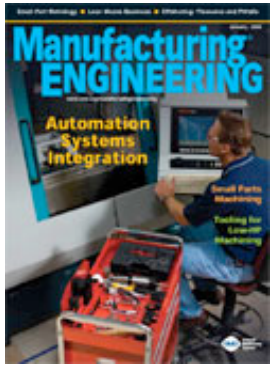
Manufacturing ENGINEERING



Manufacturing Engineering magazine delivers information you need to remain a leader, whether you are a job shop owner or other manufacturing professional and whether you work for a small, specialized shop, mid-sized supplier or large OEM.

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Shop Solutions

Birdsall Marine Rides Perfect TIG Wave

What started off with Bob "Big Bob" Birdsall Sr. building hot rod and boat components as a hobby more than 25 years ago has grown into Birdsall Marine Design, a 27-person company located in West Palm Beach, FL.

Birdsall's more than 100 distinctly crafted marine products adorn boats around the country. Boats owners from as far away as North Carolina and Puerto Rico bring their boats in to receive the Birdsall touch. Whether the boat is involved in competitive sport fishing or just used for weekend recreation, Birdsall has the products and skill to customize or restore it.

"We manufacture different designs and perform all the fabrication that goes with our T-tops, leaning posts, towers, deck towers, rod holders, and back rest arms among many other different items," says Bobby Birdsall Jr., company vice president. Birdsall even has its own in-house machine and upholstery shops, allowing them to perform all the tasks needed for custom jobs.

Anodized aluminum is used for about 85% of its products. Although anodized aluminum offers corrosion resistance and good appearance, it adds a level of complexity to the welding process, which until recently, doubled the welding time. Introduction of the Dynasty 350 AC/DC TIG inverter from Miller Electric Mfg. Co. (Appleton, WI) has made the job easier and faster, cutting welding time in half.

Bob Birdsall Jr. shows off some of Birdsall Marine's 100-plus products that must not only stand up to the ocean environment, but look good while they do it.

Anodizing, which closely resembles electroplating, converts the aluminum surface to aluminum oxide, which can vary from 0.0002 to 0.001" (0.005–0.03-mm) thick. This coating is hard, dense, and nonconductive. Unlike the rust on steel, aluminum oxide protects the base metal, providing increased corrosion resistance, excellent wear and abrasion properties, and a wide range of decorative finishes. Color varies with the thickness of the coating.

Very few welding operators can develop a technique and find a machine that lets them manipulate the AC TIG arc so that it penetrates the anodized coating and establishes a good weld puddle without adding so much heat that the puddle rolls out of the joint or the arc blows through the base metal. However, aluminum oxide melts at approximately 3600°F (1982° C), while the aluminum underneath melts at about 1200°F (648°C).

"When I first started welding, I was told you couldn't weld anodized aluminum that you had to remove the anodization first," says Bruce Saad, Birdsall fabrication manager. Saad started using a technique called "backing around weld," which allowed him to weld the material without first removing the coating. In backing around the weld, the operator first directs the torch in one direction to heat up the material and disperse the anodization to each side of the puddle. Then the operator makes a pass in the opposite direction to actually perform the weld.

This technique takes a skilled welder and doesn't leave room for error. Too much heat can burn or warp the component and cause it to be scrapped.

The Miller Dynasty 350 AC/DC TIG welder allows Bruce Saad, Birdsall fabrication manager, to weld the anodized aluminum in one pass instead of two.

"You get one chance to make a weld with anodized aluminum," says Bob, Jr. "You can't go back and sand it or do much else to it to make up for a bad weld. The appearance would suffer."

To perform their jobs, Birdsall's seven welder/fabricators use a variety of Miller TIG machines, from a 23-year-old AB/P 330 to a previous Dynasty model.

When Saad was recently asked to test a new Miller Dynasty 350 AC/DC TIG/Stick welder, he found out how easy welding anodized aluminum could be. The new Dynasty allows him to make the weld in one pass, not two. There is no longer any need to back around the weld. This saves 50% of the welding time and puts less heat into the weld, making it less likely to damage the component being welded. The ease with which the Dynasty accomplishes this makes it easier for a less skilled welder to make Birdsall quality welds. This, in turn, makes it easier to find new operators.

"You get one chance to make a weld with anodized aluminum. You can't go back and sand it or do much else to it to make up for a bad weld. The appearance would suffer."

"I've used just about every Miller machine over the last 30 years and the Dynasty 350 is the best machine I've ever used," Saad says. "It gives such a clean weld. It's efficient. I no longer have to make two passes, so it has cut down on my welding time. Since I've been using it, it's been mostly one pass—good penetration, good strength to create a clean, even-looking weld. It's just been a pleasure to use."

