PURE PRECISION

productive robotics

Designed and Manufactured in the USA!

ROBOT INTEGRATION FOR MACHINE SHOPS

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1. INTRODUCTION

A new class of robots, called "Collaborative Robots", are now able to automate many machine tending, product assembly and packaging functions. A Collaborative Robot stands in front of your CNC Mill, Lathe (or other machine), loads blanks and unloads finished parts.

OB7 COLLABORATIVE ROBOT

Collaborative robots work safely around people and don't require safety fencing. Sometimes Collaborative Robots are dedicated to one machine, while other times they are easily rolled around the shop and shared by many machines. Either way, a collaborative robot frees your machine operators to do more important and valuable work, and keeps your machine running 100% of the time.

OB7 ROBOT PACKING BOXES.

Collaborative robots are not limited to machine tending. They can also be used for packing boxes, and some more complicated tasks like deburring and polishing. With their very low cost, collaborative robots are finding homes even in the smallest of machine shops.

Most Collaborative Robots are programmed with traditional robot programming. Others offer "Easy Programming" or simple coding. The newest generation of Collaborative Robots requires no programming or coding at all. They learn their tasks from you as you show them the steps. Learning, instead of programming, means the robot can be quickly moved and set up for a new job at a different machine. Learning, instead of programming, also means that almost any employee can teach the robot a new job and makes short production runs viable.

OB7 TENDING A HAAS VF3

In this book, we try to present all of the considerations and issues of automating with collaborative robots. We'll give you the good, the bad, and the ugly. Some of the terms may be new to you. As you read this book, remember that integrating collaborative robots really is surprisingly easy, and a tiny fraction as difficult as the complexity of CNC machining of which you are already a master.

OB7 TENDING A HAAS SL20

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2. WHY ADD ROBOTS?

OK, SO YOU'RE CONSIDERING ADDING COLLABORATIVE ROBOT AUTOMATION TO YOUR SHOP. EXACTLY HOW WILL IT HELP YOU?

MACHINE OUTPUT:

You learned a long time ago that "you're only making money when you're making chips". Keeping the machine running, the spindle turning, is the key to getting the maximum out of your machine. Most people call this "spindle utilization". All it really means is how many minutes out of a possible 24 hours in the day is that spindle actually turning? Using a robot to load and unload the machine always increases throughput. Really? How? An operator can often unload and reload the machine faster than the robot can. That's true, but only if the operator is standing at the machine, paying attention and ready to spring into action when the cycle ends. How many times do you walk past the machine and see it idle in the middle of running a job? The reality is that while it sometimes takes the robot a few seconds longer than an operator to unload and reload the machine, the robot is always there and waiting. It doesn't take breaks, eat lunch, get stuck in traffic on the way to work, call in sick, or visit the bathroom. Even after keeping that spindle turning longer during the shift, the robot will happily continue to work all night long.

DEFECTS:

Defective parts in the run are a fact of life. The most common cause of defects in CNC parts runs is misload of the blank into the machine. Whether by not paying attention, or not clearing chips sufficiently, operators make mistakes. When a blank is misloaded, the next common consequence is a broken tool. When a robot takes over the job of loading and unloading the machine, the process is done identically every time. The robot doesn't get distracted. And while the robot performs the process identically every time, it's critical that the tooling be solid and reliable. Part stops must be set and stable. The robot will not notice if the stop comes loose or falls off.

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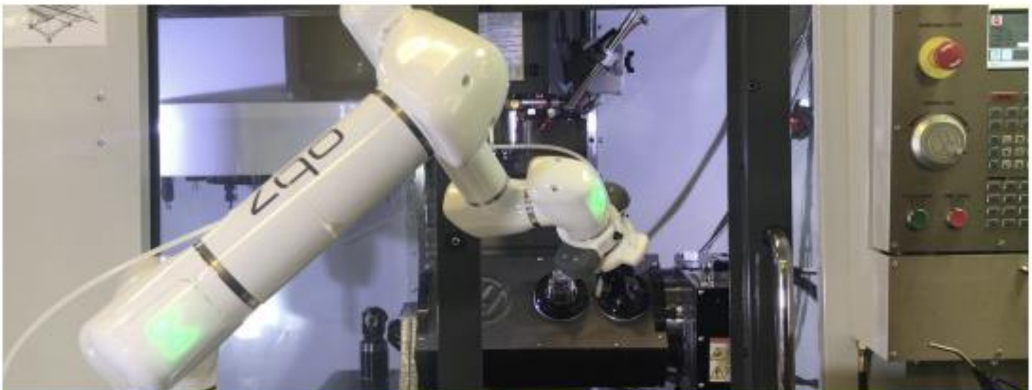

OB7 WORKS OVERNIGHT, INCREASING PRODUCTION WHEN LIGHTS ARE OUT.

