the online magazine for design & technology education

ties

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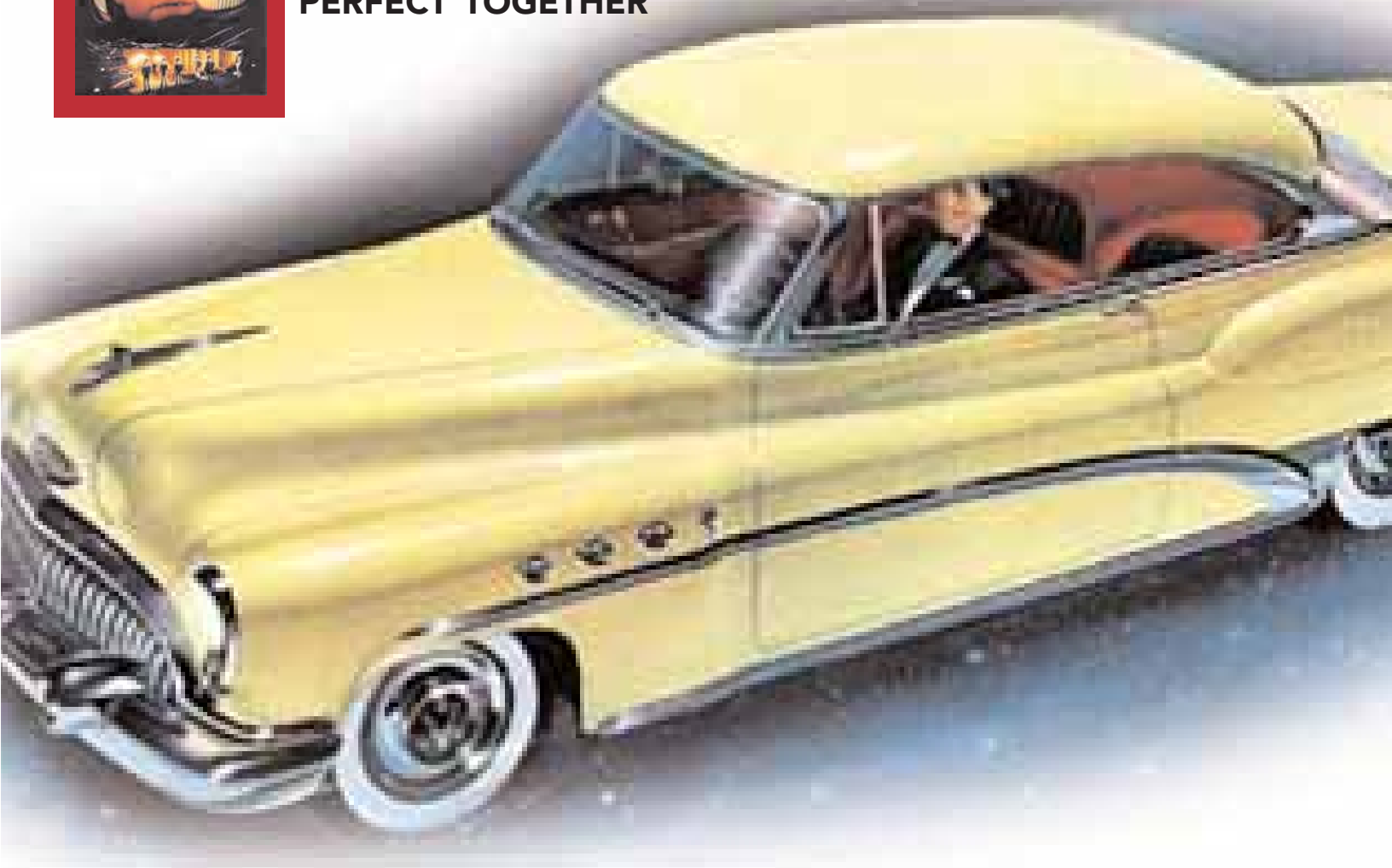
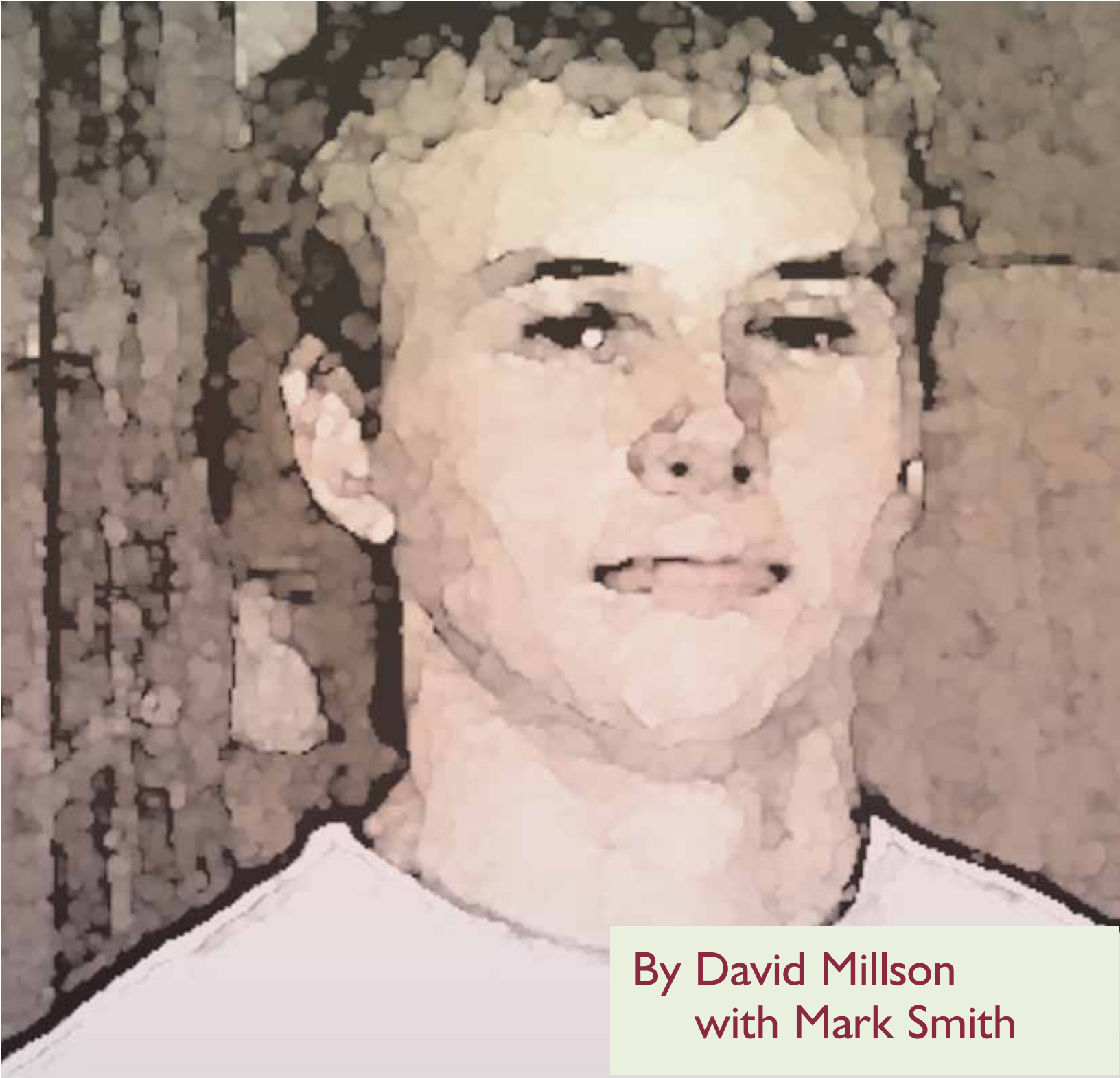




