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CNC MACHINING

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THE MASTHEAD

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in this ISSUE

"So Brain, what are we going to do today?" "The same thing we do every day, Pinky . . . Try to take over the WORLD!"

– Pinky and the Brain

Well, we may not be out to take over the world (at least, not just yet), but we are out to make *CNC Machining* a bit more worldly. To that end, this and future issues will feature stories from around the globe, not just here in the U.S. of A. After all, there are more than 30,000 Haas machines out there in all corners of the globe, and many have good stories that go along with them. To help find those stories, we've enlisted some help from abroad (and within).

Matt Bailey, whose words have graced these pages in the past, has recently been enlisted as our new European Correspondent. Based out of Barcelona, Spain (at least for the moment, or until the weather changes), he will act as our eyes and ears across the pond. For our cover story this issue, Matt visited JJ Churchill for a bit of history and a look at how they use Haas machines to produce components for Rolls-Royce jet engines. Look for more tales from the UK, Germany, Belgium, and the rest of the European Union in the future.

Adding another bit of international flavor, Tony Boult, head honcho of the Haas distributor in Australia, wrote a piece about a company "down under" that is manufacturing recycling equipment to turn old "tyres" into useable compounds. Nothing like providing a useful product – and averting an ecological catastrophe at the same time.

And if you're a regular reader of *CNC Machining*, the prose of Linda Dorr will already be familiar. Hired as a proofreader, she has proved to be a skilled writer as well. Linda's piece on Baldwin Hardware reveals there's a lot more to faucets than meets the eye. Linda's unique perspective and female point of view will continue to grace these pages in future issues.

And, as always, there's much more.

So sit back, relax and enjoy!

photo courtesy Rolls-Royce plc

by Denis Dupuis

Every day I check the mail for my $300 tax refund check. You know, the one from our new tax cut. I'm not sure what I'm going to do with this $300. Maybe I'll buy something with a Made-in-America label on it. Is there still such a thing as a consumer product made in the USA for less than $300? I wonder.

All of the business reports I read these days are saying that, even though manufacturing is suffering the most in this downturn, and many industries are taking their business overseas, it's okay. In their view, we shouldn't be participating in industries where we are not the best (the least-cost producer). In an efficient global economy, they say, each country should produce that which they do best, all other things being equal.

While theoretically I agree, not all other things *are* equal. We do not have free trade throughout the world. The U.S. is the most open market for goods and services, while other countries have erected barriers to protect their borders. Whether these barriers are duties & tariffs, government regulations or nationalistic tendencies, the effect is the same. This may sound like a vote for trade restrictions – it is not. I am a "free trader." I am just making the point that the U.S. is ahead of the rest of the world once again.

I was reading an article about the future tax cuts the other day, and the author belabored the point that the cuts were mainly for the rich in this country. As I understand the cuts, I have to disagree. The money is being returned to those who have been paying the most taxes for years. The statistics were correct, but misapplied, in my opinion. In total dollars, the majority is going back to those who earn more than $100,000 in family income per year.

But they were the ones already paying the most in total dollars. For example, a family earning $20K per year with a tax rate of 10% pays $2,000 in taxes per year. A family earning $100K per year with a tax rate of 36% pays $36,000 per year – so *they* should be getting the lion's share from the tax cuts. Otherwise, the government would be refunding more to some than they paid in. I'm not sure that's fair. It certainly is a fundamental redistribution of wealth.

The math I used in the previous paragraph is oversimplified to make a point; it is not an exact calculation of the new tax code. It would take a tax lawyer and a tax accountant to figure that out, and I didn't want to bother ours for this editorial.

As usual, I digress – so back to my original point. The big tax refunds that Mr. Bush & Company are sending out to the taxpayers are estimated to be near $2 billion. My biggest fear is that most of that money will be spent on foreign-made products, thus propping up the manufacturing economies of *those* countries rather than our own. The only benefit to this, as far as I can see, is that the U.S. dollar might lose some of its strength. Then we could export *our* products to all of the countries that make the consumer products we are so fond of buying.

Bigger and Better . . . Again!

A company doesn't get to the top by standing still, and once on top, there's no time to languish in the spoils and admire the view – it's a precarious perch. To maintain firm footing on high-most ground, a successful company must constantly improve its products, develop new markets and optimize its manufacturing processes – or risk a quick slide down the hill.

By all accounts, Haas Automation, Inc., is arguably at the top of the machine tool hill, shipping more CNC machines per month than any other American manufacturer. Since its

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Student Wins Silver on a Haas

"Machining runs in my blood," says 21-year-old Canadian Kurtis Latham. "My grandfather was a machinist, and my two cousins – who I happen to look up to – are also machinists."

A June graduate of Red River College in Winnipeg, Manitoba, Kurtis is a second-level apprentice, which is quite advanced for someone his age. He has a two-

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TRADE SHOW CALENDAR

For additional information go to www.HaasCNC.com/news/trade_show.html

Date	Show Name/Location	Booth #
Sept. 12-19	**EMO Hannover** Exhibition Grounds, Hannover, Germany	Booth B70, Hall 13
Sept. 25-27	**DETROIT APEX** Cobo Convention Center, Detroit, MI	Booth 501
Sept. 25-27	**ROCHESTER MACHINE TOOL SHOW** Rochester Riverside Convention Center, Rochester, NY	Booth 900
Oct. 2-4	**MID-ATLANTIC MACHINE TOOL SHOW** Fort Washington Expo Center, Ft. Washington, PA	Booth 501
Oct. 15-18	**CMTS, CANADIAN MACHINE TOOL SHOW** National Trade Centre, Toronto, Ontario, Canada	Booth 3641

Ah, it's mid season. Early equipment problems have been ironed out, rookie drivers have settled in to their new rides and enough races have gone by to size up the competition. Now it's time to get serious. For the remainder of the season, race teams will concentrate on fine-tuning their cars and racking up championship points. Speed and consistency are the keys to staying on top. Still, anything can happen.

NASCAR Winston Cup

June 10 was a big day for Hendrick Motorsports: When Jeff Gordon took the checkered flag in the Kmart 400 at Michigan International Speedway, he not only logged his 55th career victory, but handed Rick Hendrick his 100th career win as a NASCAR Winston Cup Series team owner. Congratulations, guys!

With 16 races down, Jeff Gordon (24) sits in the number-one spot with a comfortable lead of more than 125 points over Dale Jarrett. So far, Gordon has logged three wins, five poles and 11 top-5 finishes. Jerry Nadeau (25), despite two top-5 finishes early in the season, sits back at 21st, and Terry Labonte (5), who has struggled this season, currently sits mid-pack at 24th.

PPI's Ricky Craven (32) has two top-5 finishes so far and sits back in 27th place, while teammate Andy Houston (96) sits in 42nd position.

NASCAR Craftsman Truck

After 10 of 24 races, Hendrick Motorsports drivers Jack Sprague (24) and Ricky Hendrick (17) are running 3rd and 4th respectively in series points, with both drivers logging five top-5 finishes so far. Sprague also has a win at Texas Motor Speedway and two poles, while Hendrick has finished in the top 10 in all but one race.

CART

PacWest Racing's Scott Dixon (18), who moved up to Champ cars after winning the Indy Lights championship last year, currently holds down 7th place in the points standings after recording another top-10 finish at Portland International Raceway, despite rainy conditions. Mauricio Gugelmin (17) was well on his way to a top-5 finish in that same race, when contact with Paul Tracy, who spun in front of him, sent him into the concrete wall. "This could have been my best finish of the season," Gugelmin said. He is currently ranked 21st in the points.

photo courtesy Scott Desfor ©


photos courtesy Dan R. Boyd ©

On the Indy Lights front, PacWest drivers Mario Dominguez (17) and Dan Wheldon (1) sit in 4th and 5th place respectively, with 5 of the 12 series races down. Dominguez has three top-5 finishes so far, and one pole position at Long Beach.

NHRA

J&B Motorsports driver Todd Veney continues to blast the Haas logo down the strip – at speeds in excess of 225 miles per hour – in the Federal-Mogul Funny Car series. Veney currently sits in 19th position.

Ilmor Racing Engines

Already well known for their championship-winning CART and Formula One Mercedes engines, Ilmor Engineering has teamed up with Oldsmobile to prepare Aurora engines for IRL competition. The Ilmor Auroras dominated this year's Indy 500 with three of the top-5 positions on the grid, including pole position with Scott Sharp. Ilmor-powered cars then led for 108 of the 200 laps, and finished first and second in the historic race. Scott Sharp, driving an Ilmor Aurora-powered Dallara, also won the Casio Magic 500 in Texas, and is currently third in the IRL points standings.


photo courtesy Dave DeAngelis ©

C&C Motorsports

Joe Custer and Troy Cline continue to keep the Haas name in front of race fans on several fronts, most notably NASCAR Winston West and the Best in the Desert off-road truck series (with a bit of SCRA and USAC sprint car racing thrown in when schedules permit). With only five races remaining in the Winston West series, Troy currently sits in 13th position, yet is only a few points out of the top 5. In the desert, Joe Custer and Gene Haas are sharing the driving duties, and are first in the points after two of four races. Their goal is to push for strong showings in the final two races and take home the championship.

