning of Stainless Steel

Part 2

by Mike Castner, Sandvik Coromant

Last issue, we described five rules of thumb for simplifying turning of stainless steel. We urged you to anticipate the challenges associated with stainless and presented these first two rules of thumb: 1) Use state-of-the-art inserts and 2) Match the insert to the application. In this issue, we will cover these remaining three rules: 3) Diagnose and remedy edge failure, 4) Check your shims and 5) Use proven techniques for difficult cuts. This second installment completes the story and, hopefully, will help you meet the challenges of turning stainless steel.

Diagnosing Edge Failure

Tool failure mechanisms that occur in turning stainless steel are similar to those in turning any steels. The differences are in the degree of wear (Fig. 2).

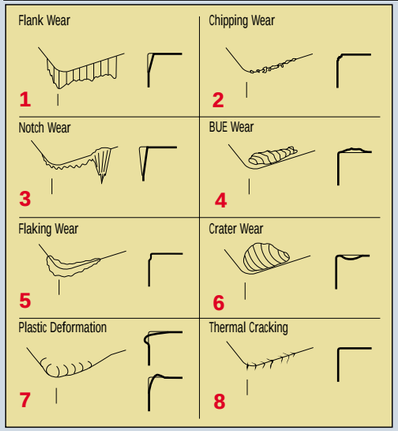
Here is a brief overview of the most common wear patterns and action you can take to correct them early (Fig. 3).

Flank wear should generally be viewed as the normal type of wear. It occurs at the flank, or clearance face, of the cutting edge along the length of engagement. Its occurrence can be positive, inasmuch as it makes the edge sharper. On the other hand, after a certain amount of wear, continued friction against the machined surface causes abrasion, and deteriorates edge performance.

The solution to excessive or premature flank wear is usually to ease-up on cutting speed. You might also select a more wear resistant coating, such as Al2O3.

Chipping occurs when the edge-line breaks, rather than wears. Advanced tool wear and intermittent cutting are frequent causes of edge chipping. The remedies are to reduce feed rate, change the tool approach angle to ensure stability and select a tougher grade insert. Often, the answer is a combination of these remedies.

Figure 2: Principal Tool Wear



The main regions of tool wear on a cutting edge are the chip face, flank of the leading and trailing clearance faces, and the nose radius. Carbide substrate cutting tools, such as Sandvik Coromant's M-Line inserts, will provide prolonged usage of cutting edges and ideal wear development.

Notch wear is the result of an oxidation process whereby the carbide actually breaks down, leaving a void on the cutting edge. With stainless steel, notch wear on the leading edge, due to mechanical stress, is more common than notch wear on the trailing edge. For notch wear, the same remedies as for flank wear are usually effective.

Built-up edge (BUE) is largely a temperature and cutting speed related phenomenon. Under high temperature and pressure the chips become gummy and tend to smear and stick to the insert flank. The workpiece material is welded onto areas of the edge where the substrate is exposed. The BUE is torn off repeatedly, leading to chipping.

Allowing BUE to grow without intervention causes premature edge breakdown, and even catastrophic insert fracture. Fortunately, the temperature and cutting speed areas where BUE formation occurs are relatively well defined, and can be avoided. Much of modern stainless steel turning takes place above the BUE area. Many modern insert grades are more resistant to BUE, if used correctly.

Increasing cutting speed usually reduces BUE. Additional remedies include switching

Continued on page 30

Figure 3: Troubleshooting Table

Excessive Tool Wear	More Positive Insert Geometry	More Tough Insert Grade	More Wear Resistant Grade	Increase Cutting Speed	Decrease Cuttting Speed	Reduce Feed Rate	Smaller Entering Angle	Stronger Geometry
1			XX		X			
2		XX				X		X
3	X	XX		X			X	
4	XX			XX				
5		X						
6	X		XX		X			
7			XX		X	X		
8		XX		X	X	X	X	X

X = possible remedy
XX = best alternative remedy

Sandvik Coromant has developed more wear resistant inserts, tougher coatings, inserts with positive geometry and larger nose radii to control premature tool wear. The above table provides manufacturer-recommended remedies for the most common types of wear.