By David Millson
with Mark Smith

your youth will see visions

Encouraged by his and other Shiloh High woodworkers' smashing success at the 2003 AWFS (Association of Woodworking and Furnishings Suppliers) Show, senior Emory Luth vowed to create a dramatic entry for 2004. Undaunted by the unexpected elimination of secondary school entries in the show, Emory, with his teacher's help, remained faithful to his goal. This is a story of one student's successful research into professional production techniques that brought his dream to life.

Mel Gibson's character in the Sci-Fi film, *Signs*, declares, "There are no coincidences." That's perhaps a valid way of looking at the confluence of two threads that we began to explore in the *ties Online* December 2003 article, "A Phoenix Rising From Its Ashes."

One industry's problem

According to the *Wall Street Journal*, and reports for the past few years in American wood products journals, U.S. furniture makers have been steadily watching their manufacturing sector evaporate in the face of offshore competition. The U.S. manufacturing sector has shed about 55,000 jobs between 2000 and 2003 alone. In that same time, imports filled over 40 percent of the American furniture market.

"Send us CNC-trained workers" is the hue and cry in the furniture industry. The readily reproducible, high-quality results of CAD/CAM design and production may well be the lifesaver of an industry barely keeping its head above offshore waters… but where are these skilled CNC woodworking technicians to come from?

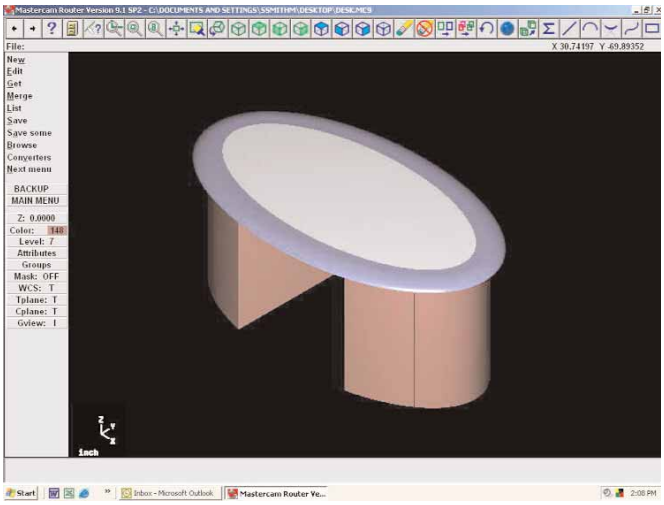
Shiloh Industrial Technology students represent their program at the 2002-03 AWFS Student Competition in Anaheim Convention Center in California. From L to R Paul Wilson, Emory Luth, Katie Weber, Heidi Kibbler, Brandon Draper and Adam Carrington, and teacher Mark Smith. Paul and Emory received their AWFS Finalist awards that year.

One man's answer...

In the summer of the 2000 school year, Industrial Technology Teacher Mark Smith at Hume, Illinois' Shiloh High School (*marks@raider.shiloh.k12.il.us*) received a call from Larry Hilchie of WoodLINKS in the US *(http://www.woodlinks.com/)*. That Mr. Hilchie volunteered as the organization 's leader in addition to his full time job serves as a sign of that organization's recognition of woodworking manufacturers' desperate need for CAD/CAM-trained people. Mr. and Mrs. Smith accepted his invitation to the Association of Woodworking and Furnishings Suppliers (AWFS) show in Atlanta. There he stood amid, as he put it, monster floor space. "We walked around for three days, all day, and saw only three-quarters of the show. It was a real eye-opener; I saw processes there that were completely new to me."

"We attended WoodLINKS USA meetings and heard the industry leaders serving as guest speakers. We learned what practical steps were needed for Shiloh High School to become a WoodLINKS USA site. We were excited because of the potential WoodLINKS could offer our program and, once we began to use their resources and curriculum, what that would do for our students." Shiloh High School 's Industrial Technology Program became the first WoodLINKS USA high school site in Illinois.

Industrial Technology/WoodLINKS USA Teacher Mark Smith stands by proudly as Emory Luth, right and Paul Wilson display the WoodLINKS USA certificates they received at the 2003 AWFS show. Shiloh High School was the first in Illinois to become a WoodLINKS USA center.



The Art Deco concept master executed in Mastercam solids. It owes its visual consistency to the ease Mastercam's associativity lends to the creation of scaled-down jigs for the drawer casements.