The Crown of Australia

Story
Tony
Boult

Photos
Bay
Reflections
Photography

Old tyres have presented an increasing disposal problem in the last 30 years. The number of vehicles on the road around the world has grown enormously. Each year tyre sales worldwide are in the vicinity of 68 billion U.S. dollars.

In the USA alone, 10 million new cars every year represent 50 million new tyres that will need to be disposed of around two years later. Modern tyre designs, including steel belting, have made it more difficult to recycle them. Burning them is definitely not on in this day and age, and there are only so many racetracks in the world where they can be used as impact buffers.

On the other side of the world (down under) an Aussie engineering company, Crown Engineering, has been working with a local design and manufacturing company, Link Pty. Ltd., in manufacturing tyre recycling equipment to turn that old rubber into useable compounds. The granules that exit the tyre recycling machines have numerous uses – as an additive to asphalt in road building, for playground matting and for numerous other experimental projects, such as embankment ground fill.

As an example in the USA, the Texas Department of Transportation has had two notable projects that used immense volumes of recycled tyres. The first job was in Odessa, Texas, where the equivalent of 200,000 old tyres were used to produce 80,000 tonnes of crumb-rubber-modified asphalt pavement, which was overlaid on a 20-mile stretch of U.S. Highway 385. The asphalt-rubber hot mix helps reduce reflective cracking, rutting, surface oxidation and road noise, and lengthens the time between required maintenance. The second project involved using 4,500 tonnes of tyre shreds for embankment fill in various combinations on the loop 375 overpass in El Paso.

Crown Engineering is a 4th-generation family company, and possibly one of the longest surviving family engineering companies in the land down under. It was founded in 1920 by Wilhelm Suchting and his son Doug, who rented premises in an area which is now near the middle of the city of Brisbane. They established a blacksmith's forge and installed a couple of second-hand flat-belt driven lathes. In 1923 they moved to larger premises at South Brisbane, installed some foundry equipment and began producing machined castings. The Brisbane City Council became one of their larger customers, but in an effort to develop a product of their own, they began producing single-cylinder stationary diesel engines for agricultural applications. Unfortunately, Wilhelm passed away suddenly one day in 1924 on his way to work on a tram, and so Doug was left to carry on the business.

During the "Reds under the Bed" era in the late 1940s, the moulders union caused so much strife in the moulding industry that the foundry had to be shut down. It was losing large amounts of money due to the go-slow work practices of the militant unionists at that time.

When the time came for Doug to step down, his two sons, John and Bill Suchting, took the reins. This was a good combination. Bill, with his university degree in mechanical engineering, was a whiz at mathematics and problem solving, and John, with his engineering apprenticeship behind him, was the practical hands-on man. They decided to move into more specialised areas, such as sprocket and gear cutting. They added milling and gear hobbing machines and found that the business began to grow steadily again.

In 1978, Ray Suchting, the great-grandson of Wilhelm, bought into the business. This was during an era in Australia when NC and CNC machines were starting to become high on the list of budgetary items for manufacturers. At the same time, the resources boom had started, and Australia was becoming a leading supplier to the Asian market of bauxite, iron ore, coal, copper, zinc, lead and almost any mineral you could think of.

The state of Queensland had enormous deposits of high-quality coking and thermal coal with very large seams close to the surface. Ray saw the company's future in mining industry support, and the manufacture of spares for the huge walking draglines used for open-cut coal mining. Moving into this area was not easy, as the long established giants of medium and heavy engineering usually were first to gobble up the available work building OEM and replacement parts.

However, the unions, bad work practices, high overheads and government indifference caused the large engineering companies to falter, and one by one they began to disappear. This opened the door for Crown Engineering. "In the early 1990s our growth soared," says Ray Suchting. Crown had developed new and more cost-effective methods of producing large gears and racks in small batch quantities. CNC machining had become an integral part of their production, and they utilized CNCs wherever they could. They upgraded their plant with new machines on a regular basis.

Factory space soon became a big problem. "Although we built a new 40,000-square-foot building in 1996, we have had to continually add to it," said Ray. "We had orders for large roller circles, which are like huge segmented thrust bearings up to 60 feet in diameter and weighing 150 tonnes. They are used under the revolving cage on the walking draglines. Each roller circle has to be completely assembled and checked before delivery to the mines, and they take up an enormous amount of space when fully assembled.

"At the same time, it became necessary to move into gear grinding

Founded in 1920, Crown Engineering is one of the longest surviving family-owned engineering companies in Australia.

and checking, which meant more machine tools and more space. We also had to become self-sufficient in heat treatment, as lead times and quality control for our large parts became an issue. So we put in our own oil quenching plant in a new factory separate to the main plant. We can now do case carburising of gears up to 2 metres in diameter and shafts up to 3 metres long and weighing up to 6 tonnes. Then we had to move the fabrication shop into its own area to make more room in the machine shop. We now have around 65,000 square feet."

With the onset of the Asian economic crisis in 1997, and restructuring by some of Australia's largest mining companies, the signs became ominous for Crown Engineering. "We had to look to other sources of work to supplement our order book – work that would fit the envelope of the CNC machines we had purchased for our mining part production," says Ray. "Essentially, we had purchased large-capacity double column CNC machining centers, ram-type milling machines and larger CNC vertical turning machines. In saying this, we had always had a hole in our machining center capacity by not having a smaller vertical machine. We always crammed the small parts into the large machines, which were relatively slow, and inefficient to set up and break down on this type of work," explained Ray.

"During 1997, we forged an alliance with Link Pty. Ltd. and started building tyre recycling machines. There were a number of smaller internal parts to be machined that we just could not afford to put on our large CNCs. We decided that we had to buy a smaller VMC to keep the larger machines free. We had been buying larger machines for nearly 10 years, and were not familiar with what was available in VMCs of around 1 meter travel," Ray explains. "Our main criteria was that the machine would need to be easy to set up, be able to produce simple programmes easily on the machine control, have enough grunt to drill and tap large holes, take a decent cut in tool steel and have flexibility in program uploading and downloading," he said.

Ron Newton, who runs Ray's CNC department, was asked to make a recommendation. "At the end of the day, we chose a Haas VF-3," said Ron. "It fit all the criteria and had a number of options which made it that bit more attractive. I reckon that it was a good value-for-money package, particularly with the 4th-axis drive included and the fact that the Haas dealer, Alfex CNC, is quite close to us. They have a full complement of spare parts in store, and they have factory-trained technicians on staff as well," said Ron.

Above: Crown Engineering uses a Haas VF-3 to machine grinding disks out of D2 tool steel for a tyre recycling machine.

Opposite: Large components and spares for the mining industry still comprise much of Crown's normal workload.

The tyre recycling process involves up to three separate machines for truck tyres or two machines for car tyres. In the case of car tyres, the first machine shreds the tyre into small pieces about 16 mm square and simultaneously strips the steel belting away from the rubber. The steel is separated from the rubber by magnetic conveyor belts. The second machine grinds the rubber into granules to a maximum diameter of 2 mm.

The first job Crown had to do on the VF-3 was produce 38 sets of grinding discs, which the grinding machine uses to grind the chunks of rubber into small granules. These sets comprise both fixed and rotating discs, which need to have pockets milled right through to allow the large chunks to be progressively ground into smaller granules as they pass through the grinding discs. There are 3 different rotating discs with 7, 9 and 10 pockets, and the fixed discs have 8 pockets. The principle of operation is probably similar to the hand-operated mincing machine that Mum used when she minced up the leftover roast to make a shepard's pie.

The discs are made from D2 tool steel, and 70% of their starting weight is machined away during the process. After using a 24 mm U-drill to drill a start hole in each pocket, a 20 mm diameter tipped endmill was used to cut each pocket out, taking 5 mm deep cuts at 2,000 rpm and 700 mm per minute feed. There were also 6 holes drilled and tapped 6 mm on a 259 mm diameter.

"As a testament to the accuracy and rigidity of the Haas VF-3, we didn't need to take a final cleanup cut after cutting through the 20 mm thick discs," said Ron. "Each 5 mm step-down was hardly noticeable, and the surface finish was more than acceptable for the application." After machining, the rotor discs were oil hardened and tempered in the heat treatment plant.

Finally, the disc faces are ground flat, and then down into the bowels of the large fabricated steel frame they go, in an assembly with the shafts and gears.

It is not easy to find engineering companies in Australia that have experienced the sort of expansion in the last 10 years that Crown Engineering has. Ray Suchting says that remaining focused on keeping the business moving ahead, targeting niche markets, and taking calculated risks while keeping the overhead costs to a minimum are some of the main contributing factors.

