MACHINING

Composite Material Creates Challenges for Machining PC Board Carrier Plate

Adopting a vacuum fixturing system for machining the carrier plate was one of several key adjustments that allowed a precision machine shop to get around manufacturing obstacles.

By David Gaines

The contract manufacturer's president told the OEM that his firm had never seen—let alone worked with—the strange composite material that it was being asked to machine. Not only would the job shop have to craft the parts precisely out of a largely unknown material, but it would have to do so on a rush basis. Yet the high-tech job shop assured its client that it would not be impossible to machine the mysterious material, and its excellent track record with the OEM helped assuage any jittery nerves.

The material, the job shop was told, would be saw-cut to the proper size, thickness, and flatness for immediate use. Due to the heavy time crunch involved, the shop knew that it would need to cut every corner possible to get the material into production. Therefore, based on material size specifications, the machine shop began making workholding fixtures immediately. When the aluminum composite material arrived, it was not flat and not cut to the specified dimensions or thickness.

"We had to trash all of the fixtures we built and start over again," recalled Kent Higgins, founder and President of **Dynamac (Dynamic Machining Services, Inc.).** "At this point, with the turnaround now closer, we decided to handle the fixtures in a different manner.

We decided to purchase a vacuum pump and then manufacture plates and fixtures to initiate a complete vacuum fixturing system."

The OEM quickly recognized that innovation, creativity, and a determination to take on the hard jobs were qualities that set Dynamac apart from other less motivated shops. It felt confident that the machining company from Wood Dale, Illinois, near Chicago, would be able to machine the specialty PC board carrier plate, no matter what obstacles got in its way.

"We started working with the special composite material made of silicon and 6061-T6 aluminum to help our customer out of a bind," says Marty Keane, Dynamac's Sales Manager. "We're one of only two machine shops in the country that have been willing to work with this difficult material, since it's like machining coarse sand. It's very messy to machine and it's very hard on tooling, but we learned how to run it," he continued. "We had to make several different variations of tooling that would last longer. And, ordinarily, you can't run this dense material at a high speed, but we devised a method of running it very fast."

Keane explained that its silicon base is what makes the arcane material so difficult to run. The plastic material was constantly clogging up the firm's coolant pumps. After several bouts with clogged pumps, Dynamac installed specialized filtration systems on its pumps to keep them clean and functioning. It was also decided that a special coolant solution would work better with the material.

In order to pursue the frantic rush job, Dynamac purchased four new high-rpm, Kitamura Mycenter, CNC vertical machining centers (VMCs). With the new high-tech equipment, the company's staff were up and running on the project in five weeks. Within this time frame, the company installed the new machinery, designed and developed its own special cutting tools and the new vacuum fixturing system, and trained personnel to machine the aluminum plate.

“After the initial order of several hundred parts, we began to produce thousands of components for our customer,” Keane pointed out. “We ran the job 24 hours a day, seven days a week to complete the first order on time. Like all of our work, it was done with a team approach with all of our managers sitting down to discuss the best way to run the parts at every step of the way.”

Tight Tolerances Required to Machine Miniature Parts

Another component, a miniature connector, required both precision machining and assembly. The tiny aluminum housing required precision, high-speed machining to tolerances within +/- 0.001 inch, using an endmill only 0.045-inch in diameter. Another challenge was to machine the even smaller pieces of Torlon™ engineered plastic used as insulators. After the plastic pieces were machined, they were carefully pressed into the aluminum body. The OEM supplied Dynamac with the Swiss-turned, gold-plated, copper slugs, 0.019 inch in diameter. The slugs were encapsulated on both sides by the plastic, and had to fit inside of the aluminum housing.

“Sixty-three of these little gold-plated slugs had to fit into a particular place with a +/- 0.002-inch fit,” says Higgins. “So, not only did the parts have to be precision-machined, but we had to create a precision assembly. We started out making five prototypes, then 20 parts, then a few hundred. After each cycle we had to make new tooling and refine our methods to maintain the precision that was required.”

The OEM had its own machine shop, but didn’t want to tackle the difficult materials or the complex component that would end up consisting of 97 separate pieces. After machining the pieces of aluminum, 38 tiny pieces of Torlon™ plastic with different sizes had to be machined. Several tolerances on the aluminum workpieces had to be +/-0.002 inch and others +/-0.0005 inch. After assembly, the completed miniature component would be ¼-inch thick, and 1 inch x 1 inch.

“Developing the manufacturing for the connector was expensive for us, but we needed precision parts so we could assemble the component consistently with repeatability,”

Higgins affirmed. “Both the little slugs and the plastic pieces had to be assembled with tweezers, so it was an incredible job. We were eventually able to cut the production cycle time in half—a good cost saving for our customer. The part is eventually going to ramp up to 30 or 40,000 parts per year, so we’ve easily saved them tens of thousands of dollars already.”

