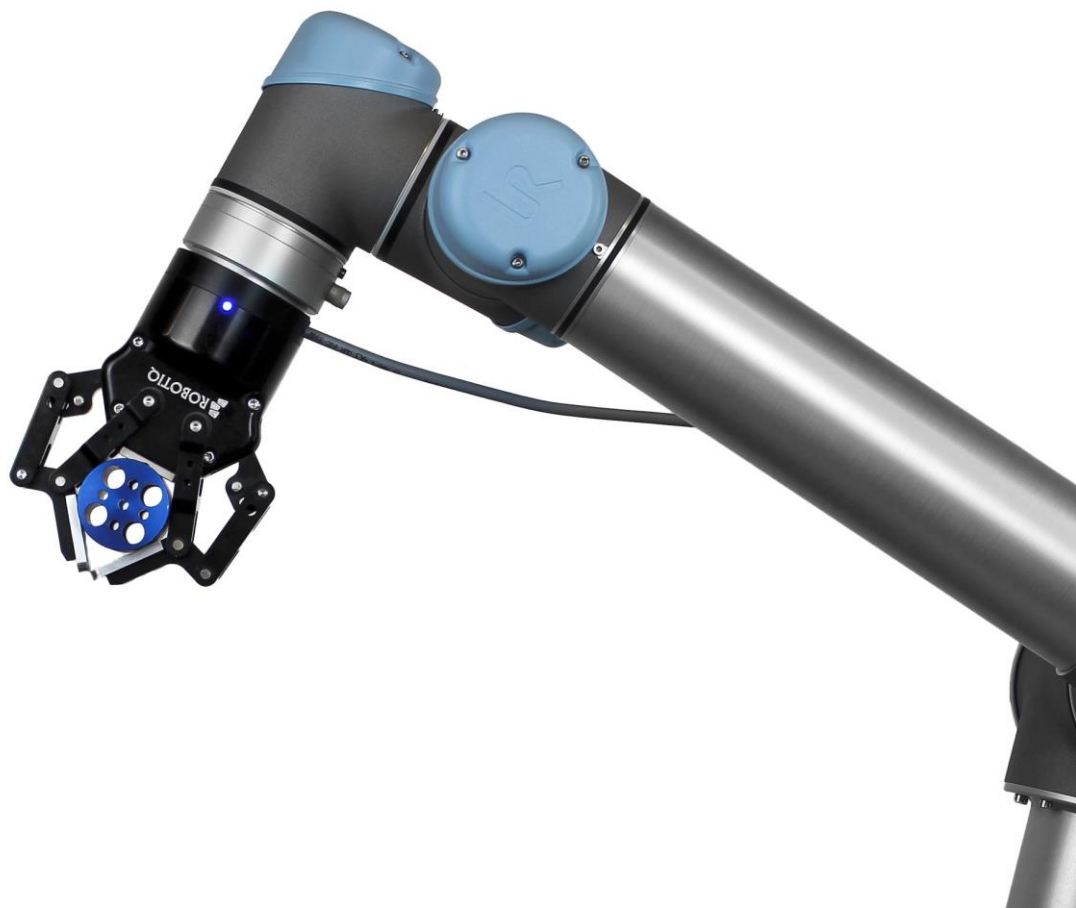




Machine Tending Automation with Universal Robots and Robotiq Gripper



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INTRODUCTION

The question often asked is: Why automate machine tending operations? Looking at industrial manufacturing, we can easily understand why companies are shifting to automated machine tending operations. First, the human resource issue. Good machinists are hard to find (and to retain!). Even if industry works hard to change the perception of manufacturing, what people have seen in the news over the past few years makes a bigger impact. Second, in this context, once manufacturers have skilled workers they want to put them to work on what gives added value to their products. And at the same time, giving them challenging tasks is often a good way to retain skilled workers. Third, the product itself. Quality Control is always an issue for every industry, especially economy where there is no room for waste (think of all the lean programs that companies are adopting for example). And if it is hard to get and retain skilled workers that means: 1) high staff turnover, 2) lack of product consistency, 3) waste, 4) increased production costs, and the vicious cycle goes on!