...and its result

Last year Four of Mr. Smith's students received their WoodLINKS USA certificates during the 2002-2003 school year. Two of them, Emory Luth and Paul Wilson were selected to exhibit their work in the AWFS Student Design Contest and received their WoodLINKS USA certificates at the banquet honoring all the AWFS award winners on August 1, 2003.

Fast forward: 2004

What do winners do in the face of disappointment?

Emory Luth's response was immediate and decisive. He set to work during the first three months of the 2003-2004 school year drawing and re-drawing his plans for the very essence of his competitive dream: an Art Deco executive desk built virtually from scratch. Emory's design was complex and required him to create in-house-laminated cherry veneer plywood, vacuum molded to conform to his original competitive plan for an elliptical form.

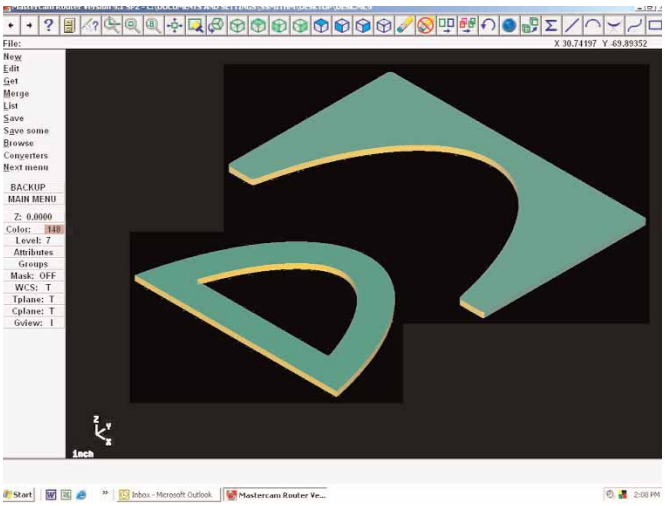
"I liked the look of a curved panel," Emory said, "and the fluid lines of a geometric ellipse appealed to me. But the main reason I chose an ellipse was that I had never seen an elliptical desk before and I thought it would be unique to have one."

Determined to follow industry practice as nearly as possible, Emory sought information on laminating, veneer and wood molding techniques, and materials selection criteria from woodworking professionals. Joe Farlow, of **Wood Wonders** of Tampa, Florida, (*www.woodwondersoftampa.com/*) and Jason Susnajara at

Thermwood, Inc., manufacturers of the school's CNC router (*www.thermwood.com*), freely gave critical advice to Emory during the planning and forming stages of the project.

Mr. Smith notes that "Ken Wilcox of **GL Veneer**, Huntington Park, CA (*www.glveneer.com*) helped us with technical questions and gave us greatly reduced prices; **Franklin Adhesives' Heather Dages** (*www.covinax.com/*) donated four gallons of their Titebond® woodworking adhesive; and LaVern Schlabach of **Das Holz Haus** gave us technical support on drawer box hardware." Das Holz Haus is among the Shiloh IT Program's business and industry supporters.

An added challenge brought the project into closer focus on real-world manufacturing constraints; Emory and Mr. Smith had agreed to finish the desk in time to make the deadline for this article. In its own way, the deadline paralleled manufacturers' striving for on-time delivery. As you can see, they met the challenge.



Male and female jigs for forming the casements are shown here as a composite of images created by Mastercam toolpath verification, the geometry of which will be toolpathed and posted for the Thermwood to achieve extraordinary accuracy in the finished pieces.

Macro-dimensional accuracy?

While we usually think of accuracy in machining/moldmaking terms as <.001", with the prospect of having to reproduce his elliptical geometry in proportionally reduced and, in some cases truncated form, Emory decided to use Mastercam® Solids (by CNC Software, Tolland, CT (*www.mastercam.com*) to create toolpaths for the desk surface, casework (the drawer sections that support the desktop, and jigs and fixtures.

Mr. Smith remarks, "We have always been able to depend on the Mastercam technical support staff in any project we've undertaken. Will Slota and Jamie Madison were of special help this time around."

