CNC Milling Machine Eliminates Three Weeks of Hand Carving Technodome Model

Peter McCann Architectural Models Inc. (PMAMI) saved three weeks in the production of an architectural model of the Technodome by cutting molds for the roof sections on a CNC Router instead of hand carving them. The Technodome, when it is built, will be "the world's largest and single-most technologically advanced indoor attraction ever," according to its developer. The architectural model itself was huge, the largest PMAMI has ever produced. The roof of the model was particularly challenging because there were many different roof styles. Peter McCann, president of PMAMI estimates that carving the roof molds by hand would have taken at least five weeks. With the computer-controlled method, cutting instructions for the milling machine were generated from the architect's CAD model and the roof portion of the project was completed in only two weeks. "The model was so large we had to divide it into sections and then glue them together," says McCann. "The accuracy we got with the CNC machine was so high that all the different roof pieces fit together perfectly."

The first step in creating the model was to import the architect's AutoCAD drawing into Techno's CNC Interface.

The Technodome is the dream of Abraham Reichmann, a member of the Toronto-based Reichmann family known for ambitious developments. Reichmann has been shopping his Technodome project around from city to city for nearly a decade. For a time, it looked as if it would be built in Toronto. Currently, it seems that Montreal will be its home. Wherever it ends up, the Technodome's proposed 1.2 million-square-foot space will reportedly feature several biospheres, making it possible for a patron to go white-water rafting and downhill skiing in the same visit. In addition to nature attractions, it will feature disaster rides, IMAX theatres, a 125,000-capacity sports and music arena, and massive indoor theme zones similar to those at Disney parks. The Technodome's capacity is 11 million visitors per year, and its annual budget is predicted to be $1 billion.

PMAMI got involved with the Technodome when an architect developing a concept for the facility hired PMAMI to produce an architectural model. With 12 employees, PMAMI is the largest firm of its kind in Toronto. The company has been in business since 1980, serving the model making needs of local and international architects, industrial designers, engineers, and manufacturers. Its 6,000 square foot facility in downtown Toronto features a full range of model making and presentation capabilities. Model making services include wood and plastics machining, laser cutting, prototype molding, casting, vacuum forming and fabrication. Plastics and wood are the primary materials used in the construction of models along with a wide variety of composites and unique materials. Other in-house services include computer animation, signage, graphics, and brochures. "We have made many large models, but the one of the Technodome, at a 1:200 scale, measured 22 feet long by 10 feet wide by two and a half feet tall, is the largest model we have made to date," says McCann.

Cutting 3D Parts

PMAMI used a laser cutter to fabricate the portions of the Technodome model that were 2D shapes, such as walls and floors. McCann didn't want to cut the roof pieces this way, however, because the roof was so complex. "The roof of the Technodome has many different roof styles, including a big dome," McCann says. "Breaking the roof up into hundreds of little 2D pieces and then assembling them would have been extremely difficult." The alternative was to create 3D molds of the different roof shapes and then vacuum form acrylic over the top of the molds. The acrylic pieces could then be assembled on top of the walls fairly easily.

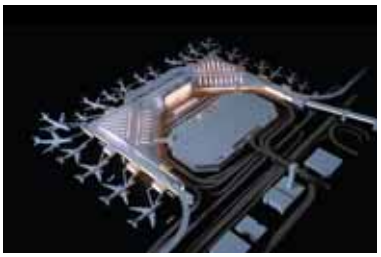
One option for producing the molds was to carve them by hand out of wood. To do this, PMAMI craftsmen would have used a band saw to rough cut the shape out of a two- to four-inch thick piece of basswood. Next they would have used a milling machine to carve more of the 3D shape. Then they would have hand-carved the details. Producing the molds this way would have taken five weeks, according to McCann. Instead he decided to look for a computer numeric controlled (CNC) machine that would be capable of producing architectural models.