TYPES OF MACHINES TO AUTOMATE:

Collaborative robots are most commonly used on CNC mills (machining centers) and CNC Lathes (turning centers). Collaborative robots are also regularly used with other machine shop equipment, both CNC and manual. Loading punch presses, Laser cutters, pipe benders and shapers, grinders, bagging machines are all well-established jobs for collaborative robots. The robot does not have to be dedicated to one single machine. OB7 from Productive Robotics can easily and quickly be rolled from one machine to another in your shop. If OB7 has done the job before, it will remember it for the next time. If it is a new job then “teaching” instead of programming makes the setup of this job fast.Types of Machines to Automate

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RETURN ON INVESTMENT

When buying new equipment, we always assess the Return on Investment. For most machining equipment we consider the value of the parts it can produce against the cost of the equipment. Calculating the ROI for a robot can be a bit more involved. Some of the benefits and cost savings are not immediately apparent. The following factors are all components of the Return on Investment when adding robotic automation to your shop.

- Simple hourly cost of the employee who would be needed to tend the machine.
- Extended employee payroll costs (Social Security, Worker compensation insurance, health insurance, vacation pay, etc)
- Hours per day the robot will be working. The robot can work 24 hours/day.
- Increased spindle time: The amount of time your machine is idle when an operator is not there to tend it. (Lunch, bathroom, breaks, sick time, etc.)
- Decreased scrap.
- Ability to scale up production when business picks up, without hiring and training additional operators.
- Safety. Decreases in employee injuries. Including repetitive motion injuries.
- Increased cash flow. When financed, the robot can cost under $600/month.
- Electricity when the robot is working "lights out".
- Some people will also consider the business lost when you have to turn down work because you're too busy.

It is a good idea to calculate your own ROI. Every shop is a little different with different costs and structures. Use this list and put a cost on each of the items. That's the best way to understand the costs and savings in your unique business.

3. THE "KEY PLAYERS" IN AUTOMATING MACHINE SHOPS

MEET THE "KEY PLAYERS" IN ROBOT AUTOMATION IN MACHINE SHOPS.

THE ROBOT

OB7 MACHNIE TENDING A CNC LATHE

Fortunately, the robot doesn't look like in the movies. It doesn't have a silly face or legs. In machine tending automation the robot is a single robot arm, often with a specialized "hand" (called a gripper) designed of the current task. If you plan to move your robot between machines, it should be on an easy rolling stand, equipped with leveling feet so it doesn't move once in position. Machine tending robots come in different configurations with differing numbers of joints (often called "axes"). For machine tending the minimum you need is six joints ("axes"). With six joints, and careful placement of the robot you can load most machines. More advanced robots have seven joints. Seven joints allow the robot to maneuver more like a human arm. With seven joints it's possible to "reach around" obstacles. This capability gives you much more flexibility when it comes to setting up your robot cell. The biggest benefit is that seven joints permit the robot to be located in a position that allows room for a person to access the machine. Robots with six joints, while able to do the job, must usually be located directly in front of the machine, blocking access by a person.

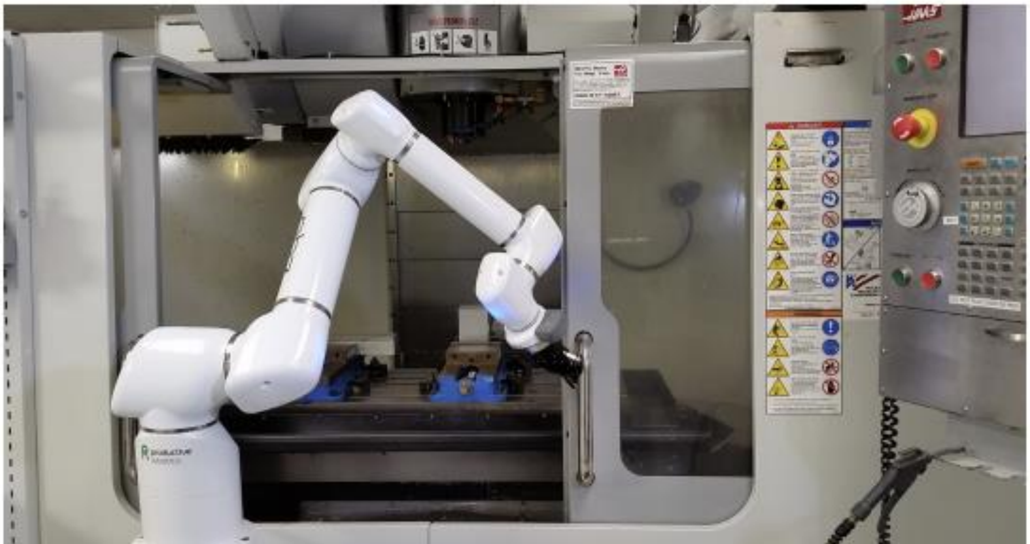
Other considerations in the robot arm are "payload" and "reach". Payload specifies how much weight the robot can carry. Your needs in this area are driven by the type of parts you make. At the low end of the spectrum, common payload capacities are 2kg (4.4lbs), 4kg(8.8 lbs), 5kg (11lbs) (this is the most common), and 10kg. As driven by the current ISO safety limits, 10kg is about the upper limit of payload capacity for a collaborative robot. This will likely increase through the years as the robots become more advanced. You should also note that the weight of the robot gripper is included in the payload capacity. So be aware that this reduces the weight of the part your robot can handle.