The secret is in the Dynasty 350's waveform controls. In conventional TIG welders, technology limits AC frequency to 50 or 60 Hz, the same as its single-phase input power. However, the Dynasty 350 is an inverter that eliminates the direct correlation to input power and allows frequency to be adjusted anywhere from 20 to 400 Hz. Increasing AC frequency provides a more focused arc with increased directional control and a narrower bead and cleaning area. A lower frequency softens the arc and results in a wider weld puddle and bead.

At 400 Hz, the arc cone is much tighter and more focused than an arc cone operating at 60 Hz.

AC Balance Control adjusts the balance between penetration (EN) and cleaning action (EP) portions of the wave. The Dynasty 350 allows the operator to set the amount of EN from 30 to 99% for greater control and fine-tuning of the cleaning action. A good weld only requires a 1" (25.4-mm) etched zone surrounding it. Using the least amount of cleaning action necessary helps maintain the tungsten point, reduces balling and provides for deeper, narrower penetration, and creates a smaller heat-affected zone.

The Dynasty 350 also allows the choice of four waveforms, depending on specific requirements or operator preference: an advanced square wave, which gives fast transitions for a responsive, dynamic and focused arc for better directional control, and a soft square wave, which provides a smoother, softer arc with a more fluid puddle than the square wave, plus a sine wave and a triangular wave.

Saad experimented with the Dynasty's different settings, and found that a soft square wave with an AC balance of 70% and frequency of 200 Hz works best for most of his work. The soft square wave has the benefits of advanced square wave, fine tuned to provide a smooth, soft arc with maximum puddle control and good wetting action. Its ability to mimic the arc feel of older non-inverter TIG units, helps convert some operators to newer technology and the benefits it offers.

Saad estimates that the Dynasty 350 cuts his welding time in half, which, in turn, cuts production time by one-third: "With the Dynasty 350, I can get the job done faster. That means the part goes to the riggers quicker and the parts fit better. The riggers can just take the parts and put them right on the boat without needing to perform adjustments. We get the boat out the door faster and the customer is happier because he gets to play with his toy on the weekend."

The Dynasty 350 puts less heat into the metal, almost eliminating the chance for burn through, distortion, or warpage. In addition, the Dynasty helps Saad create more cosmetically appealing welds, says Birdsall, who adds, "It's a very crisp weld. Bruce [Saad] can make tighter, more petite and, therefore, more attractive welds. In this business and with our products, aesthetics is very important."

"We've found that the Dynasty 350 makes it much easier to take a guy that doesn't know how to weld anodized aluminum and have him achieve a better looking weld," says Birdsall. "Finding a trained welder is an ongoing challenge in today's market. A machine like the Dynasty 350 allows us to find someone with a good work ethic, positive attitude, and willingness to learn and teach him how to weld."

Shooting Onesies and Twosies at Home

In the dialect of the manufacturing belt along Lake Michigan, "shooting a onesie" is machinist slang for a single fabrication of a part from specs. New trends in CNC are making running a home-prototyping business shooting onesies and twosies easier than ever.

Traditionally, manufacturers, designers, and inventors have had to wait in line at their local machine shops for these small custom orders. With the advent of home CNC machining and request-for-bid websites, prototype work is now going to machinists working for themselves.

Daniel Bye, who has been a machinist for shops in the Milwaukee area since 1988, invested in the equipment needed to earn his living through bidding jobs from home.

"I first got the idea about a year and a half ago, when I was working for a guy who was giving me a lot of onesie-twosie pieces. It occurred to me that all I was doing all day for this guy was driving out there, writing a program, and running a part. It was a lot of short-run, one-piece- or two-piece-type stuff. I thought I've got room in my basement. I could probably do it for myself, and for better money," says Bye, who now plies his CNC programming and tooling skills in his home through his own company Tosa Tool (Madison, WI).

Typical onesies and twosies jobs produced at Tosa Tool that are made possible by technological advancements in small CNC milling machines.

"Prototype work is staying here in the US. Engineers and inventors are here, and they want something they can assemble and look at before they send any production work overseas," says Bye. "That's the niche I'm in. My ultra-low overhead makes me unbeatable."

The first hurdle on Bye's path to independent machining was the machine itself. Although manual mills could handle many jobs, the efficiency, automation, and accuracy of CNC is needed to make short runs in short order. "Having a CNC mill is really quite necessary if you're going to compete these days in a manufacturing market."

A prototype steering wheel is typical of Tosa Tool assignments Daniel Bye handles from his home-prototyping business in Madison, WI.

Bye searched the Internet for smaller machines. He quickly found what was true in the CNC market at the time. Big mills were fast, oversized hulks with equally big price tags. The more affordable table-top CNC machines were intended for amateurs and hobbyists. They lacked not only the rigidity to make accurate cuts, but the motor strength to work with the full spectrum of materials.