At the end of the day, it is no different than most other successful businesses, and can be summed up by two words: "good management."

Beauty and the BRASS

How often do you notice door handles and light fixtures? Probably not too often – as long as the door opens and closes and the lights come on, who cares about the hardware?

Story
Linda
Dorr

Shop Photos
Preston
Gratiot

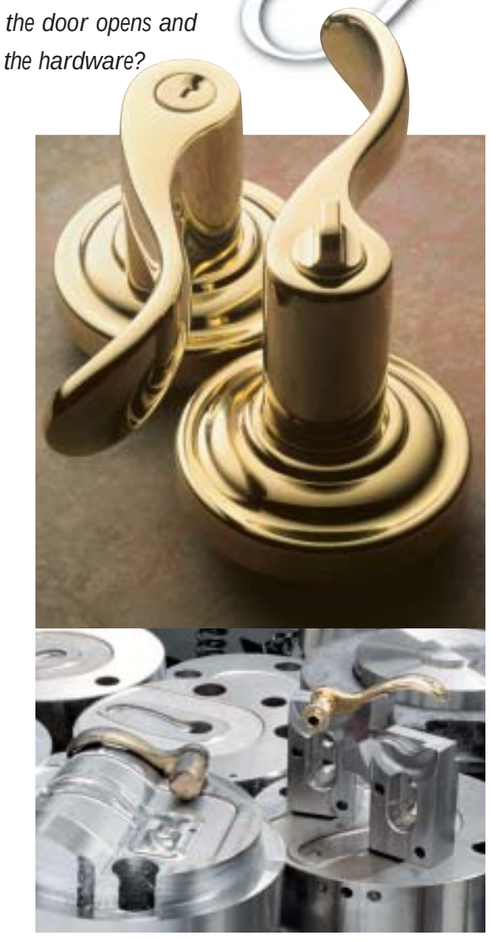
Product Photos
Baldwin
Hardware

Baldwin Hardware cares – very much. And if you walked through a door outfitted with a Baldwin handle or latch set, you would definitely notice it. The company makes absolutely stunning solid brass architectural hardware, from door hardware to lamps and candlesticks. The Baldwin name has long been synonymous with the very finest in brass fixtures for the home. "People who buy our products are not just interested in locking the door," Baldwin president Ronald J. Foy told the Reading (PA) Eagle Times. Mr. Foy noted that the Baldwin brand is a status symbol for many people who appreciate the quality of the company's products.

Baldwin Hardware was founded in 1946 by a European immigrant, Severin Feyerman, whose family had been crafting forged brass since the 19th century. Feyerman bought a New Jersey company named for the Baldwin family and, joining "timeless craftsmanship" (the company maxim) with the new American name, proceeded to forge a tradition of artisanship that is now the industry benchmark.

Since 1956, Baldwin Hardware Corporation has been headquartered in Reading, Pennsylvania, where the company currently has more than 850 employees and a 375,000-square-foot facility that includes its manufacturing plant. Baldwin recently completed a multimillion-dollar expansion: updating the Reading facility, as well as opening a new 280,000-square-foot building – which houses assembly, distribution and customer service – in the nearby North Pointe Business Center.

The company acquired its first two Haas vertical machining centers, a VF-2 and a VF-3, in the spring of 1995. "We were moving toward high-speed machining, and the Haas machines were a good price and user-friendly," says manufacturing support manager Dave Mohn. Baldwin has since acquired two more Haas VMCs – another VF-2 and a VF-0E – which, like the first two, are used primarily for cutting the dies that shape the company's products. Baldwin Hardware products are made exclusively of brass, with a variety of coatings and finishes that, to quote a Baldwin brochure, "provide the ultimate in fashion, grace and elegance." They certainly do.



A set of forging dies and the artful handles they produce. Dies are cut out of H13 tool steel; finish cuts are taken after hardening.

Details about the origins of brass are sketchy, because those origins are so ancient (and because the terms "brass" and "bronze" tend to be used interchangeably in the oldest records), but it does seem likely that brass was first produced entirely by accident. One theory holds that it may have been discovered when campfires built on beaches rich in copper and zinc resulted in run-off of liquid brass from beneath the fire. Or it may have been a slightly more intentional (although still accidental) discovery, when copper ores containing zinc were heated. In any case, a form of brass was being manufactured by the time of the Roman Empire (about 2,000 years ago), in the form of coins, cooking vessels and ornaments.

Hand forging of metals has been around since prehistoric times, when ancient man first used the technique to fashion crude, yet effective, weapons. The use of machinery for forging began during the Middle Ages, when water mills came into use. The current form of forging by machine was introduced about two centuries ago, and hasn't changed much since. While the type of machinery used depends on the metal being forged, as well as the desired size, shape and quantity of the finished product, the process is essentially the

The Baldwin name has long been synonymous with the very finest in brass fixtures for the home. "People who buy our products are not just interested in locking the door."

same. High pressure is used to force hot, and hence malleable, metal into dies to form it into the desired shape. The quality of the finished product, naturally, depends greatly on the quality of the dies used to shape it.

For a company that crafts forged brass, the forging dies are the keystone of the manufacturing process. Of course, the design of a die is paramount – as is the accuracy of the machine that cuts it. "Now, when we make replacement forging dies, all other secondary tooling still matches the first die," Dave explains. This was not the case prior to using Haas machines: "We'd get variations."

Baldwin cuts its dies from H13 tool steel (which is about a Rockwell 52), using carbide cutting tools ranging in length from 3/16 of an inch to 4 inches. In the past, Baldwin performed the finish cuts on the dies while the steel was still soft, then heat-treated them, but this often led to mismatches and other finish problems caused by the heat treating.

Since they acquired the VF-0E with High-Speed Machining (HSM), the dies are roughed out first, heat-treated second, then finished using HSM. The process was changed because the Haas machines produce a better finish. "When you're forging steel for auto parts, appearance means nothing," says Dave. "When you're forging brass, appearance is everything. The Haas machines give us better surface definition."

The contouring necessary to produce Baldwin dies makes machining them very time-consuming. There are complex shapes and surfaces, fine details with small radii in deep cavities, multiple setups, the varying tool lengths mentioned and programming times that may exceed 20 hours. It can take two or three days to run the several programs necessary to complete a die. "It's very easy to program the Haas machines to run unattended," says Neal Ziemer, the shop's day shift programmer. Doing so has increased Baldwin's annual production of forging dies by nearly 500%, from 31 to 150 dies per year. "They're so much more user-friendly compared to a lot of other manufacturers. Editing programs is pretty painless." The machine shop staff is thus able to respond to production needs more quickly. Baldwin's machinists also appreciate the ability to control speeds and feeds in 1% increments with the remote jog handle. It's one more option that makes life easier, as well as more productive.

"When you're forging brass, appearance is everything. The Haas machines give us better surface definition."

Above: Haas 4th-axis rotary tables allow several operations to be performed in a single setup, and simplify the machining for some of Baldwin's more complex designs.

Opposite: The Haas VMCs helped Baldwin increase their annual production of forging dies by nearly 500%, to 150 dies per year.

"Our secret is buying the best raw materials, using processes that get the best possible out of those raw materials, and a work force that's part artisan, part manufacturer."

Given the variety of tool lengths needed to cut a Baldwin die, setup can be no small chore. But: "Setup is a big plus on a Haas," Dave notes. "It can take three or even four times longer on some of our other machines, because you have to jump between screens to do tool offsets. With a Haas, you have that one-button tool offset." All of Baldwin's Haas machines have a 4th axis, which allows for several operations in one setup; previously, several setups were required and the part was rotated manually. "A fourth axis lets us run multiple jobs, with different work offsets, on unattended machining," says Dave.

He also likes the programmable coolant option, although he's a fairly recent convert. "With the first two machines, they tried to talk me into ordering the programmable coolant. I thought, 'What a waste that must be, why would you need it?' Well, then I bought the third machine and it was included in the option package, so I thought, 'What the heck, I'll go for it.' Now it's something

I'll always order – I wish I could go back and put it on the original two! It is so nice, when you go from a long drill to a short drill, it just moves with it."

How long a forging die lasts depends mostly on the part geometry. Some dies wear very well – long enough to produce 80,000 pieces before needing replacement. At an RC 52, it doesn't seem too surprising that a die could handle that much use (or perhaps abuse, when you consider the forging process). Still, some of the more complicated dies may have only one-eighth of that lifetime, about 10,000 pieces.

