



THE DEFINITIVE GUIDE TO
**PRODUCTIVITY IN
THE JOB SHOP**

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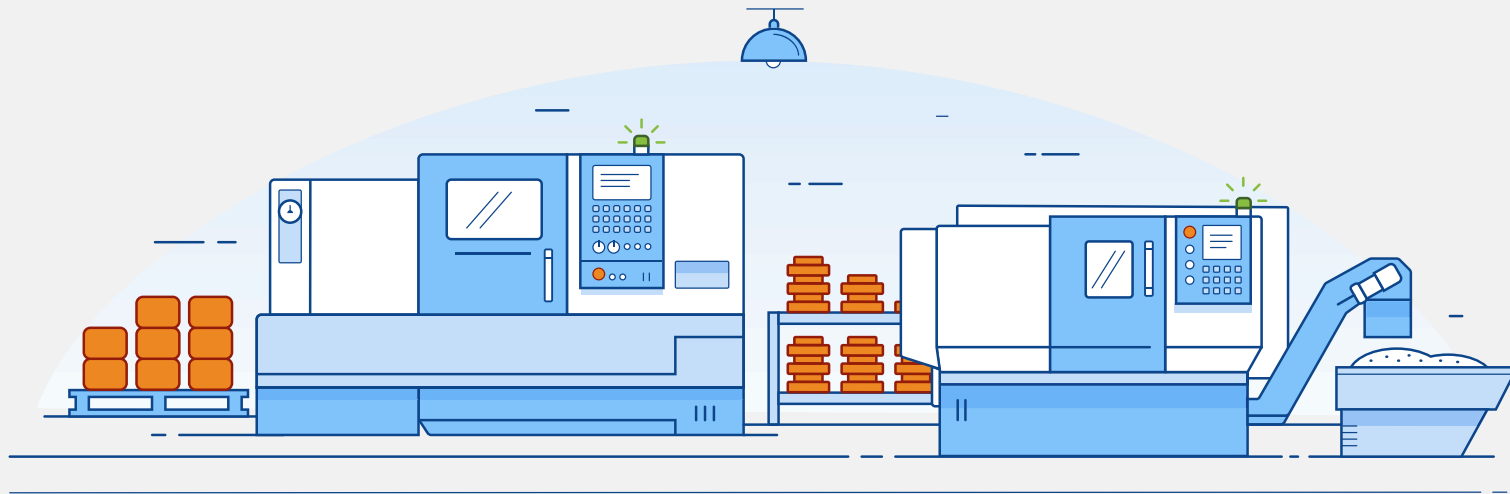
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INTRODUCTION

Due to smaller lots sizes and the demand for shorter leads times, creating efficiencies is critical for manufacturing job shops. While many job shops look for a single solution that will give them a competitive edge, the reality is that there is no one magic bullet to gain that productivity advantage.

Instead, the key to boosting efficiency is to examine the complete manufacturing process end-to-end and make many incremental gains each step of the way. This comprehensive guide will give you a broad set of techniques to help increase the productivity of your job shop.



COMMON CHALLENGES

When it comes to productivity, job shops face many of the same issues around technology, methods, and staff. Understanding these challenges is the first step towards creating more efficient workflows, more consistent results, and increased productivity.

COMMON CHALLENGES

Technology

All too often, engineers think about technology in relation to one or two aspects of their process. But it applies to each piece of the workflow. And it evolves continually.

CNC MACHINE TOOLS

New features and performance enhancements include increased spindle power and improved drives for accuracy.

CNC CONTROLLERS

Updates include faster processors and increased memory.

CAD/CAM SOFTWARE

Ongoing development means there are always new features and functions.

CUTTING TOOLS

Providers are improving coatings, helix angles and insert designs.

WORK-HOLDING AND MACHINE-LOADING

These are evolving for shorter non-milling times between parts.

Methods

To gain a competitive advantage as demands are increasing, commit to experimentation. Try new methods with the understanding that not all of them will produce the desired advantage.

