Job Shop Automation: Fast, Simple and Agile

The right type of automation delivers substantial benefits for job shops. The capability to increase spindle utilization and boost output of both people and machines is the most obvious, but improved part accuracy and consistency, reductions in human error and the potential for lights out production – all of which positively affect a shop's bottom line – should not be overlooked.

Automation options run the gamut – from simple to complex and pre-engineered to custom. Because job shops frequently produce parts in smaller and more varied job lot sizes than do larger manufacturers, these often-smaller shops face different challenges, the main one being higher amounts of job changeovers. With this factor in mind, automation best suited for job shop needs will not only emphasize fast and easy setups and reduce job changeover times to 15 minutes or less, but also be adaptable for use from one type of machine to the next.

As a single source provider for automation solutions, Mazak has installed countless systems that help job shops gain a competitive advantage. This extensive experience has resulted in a thorough and reliable process that ensures design and implementation of the right automation solution to meet each shop's specific needs.

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THE AUTOMATION PROCESS

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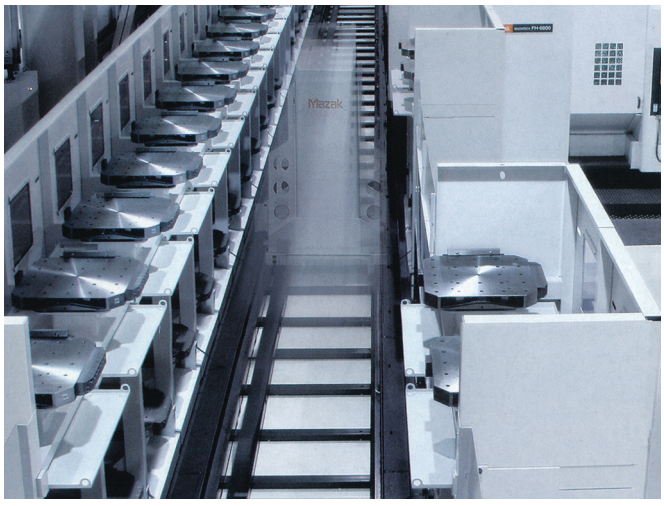
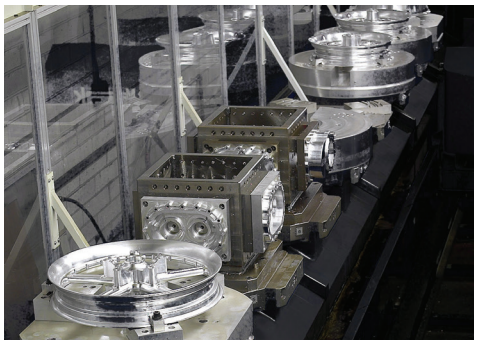
Any successful change initiative begins with several common practices: setting specific goals, thorough planning and designating a project leader. When it comes to implementing automation into a job shop, there are also several common goals. These are to reduce changeover times, economize storage space and reduce human error; maximize efficiency without increasing manpower; increase production capabilities through unmanned operations; and to enable one operator to simultaneously manage multiple machines.

Ideally, shops should plan for automation at the time of machine tool acquisitions. Machines equipped and configured for automation early on can save time and the cost of retrofitting after the fact. Such automation preparedness can include automatic doors, built-in robot interfaces and any other necessary options such as larger tooling capacities and special workholding systems. Or, if future automation needs are uncertain, shops can opt for machines that make adding automation as easy and inexpensive as possible.

Another critical, yet often overlooked part of successful automation planning is the designation of an automated system or cell “champion.” This in-house individual will attend all OEM training sessions and is responsible for any system part additions or changes in terms of new programs and/or setups.

Once a job shop has set its specific goals, determined it is automation ready and has chosen a champion, the shop must then conduct thorough analysis of every aspect of all the individual jobs involved.