Reach specifies the distance from the robot base to the end of the arm. Take care in considering reach as it can be measured differently by different robots. The most common reach for the most common size (5kg) of collaborative robot is approximately 1 meter (39"). SInce the robot doesn't move, and can't "lean over" like an operator can, some care in planning the location of the robot relative to your machine is required.

THE MACHINE

The next player in this process is your machine. As mentioned earlier, it may be a CNC machine or a more manual machine. You are the expert in your machine so we won't dwell on it here. You may be wondering: "How does the robot control my machine?" We'll address this in depth further on in this book. For now, know that the robot can signal your machine electronically. The robot can also simply push the start button (or stop button) to start (or stop) the machine.

THE DOOR



OB7 USES ITS HAND TO OPEN THE DOOR OF A CNC MACHINE

Most CNC machines are fully enclosed and the door must be opened to access the machine. Of course the door must be open for the robot to access the part inside, and of course, it must be closed for the machine to operate. The door can be controlled in two ways: 1) The door can be driven electrically, or 2) the robot can open the door just like you do - with its hand. In some cases, the door can be programmed to open automatically at the end of the machining cycle and this saves time. Similarly, if your machine has an electric door that can be controlled by the robot (instead of the CNC control), it will also save time. Barring either the robot will open the door manually. If the door is opened manually, it can take 5-10 seconds of extra time. If you're buying a new machine that you plan to use the robot with, it can be a good value to add the electric door feature. The decision should be driven based on the cycle time of the jobs you'll be running. For example: If the cycle time is 2 minutes (very short), the door will open and close about 200 times in one shift. That adds up to a considerable amount of time the machine is not running. (In this example, it's 33 minutes out of 8 hours. That's 16 additional parts per shift). On the other hand, if your cycle time is 15 minutes, the time spent manually opening and closing the door is only 5 minutes over an 8-hour shift).

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WORKHOLDING

OB7 INSERTS PART INTO A LATHE CHUCK

OB7 INSERTS PART INTO A MILL VICE

Obviously, workholding is critical to making parts. In the case of adding robot automation, the chuck or vise holding the part must be controlled electrically (either by the robot or by the CNC controller). Unlike the door, the robot can not effectively turn the vise handle.

In the case of the lathe, the chuck is almost always controlled electrically by the CNC controller. When adding the collaborative robot, the chuck must be able to be controlled interactively by the robot. It is not enough to put the chuck operation under control of the CNC controller. For example, when removing the part, the robot must have a firm grasp on the part before the chuck is open, otherwise, it may fall out inside the machine. We will address how these controls are connected later in the interfacing section of this book.

In the case of CNC machining centers, electrically controlled workholding is not common. Most common are manually actuated (by turning the handle) vises. Hydraulically driven vises are available, but are both expensive and not normally stocked. Pneumatically driven vices are available from Productive Robotics and others. A retrofittable vise controller and closer is available from Productive Robotics, for use with the OB7 robot. The controller fits all standard size Kurt mill vises as well as many other models.

PRESENTING THE PARTS

"Presenting" the parts means locating the parts in a position where they can be picked up, reliably, by the robot. It sounds simple, and it can be. It can also be tricky. The old saying of "garbage in - garbage out" can apply here. As you well know, precise fixturing of the blank in the machine is critical to a properly machined part. The same applies, but to a lesser extent, when positioning the parts for the robot to pick up. Without vision, the robot can not "see" where you've put the blanks. It must know where to expect them. The exact shape of the part, and the type of gripper you are using (discussed in the next section) will affect the robot's ability to pick up the part. The most common methods of locating the parts for the robot are "grids" and "stacks". They are exactly what they sound like. Placing all the blanks in a grid pattern allows the robot to know where to find the parts. The grid can provide a fixture that physically locates the blanks, or simply a printed legend showing where to place the parts manually. Additionally, or alternatively, the parts can be stacked. There can even be a "grid" of "stacks". There are a few things to remember when setting up both grids and stacks. For grids, you must leave enough room between the parts for the gripper to be able to grab them. If the parts are pushed together, the gripper might not be able to get its fingers between the parts. For stacks, you will need to tell the robot how tall the stack is, and how many objects to expect in the stack.