McCann was aware of two options in

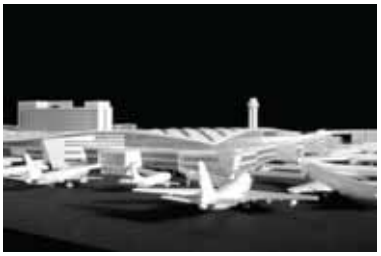
CNC equipment. The first was heavy and expensive machining centers primarily designed for metalworking. They would deliver the accuracy he needed, but the smallest machining centers start at $30,000 and machines in this price range have working areas that are too small for all but a fraction of McCann's work. A machining center with a table large enough to handle nearly all his work would cost in the $100,000 price range, considerably more than he wanted to spend. McCann ruled out most routers, on the other hand, because they could not provide the accuracy he needs. Then McCann heard about the Techno CNC router, which provides the best of both worlds. For the price of $45,000, PMAMI got a 49-inch by 40-inch working area and z-axis travel distance of 6.5 inches – large enough to produce most architectural model parts.

Another reason McCann chose the Techno machine was that even though it was one of the more affordable CNC machines, it had a number of high-end features that would allow it to produce parts with the level of the accuracy PMAMI's work required. For example, each Techno router is constructed from extruded aluminum profiles. It has four ground and hardened steel shafts and eight recirculating bearings in each axis. This shaft-and-bearing system produces very smooth, play-free motion and an extremely rigid system that produces high-quality cuts. The machine also uses antibacklash ball screws. These screws have excellent power transmission due to the rolling-ball contract between the nut and screws. This type of contact ensures low friction, low wear, and long life. The ball screws also make it possible to produce parts to the machine resolution of 0.0005 inch.

The first step in cutting the roof molds for the Technodome model was to import the architect's AutoCAD 2000 file into the CNC programming software that comes with the Techno system. Originally designed for metalworking, it is also well-suited for wood and foam because of its ability to generate the most complex contours with little programming effort. In the programming software, McCann separated the roof from the rest of the architect's model. Since it was a 3D wireframe model, he needed to add surfaces to the outline of the roof because the toolpaths would be derived from the surfaces. Next, he divided the roof into different mold shapes that could be used to form the acrylic pieces. Most molds produced multiple acrylic pieces.



A scaled model of the Technodome project.



A Techno router can help create models in various plastics, woods and composites.

Once this preliminary programming work was done, McCann gave the command to software to create the toolpaths for each of the molds. After supplying some additional information such as feed rates and cutting speeds, the system was ready to go. For each mold, a piece of Renshape, MDF, or a plaster block was placed in the Techno machine. An operator hit the "start" button and the 3D mold was carved automatically. The actual cutting took only about one hour for most of the molds. The entire process of programming the CNC machine and cutting all the roof molds took two weeks.

Accuracy and Other Benefits

In addition to saving three weeks on the construction of the roof, the use of the CNC machine gave PMAMI a level of accuracy that would have been impossible to achieve by hand. That was important in this project, which was built as 13 separate sections because of its size. When it was time to put all of the sections together, the roof pieces matched perfectly, saving the firm the rework that would have been needed otherwise. The customer was very pleased with the model, which also included a detailed interior complete with lights.

McCann has found that many projects benefit from the combination of laser cutting and CNC machining. "The laser is perfect for cutting 2D pieces, while the Techno handles the 3D pieces without the mess of cutting and sanding," McCann explains. "As we use the CNC machine more, we're finding that it really eliminates the aggravation we used to have with some of the more complicated 3D parts. We just do the programming, turn on the machine, and let it run." Having the CNC machine has also opened up new business possibilities for PMAMI, including signs and prototypes. "It makes us a lot more versatile and sets us ahead of pretty much everyone in the area," McCann adds.

On the Technodome project, the use of the Techno CNC machine generated a savings of at least three weeks in the production of the roof molds. In addition to the difference between the cutting time on the machine versus carving by hand, additional time was probably saved by the accuracy of the finished pieces. The fact that all the roof pieces fit perfectly when the model was assembled eliminated the need for rework. For complicated 3D shapes such as the roof of the Technodome, PMAMI finds the Techno CNC machine to be the perfect tool.