As the story of this project continues, bear in mind that Mastercam's associativity allowed Emory to reduce the major ellipse – the desktop – to create smaller concentric ellipses for other desk surface work as well as the casing shapes — truncating the elliptical paradigm into mirror-image parabolas — and interior drawer parts as well. It took Emory, with Mr. Smith's help and encouragement, nearly another two months to make the final working jigs.

Something from "nothing"

Emory chose vacuum forming as the primary process for shaping and laminating all curved pieces. "We were originally going to use solid cherry, steam the wood, then bend it," Emory recalls. "I learned through talking to professionals that we couldn't hope to generate the enormous pressure to bend solid 3/4" wood." He and Mr. Smith also thought they would be able to use 1/4" plywood for the forming surface of the vacuum jigs to bend the successive laminates — maple/bendable plywood/maple/bendable/maple — to the elliptical casework exterior profile. It was not to be: way wide of the mark.

After successive crashes under less-than-production amounts of vacuum, Mr. Smith suggested handing the

A 1/16" perforated steel form rests on cross-braced ash supports. An industrial vacuum forming bag bends and compresses thin plies into parabolic sections of veneered plywood. Because the layers are glued with the grain alternating at right angles, the drawer caseworks gain strength at minimum weight.

geometry over to one of Shiloh's resource professionals, Ed Cler of Paul's Machine and Welding in Villa Grove, Illinois. Mr. Cler, skilled in combining laser cutting and CNC, donated and cut 1/16" steel to size, drilled mounting holes, and bent it to the predetermined elliptical shape. The CNC accuracy of the vacuum jig uprights, and Mr. Cler's metalworking skill combined for a perfect fit upon assembly.

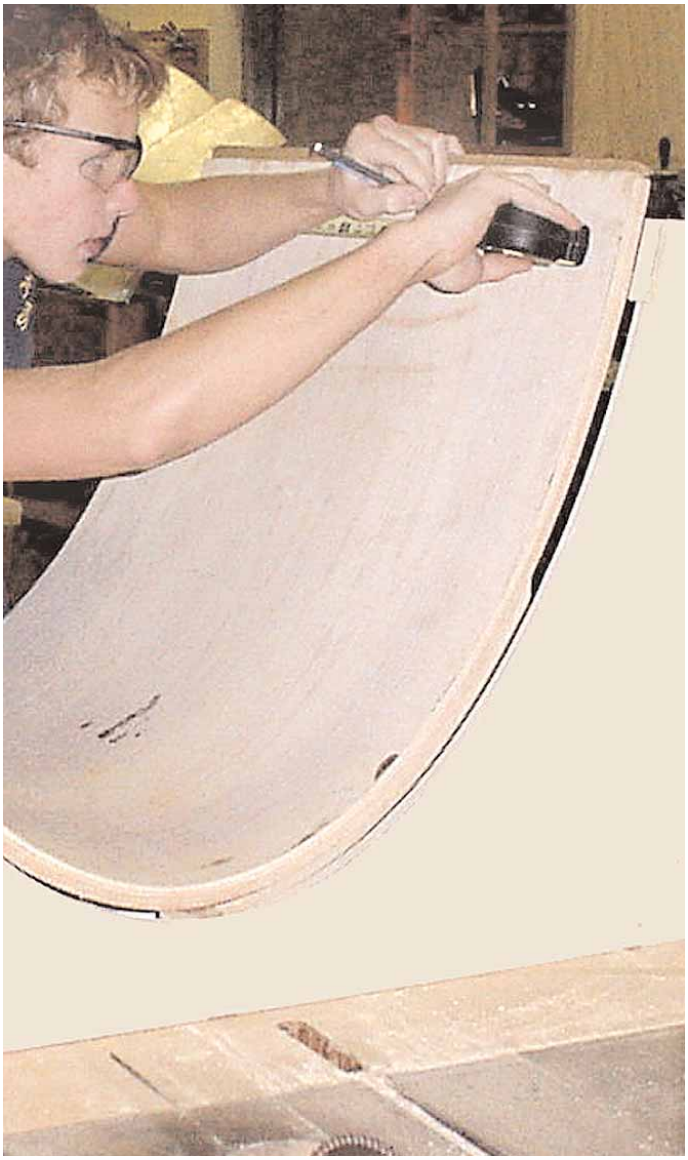
When enough is too much

Emory and Mr. Smith screwed the steel to their first support structure, fired up the vacuum pump… and found that their shop-made vacuum bag couldn't draw tightly enough. When they received their commercial bag, the understructure collapsed under what, they now realized, was an enormous amount of pressure on the 30" x 40" steel plate.