Baldwin's reputation is based, quite simply, on the extremely high quality of its products, which is based on the product components as well as the manufacturing processes. In the words of Mr. Foy, the company president, "Our secret is buying the best raw materials, using processes

Lifetime guarantees are pretty rare these days. You only find them when you deal with a company that has an exceptional commitment to quality – and the resources to back it up.

that get the best possible out of those raw materials, and a work force that's part artisan, part manufacturer." Baldwin products are known for the best finishes in the world. This is partly due to solid-core forging – "[With] hollow core, you can only finish it so deep," said Mr. Foy – and largely to Baldwin's proprietary Lifetime Finish™. This is a zirconium nitride coating, applied via physical vapor deposition, that according to company literature "allows Baldwin to guarantee exterior finishes will remain fully weatherproof and free of pitting and corrosion for the life of the product."

Lifetime guarantees are pretty rare these days. You only find them when you deal with a company that has an exceptional commitment to quality – and the resources to back it up. Baldwin Hardware clearly has what it takes.

Baldwin Hardware Corporation
800-566-1986

Be Ye Men of Valour

– Winston Churchill

Hurricane photo courtesy Ian J. Brodie

story and shop photos by Matt Bailey

Market Bosworth, England - May 1941:
The Hawker Hurricane touches down on the makeshift grass airstrip, bounces gently on its undercarriage, sets down its tail wheel and rumbles to a halt.

Before the aircraft has even stopped the young Royal Air Force officer slides back the glass hood, removes his leather flying hat and goggles and starts to unzip the thick, sheepskin jacket. The morning air, not yet warmed by the summer sun, feels fresh and damp as it floods the cockpit, washing away the heat.

Once free of the aircraft's close confines, he makes his way to the edge of the field, inching off his gloves as he walks. He crosses the narrow country lane and opens the door of the factory, glancing back at the fighter as it ticks and cools in the still air. He allows himself a contented smile as he considers the means of his commute.

Despite the demands of an intensifying war, the Air Ministry turns a blind eye to this seemingly extravagant use of a service aircraft. Having led his squadron in the Battle of France and the Battle of Britain, Squadron Leader Walter Churchill, they quietly concede, has earned an indulgence or two.

His visit to the factory is as much a matter of duty as routine. As well as serving his country in the air, he has a valuable ground-based contribution to uphold and maintain.

A week earlier, at RAF Cranwell in Lincolnshire, Churchill had witnessed an historical aviation event: the successful maiden flight of Britain's first jet engine aircraft. The occasion was particularly gratifying, for as well as being a personal friend of the designer, Frank Whittle, Churchill had played a key part in the project: His company, The Churchill Engineering Company, had supplied the compressor blades for the engine.

"The farther backwards you can look, the farther forwards you are likely to see."

– Winston Churchill

Market Bosworth, England - May 2001:

Almost exactly 60 years later, I'm sitting in the first floor meeting room of the renamed JJ Churchill Ltd.

The view from the window is England at its best. The sky is an unusually deep, almost Mediterranean, blue. The undulating Leicestershire countryside is every shade of green, and a gentle breeze carries late spring blossoms from the treetops.

History, like luck and fortune, would appear to accumulate in certain places. More than 450 years before Walter Churchill landed his Hurricane here, these and the surrounding meadows bore witness to a battle that changed the course of English history.

The Battle of Bosworth Field took place on August 22, 1485. It was a bloody fight for England's throne between York's King Richard III and Henry Tudor, head of the house of Lancaster. The confrontation culminated in the slaughter of Richard and an end to the War of the Roses. Henry Tudor was crowned King Henry VII.

James Churchill, son of Squadron Leader Walter Churchill, D.S.O., D.F.C., enters the room. An ex-Royal Air Force officer, he is well groomed, precise and effortlessly polite. Hands are shaken, pleasantries are exchanged, seats are taken. I explain the purpose of my visit and what I would like to achieve from our meeting.

"My father was probably the first graduate engineer in England," Churchill proudly tells me. "In the 1930s he joined aircraft manufacturer Armstrong Sidley as an apprentice. An enthusiastic employee, at 27 years of age he approached senior management and informed them that he would be able to provide a higher quality product in a shorter lead-time if he were to set up his own company. Not only did he ask for their blessing, but he also asked for a number of key men to make it happen. Convinced, the management gave him the backing he sought. On Christmas day 1937, the day I was born," Churchill notes, "The Churchill Engineering Company was established in Coventry."

Company Chairman James Churchill

In 1939, when Britain entered the war, The Churchill Engineering Company had already established itself as a valuable supplier to Britain's aircraft industry. It didn't take long for Germany to notice the importance of Coventry as the country's industrial heart, and, in case the employees of Churchill Engineering hadn't noticed the gathering Blitzkrieg, the Luftwaffe dropped a 1,000 lb calling card through the roof of the factory.

Operations Director John Garner

Garner - "We machine compressor blades for every Rolls-Royce military engine . . . (and) most of the Rolls-Royce commercial jet engines."

"He'd always wanted a factory in the country," says Churchill of his father. "So-called 'shadow' factories were springing up all over rural Britain, to keep them out of harm's way. Unlike some, we never moved back to Coventry."

At the outbreak of war, Walter Churchill was an auxiliary pilot commanding 605 Hurricane squadron for the county of Warwick. A natural leader and a born fighter pilot, he took his squadron to the battle of France with, in the words of James Churchill "some single successes."

In the long hot summer of 1940 he led his squadron in the battle of Britain, his participation curtailed when he was wounded.

"When he'd recovered," continues Churchill, "he was given a very interesting task: to form a fighting squadron from a group of North American bush pilots, many of whom had been mercenaries fighting for the Chinese on the Japanese front. This was before Pearl Harbour and before America entered World War II."

The newly formed squadron became the very first American Eagle Squadron and was the first operational American fighting force in Europe. Walter Churchill, Squadron Leader, was just 31 years old.

"Between postings, my father liked to visit his factory, often landing his Hurricane in an adjacent field. On one occasion he didn't have enough fuel to fly back to his squadron. He had to scour the local villages."

Then, in 1942, Churchill was sent to Malta to help the strategically vital outpost fend off a huge Axis assault. As acting Group Captain he led an attack on Sicily, where the Germans were building gliders to ensure that the tenacious Maltese would finally surrender. He was hit by ground fire and died. He was 32 years old, had been married for 6 years and had two children.

"My widowed mother was just 28 years old when she assumed full responsibility for the business," says Churchill.

"Private enterprise . . . the strong horse that pulls the whole cart."

– Winston Churchill

James Churchill is more than just custodian of a fascinating family history. An astute businessman and time-served engineer, he and Operations Director John Garner have turned JJ Churchill Ltd into one of Britain's top aerospace suppliers.

"We machine compressor blades for every Rolls-Royce military engine apart from the Adur, the power plant used in the Jaguar low-level strike aircraft," says Garner. "We also machine blades for most of the Rolls-Royce commercial jet engines, those used in civilian aircraft, marine applications and power generation."

Garner, an indefatigable engineer in his early 50s, has more energy than most 30-year-olds. Which is just as well – Garner is the man on the 'front line,' charged with making James Churchill's vision for the future a reality.

Garner - “Traditionally, we’ve always been involved in the cold end of the engine. This is the front end, where cold air is dragged in and compressed before being mixed with the fuel and ignited.”

photo courtesy Rolls-Royce plc

"Traditionally, we've always been involved in the cold end of the engine," he says. "This is the front end, where cold air is dragged in and compressed before being mixed with the fuel and ignited. The hot end is a very challenging area. Typically, because of the extreme material requirements, this end tends to be handled by the engine manufacturer or by a few, very specialized suppliers."

The large blades visible at the front of a ducted fan jet engine are, effectively, a propeller enclosed inside the engine cowling. This propeller, or more correctly fan, is driven by the jet itself, via a shaft that runs through the centre of the engine. The air passes over several rows of rotor and stator blades where it is compressed before being mixed with the fuel. "We machine the rotor and stator blades. Eighty percent of our work is the stator blades, fixed at the centre, and fixed at the outer edges," says Garner.

"We supply machined blades for the supersonic Tornado and for the vertical take-off and landing Harrier, amongst others. We also supply for the Rolls-Royce Olympus engine, famously used on Concorde, but also used in marine applications and as an industrial power generation unit," he states.

The company's experience with the Olympus engine led to its involvement on the Rolls-Royce Trent project, an all-new engine used in a wide range of commercial aircraft. The Rolls-Royce Trent is particularly innovative: Where traditional jet engines use one rotating shaft, the Trent engine uses two, one inside the other. This additional shaft allows much greater control, allowing the engine stages to rotate at different speeds.

Like all good engineers, Churchill and Garner know that to be secure, an object needs to be supported at a minimum of three points: As well as the aerospace side of the business, the company also supplies components to manufacturers of diesel engines. "A few years back we bought a small engineering company called Peacock & Waller, in Hinckley, not far from here," explains Churchill. "We're not a naturally acquisitive company," he explains, "but this was a great opportunity to bring the right skills and people on board, and gain access to customers such as Caterpillar and Perkins."

