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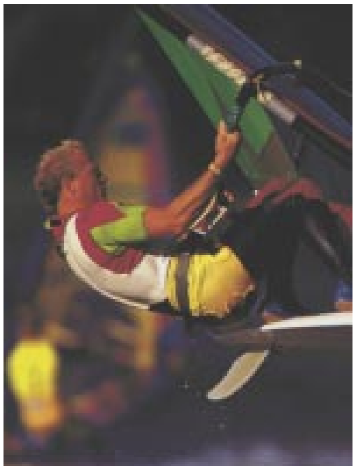
Airfoil Designs Help Improve Sailboard Performance

A more efficient airfoil design combined with computerized manufacturing technology is helping professional windsurfer racers improve their performance. The author is a former aerospace engineer who applies optimized aerodynamic profiles to the fins of windsurfing boards. Accurate machining is critical to the success of aerodynamically designed fins and it was achieved by using a Techno CNC gantry machine that produces the fins to a much higher level of precision than conventional manual methods.



High performance windsurfing boards, which are generally 7'8" to 9'4" long, operate normally in a planing condition with only the rear one-fourth to one-third of the board touching the water. This makes it impossible to use a centerboard like that used in a sailboat to counteract the side force of the sail. The only device providing counterforce is a small fixed fin at the rear of the board. The side force provided by the fin stabilizes the board and balances most of the side force generated by the sail under normal operating conditions. By allowing the use of larger sails in higher winds, the amount of balancing side force generated by the fin controls indirectly the level of attainable forward speed of the sail board. In many cases, the performance of this fin is the most significant factor in determining the overall performance of the board.

The fin operates in much the same manner as an airplane wing. However, unlike the wing of a conventional airplane, the fin must work in both directions. In this respect, it is similar to the function of wings used in certain fighter and aerobatic airplanes that are designed to fly equally well upside down. While racing windsurfing fins have traditionally been designed by trial and error, it occurred to the author, who worked for 14 years as an aeronautical engineer, that optimized airfoil designs which have been developed for aircraft could be transferred to sailboard fins with little or no modification.

Many of these designs were developed by the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration in the first half of this decade.

The problem in implementing this idea was how to produce these airfoil designs to the required high level of accuracy. Fins for mass-produced windsurfing boards are produced from injection molded plastic. These fins are not used for high-performance boards because the injection molded fins change their shape slightly as they cool. These small changes can drastically reduce the performance of the board. Fins for high-performance boards are traditionally produced by far more expensive manual methods. An experienced craftsman begins by building a series of templates that describe the contours of the fin. The craftsman then uses these templates as guides in producing the final form with a hand grinder. It typically takes about a day to make a high-performance fin. The accuracy of this approach leaves much to be desired so it is necessary to test the fins in the water to determine whether or not they are effective. A top name competitor will typically accept 2 out of 10 fins produced by these methods.

When the author originally developed the idea of building fins according to optimized aerodynamic profiles, he assumed that it would be necessary to build them using conventional manual techniques. While, as explained before, these methods are quite expensive, an even greater problem in this case is their lack of precision. Precision is much more important on fluid dynamic profiles because they are more sensitive to minor dimensional inaccuracies which can cause the flow to separate from the fin, suddenly reducing the side force and, in extreme cases, causing the board to suddenly shoot sideways ("spinout").

It was no secret that much greater accuracy could be achieved with CNC machining, but this alternative was not given serious consideration because it was assumed that the machinery and software required to implement this technology would cost at least $100,000. Unfortunately, the market for fins for high-performance sailboards is not large enough to justify this expenditure. Bernie Brandstetter, a former World Cup racer and the first manufacturer of CNC-milled sailboard fins on Maui, introduced the author to the Techno-Isel machine, which first made it economically possible to machine fins.