"I was talking to a rep from Sherline, a manufacturer of CNC table-top machinery, and I just told him, these things are toys. This isn't what I need," says Bye. The rep told him about a new midsized mill just coming into the market. "What you want is a Tormach. I think he's in the early stages of production, but I think Greg Jackson is building them now," the rep said.

Greg Jackson, CEO of Tormach (Waunakee, WI), was another Milwaukee-area CNC entrepreneur who had ventured into his own business. He had spent three years developing a mill design that would fill the gap in the marketplace for affordable prototyping. His design carefully optimizes the weight, rigidity, rapid speed, and controls of his machine. The Tormach PCNC 1100 is what Jackson calls the first personal CNC machine.

"I visited Greg at his home and saw how the machine worked," says Bye, who bought one of the first Tormach models released. The new machine cost $6800, about half of what a used large mill would have cost. "The Tormach was the size I dreamt of having. It had a good amount of *Z*-axis travel—something that I was most impressed with. It had a good-sized table, and there was a lot of cast iron involved in the machine."

The PCNC 1100 has a table 34 x 9.5" (863 x 241 mm), travels of 18 x 9.5 x 16.25" (457 x 241 x 413 mm), a 1.5-hp (1.1-kW) spindle with speed of 300–4500 rpm, capable of handling a workpiece weighing 500 lb (226 kg).

Unlike the mass-production class of CNC machines that require industrial power, the personal Tormach mill plugs into a standard dryer outlet. And getting it into the basement? "I got the Tormach down there by myself, but I don't suggest doing it alone," Bye says. The PCNC 1100 tips the scales at 1130 lb (512 kg).

Bye's second hurdle in establishing Tosa Tool was finding enough onesies to make a living. Besides getting the word out to his local connections from past employers and friends, Bye scouted the Internet. Thanks to the benefits of ecommerce, Tosa Tool can take bids from all over the world. Bye logged on as a member of a number of different quoting sites, such as www.mfg.com. The site works like an eBay for fabrication services. Companies needing quick prototypes post their part plans, and machine companies bid on them. A rating system measures a machinist's or customer's reliability, based on the history of past orders.

The advantage for inventors and designers is fast turn around—their onesies don't have to wait in queue at a local shop, which might be backed up by larger, higher-priority jobs. The advantage for machinists like Bye is the opportunity to work from home as little or as much as needed.

As the business started up, Bye did have to get used to the feast-or-famine nature of self-employment. "Sometimes I bill thousands of dollars a week, the next week I might only do one small job and spend the rest of the time quoting possible jobs. Sometimes I have to wait around, and other times I'll have so much work that it feels like a burden."

After winning a bid, Bye takes the customer's CAD or 3-D model and directs it through his CAM software to quickly

produce the machine program. He uses eDrawings to view most CAD designs, and has access from friends to solid modelers when the projects have more complicated three dimensions. For the G-code translations, he uses EZCAM software. The automatic translation of plans to machine actions allows Bye to finish a small bid in around an hour. "I shot three parts this morning and all of them were $100 or more. I started at nine o'clock and by one in the afternoon, I've made about $400 on my Tormach, so that's not too bad."

The Tormach PCNC 1100 tips the scales at a little over 1130 lb (512 kg) with a 1.5-hp (1.1-kW) spindle and can handle a variety of workpieces to 500 lb (226 kg).

If he had purchased a smaller, less powerful mill, Bye would have been limited in the kinds of bids he could take, either in the thickness of the metal parts, the type of material, or the intricacy of detail. With the mid-size Tormach, he is free to take on most metal fabrication projects. "It's not a toy. It's a real machine. I cut steel all the time, and I make pretty decent cuts. I've been able to take a half-inch rougher and make pretty hefty cuts," he explains. "I was cutting titanium on it the other day."

Bye demonstrates his capabilities on a recent project found online. "The $600 job is cut from 2.5" [63.5-mm] thick cold-rolled 1018 steel. There's a really fine slot that runs down the center that has a width tolerance of +0.0005/-0.0000. I pulled it off with relative ease. The Tormach dialed right in and cut exactly what it was supposed to. I was very surprised the first time I did it," says Bye.

Like many machinists, Bye focuses on the accuracy of the geometry to be cut, which is often only a small portion of an unidentified assembly. The name, purpose, and function of what he's making often remains somewhat of a mystery. "What's this part called? It doesn't really matter as far as I'm concerned. I just make it and ship it per print, as fast as I can."