Figure 4: Cutting Data Recommendations. Turning stainless steel with M-Line.

ISO		Material		CMC No.	Hardness Brinell HB	Coromant grades 1025			2015			2025			2035		
						Feed f_n in/rev .004	.008	.012	.008	.016	.024	.008	.016	.024	.008	.016	.024
						Cutting speed v_c ft/min											
M	Bars/forged	Ferritic/martensitic	Free matching steel	05.10	200	1246	886	640	1017	853	771	984	820	722	525	443	394
Stainless steel			Non-hardened	05.11	200	918	705	558	787	672	607	754	640	558	410	344	295
			PH-hardened	05.12	330	525	492	476	328	262	213	295	213	164	246	180	131
			Hardened	05.13	330	689	640	640	410	328	279	344	230	164	213	148	115
		Austenitic	Free machining steel	05.20	180	1476	1099	836	1164	918	705	968	722	541	574	508	459
			Austenitic	05.21	180	1017	771	607	820	640	508	672	508	377	394	361	328
			PH-hardened	05.22	330	607	574	558	377	295	246	328	230	180	279	197	148
			Super Austenitic	05.23	200	705	689	656	558	443	344	443	328	246	279	246	213
		Austenitic-Ferritic (Duplex)	Non-weldable ≥0.05%C	05.51	230	918	705	558	656	558	492	689	525	394	377	312	279
			Weldable <0.05%C	05.52	260	623	541	492	492	426	377	426	377	344	476	312	197
	Cast	Ferritic/martensitic	Non-hardened	15.11	200	—	—	—	705	574	525	672	541	492	361	295	262
			Hardened	15.12	330	—	—	—	295	213	180	246	164	131	213	148	115
				15.13	330	—	—	—	361	279	246	295	197	148	180	131	98
		Austenitic	Austenitic	15.21	180	—	—	—	754	574	459	623	459	361	377	312	279
			PH-hardened	15.22	330	—	—	—	295	213	180	279	180	148	213	148	115
				15.23	200	—	—	—	361	377	312	377	295	230	246	197	180
		Austenitic-ferritic (duplex)	Non-weldable ≥0.05%C	15.51	230	—	—	—	607	492	443	508	394	312	344	279	246
			Weldable <0.05%C	15.52	260	—	—	—	443	361	328	410	344	328	426	279	180

Sandvik Coromant recommends using specific speeds and feeds to cut the newer tougher cast and forged stainless steel grades. Proper machine settings and more wear resistant inserts will prolong edge life and ensure high quality workpiece finish.

to a tougher-grade, higher-rake insert. If tool life is too short, apply coolant in large quantities to keep the insert flooded.

Flaking involves coating damage due to inferior coating, poor adhesion of the coated layer, as well as plastic deformation. The remedy: switch to inserts with a more tenacious coating, like an MTCVD (Sandvik grade GC2015).

Crater wear occurs on the chip face and causes a weakened edge. It is caused by diffusion and abrasion wear mechanisms. The first recourse is to reduce speed to lower the cutting temperature. Secondly, reduce feed. A medium temperature CVD coated insert with positive geometry will resist the wear.

Plastic deformation often results from higher cutting forces and heat encountered when turning stainless steel. The same factors also contribute to notch wear, edge chipping and crater wear. For the tool material to stand up to this without plastic deformation, select an Al2O3 coated, wear-resistant grade (Sandvik grade GC2015). Reducing speed and feed will lower the cutting temperature and eliminate the cause.

Thermal cracking is mainly a fatigue wear phenomenon due to rapid changes in cutting zone temperature and intermittent turning. To avoid it, turn up the coolant flow, and select a carbide grade insert with better resistance to thermal shock.

Figure #4 lists recommended starting speeds and feeds for various stainless steel turning applications. Consider these recommendations as conservative. Don't be afraid to push the tooling to its limit and get its full productive benefit.