"Give us the tools,
and we will finish the job."
– Winston Churchill

Garner adds, "As well as some additional security, our work with companies such as Perkins has given us a valuable insight into supply-chain management. In fact, the production management processes we use here at JJ Churchill are based on automotive as opposed to aerospace models. We've found them to be much more appropriate for the way we work."

The third 'point of contact' is the company's range of cutting tools. "We met Empire cutting tools in Memphis, Illinois," says Garner, "and made an agreement to manufacture and market the tools as Churchill Cutting Tools, under license in Europe." The project has worked extremely well. So well, in fact, that additions to the range, tools designed and developed by Churchill, are being made under license by Empire in the USA.

A line of light grey machines with the familiar red logos stretches the length of the Churchill machine shop. Operators, noses pressed against the windows, stand ready and waiting for an M30 and the end of the program.

"As you can see, we concentrate on the VF-4," states Garner. "The 1.3 meter table allows us to use the HRT-310 at one end and the HRT-210 at the other. That's our standard package, and we have 7 of them. When I say to Haas UK (the Haas distributor in the UK) that we need another 'package,' they know exactly what I mean.

"When we went looking for machines, we wanted fast, low-cost machines that would also give us mobility of labour. This last point is important. We found that by

Garner - "...we concentrate on the VF-4. The 1.3 meter table allows us to use the HRT-310 at one end and the HRT-210 at the other. That's our standard package and we have 7 of them."

using all the same make and size of machine we've removed a psychological barrier with the operators. They move between machines very easily," he adds. And, with a mischievous smile: "We've even had our union representative keen to run five machines simultaneously."

The forged compressor blades arrive from nominated Rolls-Royce foundries in a close-to-form format. That is, the gas wash area of the blade, the aerofoil section, is almost exactly to size. The leading edge, the trailing edge and the platforms are machined before the blade is encapsulated in a low melting point alloy to form a 'brick.' These bricks are common sizes so that a standard fixture can be used for different sized blades.

The brick is held in the HRT-310 rotary table and all of the root fixings are machined. It's removed from the HRT-310, rotated through 90 degrees and held in an adjacent HRT-210, where the abutment faces and any location holes are machined.

When all of the machining is complete, the blade is broken out of the alloy brick and decontaminated. Some blades have a surface coating applied, but all blades undergo thorough non-destructive testing and inspection before being shipped.

"We machine a variety of materials, including JEHETTE, Rolls-Royce's unique stainless steel," adds Garner. "It's pretty tough, EN58-type material. We also machine titanium. Tolerances are typically 1 to 2 thousands of an inch. The Haas machines cope admirably."

Before the arrival of the Haas machines, the Churchill machine shop was populated by a number of ageing horizontal machining centres. "The twin pallet changers of the old machines were useful," says Garner, "but the Haas machines have more than lived up to our expectations: one-fifth the price of the old horizontals and they do the job almost 20% quicker!"

Garner - "The parts we're machining on the VF-6 are the backplate between a diesel power generation engine and the transmission. They're not particularly heavy, but they are quite big. The VF-6 has plenty of volume."

Some of the blades machined by JJ Churchill are heavier than others, requiring different fixtures than the standard type used on the VF-4s. "We'd carried on machining the bigger blades on one of the old horizontals," says Garner, "then Haas UK suggested we look at the HS-1RP.

"The HS-1RP is approximately half the cost of a similar machine we looked at. It's tremendous value for the money," claims Garner. "And, being twin pallet, we're able to load a job during a machining cycle."

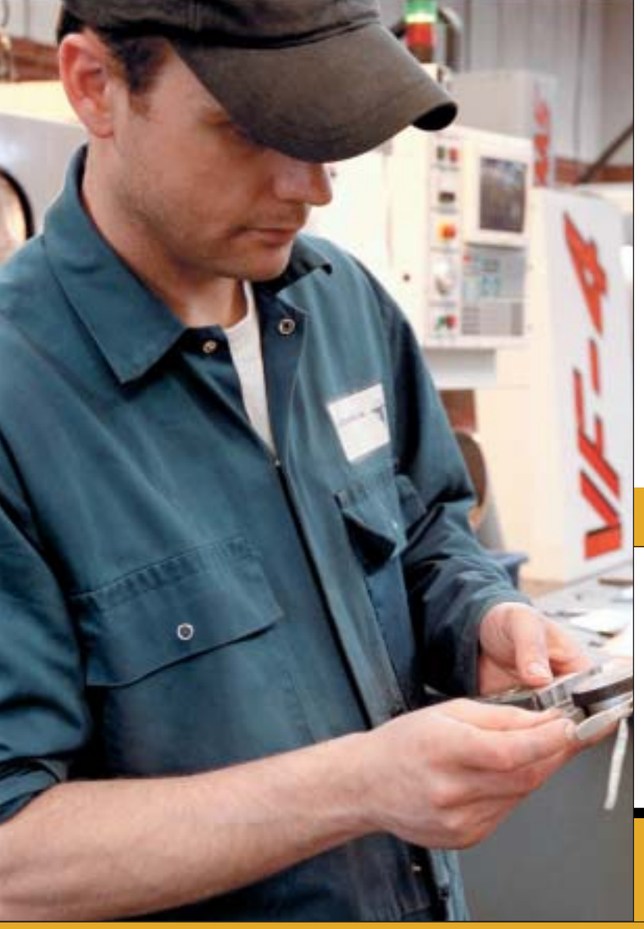
As other aspects of the company's operations have grown, Garner was on the lookout for a larger machine. "A little later we also bought a VF-6 vertical machining centre to replace an ageing Korean machine. The parts we're machining on the VF-6 are the backplate between a diesel power generation engine and the transmission. They're not particularly heavy, but they are quite big. The VF-6 has plenty of volume.

"We were also running an old Swiss lathe for a high-profile military contract. Delivery was a key part of that contract, and under no circumstances could we afford to take chances. We bought a Haas SL-40 CNC lathe to address this issue, and we now have a machine that is not only reliable but is also big enough to allow us to machine engine rings. Consequently, we can supply the customer with complete compressor blade kits."

As opposed to machine tool agencies, Haas UK only supplies Haas equipment and support. This is obviously a major plus in the eyes of Garner. "One thing I just cannot live with is a machine from company X, a rotary table from company Y and the control from company Z. I'm a big fan of the one-stop shop.

"Another thing I particularly like about Haas is delivery and installation. Typically, a machine shop will wait and wait and wait until it commits to a new machine. Then it wants it yesterday. We're a little like that," he confesses.

"On occasions, when I've needed a machine quickly, Haas UK has done everything in their power to get me a machine here. When they do arrive, they just drop clean in. Typically we'll install a machine and have it cutting metal within 24 hours. I remember the Japanese being



Garner leans forward. “We have a total quality mentality, and it works: We’re the only Rolls-Royce supplier to have zero defects per million parts. Absolutely no defects at all,” he emphasises. “That’s not just testimony to our processes, but also to the quality, reliability and accuracy of the equipment we use. Rolls-Royce fits the parts straight to the engine. They can’t afford to fit faulty parts.”

“For me,” states Garner, “quality is a company-wide attitude. Quality, delivery and cost are not separate issues. We’re running the Haas machines for more than 109 hours every week, and I need to know they are going to perform from the moment we drop them in.”

“History will be kind to me, for I intend to write it.”

– Winston Churchill

JJ Churchill Ltd has been keeping jet aircraft aloft for more than half a century. The ethos of quality, short lead times and engineering expertise championed by Squadron Leader Walter Churchill more than 60 years ago is still valid today, probably more so.

“We’re benchmarking ourselves on a worldwide basis,” says Churchill, “and we seem to be doing pretty well. We’ve had letters from Rolls-Royce and Perkins telling us that we are the best supplier they have. That’s very satisfying.”

“Also,” he continues, “we are regularly and aggressively audited by our customers on such aspects as risk management, delivery performance, quality, etc. Our customers compile and publish league tables so that all of their suppliers can see how they rank compared to one another. We post the league tables on the shop floor so that everyone can see them.”

“It’s almost embarrassing,” adds Garner. “We are consistently outperforming companies who should, quite frankly, be doing a lot better.”

So what does the future hold for JJ Churchill Ltd? James Churchill is acutely aware that when you’re top of the heap, it’s very easy to fall off.

“With our combination of expertise and facilities, project management will be a big part of our future,” he says. “For example, we currently manufacture a major component for a torpedo. Originally, the job was ‘knifed and forked’ by a number of subcontractors. We asked the OEM if we could take a look at the job. First we addressed the material issues. Then we looked at the

The numbers don’t lie: JJ Churchill is regularly audited by its customers, and the results are posted for all to see.

James Churchill - “We’re benchmarking ourselves on a worldwide basis and we seem to be doing pretty well. We’ve had letters from Perkins and Rolls-Royce telling us we’re the best suppliers they have. That’s very satisfying.”

able to do this some time back, but even they struggle sometimes. When it comes to installation, Haas UK is consistently quick.

