

DIE/MOLD AUTOMATION:

**RETOOL YOUR BUSINESS
PROCESSES TO IMPROVE
PRODUCTIVITY**

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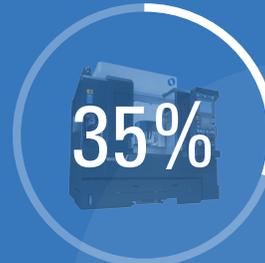
As the manager of Makino's VMC and EDM turnkey and automation proposals, John Bradford brings decades of experience in the development and implementation of complex automation systems for the tool, die and mold market. His nearly three decades of experience in manufacturing includes a diverse background of roles from being a toolmaker to leading Makino's micromachining research and development team.

DIE/MOLD AUTOMATION: RETOOL YOUR BUSINESS PROCESSES TO IMPROVE PRODUCTIVITY

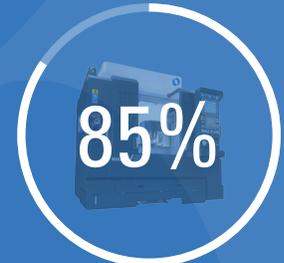
Common practice and misconceptions can lead mold, tool and die owners to conclude that automation offers few benefits to their businesses due to the demands for tight tolerances and one-off or small runs of complex 3-D shapes. In today's competitive global marketplace, with pressures to improve quality and pricing without increasing investment in machines or labor, the time is right to consider taking a production approach.

Tool, die and mold shops add automation when they need to achieve these goals:

- Add capacity
- Improve machine utilization rates
- Increase throughput without adding capital or labor
- Reduce operating and product costs
- Improve quality and reduce scrap
- Compensate for skilled-labor shortage



STAND-ALONE MACHINES
UTILIZATION RATES



ADD AUTOMATION TO ACHIEVE
UTILIZATION RATES

IN AN INDUSTRY IN WHICH SHOPS WITH STAND-ALONE MACHINES TYPICALLY ACHIEVE UTILIZATION RATES AROUND 30 TO 35 PERCENT, IT'S POSSIBLE FOR MOLD, TOOL AND DIE SHOPS THAT ADD AUTOMATION TO ACHIEVE UTILIZATION RATES APPROACHING 85 PERCENT, THROUGH PLANNING, SCHEDULING AND MANAGEMENT. THIS WHITE PAPER EXPLORES THE FOLLOWING ISSUES TO CONSIDER:

IS AUTOMATION RIGHT FOR YOUR MOLD, TOOL OR DIE BUSINESS?

The low-volume, high-mix nature of the mold, tool and die industry leads many shop owners to believe their businesses are not good candidates for automation. In fact, it's just the opposite. Mold, tool and die shops can realize significant gains in productivity and lower costs by adding processes that use the same pallets, grippers and planning techniques for moving jobs through an automated machining cell. Setup can be streamlined by using standard fixtures and pallets. Since the robot gripper is essentially moving a pallet, instead of a discreet part, the use of a pallet of standard size makes it possible for multiple workpieces of different sizes to be run through an automated cell and increases the opportunities for unmanned or lights-out manufacturing.

GOOD CANDIDATES FOR AUTOMATION



START WITH SMALL PARTS

Shops can standardize pallets by identifying the size needed for 80 percent of their jobs. Shops achieve the best results when they automate the smallest workpieces first.



PICK JOBS WITH SHORT CYCLE TIMES

Focus on workpieces where the cycle time is hours, not days, to get greatest benefit of automation. Cycle times also provide insights into how much automation equipment is needed. If a shop wants to run unattended for 24 hours and the workpieces run an hour each, then the shop would need 24 pallet locations. Cycle time combined with how long the shop wants to run unattended drives automation considerations early on.



TARGET MOST-VALUABLE MACHINES

When a shop needs to add capacity, look past the least sophisticated machines on the floor and go straight to the highest-value machines. Generally, the biggest payback comes from automating the setup and movement of jobs through a cell to the most capable milling machines and/or electrical discharge machines (EDM).



SKIP HIGH-COMPLEXITY TASKS

Evaluate whether complex human decisions or tactile interaction are required. Jobs that require wire EDM slug management, deburring, polishing and assembly are the most costly to automate, and the return on investment is longer. If the answer is yes, look for simpler jobs, especially for your shop's first automation project.

IS AUTOMATION RIGHT FOR YOUR MOLD, TOOL OR DIE BUSINESS?

WHAT LEVELS OF AUTOMATION ARE AVAILABLE?

BASIC/STAND-ALONE MACHINE

- Unmanned machining frees up operators for other jobs, and production can be scheduled during off-hours.
- Automatic tool changers (ATC) add the first level of automation.
- Pallet changers are another introductory step.
- Backup or spare tools can be easily implemented.