There are other ways to "present" the parts to the robot. These include conveyor belts, dedicated parts feeders, and parts manually sliding or falling down a ramp into a registered position. Whatever the method used to locate the parts for pick up, you will need to next consider the gripper and finally the placement of the part by the robot.

LATHE BLANKS DELIVERED BY CONVEYOR BELT

MILL BLANKS PICKED UP FROM STACKS ON TABLE

GRIPPERS AND GRIPPING

There are many options for grippers (often called End of Arm Tooling, or EOAT). The choice depends almost entirely on the parts you'll be handling. Generally, the gripper choices are either: Pneumatic, Vacuum, or Electric. Each has its place as we will describe:

Pneumatic grippers are available in hundreds of configurations. Usually, a pneumatic gripper is chosen based on the specific part or parts to be handled. Customized "fingers" are generally designed as pneumatic grippers don't generally come with fingers. Using a pneumatic gripper requires a valve to control the air, and one or two air tubes to be run to the gripper. While they can be more work to set up, pneumatic grippers are inexpensive, reliable and strong. Pneumatic grippers are available in both 2 finger and 3 finger formats, although 2 finger are more common.

Vacuum grippers: Vacuum grippers are less common in machining applications. The primary reason is that they tend to suck in coolant when picking up the completed part. Additionally, while the blank usually has a flat surface conducive to picking up with a suction cup, the finished part will often not.

Electric grippers: Electric grippers are the newest type of gripper used in today's robots. While electric grippers are generally more expensive than pneumatic grippers, they are substantially more flexible. When using an electric gripper, both the open and closed positions can be controlled by the robot. Additionally, the gripping force is easily set by the robot. For fragile parts this is valuable. Electric grippers come standard with rubber coated fingertips so they can be used without modification for many types of parts. Electric grippers come in 2 finger and 3 finger varieties, although 2 finger is by far the most common.

Handling parts for lathes is a bit different. While all three types of grippers can be used, the parts are generally round and require concave gripper fingers to pick them up reliably. Two finger grippers are almost always adequate, providing the fingertips are shaped concave to fit the part reliably.

Whether you're milling or turning, it is important to remember that the part that comes out of the machine is different from the blank that went into the machine, sometimes dramatically. So when it comes to planning the grip on the parts, you often need to actually handle two different parts: The blank before machining, and the finished part after machining. Electric grippers are usually the best choice because they offer the widest grip range.

ROBOTIQ GRIPPER

OB7 PARELLEL ELECTRIC GRIPPER

LATHE BLANKS PICK UP FROM GRID

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4. INTERFACING TO YOUR MACHINE(S)

There are two methods of interfacing to your CNC machine (or to a manual machine).

- You can interface via a computer network if your machine is fairly new and has this interface. The network interface has the potential of being the simplest wiring with the most versatility, but can sometimes be a bit complicated to set up.
- The alternative method is to interface to the machine via inputs and M-Code outputs. The number of inputs and M-Code outputs you'll need depends on the options available in the machine (e.g. electric door), and what you need to do with them. The minimum necessary is one output from your machine to the robot.

In the simplest setup, on a milling machine (not a lathe) the robot will manually open the machine door, insert the part blank, electrically activate the vise, manually close the door, and then manually press the "start" button. In this setup, the only electrical signal required is one M-Code for the machine to tell the robot when the machining cycle is finished. The process works as follows:

1. CNC machine finishes cycle and signals the robot with an M-Code output.
2. The robot opens the door to the machine, releases the part from the vise, picks up the part and places in the finished pile.
3. The robot picks up a new blank, inserts it in the vise or fixture, clamps the vise, then closes the door.
4. The robot pushes the "start" button on the CNC control panel and waits patiently for the signal telling it that the machining cycle has ended.

In the case of a more complete interface, the robot can send signals to the machine to open the door, close the door, and start the cycle. This requires additional inputs and may require that you monitor these inputs from the CNC program.