PM Parts Pose Workholding Challenge

Powdered metal (PM) parts have become an increasingly popular choice for a variety of manufactured parts. With more than 50 years of PM manufacturing experience, Burgess-Norton Manufacturing Co. (Geneva, IL) has promoted conversion to PM parts in a variety of applications and industries.

The company's PMfirst program and G20 program are designed to help manufacturers understand the potential for designing parts with powder metal. PMfirst is a four-step program that assesses the value and savings of switching to PM before production actually begins. The G20 program provides analysis of the hows and wherefores of the benefits of PM parts.

"We have two primary products, piston pins and powder metal," explains Brian Dalisay, Burgess-Norton product line manager. The powder-metal division began in the mid-1950s and has grown from basically one press to two dozen presses ranging in capacity from 4 to 1760 tons (3.6–1596 t). There are some 14 sintering furnaces for both continuous and batch heating. Secondary operations are performed on CNC turning machines and precision grinders.

A little over a year ago, an automotive tier-one supplier approached Burgess-Norton with a new powder metal component design for a transmission clutch. Burgess-Norton eventually won the contract, which required significant capital investment. "An entire line was added to manufacture the part, including compacting, sintering, and machining," Dalisay says.

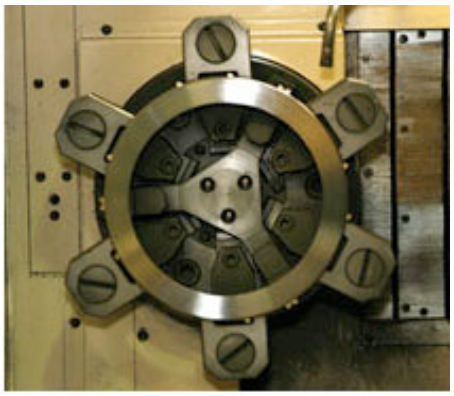
The machining cell of the line consists of several automated twin-spindle CNC lathes from Murata Machinery USA Inc. (Charlotte, NC). After the operator loads the parts into a work feeder, the cell picks up the parts, pregages them, and loads them into the lathe. The first spindle machines the face of the part, which is then transferred automatically to the second spindle where the ID bore and other features are generated. The part is sent automatically to a postprocess gage, which then feeds back information to the individual lathes within the cell. There are multiple lathes in the cell and each lathe automatically compensates based on the gage feedback.

Component design called for a creative workholding solution. The configuration of the part is such that the flatness generated on the face in the first chucking operation is critical inside the transmission. In the second chucking and turning operation of the bore, a very round bore is required.

"We were presented with several workholding challenges," Dalisay continues. "In the first operation, we need to hold flatness because it's a thin-sectioned ring. If you were to chuck it with a traditional three-jaw chuck, you might induce some distortion. You could machine it and it would be flat, but when you let go with the chuck it may go out of flat."

Burgess-Norton, in conjunction with Murata, approached Kitagawa-NorthTech Inc. (Schaumburg, IL) and its engineering staff in search of a solution.

The machining blank is 9" (228.6-mm) diam and has about 0.010" (0.25-mm) roundness variation, which is normal, but Burgess-Norton needed a much tighter roundness on the machined ID. Kitagawa-NorthTech's engineers recommended a six-jaw chuck for the application. With the six-jaw chuck Burgess-Norton is able to hold roundness to less than 0.0005" (0.013 mm). "We are able to reduce it by a factor of about 20 by holding it with the six-jaw chuck," says Dalisay. "With a typical three-jaw chuck we would have some lobing and additional roundness issues."



Burgess-Norton is able to hold roundness to less than 0.0005" (0.013 mm) on a 9" (228.6-mm) powder-metal machining blank for a transmission clutch with a six-jaw chuck that mimics a 12-jaw type.

The process has continued into a second-generation solution for the top tooling on the chucks. Dalisay is quick to mention Kitagawa-NorthTech's responsiveness and assistance with this project. Engineers from the company developed the tooling and finalized the design.

"We originally started with a version that had different clearance tolerances within the jaws, and through some collaborative efforts with Kitagawa-North-Tech, we requested that some of the clearances be reduced. With these adjustments, parallelism from one end to the other of the part, as well as the flatnesses improved significantly," says Dalisay.

The six-jaw chucks are a bit different in that each top jaw incorporates a rocker mechanism. Each rocker has two points of contact. In effect, this feature enables the six-jaw chuck to almost mimic a 12-jaw type, improves the loading around the OD of the part, and reduces the deformation whether it is cutting the face or cutting the inner diameter.

Dalisay says that Burgess-Norton is now handling significant volumes of parts, which continue to increase. Due to the success of both machining volume of the Murata machines and close tolerances delivered by the six-jaw chucks, the company is in the beginning stages of installing a second line for an additional sister part.