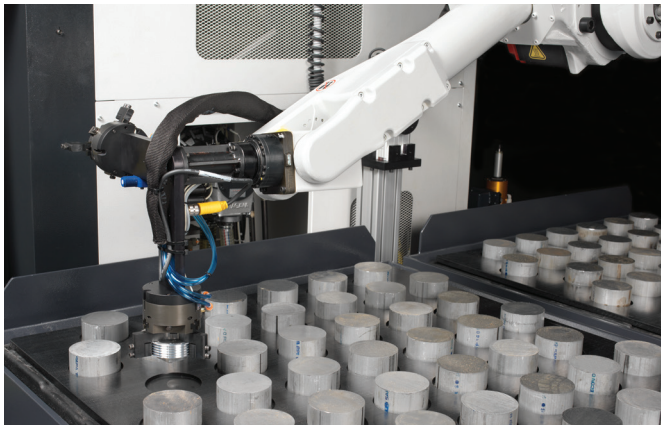
WORKPIECES

As a key factor in the automation process, shops must first evaluate workpiece weight and variation and job batch/lot sizes to determine ideal jobs to automate. For instance, jobs that involve small batch sizes of very different part numbers are inefficient and costly in terms of automation. Conversely, high-volume-per-year jobs produced in low-to-medium-volume re-occurring batches at scheduled intervals are ideal candidates for automation, especially when there is little variation in terms of part size, processes and features. Such jobs require fewer job changeovers and have workflows that permit automated cells to run and produce as long as possible between necessary job changeovers.

Automating for large workpieces requires careful consideration as to how those parts will be presented when loaded and unloaded from a machine tool. Shops must also determine what type of end of arm tooling on articulated or gantry robots will be most efficient for the larger parts.

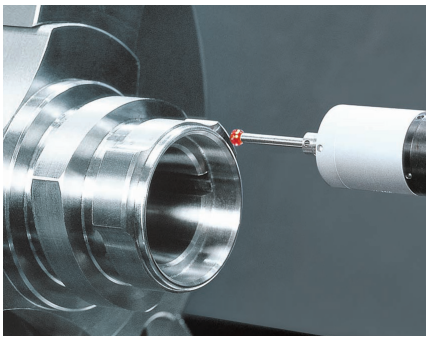
Simple fixturing can eliminate having to maneuver big parts into complex setups. In these types of production scenarios, shops should avoid multiple sequencing where parts are clamped and unclamped numerous times during processing.

To maximize automation utilization and help justify its cost also requires careful consideration of how machining cycle times effect up and downstream processes. For instance, when machining large parts with longer machining times, shops can integrate a robot to perform other tasks within peripheral processes while parts are being machined. This may require the robot to ride on rails or travel overhead to serve those other processes and pieces of equipment, or be positioned to tend several of the same types of machine tools running similar parts.



WORKHOLDING

There are many workholding situations to consider when planning automation. The physical positioning of the workpiece on the queue table or infeed conveyor prior to loading or during the loading process are common functions automated to increase speed and accuracy. If the workpiece requires positioning in the chuck or fixture in a particular attitude or needs to be aligned in the secondary operation based on features created in the first operation, vision systems or touch probes may be required to complete the task. Workholding solutions must also be designed to allow for proper clearance between end-of arm tooling and clamps when loading and unloading.



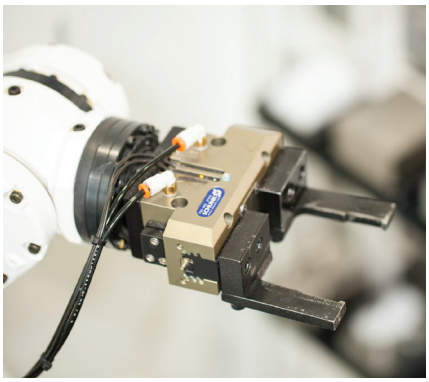
Example of touch probe

OTHER KEY AUTOMATION CONSIDERATIONS

Gauging: If an unautomated process requires the operator to measure the workpiece during or after machining, automating the gauging process should be considered. There are several in-process or post-process options including touch probes, periodic artifact calibration or even use of a post-process gauge or coordinate measuring machine.

Cycle times: When considering whether or not to automate a process, cycle times will determine the capacity/size of the queue tables and infeed/outfeed conveyors for finished work pieces. Cycle times will also be key in sequencing coordination of additional tasks required of the robot/automation such as loading to gages, coordinating measuring machines, wash stations, turn over stations or simply managing/arranging incoming and outgoing materials on pallets.