The biggest challenge is often mindset. Many job shops get into a routine and avoid new methods for fear of missing ship dates on parts, scrapping parts, or slowing down the rate of throughput in the short term. While this might be advantageous at the time, these shops are missing out on a long-term advantage.

Staff

You need highly skilled employees, and finding the right people can be a challenge. Once you do, you need the time to train them on existing tools while somehow finding time to ramp them up on new technologies. Many shops run at a fast pace, so high-performing employees can find their creativity hampered by a huge workload.

SOLUTIONS

This guide will help you adopt changes that improve productivity. We focus on solutions that support the following strategies, as they tend to produce the greatest gains:

MANUFACTURE COMPLEX PARTS

The more complicated the job, the higher the profit margin potential.

MAXIMIZE THE UTILIZATION OF EACH MACHINE

As they say, “if the spindle isn’t turning, you aren’t earning.”

MAXIMIZE THE CAPABILITIES OF EACH MACHINE

You may have access to features that you are not using.

SOLUTION #1

Eliminate Manual Programming

Adopt computer-aided manufacturing (CAM) software if you haven't already. You will find that you can bid more competitively on more complicated parts (with higher profit margins).

Benefits of CAM vs. Manual Programming

LESS DOWNTIME

Often manual programming is done sequentially. The part is programmed at the machine controller, it is proven in a dry run, and finally stock material is machined. This method often leads to a significant amount of downtime where the CNC machine is not being used for production. With CAM software, parts can be programmed ahead of time and are available when the machine is ready for the new parts.

FEWER ERRORS

With manual programming, there may be simple typographical errors and incorrect calculations. Many trigonometric math functions are used when programming parts manually, and if the math is off, the program is incorrect.

CAM software uses its own algorithms to produce error-free CNC code.

QUICKER MODIFICATIONS

Part-changes and revisions call for updates to existing CNC programs. A manual process is time consuming: find what needs to be changed, make the correction, and perform another dry run to check it.

CAM software enables fast part modifications. In many cases, the toolpath automatically updates with part revisions from engineering change orders.

SOLUTION #1 (continued)

Eliminate Manual Programming

Benefits of CAM vs. Manual Programming

FASTER PROGRAMMING OF COMPLEX PARTS

As parts get more complicated, the amount of time it takes to manually program them grows exponentially.

With CAM software, you can program more complex shapes using a lot of the same programming methods and strategies you use for simple parts. It doesn't take much longer.

HIGH FEED RATES

Often in manual programming, the cutter load varies based on the geometry. Operators must run the machine at a slower speed to account for variances. This typically happens in corner regions where the tool engagement increases.

With CAM software, you can control the engagement angle of the tool—typically during roughing operations. You can maintain a high feed-rate since there is no danger of overloading the tool.

BETTER PROGRAMMING STRATEGIES, COLLISION CHECKING

With manual programming, you cannot take advantage of the newest strategies that allow for constant scallops, toolpath morphing, spiral, or radial cutter strategies.

With CAM, you can keep track of the stock condition between operations. You get advanced collision checking that is not possible with manual programming.

SOLUTION #1 (continued)

