

► BY BARBARA DONOHUE AND ALAN ROOKS, EDITORIAL DIRECTOR

Power to the Pallet?

Before shifting into palletized parts-handling systems, you need to choose manual or automatic.

For many shops, the decision to convert to pallet systems can be difficult. Pallet systems—in which jobs are set up on movable pallets instead of directly on the machine—require machinists accustomed to traditional setups to change the way they work, and some are reluctant to do so. But even after the decision is made to convert, shops face another choice: manual or automatic pallet systems.

Manual pallet systems typically cost less, are simpler to operate and are easier to retrofit to machine tools from different builders. On the other hand, systems that automatically change pallets can help automate production and enable lights-out machining—a key advantage as shops attempt to lower production costs to compete more effectively.

Decreased Downtime

Both manual and automatic pallet systems can decrease spindle downtime. Additional pallets of parts can be set up while one pallet of parts is being machined. Also, after a pallet is set up and documented, subsequent setups go faster.

A basic system consists of a rectangular aluminum pallet and a receiver. The receiver is fixed to the machine table.

The pallet slides onto the receiver, which locates it in a precisely repeatable location and firmly clamps it mechanically, hydraulically or pneumatically. A manual pallet system may also include a structure to hold and help move the pallets into and out of the machine. An automatic system includes a mechanism that changes pallets.

Users purchase extra pallets and modify them

to fit their needs.



A Midaco automated pallet system uses pneumatic clamping and clears chips from the contact pads with a blast of air when moving a pallet into place. This pallet system has its own controller, which automatically responds to the machining center's request for a pallet change. Midaco produces systems with pallet sizes from 10"x12" to 29"x120".



The M4020FL manual pallet system from Midaco includes a pneumatic receiver with air blast to remove chips, two 40"x20" pallets and a front-loading pallet shuttle.

as needed to hold the parts being machined. One or more vises can be fastened to a pallet; toe clamps and various fixtures can also be used to hold parts in place.

A Vote for Automatic

Mack Tool & Engineering, a South Bend, Ind., job shop that specializes in medical and aerospace parts, has opted for automatic. The shop has replaced nearly all of its machine tools with Mazak units grouped in cells served by dedicated Mazak Pallettech automatic pallet systems. Mack operates four Mazak PFH4800 machines (each with a 120-tool capacity) in a 26-pallet pool, and by the end of March will have installed three Mazak 5-axis Variaxis 630 machines in a 35-pallet pool. A fourth Variaxis 630 will be added to the new manufacturing cell this fall. Mazak Pallettech palletized machining systems are operated from a separate computer called a cell controller. They can serve one machining center with a few pallets or up to eight machines with 100 pallets.

After the second automatic pallet system installation is completed, all of Mack Tool & Engineering's machining centers will be serviced by pallet



A Steel Craft pallet loaded with six substrates installed in Haas VF-0 at Ceramics Process Systems. Spring-loaded pins hold the parts as they undergo only light machining.

systems except for two stand-alone vertical machines used to produce fixturing for the palleting systems. Mack will also perform a small amount of secondary milling on a Haas Mini Mill with a rotary table.

Mack chose automatic pallet systems to tackle more complex jobs and perform unattended machining, said Paul Hartz, vice president of engineering and finance. To continue growing, the shop needs to do more lights-out machining. It is starting that process by running lights out on parts from low-cost materials as well as jobs on which the shop has a history so it can predict tool life and possible pitfalls.

Like other shops, Mack has seen its pallet system improve spindle uptime. "On complex parts, the machines used to be idle while the part was undergoing first-article inspection," said Hartz. "Now, we just change pallets and run something else while we wait for first-article inspection to be done. We can also run jobs during the day that have been set up on the night shift."

Results have been impressive. Spindle uptime increased 300 percent on the machines equipped with the first pallet system. This kind of efficiency did not come cheap, however. Mack paid \$350,000 for the Pallettech system that originally came with 20 pallets and serves the cell of PFH4800 machines, and \$500,000 for the Pallettech system that originally came with

28 pallets and will serve the Variaxis 630 cell.

Mack uses 400mm pallets (each with a maximum size of 15"×15"×24") for the PFH4800 cell and will use 500mm pallets (each with a maximum size of 20"×20"×28") for the Variaxis 630 cell.

Using pallet systems gives the shop a great deal of flexibility. Hartz said: "All jobs are scheduled independ-

ently, and you can end up running several jobs at the same time. This is where you get into flexible manufacturing. You can run what you want, when you want, without added setup time. You can produce one piece as efficiently as you can 100."

Another advantage of using automatic pallet systems, said Hartz, is that all work must be thoroughly documented. This compels operators to have the manufacturing system under control—including computer programs, tooling, fixturing and raw stock. The cell controller runs off a database, and to operate the pallet system an operator must create a part number, add operations for producing that part, put those parts on a tombstone and schedule them—all from the database. "If you are going to be running a lot of parts, you have to take a very disciplined approach," said Hartz.

Converting to a pallet system takes time, though. "We're still learning



Ceramics Process Systems Manufacturing Manager Mike Boucher installs a manual pallet loaded with parts into a Haas VF-0.

The following companies contributed to this report:

Ceramics Process Systems Corp.
(508) 222-0614
www.alsic.com

Mack Tool & Engineering
(574) 233-8424
www.macktool.com

Mazak Corp.
(859) 342-1700
www.mazakusa.com

Midaco Corp.
(847) 593-8420
www.midaco-corp.com

Steel Craft Manufacturing Inc.
(800) 891-2525
www.steelcraftmfg.com

—it's a continuous improvement process," Hartz said. "As we work with the system, we're able to add more parts to a pallet, use the pallets more efficiently and move away from using traditional fixtures with vises."