In the case of a lathe, the process is a bit more complicated, and it requires more interface signals. The door and "start" button can still be manually activated, but it is necessary for the robot to control the opening and closing of the lathe chuck. The process would work as follows:

5. Lathe finishes cycle and signals the robot that the cycle is finished (M-Code output).
6. Robot opens the door and grasps the part in the lathe chuck.
7. Robot signals lathe to open the chuck. Robot either waits for a confirming signal from the lathe or simply waits a predetermined amount of time, then removes the finished part from the chuck.
8. Robot places the part in the finished location
9. Robot picks up a fresh part blank and inserts it into the lathe chuck, then signals the lathe to close the chuck. Often the robot will push the part against the chuck to locate it while the chuck is closing.
10. Robot releases the blank part, closes the door and starts the cycle.

If the lathe has only one input available, the sequence of operations can be programmed into the CNC program. When the cycle is finished, the lathe will signal the robot, and then the CNC program in the lathe will wait for a signal back from the robot. The robot will open the door, grab the part and signal the CNC controller that it has a hold of the part. The CNC program, waiting for this signal, will then open the chuck and wait again for the next signal from the robot. When the robot inserts the new part blank into the chuck, it will signal the lathe again. The CNC program, waiting for the signal, will close the chuck. The robot can then close the door and either signal the CNC program again to start the cycle, or press the start button manually.

5. OTHER FACTORS TO CONSIDER

START SIMPLE

It is a reality that some jobs are easier to automate than others. Some parts are easier to handle, fixture, stack, load, unload and package. Some fixturing is fiddly. Some parts are more delicate. The robot makes you money by keeping your machine(s) running. There is a learning curve associated with all new technologies and robots are not an exception. Remember your first CNC programming job? So use your robot in the same way. For your first jobs, choose parts that are easy for the robot to handle. The section below on grippers and gripping will give you some advice.

THROUGHPUT

FOCUS ON THROUGHPUT, NOT ROBOT SPEED.

In most CNC applications, the machining time is much longer than the loading and unloading time. The actual movement speed of the robot is less important than you might think. What matters is consistency. When machine cycle times are short, consider using a double gripper which will hold both a blank and finished part. The finished part can be removed, the gripper flipped over, and a new blank inserted. This avoids a separate trip in and out of the machine by the robot. While running the robot at higher speeds will decrease the loading time somewhat, there are other consequences associated with higher robot speeds (like guarding to protect workers). There are more effective ways to increase throughput than simply increasing the robot's movement speed. As was mentioned before, the robot's consistent operation without breaks and other distractions is the key to increased throughput.

JOB SETUPS

MAKE SURE YOUR SETUPS ARE PERFECT.

Perfect setups. You're used to that but it's critical for the robot. No operator discretion in loading the machine can be allowed. Mostly this means that the blanks must locate reliably, 100% of the time. The tooling should have a positive stop and not rely on "eyeballing" the location of the blank. If the vise force is important to avoid deforming the part, be sure that your vise or clamping fixture provides for consistent force control. Pneumatic workholding can have the air pressure regulator adjusted for the desired force. Servo driven vise closers, like the retrofit vise closer from Productive Robotics, should have adjustable torque control.

CHIPS

THE PROBLEM WITH CHIPS.

Locating "reliably" means that you must make sure there are no chips in the vise or workholding. There are two ways to clear the chips. Which one (or both) you use depends on the quantity of chips and the specifics of the workholding or clamping.

Chip Fan: There are several models of "chip fans" available. The chip fan is carried in the tool turret along with the other tools. The last "tool" used in the cycle will be the chip fan. The best RPM is dependent on the chip fan used. The chip fan is spun up to speed and the work is moved around under the fan to blow off the chips. Be aware that this clears the chips from the top of the part and the surface of the vise or workholder. It does NOT clear chips from inside the vise under the finished part. If the part is machined all the way through, or to a shape that permits chips to fall into the vise, you will need to clear the chips from the vise before loading the new blank.

Air nozzle on end of robot: In setups where chips can get into the vise, or otherwise under the finished part, it may be necessary to blow off the workholder before loading the next blank. An air nozzle located on the end of the robot can be used for that. In most cases, the air hose is run on the outside of the robot. The air is turned on by the robot using an electrically actuated air valve. After removing the finished part, the air is turned on and the robot is programmed to move as necessary to blow out the vise.

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CELL SETUPS

Unlike your human operator, the robot doesn't shift around to the most optimal position in front of your machine. The robot is anchored in one place and you must choose that position so that it can reach everywhere it needs to. The robot needs to be able to reach the incoming blank parts, the chuck, vise or work holding fixture, and the location where it will deposit the finished parts. Depending on the type of machine you have, and how it is interfaced, the robot may also need to reach the door handle (in both open and closed positions), and the "start" button on the machine control console. If you are using an air nozzle to blow chips out of the workholding, you may need a little extra reach inside the machine.

