

Wood & Wood Products

"CAM Inspires Guitar Innovation ."

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CNC precision takes Taylor Guitars' quality and productivity up an octave.

Taylor Guitars of El Cajon, CA, manufactures instruments used by hundreds of artists including Kenny Loggins, Jewel, Clint Black and Richie Sambora of Bon Jovi.

Recording artists are turned onto the guitars for their exquisite looks as well as their great sounds. The company's selection of woods reads like a page from the United Nations. Tonewoods include big leaf maple, sitka spruce, western red cedar and englemann spruce from the western region of North America, as well as Honduras mahogany and sapele from Africa. The rosewood on Taylor guitars hails from East India and Brazil, while the ebony used for fingerboards comes from India and Africa. Other woods include imubia from southern Brazil for acoustic basses, plus claro walnut from Northern California and Hawaiian koa.

While craftsmanship has always been a hallmark of Taylor Guitars, the methods it uses to achieve its distinctive trademark quality entail an increased reliance on computerized technology.

"Our introduction to CNC production 11 years ago created an entirely new method of thought — a vision — not of cost savings or increased production, but of opening our thinking to almost unlimited possibilities in the design and quality of our instruments," says Bob Taylor, president.



The Taylor 714ce "Grand Auditorium" acoustic/electric guitar, hand-assembled and finished from CNC-milled parts.

strings above this section, the action changed dramatically, requiring artistic compensation, affecting the intonation, and, thus, the purity of performance.

One Heckuva Neck

Taylor designers put an end to that deficiency in 1999 by creating a system in which the fingerboard extends along the neck and further along a paddle-like insert into the guitar body for the remaining length of the fingerboard.

The fingerboard, attached along the new neck design, moves as one with the neck when precisely laser-cut inserts are used to change the neck angle. The fingering remains constant along the entire fingerboard. There is no hump at the 14th fret, no drop at the 20th and no scooping in the middle. Taylor

Before Taylor purchased a Fadal vertical mill with Mastercam software in 1989, the company's 28 employees were turning out eight to 10 guitars a day. Today, 400 employees, with the help of nine Multicam MT22 CNC routers and a router from Airturbine Tools, are making 200 instruments a day.

"It seems like production increased every time we used CNC to improve quality," Taylor recalls, "but, more importantly, we were — and are — able to design features and entire instruments that would have been impossible before."

To illustrate his point, Taylor says, "Designing and cutting the new neck joining and adjustment system on Taylor guitars dwarfs any other carving project we've undertaken, including our ability to machine to perfection the feel of an ideal, hand-carved prototype."

The exclusive neck system solves a problem inherent in adjustable-neck guitars from their inception. Changing the angle of the neck by turning an adjusting screw, called a truss rod, enabled a customized fingering action, governed by the space between the strings and the fingerboard, through most of the range of the fingerboard. But that part extending from the joint between body and neck — at the 14th fret — to the end of the board — the 20th fret — was fixed to the guitar body. When a guitarist fingered the

has eliminated all the artistic compromises required when the fingerboard is not straight — and the musician-customers love it.

“When we first went into the new neck system,” says senior designer Matt Guzzetta, “some customers were wary of the change. But now that they’ve tried it, they can’t wait until their favorite model will be produced with the new neck.

“Of all the parts, the neck has always been the trickiest — the most machine intensive,” Guzzetta continues. “There are no simple contours, no simple radii. Everything uses an artistic shape, and how the neck feels to the artist comes down to thousandths of an inch.”

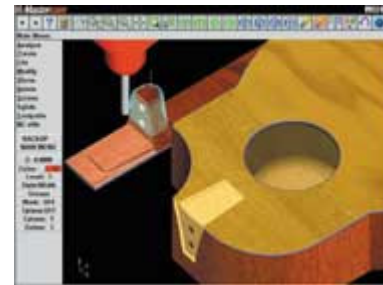
How It’s Done

The first CAD geometry file was derived in 1989 by probing an ideal hand-carved neck every 0.030 inch, creating a point constellation which Mastercam filtered to a workable file size. Creating a wireframe and then a toolpath from a virtually solid mass of points produced an exact replica of the ideal model — again and again. The main body of the neck is machined by a Mastercam multi-surface toolpath running a 1-inch ball mill at a 0.040-inch stepover. Straight sections are cut at 375 inches per minute. For more intricate curves, the software slows the feed rate to as low as 80 inches per minute.

As designers created new models based on the original, they adjusted the geometry and cut prototypes repeatedly until the “feel,” once dependent upon a human woodworker’s consistency, met their aesthetic criteria. Altering the virtual light source of shaded models and rotating views of changed designs gave designers a visual preview, enabling some corrections before machining. Prototyping time was cut significantly because each time the geometry changed, Mastercam’s associativity automatically revised the toolpath.

While other guitar manufacturers have taken advantage of CNC, none has expanded its use into the basic mechanics of historic guitar design as Taylor has done in its new neck system, Taylor says. The paddle — the part of the neck that extends into a pocket in the body — was added to the existing software’s neck geometry and toolpathed in 2-D, since it is a grouping of rectilinear forms. The paddle elements of the neck are roughed to dimension but finishing is held until the final finish of the neck body so that, when the finished neck is fixtured, the finish passes conform the paddle absolutely to design dimensions relative to the entire neck.

The pocket in the body is a three-piece assembly: the heel block, against which the neck butts and through which the neck is bolted to the body; the shelf, which receives the top of the paddle; and the fingerboard brace, which adds stability at the body-end of the fingerboard. The pocket assembly, completed within the body, is machined with the same degree of accuracy as the paddle.



Taylor programs all their CNC-machined components with Mastercam, allowing them to make quick changes on the fly.

With the body seated in a custom fixture, also Mastercam-designed and cut, the horizontal surfaces are roughed with one of the Mastercam 5/16-inch end mills. They are finished with the Airturbine Tools 1/16-inch end mill in a 65,000 rpm air turbine mounted on the spindle which follows the finish toolpath. The vertical faces are cut with a 14-inch down-spiral end mill mounted in a 90-degree right-angle head. To cut the bottom corners of the pocket to tolerance, Taylor engineers used the CAD/CAM software to design a 90-degree fixture to hold the turbine with its 1/16-inch end mill.

A Precise Fit

Taylor says the neck-to-body fit is only made possible because of the close tolerances made possible by his company’s use of software and and CNC machinery. The new design eliminates tension and stress from the assembly bolts because they draw together perfectly matched parts.

The new neck configuration is hardly the only benefit Taylor Guitars has derived from going to CAD/CAM/CNC. The company uses Mastercam to design and make almost all of its fixtures, to laser-cut body tops and bottoms, to create the forms for bending the sides of guitars, and to machine interior bracing, body molds and shaper templates for other bracing.

Guzzetta says that much credit for the exquisite finish and aesthetically pleasing form of Taylor's entire line of more than 60 models goes to the unity of production achieved by creating all parts from the original design stored in software files.

Taylor's view is more philosophically sweeping. "I didn't even finish building my second guitar before I started to rethink and change the way they were made," he says. "Even now, we're not a fully developed company simply seeking to cut costs. We wanted a future in which we could dream any design and know we could build it. Mastercam and CNC unleashed our imaginations and allowed us to create endless variations. They bring us ever closer to our ideal."

Information for this article was supplied by CNC Software Inc./Mastercam of Tolland, CT. For more information, go to www.mastercam.com.