Another way to do lights-out machining with a lower investment cost is to use two automatic, dual-pallet systems with a single machining center, with one on the right side of the machine and one on the left, said Mike Cayley Jr., vice president of manufacturing at Midaco Corp., Elk Grove Village, Ill. The controller can change pallets first from the right-side system, and when the right-side pallets are done, run the pallets from the left-side system. This arrangement can run lights out for an overnight shift. Midaco manufactures both servodriven automatic and manual pallet systems.

The Case for Manual

Steel Craft Manufacturing, Hopewell, Va., is a contract manufacturer that also makes the Steel Craft manual pallet system. "I first designed this system for my own shop out of sheer necessity," said Ronald Flournoy, president. "I got into production machining in the early '90s and went from a job shop of six or seven machinists to a contract shop with 15 to 16 machinists with six machining centers producing about 400,000 parts a year. We were spending way too much time setting up and couldn't keep the flow going at all because we had to stop production jobs to do smaller jobs." The manual pallet system he developed solved these problems.

According to Flournoy, the two most important advantages of a manual pallet system over an automatic system are lower cost and the ability to use them on machine tools from different manufacturers.

"If you're looking at an aftermarket automatic pallet system tied into one machine, it will cost \$30,000 to \$40,000. If you're looking to add an automatic pallet system as a factory option for a new \$120,000 machine, you will spend at least \$50,000 to \$60,000," he said. The manual pallet system that Steel Craft manufactures costs \$7,995, including two aluminum

pallets, and can be custom fitted to machine tools from different manufacturers. Additional pallets are \$795.

The Steel Craft pallet system includes a receiver that uses locating pins and an eccentric cam locking mechanism to align and retain the pallet. The pallets measure 22"×16", a size that by Flournoy's estimate "fits 95 percent of everything that's machined," and fits into even the smallest entry level vertical machining centers.

Smaller automatic pallet systems need not be as expensive as the Mazak system installed by Mack Tool. Midaco offers automatic pallet systems starting at \$23,900. The company's manual systems start at \$12,500.

Best of Both Worlds?

Ceramics Process Systems (CPS), Chartley, Mass., uses both manual and automatic pallet systems for different applications. The company designs and manufactures metal matrix composite components, using aluminum silicon carbide (AlSiC) and other composites. The company specializes in thermal management materials and electronic packaging designs and products for the microelectronics and power electronics industries.

Manual pallet systems from Steel Craft are installed on seven of the company's machining centers. The AlSiC process starts with a preform of silicon carbide that has clearance holes and open areas where the part will later be machined. The preform is placed in a casting mold and then infiltrated with molten aluminum, which fills in the holes and spaces. The parts are then mounted on pallets and machined.

CPS has been using a manual pallet system for about 8 years, said Mike Boucher, production manager. "The nicest thing about the pallet system is the setup time," he said, noting that in a previous job he found setup using a vise could take an hour or an hour and a half. The same job with a pallet takes about 5 minutes, he said. Swapping out pallets usually takes less than a minute.

One of his pallets holds 18 electronics substrates. It takes 15 minutes to machine them and 5 minutes to unload the pallet and then load another pallet with parts ready for machining.

CPS also uses an integrated, eight-station automatic pallet system that it purchased as a package with a Mikron machining center.



A typical fixture setup on a Steel Craft pallet. This setup shows two sets of fixtures for two different parts. For economy, a single pallet can be set up for multiple parts.

CPS's orders range from 1 to 50,000 pieces, and the company typically uses the automatic pallet system for orders of 50 or more pieces. "This allows the operator to concentrate on loading the pallets, checking that the tooling is correct and doing inspection while the machine is in production," said Boucher. The company's goal is to move into lights-out machining this year using the automated system.

However, CPS's manual Steel Craft pallet systems work better for orders of under 50 pieces. "The manual systems are repeatable and accurate to 0.0002," said Boucher. "We can pull different pallet setups in and out very quickly. We have some manual pallets set up with two vises and others with four vises, subpallets, angle plates or vacuum chucks."

Boucher noted that all new jobs begin as product development projects, and CPS machines a large number of 10- and 20-piece orders for new jobs. By using manual pallet systems, it can put any fixturing it needs on the machines within seconds.

Payback Time

For a small shop, a \$30,000

automatic or even a \$7,000 manual pallet system may seem like an expensive addition. However, because a pallet system can increase spindle uptime, it can pay back quickly.

For example, if machine time is \$75/hour and setting up a job with a pallet system takes 15 minutes instead of 75 minutes, every time a new job starts, the pallet system adds an hour of spindle uptime. Even if there is only one setup per day, a \$7,000 sys-

tem could pay for itself in about 3 months. An automatic pallet system on a faster machine with more frequent job setups could also pay for itself in short order.

If pallet systems can improve productivity, shops should consider them, said Steel Craft's Flournoy. "We are working in a business where we are charging not by the hour anymore, but by the minute. If you are spending 20 to 30 percent of your day setting up

machines, you are only making money 70 percent of the time. It's a waste of machine time to have jobs being torn down and set back up on a machine. If the majority of your work is done in a vise, why not set up offline and use the machines to do machining?" Δ

About the Co-Author

Barbara Donohue is a freelance writer and mechanical engineer. Contact her at bdonohue@alum.mit.edu.