Emory made "all kinds of calls" to determine the strength needed for the internal braces. He determined that a latticework of 9-ply 3/4" Baltic birch plywood would hold. Emory screwed the steel to the birch support-work, countersunk the screws, and Bondo-ed them flush but Mr. Smith says, "It was creaking the whole time during our final 4-hour test under vacuum on March 3rd. It held and we glued the first one up."

According to Emory, "That glue-up failed because we didn't water down the glue enough to combat dry time; and because we didn't cover up the parts being glued with a piece of bendable to apply even pressure. We were essentially making plywood that, with final lamination after the drawers were cut, showed cherry veneer on the top surfaces."

Using measurements from the left-side drawer casework, Emory prepares parts for the jig to hold the piece for the table saw pass that will square off the ends.



A strip of bendable plywood will be screwed to the molded plywood as a guide for the table saw operation. Here, Emory measures in order to position the holes, which will be filled later.

Done in jig time

Emory built a jig to hold the casework exteriors to cut the ends on the table saw. Since these cuts would true up the casework to the top and provide parallel mounting edges for the interior covering — the sides next to your knees if you sat at the desk — the saw cuts had to be perfect. "To set it up right," Emory recounts, "we clamped piece of bendable to the top, used that as a guide for our router with a flush-trim roller bit to get the first straight edge to begin trimming with the saw."

"It took two tries with the router to get it exactly perpendicular to the outer surface of each piece. Then we just set the table fence at the proper distance for the finished height of the ellipses and rotated the other end of the piece against the table saw blade. We screwed it to the jig, which holds the piece at the right angle to cut the short edges. The jig bracing had to be less than the exposed height of the saws blade in order to go all the way through the laminate."

"That went right first time," Mr. Smith recalled, with something sounding very much like relief. "If we had a 5-axis machine, we could have created Mastercam toolpaths and zipped right through this job without taking the time to make a jig."

Squaring the circle parabola

Emory solved the challenge of cutting the rectilinear pattern of the drawer fronts, projected on the curved surface of the casework desk-ends, with yet another Mastercam-defined and produced jig. Almost more important than getting square corners was the need to make certain that the saw cuts were parallel to the inside, kneehole faces of the desk ends. Even a degree or two of skew would prevent the normal travel of the drawers when opened: also parallel with the kneehole.

After he cut the drawer fronts, Emory glued a thin piece of solid cherry on the top of each, covering the top, multi-ply cross section to make the drawers appear to be solid cherry. Back at the table saw, he sliced off a

The rouged pieces are stacked for inspection before the shelf-and-drawer combinations are attached. The design of this top was scrapped in favor of a simpler, four-part inlay that displayed the grain to best advantage.

corresponding thickness from the bottom of the drawers so they would fit back into their openings. Using another industry-standard method, Emory edge-banded the drawer sides with glue-backed veneer from a roll, heated the top surface to melt the glue into the plywood, and filed the excess away.

At this point, the outward sides of the drawer fronts and the main body of the casework sections were still without their top layer of cherry veneer. Emory put each casework section back on the vacuum form, with its cookie-cutter drawer fronts taped in place from the rear.

"I didn't realize at first," Emory recalls, "that the outside veneer wouldn't flatten unless there was something more than the bag holding it tight against the layer beneath. For the final ply on the casework shapes, we laid an unglued layer of bendable to press the top veneer flat. Once that set, I cut through the veneer with a utility knife to free the drawer fronts, and cleaned the edges up with a flush trim router, thus leaving the edges of the drawer-front edge veneer covered by the drawer front layer."