Generally, this means that the robot holds a central position in front of the machine. This can be a problem for machine maintenance: including setting up jobs, changing tools, changing vise or chuck jaws, and cleaning. A 7 axis robot is optimal for machine tending. While a 6 axis robot can usually reach everywhere within the work cell, its lack of flexibility usually requires the robot to be located directly in front of the machine door, blocking human access. A 7 axis robot has the ability to "reach around" obstacles. This flexibility allows it to be positioned to the side of the work area and still reach into the machine. If you're wondering why 7 axes, look at your own arm...

As mentioned earlier: don't forget about the door and the start button. Some machines have double doors. For those machines, you may have the robot open only one door. Also, don't forget the "start" button. It is usually located on the other side of the door from where you station the robot and may require a long reach.

It is also important to consider safety when setting up the cell. Where will you locate the incoming blanks and where will the robot place the completed parts. Set up the area so that you have clear access to the parts, both incoming and outgoing. Some robots are attached to work tables which are a convenient location for both incoming and outgoing parts. When the robot is attached to the same table the parts are presented on, the registration of the parts to the robot becomes automatic.

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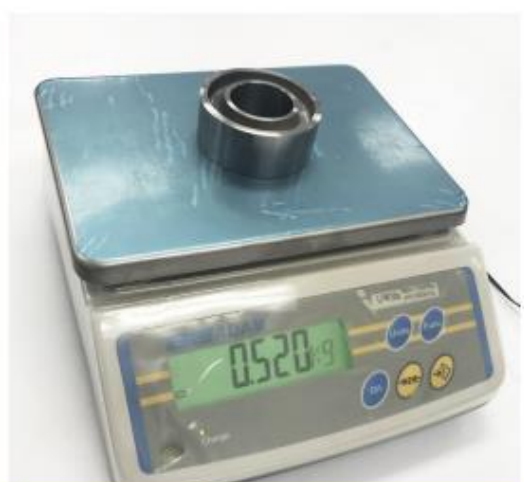
OB7 LOCATED WHERE IT CAN REACH THE WORK, THE DOOR AND THE "START" BUTTON

WEIGHTS AND PAYLOADS

Gripper included in payload:

GRIPPER ON SCALE



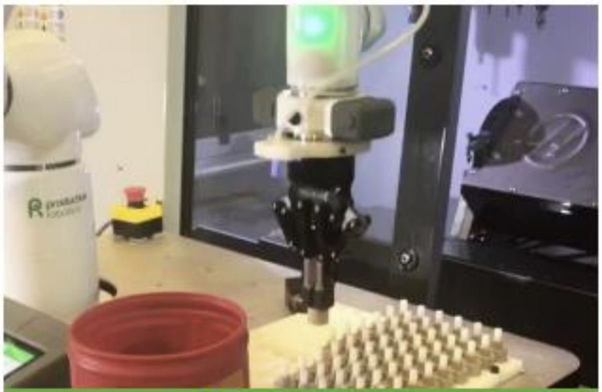
LATHE BLANK ON SCALE

GRIPPERS AND GRIPPING

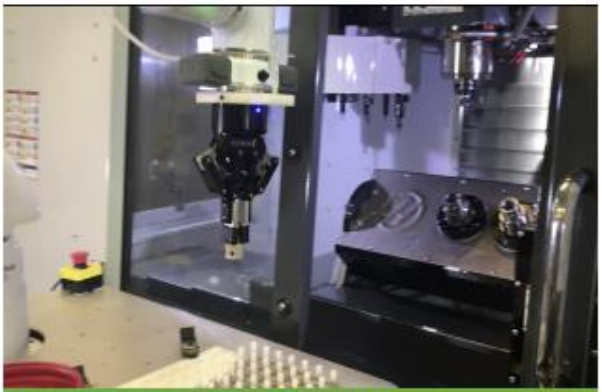
The robot does not have the dexterity that a human operator does. You will need to consider how you will pick up the materials for the job. It is common to machine custom "fingers" for the gripper to handle your parts. That includes handling the blank as well as the finished part. This is most common when using pneumatic grippers which normally have a very short range of travel. Today, electric grippers with long travel have become common. This allows for greater flexibility in the range of parts and part sizes that can be handled without customized gripper tooling. Most electric grippers today are supplied with rubber tipped "fingers", which are able to handle a wide variety of parts. Whenever these fingers can be used, it simplifies the setup and tooling requirements considerably.