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Maui Fin purchased a 3-axis CNC machine from Techno-Isel, New Hyde Park, New York, with the MAC controller for only about $18,000. This system has an accuracy of +0.1 mm (+0.004) in 300 mm and a repeatability of +0.01 mm (+0.0004). Techno machines have anti-backlash ball screws for play-free motion that make it possible to produce circles that are accurate to the 0.0005 inch machine resolution. The ballscrews have excellent power transmission due to the rolling ball contact between the nut and screws. This type of contact also ensures low friction, low wear and long life. The ability to achieve this accuracy at a low cost made economical fin machining possible.

An aerodynamic reference book provides coordinates of the profile. These coordinates are then entered into the Mastercam software package provided with the Techno machine. The result is a plan view representation of the profile. The next step is scaling the profile to create 30 to 40 ribs that give the fin's planiform its third dimension. The reference book provides the unit length of the profile used. The author wrote a BASIC program that generates an array of points for each of the ribs scaled to the cross sections of the fin's planiform. The program produces its output in CadKey CADLINK format which can be read by MasterCAM. MasterCAM reads these points as a series of splines. A surface is then applied to these splines using MasterCAM's lofted surface feature. Another feature of the program, called synch, makes it possible to space the chain intervals closely at 0.2 mm for the first 10% of the profile where accuracy is the most important. Chaining intervals are spaced at 0.6 mm for the remainder of the curved portion of the profile and at 2.4 mm for the flat portion in order to save time generating the tool path and reduce the file size.

The Techno milling machine makes it possible to produce fins to precise aerodynamic profiles at a cost that is less than the cost of hand-producing high performance fins. It takes about 4 hours to produce each fin. Feed rates are limited because the G-10 plastic material used, the same type of material used to produce printed circuit boards, is so tough. The material is supplied in half inch panels consisting of about 25 layers of fiberglass embedded under pressure in a plastic shell. A carbide bullnose end mill is used to cut this material. This tool is 3/8 inch in diameter, has 4 flutes, a 1/8 inch flat section around the centerline and 1/8 inch radius on each corner. It makes a smoother surface than the more common ball nose end mill.

The (NACA) 63A010 profile is one that has been found to provide excellent performance under a wide range of racing conditions. The maximum thickness of this profile is 35" back from the nose. Some modifications are required for aerospace profiles because they are designed for considerably higher speed operation than windsurfing fins. Maui Composites uses a computational fluid dynamics program that lets them simulate the operation of the profiles at the 30 to 40 mph speeds common to sailboard racing. The gantry machine provides sufficient accuracy to make systematic dimensional changes that allow performance to be optimized. The most critical consideration is the prevention of the onset of turbulence, which causes a phenomenon similar to stalling in an airplane. The fin then loses its side force and the sailboard begins rapidly moving sideways. The accuracy of a computer-milled fin makes it possible to reduce the wetted area of the fin by 10%, reducing friction drag and increasing the attainable speed of the board.