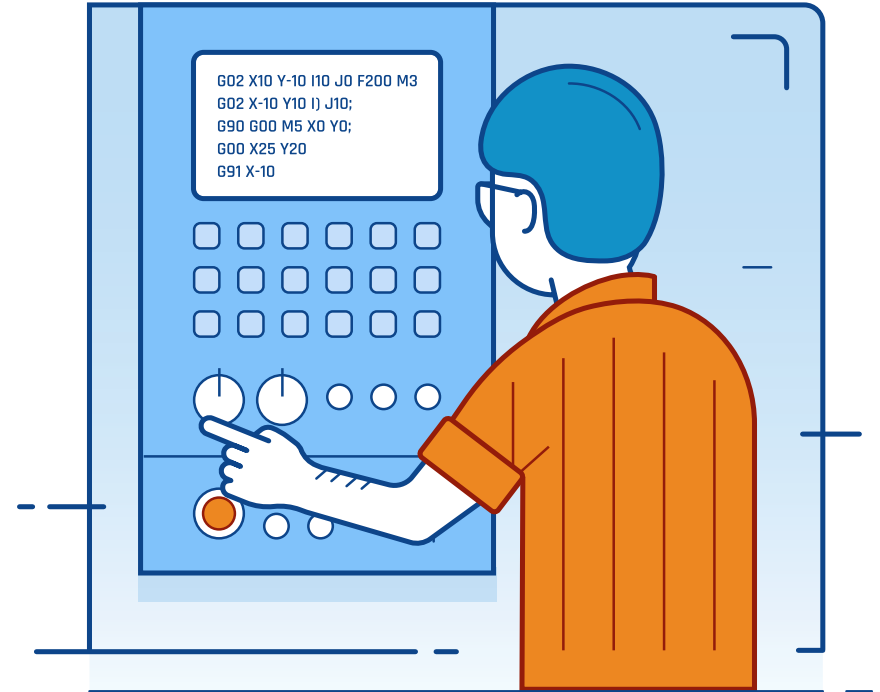
Eliminate Manual Programming

Benefits of CAM vs. Manual Programming

REDUCED STAFFING NEEDS

With manual programming, absences mean downtime.

With CAM software, one person can program for dozens of different machines and controllers, and process the data for multiple machines. Also, it doesn't take long to bring a CAM-trained engineer up to speed on your unique machine/controller combination.



SOLUTION #2

Automate CAD Programming

CAM programming enables you to impart your knowledge into the software so that it can automatically make intelligent decisions based on your input. The results can be far reaching. Use these techniques to simplify your programming process and grow your productivity.

Programming Automation Techniques

AUTOMATE TOOL SELECTION, TOOL PARAMETERS

A tool library can be used to help automate and simplify the tool selection process as well as the tool parameters. Tool libraries can often include important values such as speeds and feeds for various materials and cutters. Selecting the tool and material will automatically populate parameters necessary for the tool and material combination.

Tool libraries only show tools used for a specific operation. For example, if you choose a chamfer operation, the tool library will only show chamfer tools.

CREATE TEMPLATES

Set up a template for a sequence of operations you will repeat often, and minimize redundant programming. For example, on similar sized parts, you may always start milling or turning with the same four tools and operations. Instead of adding the same four programs every time, you can create a template for those operations.

This method works especially well on similar parts or families of parts.

CUT AND PASTE PARAMETERS

Often job shops work on parts that are of similar shapes and sizes. You can apply the parameters from one completed part to another new part. If the programming of one part was deemed to be very efficient, for example, you could simply copy those parameters to a new, similar part, and calculate the new result.

Just cut and paste, or drag parameters from the completed part to the new part.

SOLUTION #2 (continued)

Automate CAD Programming

Programming Automation Techniques

AUTOMATE FEATURE CALCULATIONS

Specify a key feature of a part and apply a complete strategy to that feature. The parameters will be automatically calculated. Best of all, if you change a size or shape, operations are automatically updated.

SET PARAMETERS FAST USING FEATURE RECOGNITION

CAM software can analyze a model and list every feature it finds. It determines the operations for each feature, then orders them for maximal machining efficiency based on their properties. For example, an open pocket may be machined with a different strategy than a closed pocket, or shallow bosses may be milled differently than tall ones.

AUTOMATE RE-MACHINING

It's hard to keep track of where stock has been removed and where stock remains. This is especially true when larger cutters are used for most of the machining process, but there are still smaller corner radii that contain excess material that needs to be removed.

CAM software can automatically locate material remaining to be machined, and re-machine it during roughing or finishing operations. Automated re-machining allows the user to program for residual material quickly and efficiently, and with fewer errors.