It is also important to consider how your blank parts are presented to the gripper. If they are located inconsistently when they are picked up, it may require an extra step to align the parts when they are loaded into the vise, chuck or other workholding. In these cases, it is common to "re-grip" the part before placing it into the vise or other workholding fixture. This can be done by placing the part on a flat surface and re-grasping the part. If the position of the part is inconsistent in the gripper, it can be pushed against a stop before re-grasping it. Similarly, when placing the part in the vise, chuck, or other workholding, it is normal to push it against a stop to assure that it is seated in the correct position, just like a human operator would do.

Remember: the part comes out of the machine in a different shape than when it went in. This affects how and where the robot will grasp the part when removing it from the machine. One advantage when removing the part from a CNC machine is that it is always in the exact same position every time.



BLANK BEFORE MACHINING



FINISHED MACHINED PART

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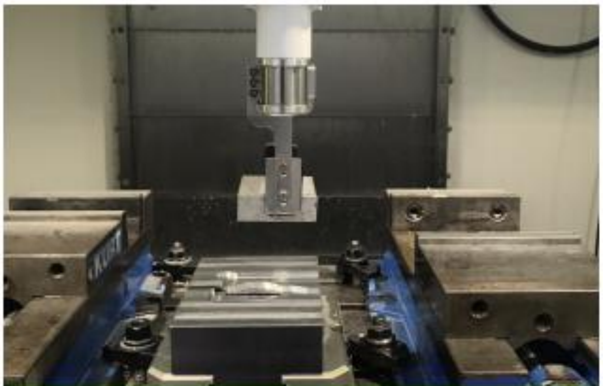
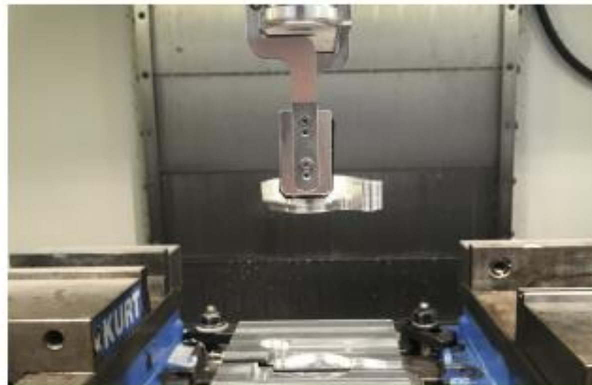


BLANK BEFORE MACHINING



FINISHED MACHINED PART

TEACHING AND CNC PROGRAM DETAILS

The next step is programming, or teaching, the robot to load and unload the machine. If you are a CNC programmer, you are probably used to looking at G-Code. (Hopefully, you are not having to write it manually.) Programming a robot can be similar to programming a CNC machine. Current robots have "easier" programming that traditional industrial robots. OB7 from Productive Robotics does away with programming altogether. OB7 "learns" the process of loading, unloading and operating the machine. The operator simply picks up the blank part by guiding OB7 manually, then places the part into the vise or chuck. As the operator moves OB7 it learns the process.

The other steps in the job are learned in the same way. Opening and closing the door, or pressing the start button need only be taught to OB7 once. Once these are learned, OB7 remembers these steps for all future jobs on this machine.
The structure of most machine tending jobs is the same. The steps are usually as follows:

1. Open the door
2. Signal the vice to open
3. Remove the finished part
4. Blow off the work holding fixture if necessary
5. Place the finished part in its destination (bin, conveyor belt, carton, etc.)
6. Pick up a new blank part
7. Place it in the vise, chuck (or other workholding fixture)

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8. Signal the vice to close
9. Close the door
10. Start the machine (Either by activating an electrical signal, or pushing the start button.)
11. Wait for a signal from the machine that the machining cycle has finished.

There are a few caveats and details to the above sequence depending on the type of machine, it's interface options, and it's workholding methods. Some examples are:

- Program the opening of the vise or chuck. With OB7, this step is usually not necessary because it is done automatically when removing the part.
- Opening and closing the door. This involves programming the robot to push the door handle through the path necessary to move the door. With OB7, this step is "learned" once and future jobs do not require it to be programmed.
- When removing parts from a lathe, the chuck can usually not be opened before grasping the part, or it can fall out inside the machine. it is necessary to program the robot to go through a sequence of grasping the part, opening the chuck, and then removing the part. With OB7, this sequence is automatic. It is only necessary to tell OB7 to remove the part.

Lathe Sequences:

- Lathe sequences can sometimes require the robot to synchronize with the CNC program. This is because lathes will commonly restrict external control of the chuck. This is a safety to prevent parts from flying out when running. If your lathe does not have external control of the chuck opening and closing, you can easily build this operation into the CNC program. This generally requires One M-Code output from the lathe and One external input to the lathe. The sequence is as follows:

12. Start the CNC program (with external input, or by pressing the start button)
13. Robot waits for the lathe to signal that the machining cycle has finished. The lathe activates one M-Code output to tell the robot that the machining cycle is finished, then waits for the signal

back from the robot on one of its external inputs.