Many races have been won with fins produced by CNC

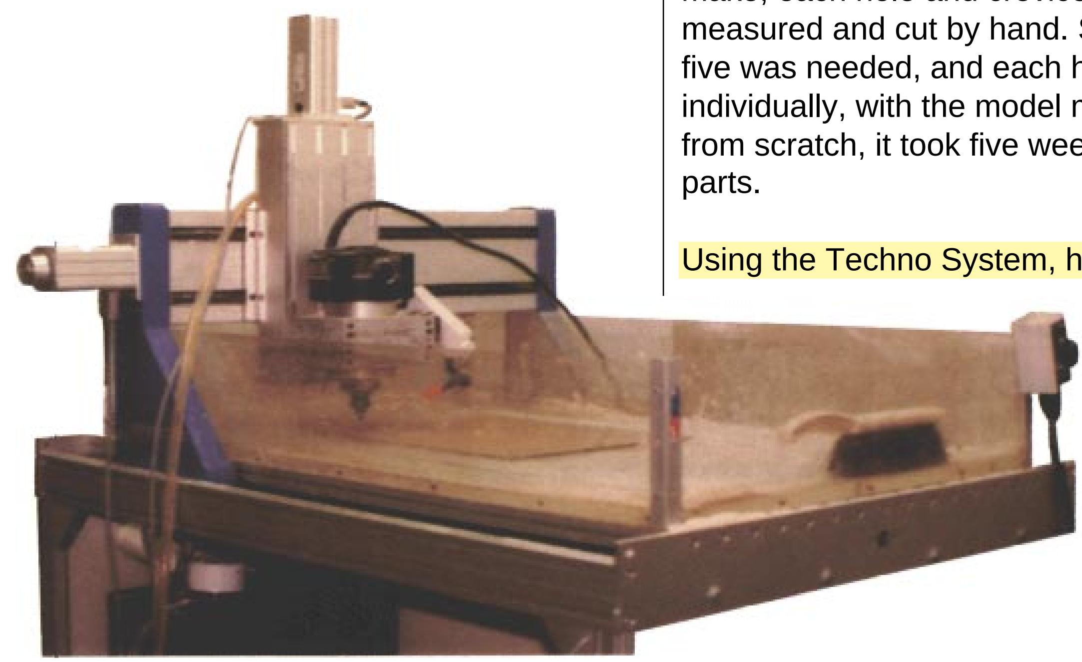
milling. Anders Bringdahl is only one of the well-known racers that have used the fins to beat their best previous times. Other fin producers have tried to copy these profiles using manual manufacturing methods and/or tracer milling machines, but found that performance is substantially reduced by machining inaccuracies. The aerodynamic profiles have also been used to produce molds in order to produce mass market sailboard fins; so far with mixed results due to uncontrollable shape changes (see earlier in this article). All in all, computer milling technology is having a major impact on windsurfing by providing a better performing fin at a reasonable cost for the performance achieved.

About the author: Gerhard Opel is a retired airline captain and a former bush pilot, having flown in the Alaskan and Canadian arctic. He spent 14 years as an aeronautical engineer working on various U.S. and European transport and fighter aircraft. He holds a Graduate M.E. degree from the T.U., Vienna, Austria and a M.S.C. (ME) degree from the Massachusetts Institute of Technology. He is also an enthusiastic board sailor learning a lot from testing his own fin designs.

Using The Techno Gantry For Precision Plastic Prototypes

"We could not survive in the modeling industry without the machine, (Techno CNC router)" says Rick Delfosse of Precision Prototypes, Mineola, New York. Precision makes prototypes of anything from gears to coffee mugs to Sesame Street characters. Done by hand, the process is painstakingly long and extremely costly. So costly in fact, that the prices Precision would have to charge for the handmade models, customers would not pay. However, through the use of a Techno Series III Gantry Machine with a MAC Controller, and a 3D MasterCam CNC programming system, Precision is not closing their doors, but producing models of them – and toys and machine parts – doing so more easily, quickly, and cheaply than ever before.

Previously, Precision received the blueprints of a product from a client and sent them directly to their model makers on the factory floor. The model makers would then produce the prototype by hand. The amount of time this took varied by the complexity of the model, but it was by no means short in any case. An example is one of the last projects Precision worked on without the Techno machine. The part, of medium complexity, took a week to make, each hole and crevice being measured and cut by hand. Since a set of five was needed, and each had to be done individually, with the model maker starting from scratch, it took five weeks to finish the parts.



Using the Techno System, however, Precision follows a simple procedure which allows them to speed up production time greatly. Now, when Precision receives the blueprints, often in AutoCad, they transfer them to MasterCam in order to create a toolpath for the Gantry. They can then immediately produce a test model, make adjustments as necessary, and produce a finished model. This model is then sanded and smoothed and used to produce a silicon mold. From this mold, Precision can then get a polyurethane part which replicates an ejection-molded part. Production with the Techno System can save 1/3 to 1/2 the time of manual production depending on the complexity of the part.

In the above example, had Precision possessed the Techno System at the time, a part could have been completed in two days instead of a week – and it would not have been necessary to start over for each part; the other four could easily be produced from the first pattern.

At an approximate cost of production of $60 an hour, a decrease in production time from 5 weeks to under one week is savings of thousands of dollars on one project alone.

