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Fit It First

Fixturing needs to be one of the first considerations when buying a new machine, not one of the last.

▶ BY BRAD LEWIS, ASSOCIATE EDITOR

Buying a new machine is exciting. It can put a gleam in a shop owner's eye, what with all the new parts he or she will be able to manufacture and the improved profits that will result from increased production capacity.

However, decisions made long before the machine is installed on the shop floor can severely restrict its performance.

One of these decisions is the type of fixturing that goes into the machine. Not only can the choice of fixturing determine the quality of the parts produced, it can also make the difference between profit and loss on a job.

Planning for Profits

In Dennis Varnau's mind, the fixture is the baseline for any application plan. As vice president of Prohold Workholding Inc., a Cincinnati-based maker of hydraulic tombstones and fixtures, Varnau has seen what happens when fixturing is given the short shrift. And, as an example of the impact proper fixturing can have on boosting production efficiency, he cited the work his company did for an auto parts manufacturer.

"We eliminated 10 machines. We got them down to six, and they produced 28 different sizes of universal-joint yokes across one tombstone. That's what shops need to do," he said.

According to Bill Tulloch, vice president of engineering for InteliTool Manufacturing Services Inc., Wickliffe, Ohio, workholding fixtures ought to draw the kind of attention the machine and the cutting tools receive.

Tulloch said that shops need to put as much thought into the fixturing for a project as there is into the machine that the shop is selecting or the cutting tools that will go on it.

"A turnkey manufacturing system is no stronger than its weakest link. I've seen shops spend $450,000 on a machine, then turn around and buy the cheapest workholder they possibly can and then wonder why they can't get a part to repeat," he explained.

Although workholders don't make chips, they have a direct impact on the profitability of a job. Therefore, it's imperative that shop owners team with fixture designers to create an optimal fixture solution.

"We've seen companies quote jobs based on getting an unreasonable amount of parts on a pallet," Tulloch said. "They quote a job with an expectation of machining eight parts per pallet, but after the fixture design is complete, they find they can only get four or six parts. Therefore, their cost per part increases, which cuts into profits."

Dedicated fixtures allow shops to get more parts per pallet while lowering tool-change and part-indexing times.

The Machine-Fixture Connection

The pallet-weight capacity of the machine tool is a particularly critical factor in respect to fixture requirements. Indeed, pallet weight can determine one of the most expensive aspects of a machine purchase—its size.

Prohold Workholding's Varnau is very familiar with the precise weight

Prohold designs fixtures with an eye toward maximizing part production. Here, a valve body is set up on a tombstone fixture.

Prohold

InteliTool offers to color its fixtures for multiple operations. Color-coding can reduce operator error.

InteliTool

capacities of major machine tools, since he must design his company's fixtures within those parameters. He said machines that have a 500mm square pallet with a pallet capacity of 1,200 lbs. are ideal from a fixturing perspective. "We can fit anything in those machines. We can easily fit our fully automated steel tombstones on them.

"Steel," Varnau added, "is better than aluminum for tombstones, both for its rigidity and longevity. We have steel tombstones out there that are 10 to 12 years old, and they are still working fine."

Working within these parameters requires knowledge of materials and a nimble imagination. "We design a lot of our fixtures for 400mm machines, but many of those machines have a very low pallet-weight-carrying capacity."

One of Prohold's solutions to the weight-capacity problem is to make the tombstone core out of aluminum, while retaining the steel faceplates.

More rigidity may be lost when aluminum faceplates are placed on the fixture. "However," Varnau said, "it's still thick enough and still pretty darn rigid."

The machine's travel capacity is another factor that determines fixture capacity, according to Varnau. Fixturing, by its nature, impinges on the work envelope within which a machine must operate. As such, he said, fixtures must fit well within the machine's X-, Y- and Z-axis travels, so the tool can reach every point on the fixtured part.

Therefore, Prohold always designs its standard workholders for the smallest envelope, Varnau said. "If you design for the smallest envelope, you can always make it larger."

To truly maximize overall productivity, Varnau consistently recommends that shops "pin down the fixturing design first before purchasing the machine." However, such an approach is often not possible because the machine is already on the floor and the fixture must be constructed to hold parts within the existing work envelope.

Going with the Flow

Two other factors critical to the success of a fixture's design are part flow rate and the part's dimensions. Varnau said that once these are known, ideal fixtures can then be designed. Morphable fixturing, or fixturing that allows quick changeovers, enables a greater number of parts to be produced on a single machine. In turn, these fixtures reduce the need for more machines on the shop floor.