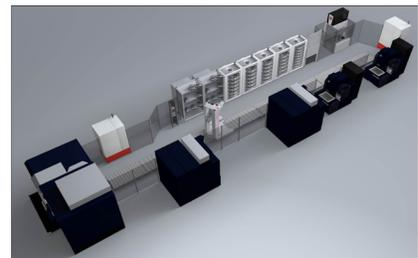
SINGLE OR MULTIPLE MACHINE CELLS

- Robots load and unload pallets.
- Two or more machines share automatic work changers (AWC) to significantly improve productivity.



COMPLEX MACHINING CELLS

- Cells may include a wide variety of machining centers and other equipment, including milling machines, EDMs and coordinate-measure machines (CMM).
- Linear setup of machines enables a robot to efficiently travel along a rail to deliver workpieces.
- Centralized software controls all functions in the cell, including presetting, loading, scheduling, machining, measurement/verification, washing and drying.



HOW SHOULD YOU PREPARE FOR AUTOMATION?

There are six steps to take now to get your mold, tool and die shop ready to add automation. Here's what companies that successfully adopt a more production-oriented approach have done:

1



Identify and consult with an experienced equipment and engineering services supplier to discuss your system and the appropriate solution. The right supplier should provide not only consultation on equipment needs but also engineering support for process optimization.

2



Standardize pallets and zero-point work-holding fixtures. This step is critical to enable your shop to run workpieces of different sizes in one cell.

3



Use your current automated tool changer (ATC). Become accustomed to using your ATC for unattended operation, if you have not already. Set up your tool magazines with redundant tooling, and make sure your operators are confident in using and relying upon current machine and control functions that facilitate automatic operations.

4



Purchase machines with robotic and automation capabilities enabled at the factory before delivery. An experienced supplier should be capable of advising you on features that your new equipment should have:

- A. Air through tables on 5-axis mills for supporting automatic table chucks
- B. Robot interface (cables, software)
- C. Robot doors (shutters) and machining center cabinets located to allow access for the robot
- D. Operator panels and controls located to allow for movement of the robot and access for operators

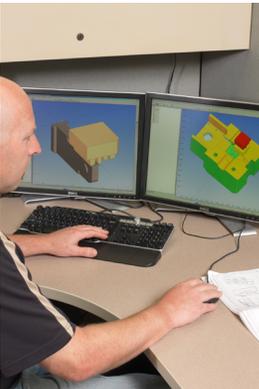
5



If you're not already doing this, implement the practice of setting up workpieces off the machine to improve utilization rates.

- A. Learn to trust your tooling system to provide the location, alignment and repeatability of the pickup of parts on and off the machine.
- B. Establish a system to register and transfer electronic information about each workpiece and electrode offset. Move away from manual input of this setup data.

6



Program all machines (especially sinker EDM) offline to enhance machine uptime and to reinforce the practice of creating NC programs and performing toolpath simulation away from the physical machine tool.

ENGINEERING AND SUPPORT CONSIDERATIONS

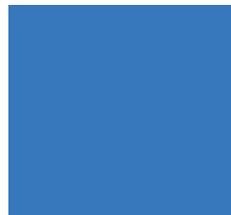
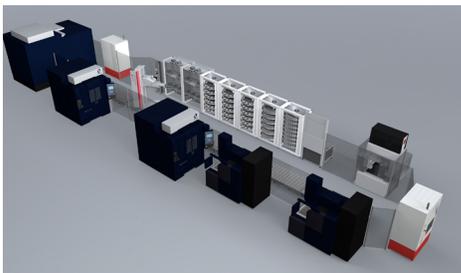
Die/mold automation is not a project to take on without an experienced, credible automation partner who can educate and guide you. Selecting the right suppliers and integration partners is critical, and it can determine how smoothly projects proceed. A single-source supplier should be able to handle all aspects of the project, enabling the company to focus its attention on larger objectives—such as the next customer opportunity, internal continuous improvement processes or optimizing business continuity.

Expect your machine, automation and engineering supplier to help you avoid the risks and pitfalls inherent in the purchase and implementation of automation equipment and software. Knowledgeable consultants and suppliers can apply what they've learned from previous automation projects to help you meet the unique requirements of your die/mold business and your customers.

You should expect your automation partner to provide overall leadership throughout your project in the following ways:

- Layout and proposal engineering
- Project management, site supervision
- Operator training, runoff, debug
- Cell upgrades / redeployment
- Software maintenance, support, documentation

Manufacturers should evaluate whether or not all automation components can be purchased from one supplier, or if, for example, a robot will need to be obtained from one partner, and conveyor systems from another. A single-source supplier who has knowledge of third-party equipment can provide recommendations for the entire system, streamlining the purchasing process.