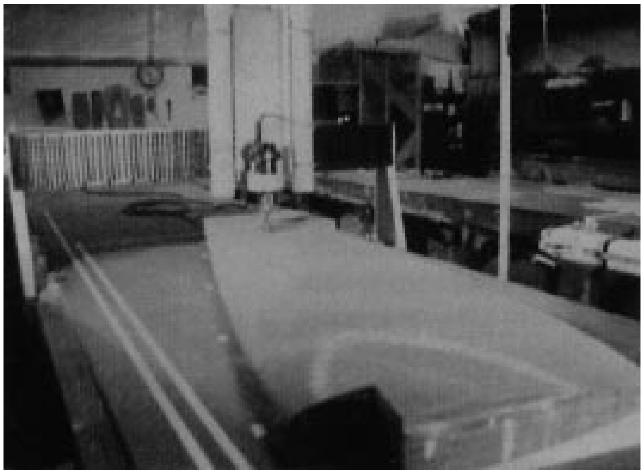
Precision has found the Techno System particularly useful for larger parts as well. For a large, complex door model they are producing for Pitney Bowes, Precision discovered they could create the model as 50 individual pieces and then assemble the pieces as a kit. If an adjustment is needed in some part of the model, the particular piece in question can be adjusted in MasterCAM and then remade on the machine. Previously, if an error was made, or an adjustment was needed in part of the model, the whole model would have to be remade from scratch. The savings created by this use of the Techno Gantry System is obvious.

This ability to quickly and easily adjust and correct parts is a tremendous advantage to the Techno System. In addition to allowing Precision to fix pieces of a larger model much easier than before, they can also easily make corrections in small, detailed parts. Errors in such parts are common, but using the Techno machine adjustments can be made and additional parts produced with little difficulty. In fact, Precision regularly produces test models before creating a finished product to allow for such adjustments, a luxury afforded courtesy of the Techno System.

Similarly, if after producing a prototype, a customer makes a modification in the design of a product, Precision can easily incorporate the modification into the MasterCam file and produce a new part in a fraction of the time that would have been needed if the models were still made by hand. This ability to adapt quickly to customer needs is invaluable and a direct benefit of the Techno Gantry System.

CNC Speeds Racing Boat Design

America's Cup boats are getting faster all the time, and part of that is due to Goetz Marine Technology's (GMT) use of a CNC machine from Techno-*isel*, New Hyde Park, NY. GMT engineers use the machine to produce precisely shaped, perfectly symmetrical composite rudders. GMT rudders guided several boats competing in the 1995 America's Cup race, as well as on the 1992 winner *America* and contender *Stars & Stripes*.



Symmetry and accuracy are critical in rudder production because the design is optimized for maximum speed and lift. With manual production methods, GMT was able to get within four or five millimeters of designers' specifications; but by using the Techno CNC machine, rudders are now accurate to within 0.5 mm, says GMT Shop Foreman Gary Crosby.

The CNC machine, driven by geometry from KeelCAM software from AeroHydro, Inc., Southwest Harbor, ME, cuts the two halves of a rudder's high-density foam core. In addition to helping GMT engineers produce rudders to customers' specifications, the Techno machine reduces the time needed to shape a rudder from 16 hours to about 10, says Crosby.

Bristol, RI-based Goetz Marine Technology is recognized throughout the boating world for custom design and construction of advanced, high-quality composite parts such as keels, rudders, masts, and booms. In 1989, GMT became the first company to offer a carbon fiber mast for cruising boats.

Carbon fiber is a popular material for boat parts because it's strong yet lightweight. According to GMT Marketing Director Ben Sprague, a rudder made entirely of carbon fiber weighs about 60% less than one made with a stainless steel post and fiberglass blade.

Strength and lightness are especially important in racing designs such as the America's Cup boats, which incorporate carbon fiber in many components. Rather than pouring material into a mold to form a part, they cut a high-strength core to the desired shape, then laminate it with carbon fiber. "By laying carbon fiber over a high-density foam, that holds its shape well, the part comes out stronger than one produced in a mold," says Crosby.