Unattended process: Job shops seeking to run unattended or lights out must ensure machine reservoirs for grease/oil lubrication and coolants are of sufficient capacity to last the duration of the unattended cycle. Likewise, chip evacuations and capacity to contain chips must be large enough to eliminate the need for human intervention throughout the entire unattended cycle. Another important precaution is to set spindle and axis overload detection to force the machine into an e-stop mode or alarm state to avoid potential for catastrophic results such as damage to the machine or scrap of expensive material or workpieces.



Tooling: Unattended automated processes necessitate excellent tool life management including predictive tool life and often redundant tooling. This is particularly true when machining hard materials such as hi-temp alloys or hardened steels.

End of arm tooling: Frequently, end of arm tooling needs vary from one operation to the next requiring the tooling to be changed over during part production. End of arm tooling solutions can be designed using workpiece drawings, material dimensions and weights, sample castings or forgings.

Safety: A safety review should take place before, during and after the automation implementation project is compete and must comply with ANSI / RAI R1506 2012 risk assessment. To secure a safe work area may require the addition of light curtains or fencing.

Monitoring: While automated operations may eliminate the need for a dedicated machine operator, they still require monitoring. Advanced connectivity, such as through MTConnect®, provides the capability to remotely monitor the system as well as trouble shoot and diagnose problems.

PRE-ENGINEERED AND CUSTOMIZED AUTOMATION

Job shops have many automation options to achieve their goals. Solutions range from pre-engineered to customized systems that are scalable in size, cost and capability.

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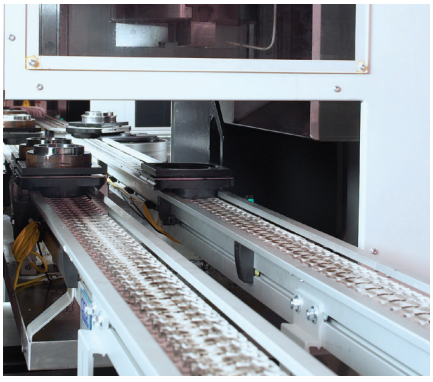
Pre-Engineered Solutions cover a broad range of process requirements and can enable a job shop to quickly increase productivity and improve the bottom line. Such systems include bar feeders, gantry loaders multiple pallet systems. While on the other hand, shops with more sophisticated needs such as automating multiple machines, part transfers to peripheral operations, or the handling of large, heavy or cumbersome parts can benefit from customized solutions such as articulated robots.

- **Bar Feeders** are one of the simplest, most cost-effective forms of automation available, and are used to automate the loading and feeding of bar material into a CNC lathe with built-up area required.
- **Gantry Loaders** provide fast, high-production loading and unloading during chuck and shaft work. The systems are easy to install and operate, and provide a quick, turnkey solution that helps shops immediately increase productivity.
- **Mazak's Multi-Pallet Pool (MPP) System** is a compact multiple pallet stocker system ideal for manufacturers who require basic automation to increase productivity and/or have limited floor space that prevents installation of a system with a horizontal pallet stocker. It's an expandable system that allows shops to initially incorporate the stocker with a few pallets and grow the system as production needs change.



Example of bar feeder

Example of MPP System

Example of PALLETECH

- **PALLETECH** from Mazak is a modular system available in single, double and triple level pallet stocker configurations. It is compatible with a range of horizontal machining centers, Multi-Tasking machines and ORBITEC 20 machining centers and is well-suited for high-mix, low-volume production as well as high-volume operations common in job shops.
- **Smooth PMC** is schedule operation software for Mazak Flexible Manufacturing Systems (FMS) that predicts necessary tools and production output according to the production schedule. Information is displayed in a variety of graphs that enable easy utilization analysis.
- **Articulated robots** use rotary joints – ranging from simple 2-joint robots to complex 10-joint robots – to complete tasks and gain a competitive advantage.

SUMMARY

When it comes to automation, machine tool OEMs, such as Mazak, realize that one size does not fit all – especially in the case of smaller job shops – and continue to develop scalable automation systems. Such systems are pre-engineered or customized and scalable in size, cost and capability. With the right automation solution, job shops can realize the benefits of increased output of both machines and existing labor force to essentially do more with less.

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