Dennis Kelly, estimating manager for CityMachine Tool & Die Inc., Muncie, Ind., added that annual part-production requirements determine whether the fixturing should be manually or hydraulically actuated. Kelly said that if a shop needs to produce a million parts a year, the machining cycle, including load and unload time, can only be around 15 seconds. This would require hydraulically actuated fixtures. Whereas, if only a few hundred parts per year are needed, a manual fixture would probably be fine.

InteliTool's Tulloch said that proper engineering is critical to maintaining a profitable operation. When parts aren't flowing at a profitable rate, he said the problem is usually caused by fixturing that has been designed using improper engineering practices. "There are three planes that must be used to locate a part; this is called the 3-2-1, or 6-point, locating principle. You'd be amazed how often this principle is not adhered to," he said.

As an example, he cited an instance where a job shop had won a contract to produce engine brackets for vehicle mounts for one of the Big Three automakers. Tulloch said he could see that the blueprints had designated that the parts were to be machined in two operations. "The prints showed the points of contact for the first operation, then had machined features from the first operation set up as datums for the second operation," he said. The company, in an attempt to lower costs, wanted InteliTool to design a fixture to do the job in one operation. "We turned the job down, based on that," he said.

Tulloch said the job shop eventually found somebody who said it could be done in one operation. "They've been trying for 5 months to machine a good part, and because they need specialized tooling, their tool costs have almost doubled."

John Darling, chief engineer for Royal Machine & Tool Corp., Berlin, Conn., concurred. "Sometimes I would prefer to get the maximum number of parts and break it up into multiple operations vs. trying to do everything in one operation. Sometimes it's to your advantage to break it up. You could actually do more parts faster."

Labor Pains

Labor is the hidden factor when it

Companies that contributed to this article:

CityMachine Tool & Die Inc.
(765) 288-4431
www.citymachine.com

InteliTool Manufacturing Services Inc.
(888) 656-9537
www.intelitoolinc.com

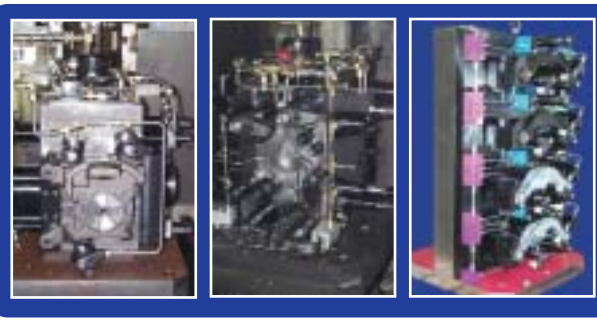
Prohold Workholding Inc.
(888) 565-7764
www.prohold.com

Royal Machine & Tool Corp.
(860) 828-6555
www.royalworkholding.com

comes to fixture design and its impact on machine tool selection. Recent advances in modular fixturing have meant operators have more time available to perform other duties while parts are being machined. Thus, the fixture's need for operator attention or, rather, its lack thereof, means that how the operator spends his time with the fixture is one more factor in considering the right fixture for a machine.

For Varnau, fixturing has to be designed to be operator-proof. "A lot of these shops have college kids running their machines. They're not really machinists. They're just loading and unloading parts."

Ideally, then, fixtures should be designed so a part will locate properly, even though it might be put in somewhat askew by an inexperienced operator. Varnau said hydraulic fixtures could be designed to not only locate the part automatically, but also provide consistent clamping forces from part to part.



IteliTool

Hydraulic clamping allows parts to be held consistently. In some cases, such fixtures can compensate for inexperienced operators.

For Tulloch, the chief consideration is what the operator is doing during his dead time. "If he does nothing more than load and unload parts, we would more likely lean toward either manual clamping or single-acting hydraulics." If he has other duties, he recommended fixtures with automated clamping.

Fixturing presents the subtlest challenge for job shops. A machine tool's fixturing generally gets the least amount of attention—until it begins to cause problems. At that point, however, the machine tool is already on the floor, making chips. Once that happens, maximizing flow rate, worker productivity and, of course, profits yields to taking what you can get.

Clearly, the most profitable path is to bring fixture designers in on the machine tool purchase planning and use their advice to obtain the most versatile and profitable machine you can.