PROCESS CONTROL

When is predictability critical? When part quantity is low, the value of the parts is quite high and the tolerances required are small.

If you want your mold, tool and die shop to successfully compete for new business, automation can provide significant advantage, but you must adopt more systematic approaches to produce predictable workpieces at lower cost. Here are the four key areas on which you should focus:

1 STANDARDIZATION	2 STABILITY	3 PREDICTABILITY	4 REPEATABILITY
<ul style="list-style-type: none"> • Common tooling and pallets • Consistent process flow • Process planning • Fixture/workpiece design • Material preparation • Presetting • Tooling selection • Programming • Machining order • Scheduling • Simulation/verification/inspection • Periodic audits of performance 	<p>Understand the variability of your process:</p> <ul style="list-style-type: none"> • Shop conditions and ambient temperature • Machine-tool drift, thermal changes • Tooling quality • Cutting-tool deflection • Machining process • Ability to repeat a measurement or set of measurements (Gage R and R) 	<ul style="list-style-type: none"> • How closely can your shop meet target objectives the first time? • How accurate are process variables (e.g., feeds, speeds, cutting tools)? • How reliable is the performance of your tooling assemblies? • How accurately will your machine tool position? • How can your process input benefit from experienced applications support and software (e.g., FFCam and EDCam)? 	<p>How closely can your shop replicate previous tasks or machining operations? To answer this question, consider:</p> <ul style="list-style-type: none"> • Machine stability/tooling performance • Process stability (random process = random result) • Ability to repeat a measurement or set of measurements (Gage R and R) • Is my shop's process accurate, repeatable, or both? • Can my shop repeat this capability in a fully automated manner?

IS MY PROCESS ACCURATE, REPEATABLE, OR BOTH?

LOW ACCURACY HIGH REPEATABILITY	HIGH ACCURACY HIGH REPEATABILITY	HIGH ACCURACY LOW REPEATABILITY	LOW ACCURACY LOW REPEATABILITY
INITIAL MACHINE THERMAL DRIFT, STABILIZED AFTER WARM-UP/STABLE MACHINING PROCESS	STABLE MACHINING PROCESS (IDEAL)	SMALL MACHINE DRIFT AND SLIGHT PROCESS INSTABILITY, OR STABLE MACHINE BUT HIGH PROCESS INSTABILITY	LOW MACHINE STABILITY, POOR PROCESS STABILITY

COMMONLY OVERLOOKED FACTORS

Owners of shops producing expensive die/mold cavities and cores are typically hesitant to use untested cutting processes because the number of workpieces available is generally quite low. There might be one practice piece to help dial-in a process. More often than not, no practice workpieces exist. Properly implemented automation can help lower such risks by using proven machining strategies and by standardizing the alignment and location in process and after process.

Die/mold production with this approach can become so reliable that shops that implemented it have achieved 8,000 hours of production time per machine, much of it unattended. No mold, tool and die shop can reach that level, however, unless owners are willing to do presetting and process modeling.

PRESETTING



All part setup, mounting, fixturing, alignment and location must be performed away from the machine tool. Doing so eliminates parasitic time typically required to perform on-machine probing.

If a high-quality CMM is used for presetting, this device can also be used for in-process verification and control measurements. Many metrology operations can be integrated into an automation environment.

VERIFICATION

Verification is being able to model or visualize the physical movement of a machine tool or cutting device relative to a workpiece and the fixtures in motion inside the machine tool. To reduce risk, model all of the motions, and anticipate fixture and clamp clearance, table rotation and overhang length of cutting tools relative to the tool holders. This step enables mold, tool and die shop owners to understand as deeply as possible and to anticipate and prevent any problems that might stop the automation or the automated operation. Importantly, verification accomplished by modeling protects your capital investment in machines and the dies and molds as well by preventing costly collisions.

In-process inspection and post-process measurement provides important elements of feedback, which trigger process-critical decisions. Coordinate-measure machines can be used for this, along with on-machine tool measurement probes.



CONCLUSIONS

To compete in today's global die/mold market, automation is essential to reduce costs and increase capacity. Automation fundamentally changes the way mold, tool and die shops do business:

- Operators confirm before cutting begins, that required design tolerances can be achieved while protecting capital investment, not only in the machine tool but also in the expensive workpiece.

- Presetting and verification of the movements of the cutting tools create processes that die/mold operators can trust to produce predictable, high-quality workpieces.

Automation programs are low risk and profitable when mold, tool and die shop owners leverage the experiences of an equipment and engineering partner who can be the single source for the complex integration and implementation work.

RESOURCES

VISIT US ON THE WEB:

READ TRUE STORIES FROM REAL-WORLD DIE/MOLD MANUFACTURERS

WATCH THESE ONLINE SEMINARS

7680 Innovation Way
Mason, Ohio 45040-8003
800.552.3288