Mazak Case Study

Mercury Marine Powers Outboard Engine Manufacturing

Mercury Marine (Fond du Lac, WI), has long prided itself on its ability to live up to the reputation of its namesake, the mythical messenger of the gods. Not only does the division of Brunswick Corporation (Lake Forest, IL), produce some of the world's best-performing 2.5 to 250-hp outboard motors, it also delivers technical innovation and engineering creativity with incredible speed—no matter the demands placed on the company. As its engineers adapted quickly to restrictions on aluminum during World War II, the current generation is racing to bring some of the most sophisticated, environmentally-friendly two and four-stroke engines to market.

Its manufacturing operations are the key to the company's ability to design and deliver these new products, based on long-term relationships with capital equipment builders. This is especially true of Mazak Corp. (Florence, KY), Mercury Marine's machine tool builder of choice. Without tapping into the expertise and continuing support of outside experts, management foresaw machining technology and its deployment would become the primary constraint on the company's ability to create and deliver its innovative and market-leading OptiMax line of clean and lightweight motors.

"We realized the quality standards required for the new concepts would change the complete landscape of what we do in machining," says Leo Santini, vice president, corporate manufacturing. For this reason, in 1994, he challenged manufacturing operations to find a better way to machine and assemble engines before the new design would go into production. Under the leadership of Jeff Smith, director, manufacturing engineering, teams of Mercury Marine

engineers and machinists studied best practices in their own and other manufacturers' engine lines.

Meanwhile, Mercury sought a technologically astute machine tool builder with a proven record of building robust machines in the size range necessary for machining its blocks, heads, and gear cases. A team of personnel from all areas of manufacturing would conduct the research. It included manufacturing engineers, quality engineers, maintenance managers, and N/C programmers. Of 10 machine tool companies initially invited to discuss a partnership, Mercury dismissed half immediately because they wanted to talk about machines in their catalogs, rather than systems engineering and continuous support once the lines were in production.

"The program was going to be markedly different than the conventional approach of buying machines through competitive bidding," explains Santini. "Because the basic issue was the quality of undefined new products, the challenge was to find a builder that could provide creativity, flexibility, and partnership. We wanted a partner with a reputation for delivering significant advances in technology."

A Better Builder Stands Out

During the ensuing discussions with the remaining builders and their customers, not only did Mazak's record of introducing new machines, controllers, and tool packages impress Mercury Marine, but they also liked the builder's reputation for integrating machines into cells and systems.

"We wanted to link eight machines together into cells rather than use them as stand-alone machines," says Santini. "Besides having lots of experience in this, Mazak also was careful to allow inserting new machines into old systems. We didn't want to obsolete a system if we later decided to raise its output by installing new high-speed machines."

The sincerity and insight of Mazak's top management also went a long way toward convincing Santini that the builder was the best choice. Not only was Mazak Corp. President Brian Papke involved early in the project, but Terry Yamazaki, chairman of the parent company, Yamazaki Mazak Corp., also participated in initial discussions. "You never saw the CEOs of the other builders," notes Santini. "You saw only a sales representative, a regional sales manager, and a vice president of sales. And their emphasis was on fulfilling the order, rather than on creating a partnership."

Santini knew Papke and Yamazaki were serious about committing to a relationship because their concerns were the long-term business ramifications, not the specifications for the job at hand.

"The issue for them was: were we asking for development on a few machines or were we really serious about a long-term arrangement?" recalls Santini. The discussion revolved around why the program was important to Mercury, the amount of the company's business that would be flowing through the new machines, uptime requirements, and the manufacturer's plans for rolling out the program over a four- to five-year period.

Collaboration Boosts Flexibility and Uptime

Over four and a half years, engineers from both companies collaborated on installing five Palletech cells of seven or eight FH-680 horizontal machining centers fitted with 120-station tool magazines. The installation strategy was to develop a standard manufacturing process for the gear case, a component common to existing models and the new environmentally 'clean' engine, and prove the robustness of the concept by producing blocks and cylinder heads for models already in production. Manufacturing then was in position to begin installing a sixth cell to produce the heads and blocks.

This gave the company enormous flexibility for managing volume through all of its lines. Because the tools and programs for running the work planned for the cell are resident at each machine, each cell can produce more than one type of part in random order. In fact, one cell makes more than 30 versions of cylinder blocks and heads. The cell controller reads the tag on an incoming pallet containing a fresh casting and tells the next available machine which job to execute. Consequently, carrying large inventories to accommodate changeovers is unnecessary.

“Mercury’s philosophy is to run every model every day,” says Santini. “We don’t like a large inventory separating us from our customers.”

Juggling volume among the cells is possible, too. Any part can run in any cell if the need to reapportion production were arises. The only difference among cells is that some have seven machines instead of eight, and the machines inside the cells are the same model, configured the same. Each machine, for example, has the same 120-station tool magazine, even though none are full. “We fill 100 tool stations on some machines and 60 on others,” says Smith. “We wanted the ability to reconfigure the machines should it become necessary.”

The only adaptation necessary for preparing a cell to run a new job, therefore, is to load the appropriate tools in the machines’ tool magazines and proper programs in the cell controller and to put pallets fitted with the required fixtures in queue. The cell controller pulls the correct pallet from a ‘parking lot,’ tracks it through the cell, and parks it afterward until it is needed again.

Despite the flexibility to handle any block, head, or gear case, the first cell normally makes gear cases; the second machines both blocks and cylinder heads for various two-stroke engines. The third and fourth cells typically produce the larger engines, the third one performing the qualifying operations on the blocks and the fourth cell finishing the blocks and machining the cylinder heads. The fifth cell produces blocks for smaller four-stroke and 6 through 15-hp, two-stroke engines.

Next to the respective cells are special operations not suited for machining centers: line boring, liner pressing, cylinder boring, final deburring, and washing. The design of the lines is such that parts coming from the cell flows into the special lines.

A Successful Relationship

The results have been phenomenal for both sides. “There isn’t a Palletech cell in our plant that doesn’t have a highly favorable return on investment,” says Santini. On average, the Palletech systems take half the floor space occupied by the old machines and need only a third of the operators. For the first cell, for example, floor space collapsed to 7,800 ft^2, from 9,900 ft^2, and the number of operators shrank to 6 from 18. The company reassigned those displaced workers to other departments to help it cope with the expanding demand brought by a growing market and the competitive advantage from its deployment of technology.

So far, Mercury Marine’s outboard motor division has bought 52 machining centers for its six Palletech machining cells, which amounts to 22 more than the initial commitment of 30 machines. The count for the broader organization, however, is much higher because of the stand-alone machines and cells bought by other divisions. For example; two, five-machine cells are producing various components in a plant in Stillwater, Okla. and a number of stand-alone Mazak machines are working in another plant in Mexico.

The agreement also extends beyond Mercury Marine. When a sister division considered buying some machines from another builder, Santini convinced managers there to leverage the relationship and existing agreement with Mazak. “I told them that it covers all the service parts, service, and machine costs,” he recalls. “Upon telling Mazak that they were part of the Brunswick agreement, they were treated like family and saved a lot of money. They are better off today than they thought they would be. The companies complement one another because

their relationship is based on a philosophy of mutual respect and utilizes each company's strengths to achieve a common goal."

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