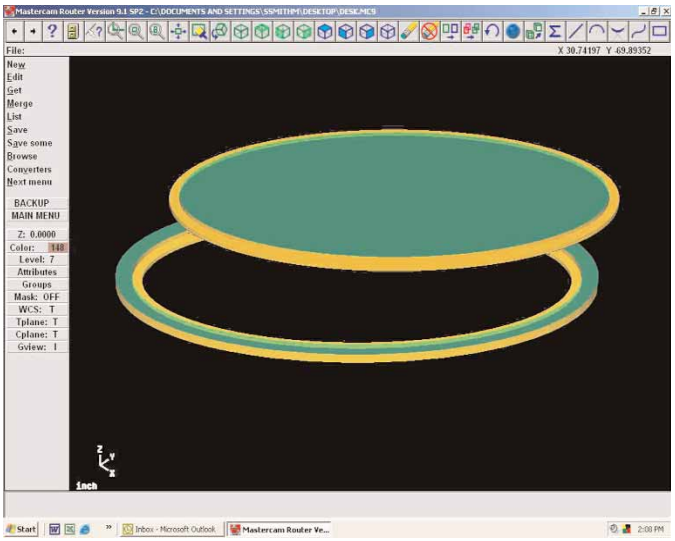
An inside job

Once again using the basic ellipse geometry, Emory cut three 3/4" plywood pieces to the horizontal cross-section of each desk end, offsetting the toolpath by the thickness of the composite around the curve. They also left space inward from the front edges of the kneehole sides for the inset of a finishing flat panel.

The uppermost of these pieces is flush with the top of the desk-end and will be used to anchor the desktop to the desk ends. The remaining two sit just below each of the two drawer bottoms on either side. These will accept the Blum Hardware bottom-mount drawer-slide hardware. All of these pieces provide structural integrity for the desk-ends, resulting in a rigid base for the desktop.

Emory next cut already veneered flat pieces, edge-trimmed to the interior parabolic shape, to cap the ends of the parabolas to finish the kneehole sides of the bases. Using another researched furniture industry practice, he

Early on, Emory laid out tentative shapes until he found the proportions for the ellipse he liked best. This is the selection we see in production.



The quality of fine joinery is built into the tabletop by creating the geometry applied to forming the transition ring and the outside curve of the central segments from the outer ring. Routed to the exact curve at the joining line, first the transition curve, then the segments, are shaved .005" at a time until they press-fit into a sturdy assembly.

inset these end caps past the desk-end edges. With the interior and edges of the parabolas veneered, all still appear to be solid cherry, with the addition of the eye-appealing enrichment of quality-enhancing detail.

Topping it off

Emory's design for the elliptical desktop called for a dual approach: a cherry outer oval ring, to appear solid; a band of maple as a visual transition and to reinforce the elliptical major design element; and an inner, concentric section — the main area of the desktop — in quadrants ending with the inner curve of the solid maple transition ring. For appearance and durability, Emory created toolpaths for a series of roughed solid cherry pieces butt end-to-end and extending beyond the width of the outer ring geometry. He used the Thermwood with Mastercam accuracy to ensure that the four joints were as nearly perfect — and, thus, as strong — as possible. Once cut out, the segments were dowelled-and-glued together. The maple transition ring was produced in much the same way. Wayne Sutter of **Woodline USA** (*www.woodbits.com*) donated router bits for the project; additional CNC tooling

CAM/CNC accuracy resulted in the perfect fit of all pieces. Note the maple accent band in contrast to the solid cherry outer ring and the central segments, also in cherry.

Emory is one proud technician and craftsman as he shows off his completed Art Deco desk. Look for it in five more years with a nameplate on it and a workstation behind it.

came from **Onsrud Cutter** (*www.plasticrouting.com*) through Jim Servis.

The center four wedges of quarter-sawn 1/32" Pacific madrone veneer were also CNC-cut and mounted on a 3/4" + 3/4" plywood sandwich — and the entire 1-1/2" thick assembly milled, associatively using the original geometry, to the exact inner curve of the solid cherry ellipse. "We then began to shave the madrone-veneer oval .005" at a time until it made a tight press fit within the maple band," Mr. Smith continues, "which occurred after six passes."