SOLUTION #3

Simplify Your Workflow

While automation breaks down each step of a workflow, simplification involves shortening the number of steps. For example, if your current workflow takes ten steps to go from design to finished part, simplification would reduce the number of steps required. In general, automation goes hand and hand with simplification.

How to Simplify Your Workflow

INTEGRATE CAM AND CAD SOLUTIONS

With integration, programming and design teams can utilize the same software. This eliminates the steps required for exporting files and loading them into separate software.

It also removes the need to translate part geometry, which can cause problems at import. Integration also gives programmers access to CAD tools, to make any necessary edits to the geometry for manufacturing.

UTILIZE ANYCAD

Many job shops get their CAD data from a variety of sources, in many different CAD formats. When working with outside data, keeping track of changes and data can be tricky.

With AnyCAD, you do not translate third party data, but rather load the part directly into your workspace. Changes to the original model will show up in your model, and CAM programs will update as necessary. This not only reduces mistakes, but also simplifies the workflow when changes are necessary.

IMPROVE COLLABORATION

Any time you stop a manufacturing process to get new information, time is added to your workflow. Ongoing, close collaboration with colleagues and clients can help you identify issues earlier, minimize interruptions, and speed up time to completion.

STANDARDIZE CNC PROCESSES

Eliminate the clutter that comes with tooling every machine and part separately. It wastes time and introduces unnecessary equipment into the workflow.

SOLUTION #4

Use Simulation

To increase productivity, use simulation within CAM software before machining. Simulation provides you with a digital representation of the milling or turning process, including the stock material removal, before machining the parts. Because you avoid errors, there is less downtime.

Benefits of Simulation

AVOID DRY RUNS

Digitally simulate parts to see whether you have a quality toolpath, and to find errors. This is better than a dry run. The simulation can show the stock before a milling or turning operation, as well as the condition of the material after each successive operation.

By including clamps, vises, and fixtures in the CAD/CAM environment, the simulation will show if there are any collisions between the tool and the fixturing. This is something often difficult to see when performing a dry run.

CATCH ERRORS EARLY

Without simulation, errors are sometimes found while running your mill or lathe. This can cause considerable downtime. With simulation, errors within the toolpath will show up on the simulated model. Boost efficiency by correcting errors before the part is loaded into the machine.

VIEW REMAINING STOCK

Assess what stock remains after each operation, and verify that the part is finished after the last operation.

USE SHORTER CUTTERS

One key way to increase efficiency is to run with the shortest cutters possible. Short cutters deflect less, and can usually be run at a faster feed rate. Utilizing advanced CAM software, you can calculate for the tool and holder to avoid collisions. Verifying there are no collisions with the tool holder during simulation allows for utilizing shorter tools with faster feed rates.

SOLUTION #4 (continued)