14. Robot receives signal from the lathe and opens the door
15. Robot grasps the part:
16. Robot signals the lathe to go to the next step. In this case, the next step is for the lathe to open the chuck so the part can be removed.
17. Robot waits for chuck to open (about ½ second) and removes the part.
18. Robot places the part at the finished destination.
19. Robot picks up a new blank, inserts it in the lathe chuck then signals the lathe to go on to the next step in the CNC program. In this case, the next step is to close the chuck.
20. Robot waits for the chuck to close (about ½-1 second) then release the part.
21. Robot closes the lathe door
22. Robot starts the CNC program.

Note: If your machine is of a more current vintage, it may have extra inputs and outputs available. It may have inputs for opening and closing the door, or for starting off the CNC program. When your machine has these capabilities, you can actuate these controls with an electrical signal, rather than pushing a button physically, or physically pushing the door open or closed.

6. MOVING OB7

MOVING YOUR ROBOT BETWEEN MACHINES

OB7 can come mounted on a rolling stand and can be easily moved between machines. Moving OB7 involves raising it's leveling feet, rolling it to its new location, and lower the leveling feet. It takes about one minute. Whenever the robot it moved, its positioning at the new location is important. Some users drill holes in the floor for pin registration when moving the robot. With OB7 this is generally not necessary. Marking the floor location is sufficient to get the robot stand back to its original position. Robot operation, however, requires high precision in its movements and location.

OB7 employs QR code position labels to allow it to recognize the machine and accessories and automatically realign itself for operation. QR code plaques are placed on the parts of the machine that OB7 will need to touch. Commonly, this includes the machine door, the control panel (next to the start button), and the blank parts fixture. When running the previous job, OB7 will automatically align itself using the QR code position labels. For components in the job that do not use QR code position labels, it is common to have to "touch up" the robot positions a little bit after the robot is moved.

SAFETY

This very important section has been saved for last. As a machine shop, safety is always your primary concern. Robots are no exception and it is very important to follow all safety procedures and rules. OB7 is a "collaborative" robot and is fully compliant with the safety standards and rules governing the application and operation of collaborative robots. Here we give a brief summary of the rules and practices for your collaborative robot.

ISO-10218 is the number of the industry safety standard that sets the rules for collaborative robots. There are two parts: Part 1 sets the rules for the robot itself. OB7 complies with these rules. Part 2 sets the rules for using the robot. It is a good idea to become familiar with these rules. Here is a summary of some of the key points:

To use your robot without safety guarding or protections, the robot speed and force must be limited. The key numbers here are that the robot must run no faster than 10" per second and with a force lower than 33 lbs. (250mm/sec, or 150 Newtons). In practice, this is often fast enough for your machine tending needs.

If you want OB7 to go faster or need higher force, OB7 will do it. OB7 can run up to 10 times that speed. However, you need to take steps to keep people clear of the robot when its running. You can use a fence, a pressure sensitive floor mat, a laser scanner, or even a moat. What matters is that you prevent people from getting close enough to be hit by the robot when it's running fast. OB7 is commonly supplied with a laser safety scanner. The laser safety scanner will slow, or stop OB7 when a person gets too close. Employing the laser safety scanner is a fast and simple way to get the highest performance from your robot.

Risk Assessments: You must perform a risk assessment for your robot installation. It is not difficult and safety standards already require that you've performed risk assessments in your shop. There are books and guides to help you with your risk assessments. This book is not one of those. What matters in the risk assessment is that you have considered the ways in which employees could become injured with your equipment, and have taken steps to reduce or eliminate the chances of that happening.

CONCLUSION

Each day business becomes more competitive. Overseas competition is driving prices down. Unemployment levels are at record lows. Costs of injuries and insurance are at record highs. At the same time, businesses are looking for ways to bring manufacturing back home from overseas suppliers. There is more opportunity than ever, but only if you can produce high-quality product efficiently. You can add more machines, but you still have to keep them staffed and running.

As the saying goes: "You're only making money when you're making chips.". It is easier and less expensive to add robotic automation than it has ever been. Today's robots, especially including OB7, can be quickly and easily set up by you and your staff. Traditional "robot integrators" are no longer necessary for most machine tending operations. The first plunge can seem scary, but it's faster, simpler and less expensive than any of your CNC machines.

Examples: What can the robot do while it's waiting for the machine to finish a part?

OB7 PACKING A BOX

OB7 ASSEMBLING PARTS

It's time for you to get started... Contact **Pure Precision OEE** to learn more.

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