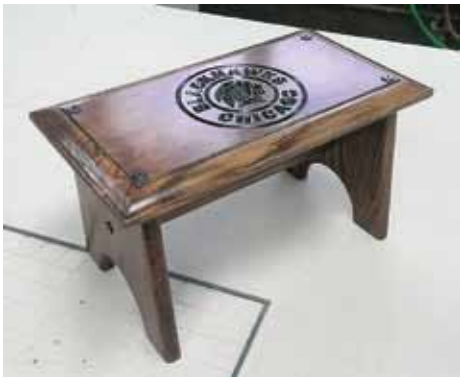
Teaching the Ins-and-Outs of Advanced Manufacturing

By Barry Van Name

THE next time you admire someone's fashionable wood-framed sunglasses, you may be looking at a pair of stylish peeper enhancers created by teacher Mark Smith's Industrial Technology class at Morris (IL) Community High School.

Located at the suburban edge of Chicago, Morris High attracts students looking to enter the area's booming manufacturing job market, with many planning to continue their career pursuits at a community or four-year college. Of the 60 or so students enrolled in Industrial Technology, 30 are in Smith's woodworking-oriented computer-integrated advanced manufacturing program. His classroom shop has a full complement of hand and machine tools.

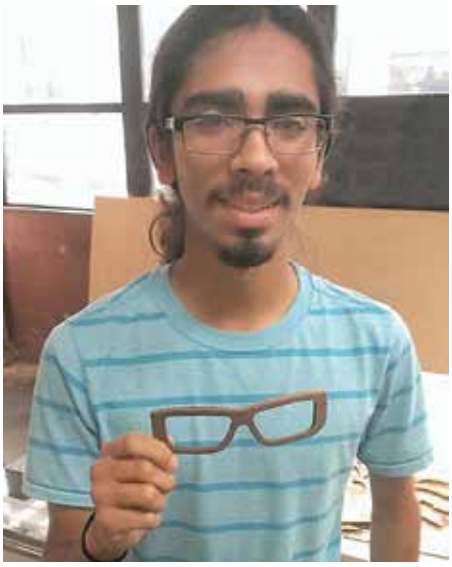


This personalized footstool was programmed in Mastercam and machined on the CNC router by a Morris student.

Smith is uniquely qualified for his position at Morris, currently completing his third year there. Previously, he taught advanced wood manufacturing at Shiloh High School in Hume, IL, then spent two years managing a CNC and shaper department in the wood products industry. He is also adjunct professor of CADD (computer-aided design and drafting) in the Technical Department at Joliet Junior College, the oldest public junior college in America. He brings to his classes both academic experience and the hands-on knowledge of the ins-and-outs of today's advanced manufacturing workplace.

Students begin the program with a course entitled Orientation to Technology. Here, they are given their first taste of everything the Morris Industrial Technology/Pre-Engineering program has to offer. They begin developing skills in record keeping, safety, material selection and handling, precision measurement, problem solving, computer design, prototyping, and finishing processes. They are given exposure to software programs like Mastercam (CNC Software, Inc., Tolland, CT) and learn to use manual equipment as well as advanced CNC equipment.

Students, usually freshmen or sophomores, are given a footstool project to gain practical experience.



Morris student Alan Alvarez holds a stylish wood sunglass frame being created for iWood Eco Design.

After cutting out the parts using manual equipment, they bring them to a Laguna CNC router to achieve the final machining. Using Mastercam to program the toolpaths for one of the 20 designs available to them for the top of the footstool, they watch the router automatically bring the design into reality, whetting their appetites for more complex projects like a long board project where they create their own design.

Once the students have become comfortable with the basics, they move on to the CADD course where they become familiar with various utilities and learn to create designs with modern CAD software. The next step is the Manufacturing 1 class, where the students use hand tools

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and small power tools to create an acoustic guitar.

Also covered in the classes are the general concepts and programming procedures using G- and M-codes, and students get hands-on experience setting up the router. Stressing the ability to apply math, science, and design concepts to complex problems, according to the Morris syllabus the classes are designed to prepare students for the world of work, advancement to a local community college, or a four-year university under the umbrella of engineering and manufacturing.