Emory picks up: "I surface sanded the completed outer ring piece for a true plane surface; then finally milled it from the back with another Mastercam toolpath to 1- 1/2" thickness. Now this 60-pound assembly was almost as solid as a single piece, due greatly to the toolpath accuracy and reference points from Mastercam. Screwing it on through the top casework shelf and adding the drawer pulls were was simplest parts of the project."

Buying boxes, making them their own

As many in the industry do, Mr. Smith purchased four ready-made maple drawers of the correct width and depth. They were considerably longer than needed to leave stock to conform at the front to the already formed curved drawer fronts. The remainder was cut away consistent with the front profile, an industry technique Emory gleaned from networking among manufacturers' representatives.

Emory used the drawer fronts as jigs for the inner drawer box fronts that would join the box to the veneered outer faces. The box fronts were also vacuum formed as a maple veneer laminate with solid pieces of maple on top

to make them appear solid. Once a curved piece was placed inside the box, Emory coarsely trimmed the sides on a band saw and then used the trim router to flush them and the drawer bottom as well. He glued and screwed the box front from the sides and bottom, covering the holes with dowel plugs.

Finishing up

After final touch-up sanding with abrasives donated by **National Detroit**'s Gary Swanson (*www.nationaldetroit.com*) and Robert Newman of **Mirka Abrasives, Inc.,** Twinsburg, Ohio (*www.mirka-usa.com*), Emory finished the desk with Valspar™ Facette®, a pre-catalyzed lacquer finish, "harder than normal lacquer but not as hard as varnish," according to Mr. Smith. Emory used two coats on the desk sides and three coats for the top. **Paints and Solvents** of Arthur, Illinois donated the lacquer to the project. The proprietor, Stan Sanner, is a member of Shiloh High School's Advisory Council, which helps generate direction, support, and ownership among the school, and community and industry leaders.

But the real finish to the story is Emory's plan to save his unique desk for "the big office I'm going to have some day." Some day may not be too far off for Emory Luth. He is working toward a WoodLINKS scholarship and has been accepted to the University of Illinois College of Engineering, considered to be the fourth-ranked program in the country — and he is on the waiting list at MIT.

"I'm going to study Mechanical Engineering and," Emory hopes, "become involved in designing machinery and workflow patterns for woodworking factories. I'm also working on getting an internship at Thermwood®, either now or after a year in college. But any way my career goes, I intend to 'pay it forward' for the experiences and professional insider tips I've received through work on this project, and for the contact with the people I have met from a lot of really great companies through the AWFS events. I also have a tough yardstick to measure my own willingness to help students, when my time

Once instructor Mark Smith learned the techniques, Shiloh tech students helped upgrade and equip their lab by producing and installing professional-grade cabinetry for family, friends and others who had seen their work. The DeWitts stand in their new "*Cabinets by Shiloh*" kitchen, with different views of the complex job at the four corners.

comes; Mark Smith, a mentor in all of the best senses of the word — teacher, friend, example, coworker, coach — will be a tough act to follow."

Still on the rise

As we learned in *Ties Magazine* last December, Mr. Smith and his students, with the proactive support of school, administration and industry partners, created a first-rate, wood-based Industrial Technology facility from a rusty, dusty relic. Today, Shiloh sends many students like Emory out as interns in industry; places some graduates into production-grade jobs; and sends others into post-secondary and college to study in fields ranging from design engineering to computer-animated graphics.

From the beginning Mr.Smith felt that, "Over time, the school would be proud of our students and they would serve as examples to the community of what our young people could do when given across-the-board support. I truly believe that if we can help adolescent students — kids at a very vulnerable stage in their lifetime development — gain confidence and feelings of self-worth from patently obvious results, we will have given them a gift for life."

David Millson,
editorial consultant to CNC Software, Inc./Mastercam, works from his home in New Haven, VT as a free-lance journalist and advertising copywriter.

Mark Smith
is the Industrial Technology WoodLINKS teacher at Shiloh High School, Hume, Illinois.