Typically, when customers come to GMT with a request for a part, they provide drawings, explains Crosby. Often, the designer has done extensive computer modeling and tank testing to optimize the part shape – especially for the foil shapes of keels or rudders. "It's important that GMT match the customer's drawings exactly to give the boat as much speed as possible," adds Crosby. That's where precise motion control comes into play.

A rudder consists of two parts: the post that attaches to the boat and permits the turning back and forth, and the blade which is the foil shape that does the turning. Before CNC was available, technicians manually carved the blade's foam core, one half at a time. Using a circular saw, they cut kerfs or slots into the foam blank every 12 to 18 inches.

Next, they inserted templates representing the blade half into the slots. They then carved the foam with a power planedown to the tops of the templates. "This required a skilled operator," recalls Crosby.

After one side was carved, technicians placed carbon fiber on that side and allowed it to set. The next day, they flipped the piece over so the other half could be carved, and the two halves were joined. A pocket for the post was cut into the blade with a hand saw and the post was bonded into place with glue. The drawback to this method was that because the foam core was cut by hand, accuracy was only possible to about four or five millimeters. This approach was also time-consuming.

GMT purchased Techno-*isel*'s CNC milling machine with the MAC controller to improve accuracy and reduce production time. The system was the most affordable and highly accurate available, says Crosby. The machine has a resolution of 0.0005 inches: about 100 times the precision that can be achieved by hand. The system is easy to use and compatible with all the leading CAM packages, adds Crosby.

With the CNC machine, the rudder production process is more efficient. Crosby models the blade in KeelCAM , entering points along the leading and trailing edges of the blade in a grid format. He then builds a table of numbers as an ASCII file from which the software generates the planiform and the foil offsets for the foil shapes and run up and down the blade. After the designer enters half a dozen foil shapes, the computer smooths them out to produce the finished shape.

The smoothed blade produced by KeelCAM becomes the cutting file for the Techno CNC machine. Data describing the planiform of the rudder blade is transferred into the machine's MAC controller. The Techno is a three-axis machine with a Z-axis travel of 11 inches. It has a work envelope of 40 inches by 40 inches. However, most rudders are longer than that, so the machine is programmed to carve 40 inches at a time.

The cutting bit is a 1.75-inch ball mill on a 2.5-hp router. The carving stroke is in the fore and aft direction. The step-over is about 15 mm, which leaves little scallops that are smoothed out by hand. After one half is carved, the foam is laminated. Using a plywood cradle, the builder then turns over the piece and completes the other side.

Most rudders can be carved in several 40-inch cutting sessions. Each session requires between 120 and 130 passes and takes about 20 minutes. Usually, the carving for one side of the blade takes about four hours, including set-up time. Programming time depends on quality of information provided by the designer. "Generally, it takes two to three hours for programming and getting the cutting files ready," says Crosby. Therefore, the automated method typically takes about 10 to 11 hours to produce the finished blade, compared to the 16 hours required by the manual approach.

"For a rudder blade that's two meters tall and 500-600 mm fore-to-aft, GMT is now delivering blades with 0.5 mm accuracy," he adds. The Techno CNC machine also allows exact duplicates to be made for spares or testing.

The CNC machine has four ground and hardened steel shafts and eight recirculating bearings in each axis. This shaft and bearing system delivers very smooth play-free motion which generates high-quality cuts, says Sprague. Also, the machine's anti-backlash ball screws provide play-free motion that makes it possible to produce accurate circles.

Says Crosby: "It saves time, but the real benefit of the automated method is that creates very accurate rudder blades.