Check Your Shims

Proper shims – in good condition – are essential to turning stainless steel. They protect both insert and toolholder from damage due to high cutting forces.

Stainless steel turning creates high pulsating pressures on the insert seat and shim. The shim acts as a shock absorber for the insert and workpiece. Rule of thumb: check the condition of your shims every time you change an insert. When in doubt, replace them. On a two-sided insert, watch for a shim face that has an imprint of the insert embossed onto it. Loss of the shim's flatness will impair its ability to properly support the insert (Fig. 5).

Dealing with Difficult Cuts

For hard to machine cuts, such as approaches to shoulders, uneven entering angles and face turning, here are some new application techniques (Fig. 6) that will help it go better.

Turning Against Shoulders

The approach to a shoulder presents a severe change of condition for a turning tool, and can be highly stressful on the cutting edge. Chip jamming and hammering can also occur. To overcome the risks of turning against a shoulder, you can do several things. To overcome chip jamming/hammering, increase the cutting speed about 0.040" before the shoulder. Another is to turn the shoulder through a number of axial cuts, forming a step-like profile, then finish by making two radial cuts. To improve chip control and reduce cutting edge stress, instead of feeding radially out just before the shoulder, redirect the tool radially in.

Mechanical notch wear

When initial cuts have an uneven, acute start, the solution may be to use ceramic inserts for the starting passes. The tool can have a 45 degree or similar entering angle, which eliminates the rough edge, and provides an advantageous approach for the main tool.

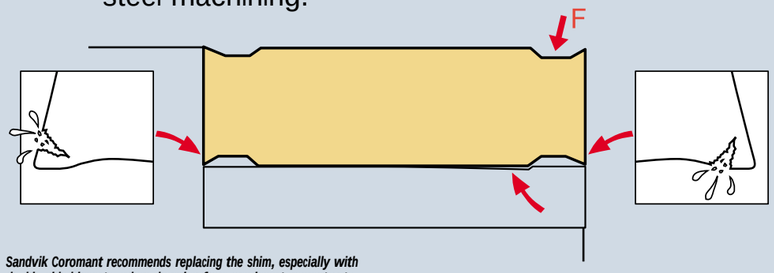
A lower feed rate to engage into the cut is another way.

Facing toward center

Face turning is common in stainless steel, and may involve facing to the center, or to a hole. In the first case, the cutting speed approaches zero at the center, effectively upsetting the relationship between feed and speed. Higher spindle speeds in modern CNC lathes can compensate for small diameters – but only to a point. Close to the center, the tool begins to push the workpiece material instead of cutting it. Lower surface speeds also have the added disadvantage of plastic deformation of the workpiece, and BUE formation. The best solution is to let a drill cope with the material in the center, then follow with the facing. The drilling operation can also be performed before the facing. In the event there is no center hole, reduce the feed rate when the facing diameter becomes 0.400". For example, a feed of 0.010"/rev can be reduced to 0.002"/rev.

To encapsulate these hints, so you can successfully tackle most stainless steel turning jobs, I leave you with these closing thoughts. Stainless steel, though difficult to turn, is still a very manageable material. Heat is the main enemy, but new inserts and properly applied turning techniques overcome this hurdle. It's usually better to push the tool to its limit, rather than ease up on it. Apply these proven rules of thumb, and pile those stainless steel parts in the bin.

Figure 5: Proper shim support is critical in stainless steel machining.

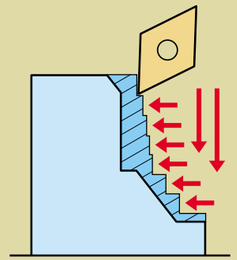


Sandvik Coromant recommends replacing the shim, especially with double-sided inserts, when changing from one insert geometry to another. A flat shim ensures adequate insert-face support.

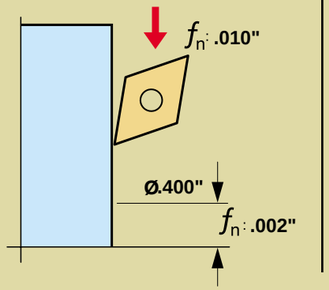
Figure 6

Sandvik Coromant recommends trying M-Line positive geometry inserts, combined with creative stainless steel techniques, for severe changes in turning conditions. These techniques will eliminate chip jamming, mechanical notch wear, and other common turning challenges.