“Let me give you an example: We had a just-in-time job to supply parts for oil coolers to Perkins. The machine was delivered on the Thursday and we delivered the parts on the following Tuesday: Installation, tooling-up, programming and machining in two working days and a weekend! This kind of turnaround is very impressive.”

In fact, it’s all-round speed and quality that define JJ Churchill and continue to open doors to the future. “We’re also involved in the BMW and Rolls-Royce aero engine collaboration,” says Garner, “developing blades for projects in very short lead times. That’s our speciality: Being able to provide a blade kit for an engine very quickly. We aim to be able to kit an engine, just-in-time, in days.”

machining, the anodising, etc. Little by little, using project management techniques, we solved all of the problems and manufactured a great product.

“Projects of this nature are great for our engineers,” says Churchill. “They like to have something new and challenging to get their teeth into once in a while, and new machines to work with.”

When one considers the special relationship that JJ Churchill Ltd has historically had with the USA, it seems fitting that many of these machines will come to Market Bosworth from a company on the other side of the Atlantic. A company of men and women, like those at JJ Churchill Ltd, to whom history will be kind, because they are writing it.

JJ Churchill Ltd
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It's So Hard To Find Good Help These Days.

It's a common theme in the metalworking industry. The continuing shortage of skilled labor is making it difficult for some shops to grow, or even take full advantage of the current demand for their services.

Story & Photos
Scott Rathburn

Such is the case with Perkins Engineering of Sussex, Wisconsin. "The current low levels of unemployment and the lack of skilled – and I mean skilled – people to program and run machines," explains Allen "Rusty" Perkins II, company president and chief designer, "is making it difficult for us to take full advantage of our potential. I would add another machine in a second if I thought that we could get more people."

Perkins is a full-service shop that specializes in taking customers' jobs from concept to completion, providing product design and development, prototyping and all the associated metalworking to build custom machines, tools and equipment for a variety of industries.

"We like to think of ourselves as not only a machine shop, but a shop that's able to take a customer's concept from start to finish," says Rusty. "If somebody comes in and says, 'I would like to develop a product,' we can design it, develop it, model it in CAD and make the prototype."

In years past, that's where the process would have stopped. If the customer wanted to go into production, Perkins didn't have the equipment to do the job economically. Such is not the case today. Since 1997, Perkins has expanded its capability and increased its machining capacity by adding four Haas vertical machining centers to its lineup of machine tools: a VF-2, VF-3, VF-4 and VF-5.

"We try to control all manufacturing processes," Rusty explains, "to first give the customer a prototype; then, if he feels it's something he wants to produce, we can make a production version and quote production quantities. With the Haas machines, we now have the capability to be competitive all the way through to the end."

According to Rusty, this start-to-finish approach is what gives Perkins its competitive edge. "There are a lot of machine shops," he says, "but I don't think there are as many with the engineering talent to do the design work and carry it through to the build. That's our little niche."

And it's a niche that keeps Perkins busy. "I can get more work now than I can eat up. All I have to do is pick up the phone," Rusty says, "which is a good position to be in."

"We're very diversified," explains Ralph Bartelt, plant manager. "We do a lot of things other than machining. We have welding, sheet metal, fabricating, bending, prototype; we have an engineering department, a lot of different things. You can bring us anything you want, and we can make it, design it, make drawings for it, whatever it takes. We sort of have a name for it: If you can't get it made, go to Perkins."

Such diversification not only keeps the work flowing, but also offers Perkins some insurance against economic downturns.

"We're invested in different areas of the economy," notes Rusty, "from electronics to horticulture to the food industry to the chemical industry. So if the economy does take a dump, at least we're relatively spread out." A valid concern, in light of current economic forecasts.

By providing its services to many different industries, Perkins is able to smooth the economic ebb and flow. The company boosts the bottom line further by investing wisely in the business, and buying equipment that provides the best value.

"I would like to see our building get bigger over the next five years," Rusty says, "but I won't put money into a building unless I absolutely have to. I would rather put the money into a machine first, and literally force myself out of the building. I'm conservative," he adds, "and I won't add equipment unless I feel comfortable enough with the economy, comfortable enough with the manpower, to keep that equipment busy."

When Perkins purchased their first Haas machines in 1997 (a VF-3 and a VF-4), they had more than enough work to keep the new equipment busy. Although they had other CNCs at the time – a couple of Brown & Sharpes, a Mazak and a newer Milltronics – these were

older and slow, and, according to both Rusty and Ralph, getting the machines serviced was difficult. “Those machines were very slow,” Ralph says, “and the service was terrible. The Haas machines are probably three times as fast, now.”

Perkins chose the Haas machines largely on the recommendation of one of their customers. “A company that we were doing a lot of work for down in Milwaukee was using them,” Ralph relates, “and they liked them; they were very happy with them. I went down and saw what they were doing, saw the parts they were making, and decided to get two of them. We tried the VF-3 and VF-4 first, then went on from there. As far as I’m concerned, for the machine, the quality, the workmanship, they’re great. I don’t need a machine that costs $200,000.”

But Perkins was concerned with more than just the up-front cost of a machine. “When you buy a machine,” Rusty comments, “the first thing you want to look at is who’s going to take care of it for you, and what happens when it’s down. You’ve got this investment, and if you can’t keep the thing up and running, you might as well throw it away.

“We get outstanding service from Haas – we probably couldn’t expect better. If there’s a problem, they’re over here in 10 minutes.” (Of course, it helps that the local Haas Factory Outlet, a Division of Productivity Wisconsin, is just up the road.) “The guys who are doing the work seem to know their stuff,” adds Ralph. “They’re very knowledgeable.”

So, what’s holding Perkins back? They’ve got the work; they’ve got the equipment. In fact, they could probably take on more work and add more equipment . . . if only they could find the people to run the machines.

“The quality of workmanship here is fantastic; it’s beautiful,” Ralph says. “That’s what our customers require. There has to be no burr, and we have to hold half a thousandth on almost everything. That’s what the machines are doing; that’s what our guys are doing; that‘s why we’re where we are.

“The work is out there,” he continues. “We have the clientele, if I could find the people. Right now, in all honesty, I could put several machines on that floor and fill them up with work – if I could find the people to run them. As far as I’m concerned, the machines and the people are the company.”

Rusty agrees, “You have to bring the people together with the machines; they work synergistically. One without the other isn’t going to help you at all. We’ve got some very creative, talented people out there who are able to make these machines really sing. It’s through their creativity, and running the parts in the most efficient way – multiple setups, multiple vises, multiple jobs in the machine, proper use of tooling – that they generate a profit for us. Now, combine that with a good, fast machine, and you’ve got something going for you.

“Anybody can buy a machine,” he continues, “but if you don’t have anybody to run it, or anybody to do a good job running it, you’re in trouble.”

Perkins Engineering
262-246-6572

Why Cutting Tools Fail

Start optimizing your operations by looking at the forces that wear or fracture tools

Story
David Johnson

Photos
Courtesy Kennametal

Tool life can be long and productive, or short and disastrous. Understanding the basic forces in the metal-cutting process that contribute to tool wear or failure will help you use today's tool technologies to ensure that your cutting tools will have a long and productive life.

In the violent world of metal-cutting, cutting tools must resist extreme heat, high pressure, abrasion and shock. Temperatures at the cutting edge can exceed 1800°F. Extreme heat degrades binders and other tool constituents, and can also trigger detrimental chemical reactions between the tool and workpiece. Abrasion is always part of the cutting process. While in the cut, the tool is in constant contact with the workpiece, under pressures greater than 2,000 psi.

Varying levels of thermal and mechanical shock also play a role in tool failure. Thermal shock – rapid heating and cooling of the tool – is most common in milling operations, in which the insert heats up while cutting and then cools while away from the cut. Mechanical shock is also a factor in milling, in machining interrupted surfaces, and even in turning, depending on the operation involved and the condition of the workpiece.

Basic failure mechanisms include crater wear, thermal deformation and cracking, nose wear, depth-of-cut notching, built-up edge, chipping, fracture and flank wear. Tool manufacturers design tools to resist these mechanisms, but must make compromises. For example, as cobalt content increases, a carbide insert's toughness generally improves while its hardness declines. Tradeoffs must be made among hardness (wear resistance), toughness (impact resistance) and chemical stability.

Hard coatings introduced in the late 1970s make it easier to balance hardness and toughness. Now, toolmakers can fine-tune the elements of the substrate/coating system, combining the impact resistance of a high-cobalt substrate with the wear resistance of hard coatings such as titanium nitride or alumina. They now have ways to create zones of cobalt enrichment at the cutting edge, so that the edge is tough while the rest of the tool remains hard.