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CNC Router Does Light Prototype And Production Work At 1/3 The Cost Of A Machining Center

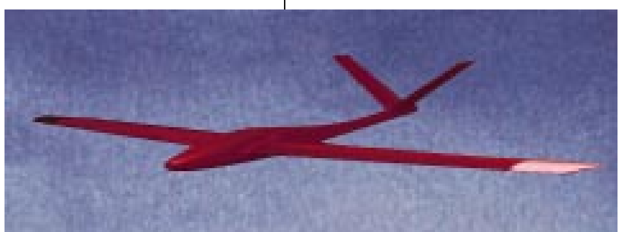
Tectonics Maui has dramatically reduced light prototyping and production costs by using $15,000 CNC routers from Techno instead of a $45,000 small machining center. The CNC router produces a wide range of plastics, aluminum, carbon and steel components to virtually the same level of accuracy as a machining center. Operating costs, including electricity and maintenance, are only a fraction of what it would cost to run a machining center. The CNC router also is capable of machining larger parts because its working area is 56 by 96 inches compared to 11 by 49 inches for a typical small machining center. The only limitation of the router is that it cannot take as heavy a cut as a machining center. Since the majority of parts produced by the firm are plastic, this limitation is not a major drawback.

Tectonics Maui and KJM Design specialize in producing prototypes on a rapid turnaround basis for a wide range of industries located around the world. Many of their customers are in the sports equipment business. They also run production for a number of sports equipment manufacturers. Tectonics Maui was established to produce high performance windsurfing fins and rapid prototyping. KJM Design was brought in to set up the CNC machines and design a working environment for production. KJM also designs the fin line and all mechanical work that comes in. Some other products manufactured — in addition to windsurfing fins — include UAV airplane components and radio control, and crossbows.

Face panel created with 3D surfacing

Tectonics Maui started in the prototype machining business by operating a group of manual machine tools including milling machines, drill presses and band saws. Several years ago, it became apparent that a move to CNC machining was required in order to improve quality and reduce machining costs. At that time, Tectonics Maui considered the common approach of purchasing a small machining center, but were discouraged by the high initial and operating costs of these machines and by the fact that their relatively small bed size makes them unable to produce much of the company's product mix.

Instead of a small machining center, Tectonics Maui selected a three axis gantry router from Techno, New Hyde Park, New York. Because of its superior accuracy, soon after buying the first machine, they purchased two more. Techno routers have a positioning accuracy of ±0.1 mm (.004 inches) in 300 mm and a repeatability of ±0.01 mm. The accuracy of the router is the result of several features inherent to the table. Anti-backlash ball screws permit play-free motion that makes it possible to produce circles accurate to the 0.0005 inch machine resolution. These ballscrews also make it possible to produce parts as accurate as the machine resolution. The ballscrews have excellent power transmission due to the rolling ball contact between the nut and screws. This type of contact also ensures low friction, low wear and long life. KJM Design developed a wide range of special tooling to optimize the productivity of the new machine. The first tooling item built was a reduced-speed spindle that handles R-8 tooling such as carbide fly cutters and bullnose end mills for aluminum machining. Later, a dual spindle head capable of machining two parts at the same time was developed. Both of these spindles were completely machined on the Techno router. KJM is currently in the process of developing a triple spindle head. KJM Design has also designed a wide range of fixtures using pin alignment and tool-less clamps to provide quick setup changes. The goal for every fixture developed is 30 second replacement of stock in the fixture. KJM has found that carbide tooling gives the best results on aluminum parts. For fly cutting and boring, indexable carbide cutters are used, while for cavity and contour work solid carbide tooling is utilized. Generally, solid carbide end mills are so inexpensive these days that it often doesn't make sense to spend the time aligning and setting up inserts for aluminum machining.



KJM design uses the CADKEY computer aided design software from Baystate Technologies, Inc., Marlborough, Massachusetts, for nearly all mechanical design. The 3D CADKEY model is then exported in the CDL neutral file format and imported into the Mastercam CNC programming package from CNC Software, Inc., Tolland, Connecticut. Mastercam can generate complex contours with little programming effort and features true 3-D geometry construction plus IGES, DXF and CDL converters so that geometry can be uploaded from nearly any CAD system. Operating costs are substantially lower with the CNC router compared to a machining center. The 1/2 horsepower, 3 phase motor used in the router uses only about 1/4 of the electricity of a machining center.