Use Simulation

Benefits of Simulation

PREVENTS MACHINE CRASHES

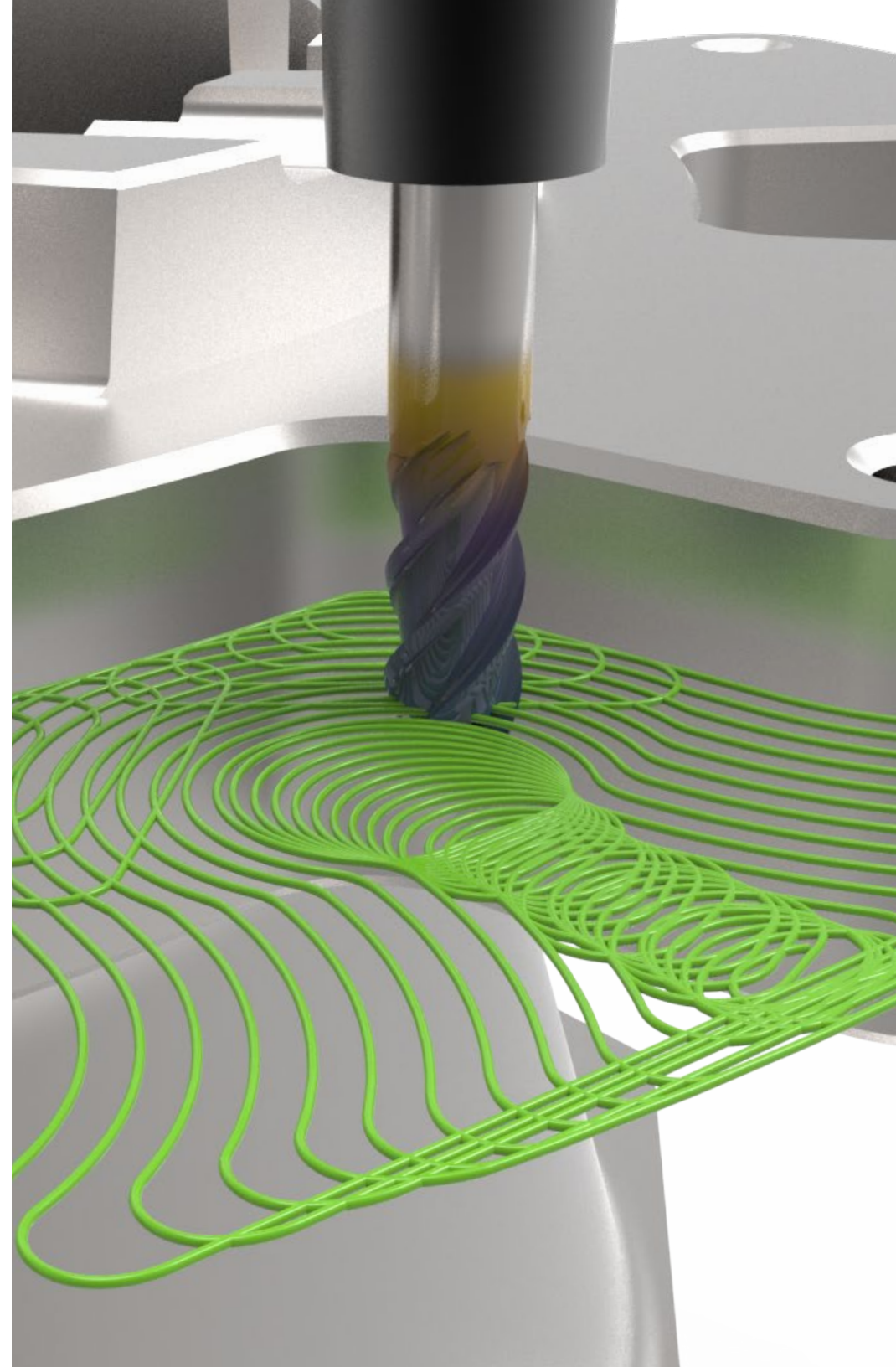
Multi-axis and multi-tasking machines, such as 4 and 5-axis mills, turn-mills or Swiss lathes, add an extra layer of complexity to the machining process. Not only are these machines typically more expensive, they are easier to damage.

Completely simulating your multi-axis toolpaths can save significant downtime from an inadvertent machine crash. Additionally, simulation can be used to help find rotation angles for 3+2 axis machining where tool and tool holder clearance are important. Simulating multi-tasking machines can verify the machine's position during synchronization, and ensure your machine runs collision-free.

ENABLES SAFE OVERNIGHT RUNS

Simulate your toolpaths until you gain the confidence to run your machine unattended. This provides a significant boost in efficiency because you capture those hours.

It also frees up your workforce to start programming the next parts while a machine is running, or run multiple machines at once.



SOLUTION #5

Increase Machine Utilization with Fixturing

One of the best ways to get the most out of your CNC mill is to fill it up as much as possible when milling. If you can fit two parts in at the same time instead of one, you reduce the total number of setups and reduce the downtime caused by swapping parts.