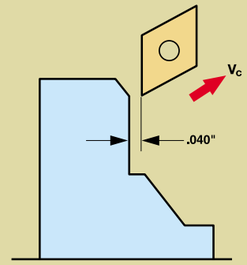
shoulder through several cuts



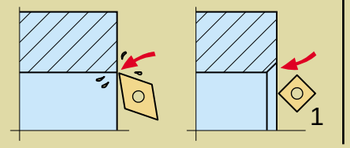
reducing feed towards center



changing speeds before shoul-



avoid notch wear



98% Up-Time Will Roll On In '98

Not many things in this world come with a guarantee like Haas Automation's promise of 98% Up-Time. Sure, most consumer products carry a warranty of some type, but most only cover repairs during a limited period of initial ownership. The Haas guarantee actually pays a set amount for lost productivity in the event of an in-warranty machine failure. This dependability-linked guarantee has been so successful as a marketing tool that Haas Automation has announced plans to continue the program for the upcoming year.

Now going into its second year, the Haas guarantee promises "98 for 98," according to Peter Zierhut, Haas Marketing Manager. "The 98% Up-Time Guarantee has been very successful for Haas, simply because our customers understand immediately what a promise like this means. It's concrete; and it really expresses something

to machinists, business owners and managers about Haas as a company and how we stand behind our product," said Zierhut.

The 98% Up-Time Guarantee covers most new Haas CNC models for the first year of ownership. It will pay for any machine down-time beyond a very slim 2% of overall usage.* "Haas customers know they're buying a very, very reliable machine that will give them many years of dependable service," said Zierhut. "This is just our way of making sure everyone understands how important quality and reliability are at Haas Automation," he said. "And it's a good way to let our customers know that we at Haas understand how important reliability is to them."

*Contact Haas Automation or your local distributor for complete details.

Haas Vector Spindle Drives Revolutionalize Market

Adding even more value and performance to their already feature-packed CNC machines, Haas Automation, Inc., is installing high-performance vector spindle drives as standard equipment on their complete line of VMC's, HMC's and CNC lathes. These extraordinary drives allow you to push the spindle to 150 percent of the motor's rated horsepower for 15 minutes and 200 percent for 5 minutes. That's more performance headroom than any other drive on the market. Previously only available as an option, Haas vector drives are now being shipped at no additional cost on every Haas machine coming off the line (except economy VF-E and VF-EXT models).

The Haas-designed vector drive uses the same technology as their brushless servo motors to provide peak performance and speed control under heavy cutting loads (up to the limits of the drive).

VECTOR DRIVE

This true closed-loop system with encoder feedback optimizes the slip angle between the rotor and stator of the spindle motor to double low-speed torque and accelerations, resulting in the fastest and most powerful spindle output ever.

The Haas vector drive provides a robust 250 ft-lb of maximum torque from the standard 20-hp motor (VMC & HMC), with a broader torque range for heavier cuts and increased feeds per revolution. The drive provides precise speed control and a constant load on the tool for longer tool life; and faster acceleration and deceleration reduce chip-to-chip times for higher productivity. Electronic spindle orientation further reduces cycle times and increases reliability by eliminating the shot-pin mechanism.

High Torque and Low Maintenance with Haas Brushless Rotary Tables

High-performance brushless servo motors are now available as an option on select rotary tables from Haas Automation, Inc. These highly-reliable servo motors provide high torque for heavy operations and yield higher acceleration / deceleration rates to reduce cycle times.

With no brushes to wear and generate dust, maintenance is reduced and reliability is increased. And, since the heat-producing windi

are attached to the outer shell of the motor, an brush-type motors, are d have a longer life. formance option is avail- 5C single-head indexers, as the full series of stan- rd HRT rotary tables (HRT-160, 210, 310 and 450). Production units are expected to be available in limited quantities by January.