Dynamac opened its doors to offer precision machining in 1989, and now has a staff of 37 people operating out of a 12,000-sq-ft plant. Its main marketplace is the electronics industry, for which it produces aluminum housings and enclosures for power amplifiers and digital attenuators, heat deflection plates for PC boards, connector and terminal housings, and fiber optic connectors. For the medical industry, the company manufactures a variety of surgical tools and other medical equipment parts.

The company’s production runs are in the medium-to-high-volume area. It finds that production runs ranging from 250 to 250,000 parts or components are the most effective. Dynamac is ISO-9000 compliant for several of its ISO-certified OEM customers. Four of its largest customers have named the company in their Top Three Supplier category for several years running.

“We are very willing to take on the hard, complex jobs,” Higgins remarked. “And we are able to work on a project 24 hours a day, seven days a week, if necessary. We’re willing to do fast turnarounds because we have both the equipment and personnel to get it finished on time without sacrificing the quality,” he added. “I don’t see most high-production shops doing the part complexity that we do; they are mostly turning out simple parts. But we can handle the complex parts very quickly.”

Non-standard Broaching for Sharp Inside Corners

Higgins speculates that most people would never use a broach in a machine tool, but Dynamac is not most people. A conventional broach tool is usually used only in a broaching machine. This innovative machine shop, however, has handled broaching cuts right in its machining centers.

“We have often been successful in accurately broaching holes non-traditionally by starting the hole first with an end mill,” Higgins states. “We’ve dealt with a number of parts that have sharp inside corners, where it would be impossible to get an end mill in there,” Higgins states. “If we need to take out a sharp inside corner, and it’s a through hole, we’ve had very good luck with creating a broach and then using it in a machine tool.”

One particular part—a fiber-optic connector—required anywhere from four to twelve rectangular holes with sharp inside corners. Since a VMC is designed to do mainly milling and drilling, Dynamac’s tooling department had to create special tooling for the broach. The company developed a unique process to first mill the holes and then broach them.

“The tool had to be completely square to the part every time, which is not easy,” says Higgins. “In this process, the spindle doesn’t come on, so we just had to crush the material out of the workpiece. Therefore, it was very hard to maintain accuracy from one hole to the next, but we persevered to complete it accurately. I know that we were able to save thousands of dollars and many hours of production time for this client by doing the broaching this way.”

Over the years, Dynamac has purchased machining equipment ideally suited for its own marketplace. Since May 2001, Higgins has bought four CNC Kitamura-Mycenter IIs and five Mycenter I machines for the electronics and connector work. The company now has 10 Kitamura VMCs in full-time operation, all of which have rotary pallet changers and pallet shuttles. Its equipment battery also includes nine other CNC VMCs, two CNC turning centers, a milling machine, a turret lathe, and an assortment of grinders, saws, and deburring equipment.

The company’s managers believe that the Mycenter VMCs are ideally suited to this type of work because the machines are strong, durable, and very fast. Higgins says that his

plant manager, Joe Kuechel, can push these machines to their fullest limits in a high-speed mode. He says that they would never push their other machining centers this hard.

“Most of our machining can be done as a primary process; consequently, we eliminate a lot of secondary processes, like deburring,” Higgins maintains. “We do this with a combination of speeds, feeds, and chamfering in the machine. A lot of the larger plastic manifolds that we do, have less burrs because we are now using through-the-tool coolant. It flushes most of the burrs and slivers out of the part. As an added precaution, we inspect parts and clean them by hand under a microscope, which is tedious, but necessary for high-precision parts.”

Even now, the firm’s managers say that very few shops are using vacuum fixturing as extensively as Dynamac is. Only 5% or 10% of shops nationwide may be using it, they say. Dynamac machines both large and small parts that require precision, from tiny parts the size of a pat of butter, to large 40-inch x 20-inch workpieces. The biggest challenge, though, are the tiny plastic parts that would not be possible without proprietary workholding devices created by the company’s toolmakers.

The company manufactures, for a connector company, one series of plastic parts that have very tight tolerances. The part has up to 6,000 tiny, 0.019-inch holes that have to be drilled very carefully. Hole diameter must be held to +/- 0.0005 inch, and depth must be held to +/- 0.001 inch.

Dynamac machines another part out of FR-4, an engineered plastic, with thickness tolerances on some areas that are +/- 0.0004 inch. Material thickness starts out as 0.030 inch and ends up 0.015 inch. Another piece of plastic is so flimsy that it seemed impossible to machine at first. The 5-inch x 5-inch, 0.030-inch-thick part flopped around crazily when the company first started to machine it. But after many fixture refinements, the firm was able to machine the delicate piece of precision plastic successfully.

“The machining marketplace is very competitive these days,” Marty Keane insists.

“Quality has to be a given, as well as a competitive price. And, yet, customer service is very important to remain competitive. You have to be willing to work closely with a customer. We do all of these things, and I believe we do them very well.”

For more from Dynamac, **circle RF312.**

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Captions:

- The machined carrier plate undergoes final inspection at Dynamac.
- Electrical connector components manufactured by Dynamac for a high-end filter connector.
- A selection of intricate precision component parts manufactured at Dynamac.