The Techno CNC router requires very little maintenance. These machines will typically run 1000 hours without any maintenance. Replacement parts are also available at considerably lower cost. A new table extrusion, for example, costs under $200 as compared to approximately $1000 to replace a table surface on a machining center.

A considerable portion of Tectonic Maui's prototype machining work consists of finishing parts produced with stereolithography apparatus (SLA). SLA is an outstanding method of producing geometrically complex prototypes. The problem is that it's not capable of producing fine details with the crispness associated with CNC machining. Moving the part to a conventional CNC machining center for touchup would be very expensive. So, Tectonics Maui uses the Techno CNC router to produce fine details on SLA parts resulting in an unparalleled level of quality at an affordable cost. Modifications to the SLA model can be made by machining the SLA material itself or machining small pieces of ABS which can then be bonded into the original model. These can be small logos or icons as well as any overall modifications to the parts including the addition of ribs, bosses, through-holes, etc. For example, several holes designed to hold brass inserts were machined on an SLA part. SLA is not capable of holding a bore to the tolerances required. It should be noted that the option of cutting directly into the stereolithography part is preferable when it can be accomplished because it eliminates the need to mount, flush and sand the machined insert. Also, SLA parts typically have thin walls so they require a special clamping fixture to hold one side of the wall while the other is machined. While SLA is growing in popularity, machining plastic parts from scratch on a CNC router is still preferred for most recreational equipment applications. The main reason is that most recreational prototypes are required to possess mechanical properties close to those of the finished part so that they can be tested. While SLA requires the use of special materials that nearly always do not have the needed properties, the CNC router makes it possible to use functional materials that allow the prototype to be fully functional. Typically, the company is able to get within 15% of the mechanical properties of the actual injection molded part. All in all, Tectonics Maui has found that the use of CNC routers provides major advantages in cost and flexibility compared to machining centers for light prototype and production work.

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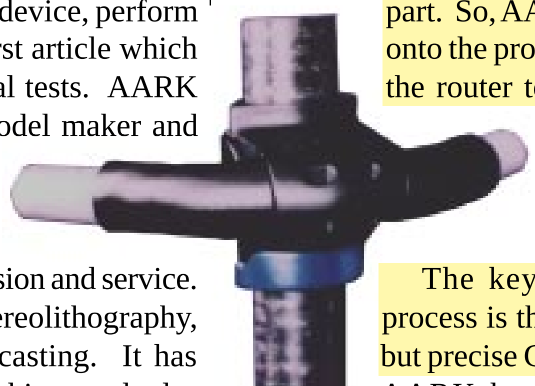
COMBINATION OF SLA AND CNC ROUTER PRODUCES HIGHER QUALITY INJECTION MOLDING PROTOTYPES

Combining stereolithography apparatus (SLA) with a Techno CNC router makes it possible for AARK Creative Network to produce injection molding prototypes of a much higher quality than can be produced on SLA alone. SLA is an outstanding method of producing geometrically complex prototypes. The problem is that it's not capable of producing fine details with the crispness associated with CNC machining. Moving the part to a conventional CNC machining center for touch-up would be very expensive. So, AARK uses a low-cost, easy-to-operate CNC router from Techno to produce fine details on SLA parts resulting in an unparalleled level of quality at an affordable cost.

Prototypes are required for most injection molded electronic components. They are used to obtain sign-off on the styling of the device, perform packaging studies, and build the first article which is used for a wide range of physical tests. AARK Creative Network is the largest model maker and prototype manufacturer in the world. Over 650 professionals take advantage of the latest technology to provide outstanding quality, precision and service. The company's services include stereolithography, CNC machining, fabrication and casting. It has factories in San Diego and Troy, Michigan and sales offices throughout the world.