Fixturing Methods

INSTALL MULTIPLE VISES

Clamp down multiple parts and machine them in one run. You can also take advantage of vises that hold two parts at one time.

INSTALL A TOMBSTONE

Installing a tombstone is a more advanced way of milling multiple parts at one time in your mill. A tombstone is basically a multi-sided fixture that rotates, and you can mount parts to mill onto each side. The tombstone will rotate into position and the parts on that side can be milled.

MAKE A MULTI-ORIENTATION FIXTURE

Many parts require milling from multiple angles. These can often be done efficiently on multi-axis machines, like a 5-axis milling machine. If you don't own this type of mill, you can still mill all the sides through multiple operations.

In this case, make a fixture that can hold the part for each orientation of milling. That way parts can be moved from one station of the fixture to the next, then simply run the same program again. This is generally faster than setting up the machine for each orientation and running the parts separately.

USE A SELF-CENTERING FIXTURE

Place a self-centering vise on the table and zero it to the center once. Provided every part has its origin in the center, you don't need to re-zero the vise.

Other vises have attachments that can be added. If the attachment utilizes locating pins or other locating hardware, it reduces the downtime required from constantly re-zeroing the part.

SOLUTION #6

Increase Machine Utilization with Pallets and Robots

Boost utilization with quick-change pallets and automatic loading. Many CNC mills are able to swap out pallets that are already aligned– in just a couple minutes. With no need to set up individual parts, there's less downtime.

PALLETS WITH SINGLE MACHINES

Mill one part while setting up the next one to mill on a pallet. This allows for quick swapping out of pallets. Location points on the pallets allow for setting up and utilizing work offsets easily.

PALLETS WITH MULTIPLE MACHINES

You can optimize the machining based on the hardware as well. For example, while utilizing a pallet you can:

- Rough the part on one machine and finish on another to optimize the individual milling machine strengths, if one is better suited for a task than another.
- Machine on less expensive 3-axis mills and send the pallet to a more expensive 5-axis machine only when necessary, instead of having it mounted there for the whole part run.
- Run on the first available machine, if waiting in a queue.



SOLUTION #7

Automate Setup and Inspection

Many milling machines utilize probes for part setup prior to machining. Use these probes to perform time-saving operations.

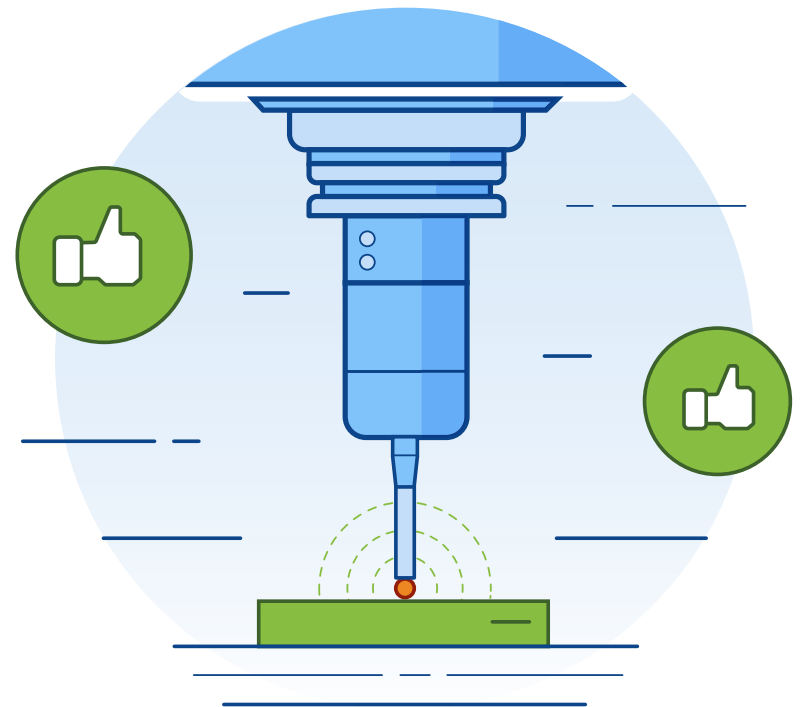
SET PART ORIGIN

Probes can verify a stock block size and set the origin based on the probed features. If a part is not aligned perfectly, it can be adjusted based on the deviation from the inspection results.