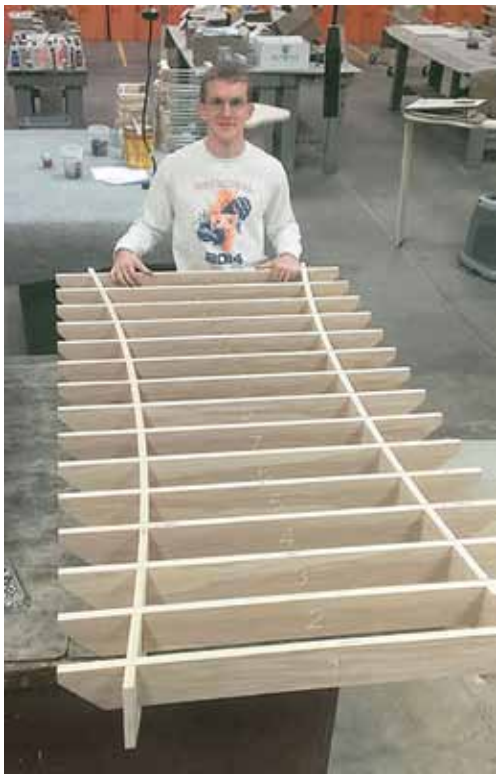
"One of the more interesting projects a student tackled at this stage," says Smith, "is a flat-pack bed frame. A series of slats force the sides out wider and wider to become a rigid frame for a single bed. It's designed to pack flat, hence the name, and no tools are required to put it together or take it apart. The frame is created as a solid first, to get all the geometry correct. Then, the toolpaths are programmed in Mastercam. A special 3D fixture is also created to hold the sides in a curved position for CNC machining on the router."

Mastercam programming software for the router includes everything needed for students to rough and finish machine their projects, including contouring, drilling, and pocketing. Students can choose multiple roughing and finishing passes and multiple depth cuts for any contour and can easily machine 2D and 3D contours including parametric splines.

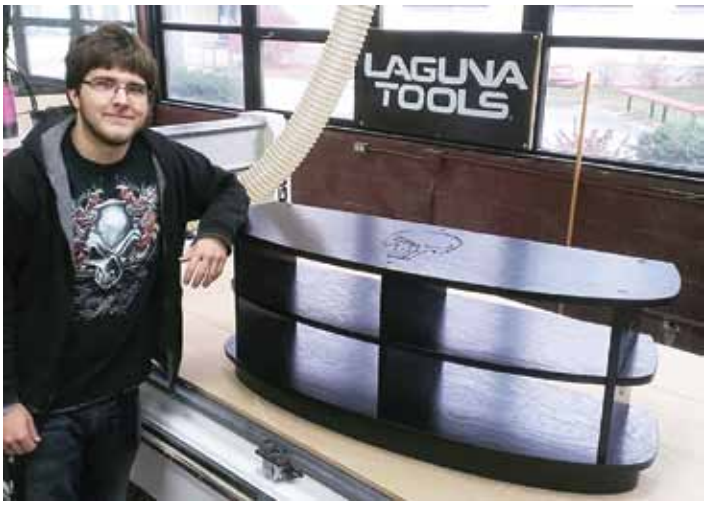
In drilling operations, the software lets students automatically identify and pre-drill multiple operations at their plunge points, while the auto drilling feature lets them create complete cycles of drilling operations on sets of holes, even with different diameters. "Mastercam software gives our students an extensive range of capabilities with the router," says Smith, "resulting in a beautiful finish to their projects and boosting their sense of accomplishment."

Students can create contours, pocket walls, and pocket islands, including islands of different heights, while smart pocket depth control for thin-walled pockets lets them machine depths without retracting or machine all cuts in a single area before moving to the next. The Dynamic Milling feature creates an active toolpath that delivers more consistent cutting conditions and allows the use of the entire tool flute.

Continuing on to their Manufacturing 2 courses, students develop additional skills in business fundamentals, teamwork, leadership, marketing, planning, organizing, and decision making while they gain knowledge in methods of joiner operations, finishing, and the selection and installation of hardware.



Morris student Austin Stacy shows off a completed flat-pack bed frame.