Webster's dictionary defines value as: 1. A fair equivalent or return for something, as goods or services. 2. Monetary or material worth. 3. Worth as measured in usefulness or importance; merit.

A True Value Realized

When it concerns machine tools, you might define value in more simple terms, like "getting more than you paid for." And in today's world, getting more than you paid for is not an easy thing to come by. True value is far more than paying as little as possible for a particular thing. It's also different than paying absolute top-dollar for something that can be had for far less.

In everyday terms, an item's real value usually doesn't show itself until it's been around for awhile. Its true worth grows as its usefulness, dependability and real cost are measured against competing items. Reliable service, low maintenance and fair initial investment are the things that set a true value apart. You could say that a true value is realized over time, not recognized in an instant.

In the world of CNC machine tools and multi-axis rotary tables, Haas Automation is known for producing products of real value. From its small beginnings, and continuing today, Haas has always manufactured products that are rugged, dependable and very, very affordable. Most people who know Haas products would agree, this unbeatable triple combination is a real value – and it is.

But perhaps of more interest is why and how Haas Automation continues to deliver this popular triple combination. The "why" part is fairly easy to figure out. Look no further than the unbelievable growth and success of Haas as a company. By delivering machine tools that meet the criteria of a true value, Haas Automation essentially guarantees the success of their customers, which, in turn, guarantees their own success. A story of success breeding even more success to be sure.

The question of "how" is a bit more complicated. It is a core philosophy that has been there from day-one, and ultimately, it's what makes Haas machines a real value. If you visit the Haas works in Oxnard, California, you won't find these principles of operation written out, framed and hanging on a wall as you walk through the front door. As you walk through the facility, however, you'll see that the principles are there, and they are in full use everyday.

It starts with the attitude that all Haas products will be designed and built to the customer's specifications. This does not mean that Haas will engineer and build machines to special order. Quite to the contrary. What Haas does, is design their machines as if *they* were the customer. As a company, Haas Automation has this unique ability to "be the customer" and deliver all-around economic results. That's the value. (By the way, 40 of the 200 machines in Haas' machine shop are Haas machines.)

Haas products are engineered and designed for economy as well as results in daily use. Constant engineering and design improvement follow two simple guidelines: make the machines better, and get better at making the machines. Considerable effort and resources are invested to continuously upgrade both the product and the manufacturing process. By designing and building both the numerical control and the software in-house, Haas is able to produce one of the most user-friendly CNC controls available anywhere. For customers on the receiving end, this plays out very well.

Continuous refinement of the design just enhances the machine's overall value. Components are simplified, redesigned, and made more reliable and easier to manufacture on a daily basis. The latest manufacturing technologies and strategies are employed to make parts better, faster and for less money. Evolving techniques for advancing the assembly and testing operations are deployed and refined. In the end, Haas is able to produce machine tools that offer an ever growing list of features and options for essentially the same price as previous generations of products.

Simply put, this is how Haas is able to produce quality CNC machines at truly affordable prices. The order of the day is to make them rugged, reliable and simple, while borrowing and inventing ways to bring the processes in-house, under budget and at a higher quality than anyone thought they could be – and don't look back.

Add to all this a long list of standard features – features that would be options from almost every other manufacturer – a 98% Up-Time Guarantee that pays for down time, and the undisputed best resale value of any CNC machine on the market, and the value of Haas products becomes perfectly clear.

For Haas customers this is only the beginning. Sure, the Haas philosophy produces quality machines at really great prices. But remember, true value is realized over time. All told, the real value of Haas products shines as they are put to use.

Success breeds success – to be sure.

The Manufacturing Solutions Company.

At Haas, providing solutions is what we do best. We offer America's most complete line of VMC's, HMC's, CNC Lathes and Rotary Tables. All are affordably priced to make you more competitive, and each one comes with the industry's only 98% Up-Time reliability guarantee–providing real peace-of-mind. And, all Haas CNC technology is available with financing plans to fit your needs.

Making Technology Affordable.