The first coatings, effective as they were, were applied by the chemical vapor deposition, or CVD, process. High temperatures used in CVD could degrade edge strength, however, so toolmakers developed alternatives – physical vapor deposition (PVD) and medium-temperature CVD. The lower temperatures used in PVD permit coating of sharp insert edges; medium-temperature CVD coatings maintain edge strength better than higher-temperature processes. Coating materials such as CVD alumina ceramic and PVD TiAlN also broaden the ever-widening selection of substrate/coating systems that can be custom-tailored to resist specific wear mechanisms.

As complex as all this may sound, the list of reasons why tools fail is a short one – only eight basic possibilities. Any one of these factors, or a combination of two or more, can produce tool failure.

CRATER WEAR

Crater wear occurs on the rake face or top of the insert, typically when machining steels at elevated cutting speeds. Unlike abrasive wear, this kind of wear is caused by a chemical interaction between the hot chip and the workpiece material. When a tool is used to machine steels and other materials at high speeds, the tool material may dissolve into the chip, or tiny particles of the tool may adhere to the chip and get carried away. In either case, a crater forms. Excessive cratering weakens the cutting edge, inhibits proper chip flow, and increases heat and pressure on the tool. Left unchecked, crater wear can lead to tool fracture.

To combat crater wear, tool manufacturers can increase the chemical stability of the tool material, as when they added titanium carbide (TiC) to tungsten carbide (WC) in the first successful steel-cutting carbide tool. Applying a hard coating to put a hard, inert barrier between tool and workpiece at high cutting speeds will also minimize crater wear. Tool geometry can also make a difference. A positive-rake tool will reduce tool pressure and decrease contact between the chip and the insert, and the reduction in pressure and contact can reduce crater wear.

Thermal shock – rapid heating and cooling of the tool – is most common in milling operations, in which the insert heats up while cutting and then cools while away from the cut.

THERMAL DEFORMATION

Heat and pressure generated by machining can cause the cutting tool's binder to soften, allowing the carbide grains to move. Little insert material is actually worn away, as it is in crater wear, but the nose of the insert becomes distorted. As thermal deformation progresses, heat and cutting pressure increase. Inconsistent part size and tool breakage can follow.

To minimize thermal deformation, users can pick inserts with lower cobalt content, finer carbide grain sizes and a higher cubic carbide content (particularly TaC). Hard coatings also help minimize thermal deformation because they decrease generation of frictional heat.

THERMAL CRACKING

Large differences in temperature between the cutting edge and the bulk of the insert cause evenly spaced cracks perpendicular to the cutting edge. Interrupted cutting (as in milling), or machining materials like titanium that generate high heat when cut, can cause these temperature fluctuations. Cracks will progress slowly, leading to chipping and eventually to tool fracture.

Choose a carbide tool grade with a high cobalt content for toughness and resistance to thermal shocks and cracking. If possible, avoid using coolant. If you must use it, be sure that the flow is strong, steady and well-directed, so that it will moderate the temperature changes experienced by the tool.

NOSE WEAR

When machining hard alloy steel, rubbing or abrasion and local deformation of the tool's nose into the workpiece can occur. As the tool nose wears, part size changes and surface finish deteriorates. Often, the workpiece material will smear. Choose an insert grade with a higher cubic-carbide content and a larger nose radius to reduce nose wear.

DEPTH-OF-CUT NOTCHING

When machining stainless steels, high-temperature alloys and work-hardening materials that generate high cutting temperatures, depth-of-cut notching can occur at the free end of the chip. A depth-of-cut notch can cause a burr to form, leading to tool fracture.

A popular way to minimize depth-of-cut notching is to use an insert grade with higher cobalt content. Alumina or TiN coatings can also help alleviate depth-of-cut notch. Because it extends the depth of cut over a greater length of the cutting edge, a lead angle tool is often helpful. You may find that a simple modification of the part program to vary cut depth will minimize the problem.

BUILT-UP EDGE

When soft materials such as aluminum, brass or soft steels are machined, the workpiece material can bond to the cutting tool chemically and mechanically. Built-up edge can increase tool pressure and cause poor surface finish, part size changes and tool breakage. The build-up is often unstable, and is periodically washed away by the cutting action. Part size and finish will fluctuate. Tools can chip or break because of built-up edge, but users may not recognize it as the cause.

You can minimize edge build-up by using a smooth or polished cutting edge or a cutting tool with positive-rake geometry, or by increasing cutting speed. Picking a grade with lower cobalt and/or finer-sized carbide grains will raise the tool's abrasion resistance and can reduce surface roughening, and thereby help control edge build-up. A sharp cutting edge also can reduce the occurrence of built-up edge.

CHIPPING/FRACTURING

Non-rigid setups, with vibration or inconsistent cutting pressures, can cause a tool to chip. Interrupted cuts can often cause chipping or fracturing. Tool fracture can occur when one or more failure mechanisms weaken the tool, or when cutting forces rise to such a level that the insert can no longer bear the load.

Pick a tool with high cobalt content and strong edge geometry, like a hone or chamfer. Don't overlook the possibility that part rigidity and the workholding system may be causing chipping.

FLANK WEAR

All tools wear, but some types of wear are more desirable than others. The motion of the tool's flank face against the surface of the workpiece causes flank wear. Most users think "uniform flank wear" is the most desirable type because it's predictable. When wear dulls the cutting edge, tool pressure and stress on the machine and the part increase. Excessive edge wear causes deflection of the part and a change in part size and forces more heat back into the part. The longer edge wear is left unchecked, the worse it gets. In the end, it can precipitate tool fracture.

Where edge wear is the predominant wear mechanism, use a more wear-resistant insert grade to extend tool life.

In a perfect world, a shop has the time and resources to optimize every metal-cutting operation. Even in the real world, when the firm concentrates on high-volume, high-revenue jobs, improvements in productivity are multiplied over a long production run, and it's worth researching, testing and choosing the optimum grade for the cutting tool. In an environment of short production runs and rush jobs, however, shops often find that a lengthy tool evaluation process is not worth the investment, and that economical management of a large inventory of seldom-used cutting tools is too difficult.

Cutting tool manufacturers, responding to the problem, have begun to offer tools versatile enough to handle a wide range of workpiece materials and cutting parameters. Kennametal's KC8050 "universal" turning grade is a case in point. It has a cobalt-enriched substrate and a multilayer coating that balances toughness and wear resistance.

Despite new materials, coatings and substrates, the basic forces in the metal-cutting environment haven't changed over the years. Tool designers must always juggle hardness, toughness and chemical stability to get the combination that best protects users against tool failure. However, more than six decades of innovation in carbide tooling technology have increased the range of options available to match tools to the job and overcome the forces of failure and wear. Take advantage of them.

Kennametal Inc.
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HOLLYWOOD Machining Goes

Story
Linda Dorr

Photos
Earnest Pruett Center of Technology

Jackson County, up in the northeast corner of Alabama, is a hotbed of machine shops. The town of Hollywood, which is just about smack in the middle of Jackson County, has roughly 600 machine shops in the immediate area – and about 2,000 shops within an hour and a half of driving time.

The city of Huntsville, in neighboring Madison County, was recently named the third-ranking high-tech city in the U.S. by *Expansion Management* magazine.

It's not hard to see why the region is high-ranking when it comes to high-tech. An Internet search for companies in and around Huntsville turns up names like Boeing, Litton, Lockheed Martin, Motorola, NASA, Raytheon, SCI Systems and TRW Space & Defense – and this is a small percentage of the total.

Earnest Pruett Center of Technology (EPCT) is a technical high school in Hollywood. Founded in 1972 as the Jackson County Technical School, it was part of a network of technical education high schools funded in part by the federal government, with matching funds from the counties. Earnest Pruett was the school's first director; the school was renamed after him at its 25th anniversary celebration.

EPCT has, of course, had a metalworking program from its inception, and Robert Dean has directed it from the start. In the summer of 1999, EPCT was granted accreditation by the National Institute of Metalworking Skills (NIMS). NIMS was organized in 1995 by a number of industry groups, including employers, trade associations (such as the National Tooling and Machining Association) and labor unions.

The NIMS credentialing program established a set of 24 skill standards for metalworkers. The standards, which describe "full competence" – there are several credentials within each standard – cover all phases of machining and metal-forming, from entry level (Level I) to journeyman (Level III). Training programs must meet similar standards in order to be certified by NIMS, and both the program and its instructors must meet NIMS requirements.

The number of credentialed individuals and programs is growing exponentially as NIMS becomes well-known in the industry. Mr. Dean is one of very few instructors to be certified in all skill levels at one time. EPCT principal Dana Moore noted at the time that "Mr. Dean has always worked hard to offer the best quality of instruction to his students. He is now getting recognized nationally for what he has done for 27 years."