Probes can often find the center of a hole or boss much faster than can be done manually with a dial indicator. Use them to reduce downtime and increase safety by minimizing human intervention.

IN PROCESS VERIFICATION

Verify if the tolerance of a machined feature conforms to specification during the machining process. It is better to stop a run part way through to make a correction because of a critical dimension, than to waste time running the whole part, only to find out at the end it was out of specification.



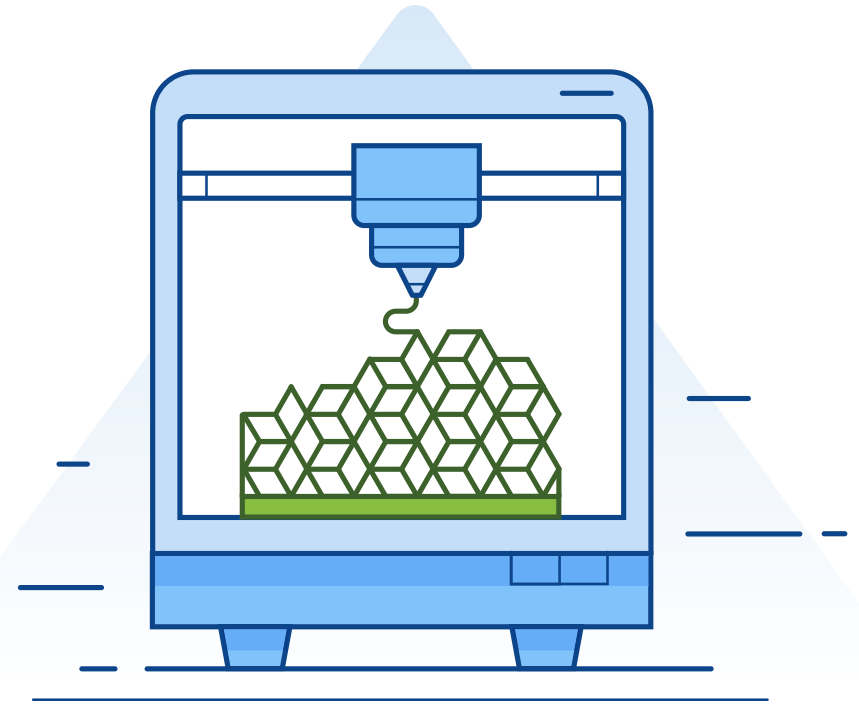
SOLUTION #8

Utilize Additive Manufacturing

Additive manufacturing can complement CNC milling in many ways. It can be used to manufacture soft jaws or other fixture items to hold the part for secondary machining operations.

3D-printing of metals can be used to print shapes efficiently where a strictly subtractive process would remove too much material. Finish machining may be necessary for dimensional finish needs.

Programs like Generative Design can make light weighted 3D-printed metal objects, yet retain the necessary strength characteristics needed. In this instance, milling may be needed just on certain surfaces.



CONCLUSION

It's often difficult to find the time and the budget to increase productivity in the job shop. The key is not to try to do everything at once. Rather, best-in-class job shops continually make incremental changes. This is made possible by the fact that most improvements are not dependent on one another. This allows for lots of flexibility when creating your productivity roadmap. Assess which solutions will have the greatest impact on your organization and roll out the changes over a period of time.

In this fast-paced environment, it's more important than ever to boost productivity. The good news is becoming a best-in-class job shop is within your reach, one improvement at a time.

Get Started

Read to explore software solutions that can help boost productivity? Check out product demo videos to learn about how various software solutions can help you become a best-in-class job shop.

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