While SLA has become an extremely popular prototype manufacturing tool, it cannot achieve the crispness possible with machining or injection molding. As a result, prototypes produced by this method are often rejected for styling reasons. CNC routers can dramatically improve the quality of prototypes produced with stereolithography. Details produced by the CNC router may either be machined directly into the SLA produced part or into blocks of material that are then bonded with the original component. A typical example of this practice in action is producing the bezel for an electronic component using stereolithography and using a CNC router to produce details such as LED readouts. It should be noted that the option of cutting directly into the stereolithographed part is preferable when it can be accomplished because it eliminates the need to mount, flush and sand the machined insert.

This technique can also be used to make changes to SLA parts in much less time than would be required to produce a new part. In one case, AARK made an SLA part from a PRO/Engineer file. When the customer checked the fit of the prototype, they decided to make a lot of changes to it and needed a new prototype the next day. This didn't leave enough time to produce another SLA part. So, AARK bonded new material onto the prototype and machined it on the router to the new specifications. The cost was only 15% of what it would have cost to produce a new SLA prototype.



The key to the success of this process is the availability of low cost but precise CNC routers from Techno. AARK has two three-axis gantry routers from Techno. These routers have a positioning accuracy of ±0.1 mm (.004 inches) in 300 mm and a repeatability of ±0.01 mm. The accuracy of the router is the result of several features inherent to the table. Anti-backlash ball screws permit play-free motion that makes it possible to produce circles accurate to the 0.0005 inch machine resolution. These ballscrews also make it possible to produce parts as accurate as the machine resolution. The ballscrews have excellent power transmission due to the rolling ball contact between the nut and screws. This type of

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contact also ensures low friction, low wear and long life.

The Techno CNC router is able to finish SLA parts and many other injection molding prototypes from scratch at half the cost of doing the job on a conventional CNC machining center. The router has a lower hourly rate because it requires a small fraction of the investment of a machining center and material costs are frequently cut by 50% because prototypes can be constructed by machining walls and bonding them together rather than cutting from a solid block.

AARK typically receives geometrical data from customers as either a native CAD file or an IGES or DXF format neutral file. The company reads this file into one of several CAD systems that they use including AutoCAD and PRO/Engineer. To produce an insert covering a detailed area of a stereolithography part, a section containing the detailed area must be removed from the SLA geometry and transferred to a CNC routing program. Finally, if the router is to directly machine the SLA part, then extra material must be added in this area on the stereolithography geometry while the CNC router is programmed to produce the final geometry.

When the geometry is finished, the designers produce an IGES or DXF file and import it into EZ-CAM, their CNC machining software. This package produces a file that is read by the MAC controller used by the router. An important point to note is that the Techno router is much easier to operate than a CNC machining center. The machine has just a few buttons and commands and all commands use plain English rather than "Machinese". Operators typically get up to speed on using the machine in 30 minutes or so.

The routers also provide a unique method of producing box-like prototypes such as bezels for electronic systems. Bezels are normally produced on a CNC machining center from a solid block of material. This is a very time-consuming process on an expensive machine that typically requires a high degree of operator attention. Machining parts from a solid block also is expensive from a material standpoint.

Not all low-cost CNC routers have the precision or size range to accomplish the objectives. The Techno router is one of only a few that combines low cost, precision and large travel (up to 5' x 8'). This type of router can dramatically reduce the cost of producing this type of part without reducing quality.

The original model of the housing is exploded into six separate walls. On a router, these walls are produced from sheet material and bonded together to form a cube. Material cost is typically reduced by 50% and machining time is cut by about 33%. Finally, the hourly cost of the Techno CNC router is typically half the cost of the machining center. As a result, the cost of producing the prototype is cut by about 50% without any reduction in quality.

Producing bezels piece by piece also provides the opportunity to enhance the finish of the prototype. AARK recently produced a business telephone bezel using this approach. Making the bezel prototype hollow made it possible to polish the top panel so it was transparent and produce a second panel that fits underneath it containing the buttons. This second panel was silkscreened, adding a level of realism to the prototype that would have been impossible to achieve with a solid block.

All in all, the use of CNC routers provides major advantages for producers of injection molding prototypes. AARK has seen a significant increase in its injection molding prototype business since it developed this new machining methodology.