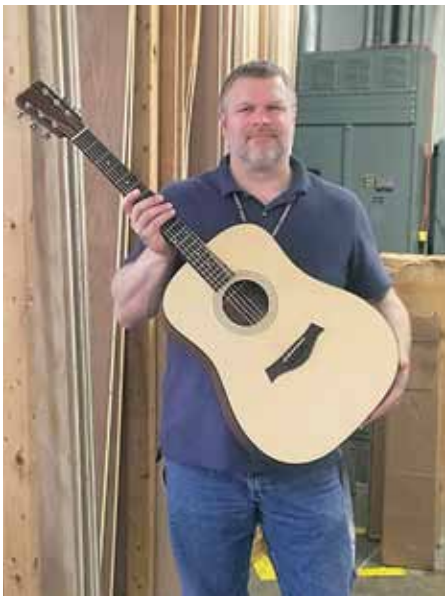
Morris student Ethan Meier shows off the entertainment center he programmed in Mastercam for the school's CNC router.

Students design, problem solve, prototype, and produce an advanced product on the CNC router. "Projects in this phase of their course of study include entertainment centers for flat-screen TVs," says Smith. "They do all the creation of additional design work and programming in Mastercam."

In Production 1 and 2 classes, students learn the concepts of corporate structure, research and development, just-in-time (JIT) mass customization, and servicing. They also expand their portfolio of work with a variety of projects.

"We are very fortunate to have a great deal of interest and support from various manufacturing companies in the community," says Smith. "For example, Laguna Tools donated the CNC router, and we continue to receive tooling, materials, adhesives, hardware, and finishes that allow for expanding the scope of projects.

"Each year, Taylor Guitars has



Industrial Technology instructor Mark Smith holds one of the many guitars created by his students using materials contributed by Taylor Guitars.

given us about $25,000 worth of guitar parts and rough lumber and the students have produced some 150 acoustic guitars in the past three years. They look and sound like professional guitars you would buy in a music store and the level of pride the students feel when they take their guitar home is 'off the charts'.

"The parts are considered 'irregular' by Taylor standards, but I have trouble finding irregularities and the students can never find them. Remember, premium guitars from Taylor can run as high as $15,000. All we have to provide are some materials such as sandpaper, glue, and finishes. Everything else comes from Taylor. The guitars are being added to the CNC program so we'll be able to use Mastercam to program the toolpaths for creating the rounded necks with the Laguna router."

Now, about those wood sunglass frames. While Smith was at Shiloh, he was approached by iWood Eco Design of Louisville, KY, to help them develop their wood-based sunglass frame line. Smith and his students started the venture with aircraft-quality quarter-inch reclaimed panel product, supplied by iWood Eco Design, that comes from luxury business jets and features exotic veneers such as ebony, teakwood, bamboo, and zebrawood.

With toolpaths for various designs programmed with Mastercam, the selected wood is cut out and edged on a CNC router, steamed to make it pliable, and formed using wooden molds made in the class. When dry, the frames are sanded and finished.

"iWood Eco Design has now come here to Morris," says Smith, "and asked that I continue the line with my students. They brought to Morris all their molds, materials, tooling, and equipment that had been at Shiloh. The students will be expanding the line with new designs, even some wood temples, to offer choices beyond their imported Italian metal temples."

In addition to supplying the wood, iWood Eco Design provides a stipend to the school for each pair of sunglasses made. Using this stipend, students can take the frames home to complete the sanding, providing them with substantial after school earning-while-learning income. After finishing, the frames are sent to Louisville to be fitted with optical-quality Carl Zeiss lenses. "These iWood Eco Design sunglasses have become pretty famous," says Smith, "with owners ranging from Bono to Oprah. Even New York models wear them on the runway. You can imagine how excited the students are to be involved in this creative process."

Morris High students in their junior and senior years are being offered internships with local manufacturing businesses. "There are hundreds of companies in the Chicago area looking for qualified employees," says Smith. "Most are using Mastercam for programming the CNC equipment on their shop floors. They are having difficulty in finding people with the programming and CNC operating skills needed to be competitive. At Morris, we're developing the talented people to help fill those positions, as well as providing a good foundation for those planning to continue their education at the college and university levels."

At Morris Community High School, the "eyes" have it, as do the skilled hands and sharpened minds!

Morris student Avery Baetzel holds a personalized skateboard she machined on the CNC router.

Sample frames, temple pieces, and fixtures for wood sunglass frames being created for iWood Eco Design by students at Morris Community High School