In the fall of 1999, EPCT acquired three Haas machines (a VF-3 vertical machining center, an SL-20 lathe and an HS-1RP horizontal mill), giving its already well-regarded machining program state-of-the-art status. The school's Craft Committee, which was charged with the task of choosing CNC machines, is composed of industry leaders from Jackson County. "The overwhelming first choice was Haas, based on their dependability, ease of use, appearance and reputation," said Mr. Dean. "In fact, there were about

sixteen Haas machines owned by committee members. We also liked the fact the machines are produced in the USA." Once the decision was made, Tom Jenkins, General Manager of the Birmingham Haas Factory Outlet, "was super," according to Mr. Dean. "He put it all together like the proverbial well-oiled piece of machinery."

The Haas Technical Center (HTC) at Earnest Pruett has generated a great deal of enthusiasm among area students. "We had an orientation for seventh- and eighth-graders recently, and the response was unreal," said Mr. Moore. Students from eight county high schools are enrolled in two- and three-year Precision Machining programs. Those who complete a three-year program graduate with 1,050 hours of machining basics and 525 hours of CNC/CAM training. EPCT will also begin offering evening classes for adults this fall.

The curriculum at EPCT is not for the faint of heart – course requirements are rigorous, to say the least. The CNC/CAM course outlines are three pages long, and include a notice about keeping notebooks up to par (notebooks are graded, and count as an exam). Precision Machining 101 and 102 are the prerequisites for computer courses. Safety rules are the first thing students learn, of course, followed by shop math, precision measuring, blueprint reading, and the setup and operation of manual machines. At the end of the first year students are introduced to G and M codes, and then the intensive computer instruction begins. By the time they complete two years of the CNC/CAM curriculum, including several semesters of Surfcam™, students are not only machinists, they have a good start on being programmers as well. The last semester includes a unit on creating a résumé, applying and interviewing for jobs, and understanding the workplace and the role of small business. EPCT has an internship program that places students with area manufacturing companies while they're still in school. As a consequence, many students have jobs lined up before they graduate.

The Vocational Industrial Clubs of America (VICA) is a national organization serving high-school and college students as well as working professionals enrolled in technical training programs. Among other activities, SkillsUSA-VICA is an annual competition in which students demonstrate occupational and leadership skills. The contests begin locally, and winners advance to state and national competitions. The 2001 Alabama state competition, held in April, was a 2-day affair with more than 800 competitors in some 40 events. The Precision Machining portion, with 25 contestants, included written and hands-on divisions, and both manual and CNC skills were tested.

Dale Prince, Nick Baugh and Steven Olinger, all seniors (high-school seniors, remember) in the EPCT metalworking program, took first, second and third place respectively in the state competition. The boys won scholarships to Drake Technical College in Huntsville, as well as earning spots in the national SkillsUSA-VICA competition. The national contest was held in Kansas City during the last week in June, and just before going to press, we learned that Dale garnered a silver medal in the event. Principal Moore was thrilled when he gave us the news: "Second in the nation!" he exclaimed. As young as these kids are, their education and experience could hardly let them do less.

Haas Automation is working with technical schools across the country to provide the latest in CNC machine tools for students in the metalworking industry. As Mr. Dean notes, "Tomorrow's machinists, engineers and technicians are receiving a better educational foundation on which to build their careers." Adds Dana Moore, "What Haas has done for us can't be matched. We're on the cutting edge of new technology here."

Earnest Pruett Center of Technology
256-574-6079

Haas TM-1 Toolroom Mill

The new Haas Toolroom Mill combines the power of CNC with the ease of manual controls.

The TM-1 Toolroom Mill is an affordable, non-enclosed machine that combines the precision control of the Haas CNC system with the convenience of manual handwheels. It uses standard 40-taper tooling, and a tool changer is optional.

USA Release:
August 2001

Int'l. Release:
To Be Determined

FEATURES

- **User-Friendly Haas Control**
  - Visual Quick Code Programming
  - Jog/Index Function
  - Electronic Travel Limits
  - Incremental Manual Motion
- **Three Modes of Operation**
  - Full CNC
  - Full Manual – DRO
  - Combined Manual/CNC
- **40-Taper Direct-Speed Spindle**
- **One-Piece Cast-Iron Base/Column**
- **Built-In Toolholder Rack**
- **Optional Tool Changer**
- **Single- or Three-Phase Power**

Dual-Axis Trunnion Tables for Five Axis Machining

Five-axis machining of complex, multisided parts saves setup time and increases accuracy – and that means lower costs and increased profit. Haas Automation, builder of benchmark rotary products for nearly two decades, introduces a pair of high-productivity solutions for CNC job shops: the TR-210 and TR-310 Trunnion Rotary Tables.

Bolt one of these dual-axis tables onto a three-axis mill to provide full five-axis simultaneous motion. With ±120 degrees of tilt on the A axis and a full 360 degrees of rotation on the B axis, these trunnion tables can position workpieces to almost any angle. As with all Haas rotary products, the powerful Haas servo control allows these rugged, versatile tables to be used on any machine.

The TR-210 and TR-310 are available in three configurations: as stand-alone units, which include the Haas dual-axis servo control, for use on three-axis mills; with a single-axis servo control, for use on Haas mills equipped with brushless 4th-axis drives; and as full CNC models, for use on Haas mills with brushless 5-axis controls.*

If you're searching for an economical solution to five-axis machining, look no further. The new TR series of Trunnion Rotary Tables from Haas is the right answer.

The TR-210 and TR-310 feature powerful brushless servo motors, which require brushless 4th- and 5th-axis drives in the Haas mill. Call for details.

Haas Super-High-Speed 5C Collet Indexer

For small parts machining, high-speed drill & tap operations or repetitive parts where fast cycle times are important, the new Haas HA5CSB super-high-speed collet indexer is the perfect solution. This compact indexer features a powerful brushless servo motor and 33:1 gear ratio to provide feedrates up to 800˚/second for reduced cycle times and high-speed production. That's three times faster than the standard HA5C.

FEATURES

- **High-Torque Brushless Servo**
- **800°/Second Feedrates**
- **Simple Bolt-On Mounting**
- **Reduces Cycle Times**
- **Speeds Drill & Tap Operations**
- **High-Speed Engraving**
- **20 ft-lb Spindle Torque**

EXPANSION continued from page 3

inception, the company's philosophy has been to use the most modern manufacturing processes to build the best machine tools at the best prices. This approach has yielded nearly constant growth over the years, and that growth continues today.

The company's latest major expansion – the second since moving to Oxnard, California, in 1997 – brings the Haas facility to more than 800,000 square feet. Although construction is pretty much complete, the final configuration of the additional space – and the facility as a whole, as changes are being made throughout to improve manufacturing flow and efficiency – is still a work in progress.

The goal of the expansion is threefold: to increase production capacity, increase efficiency and further reduce the cost of Haas products. Ultimately, production capacity will increase by about 40%, to 1,000 machines per month, if required by demand. Toward this end, 10 new FMS machines are already in place and running, with another 8 machines planned in the near future. This will bring an additional 316 FMS pallets online by October of this year, allowing Haas to produce more parts more efficiently through just-in-time production practices.

We'll keep you posted on how things are going – stay tuned!

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year diploma certifying that he is a manufacturing technician, and he possesses a "can do" attitude that serves him very well.

Like many technical school students, Kurtis entered the Skills Canada competition this year. After winning the CNC Turning division in the local contest, he went on to win the Manitoba competition as well. "After conquering the provincial level," Kurtis adds, "I went off to the Nationals in Edmonton, Alberta," where he took second place with a final score that was within 2% of the winning score.

Skills Canada is a national, non-profit organization with, according to its website, "a mandate to look for ways to guide students toward the professional opportunities available in the skilled trade and technology fields." The annual Skills Competition provides hands-on experience for the competitors, and raises their awareness of careers in the trade and technology fields.

The organization and its annual competition are sponsored by government agencies, technical schools and industry. Thomas Skinner & Sons Ltd., the Haas Factory Outlet (HFO) for western Canada, provided sponsorship in the form of two SL-20 CNC lathes contributed to the competition. They also allowed Kurtis to practice his techniques on their Haas machines prior to the national competition.

"I was studying at school, practicing conventional machining, and in my spare time I was at Thomas Skinner," says Kurtis. "I practiced turning, boring, threading, tapping and drilling by programming the data for the Haas lathes. They're really easy to understand and operate." Over the course of a month, he spent several days running Haas turning centers.

"He's a very good operator," says Don Babineau, manager of the Winnipeg HFO, "plus he writes programs." Babineau was so impressed, in fact, that he asked Kurtis to run an SL-10 during the HFO's open house. Happy to return the favor, Kurtis ran demos and answered questions all day long.

To say Kurtis is enthusiastic about CNC machining is an understatement. He recently volunteered to work at a Career Symposium in Winnipeg, where he spent the day telling technical students about the rewards of CNC work. Red River College also awarded him its Most Improved Student honor for 2001.

The week after graduating, Kurtis began a full-time job as a CNC machinist. While his employer doesn't own any Haas machines at this time – "unfortunately," says Kurtis – the company does have a new machinist who loves his work and is very good at it. One down, one to go.

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