Manufacturers doing machining are getting to a point where they need to automate machine tending to stay competitive. So they want to get the most value from their skilled machinists. One way of doing this is to let the machinist focus on the programming and the setups, then let a robot do the loading and unloading of the parts.

1. What to Look for in Machine Tending Applications

In industrial automation, when it's time to automate a process it's sometimes hard to know where to begin. There are plenty of systems integration companies that offer off-the-shelf kits for specific applications, but what if your application is different? What if you want to build your own custom cell? The following section will give you some tips about [what to look for in machine tending](#). As all machines, robots, programming tools and applications are different, I will explain this subject using general terms. This section uses a complete machine tending loop as the example.

Part Ordering: Mixed-up or Classified?

The first operation for the robot in machine tending would be to grab a part. When a robot needs to grab a raw part, localization needs to be given to the robot so that it can grab the part correctly. There are two general ways to structure the parts that need to be machined. First of all, a classified racking system can be used. In fact, if the parts are classified in a certain way, so that the robot knows exactly where the part is, then coordinates for the parts are easier to program. By using this system, a certain amount of time and effort has to be put into the design of the racking. If the parts that are going into the machine will remain the same over a long period of time, there is no need to think about flexibility. Although, if the production needs to be changed and a new raw part needs to be classified, it's a real puzzle to design a racking that can fit every raw part or material. Here's a video on how to order raw material using [rigid racking methods](#).



The second way to order your raw material is by using a vision system. Depending on the size of the parts that must be machined, a conveyor, a bin or a drawer can be used for placing parts. Since the parts are not positioned at a precise position, a vision system needs to be paired with the robot program. By taking a photo, the system knows exactly where to pick up the part. If the system needs to be dynamic, an encoder on a conveyor can be paired to the vision system and the robot(s) will know precisely where to pick up the raw part even while it's moving. Here's a video that shows how to order raw material [using a vision system](#).

Prehension: End Effector Grip Force, Payload, Shape...

Prehension is probably the most complicated aspect of the machine tending process. In fact, prehension includes the choice of an end-effector and robot. You need to know what kind of parts in all probability will be handled in the cell. You also need to ask yourself if the cell will be dedicated to a single product or if the production will change every month for example. This criteria will decide the size of your component ([Grip force and payload](#) needed) and if you will need a flexible or rigid cell. In fact, you can use a 2 position gripper for a production that will stay steady for years. On the other hand, you want to use a flexible robot gripper for production that changes relatively often. Grippers like our [2-Finger 85 Adaptive Gripper](#) and even [3-Finger Adaptive Robot Gripper](#) are ideal for flexible applications.



Don't forget to check if the grip force and payload of the gripper and the robot are appropriate for your machine tending. Consider having a double gripper so you can exchange parts faster with the machine. Don't forget your number of setups. Having several setups for the same parts requires you to have a gripper that can handle the same parts, but with different characteristics. Get more information on [how to choose the right gripper for your robotic application here](#).

Movement: Speed vs. Precision

When thinking about machine tending, most people are obviously thinking about fast production. However, don't forget that being too fast is often synonymous with lack of quality. The speed of the different movements of the robot needs to be correct for each step. Normally, the prehension operations are done very slowly. In doing so, the gripper can take the parts very precisely and apply the correct amount of pressure on the part. The motions from outside the machine to near the machine vise can be executed with a relatively fast speed. The insertion of the part into the vise needs to be done with caution (which means slow speed!) Be careful in putting the part in the right position—you don't want the part to be inserted too fast and therefore to be mispositioned.

Vise

Even if it seems fairly simple, the vise inside the machine needs to be precise and adjusted to the parts that are machined. Most vises are equipped with a pneumatic or hydraulic system that keep the part in place during the machining operations.



Moving out!

As the part is being picked up by the robotic end effector, the robot can move relatively fast to put the part into the final ordering device.

Final Ordering

Consider a basic ordering method and try to enhance this process to simplify packaging or further production steps.

Measure

By transferring the loading task to the robot, the operator can look at some important dimension of the parts. By doing so, the operator can insure that the production is stable, the tools are nice and sharp and that the final product answers the customers' needs.

Other Tips

Like most robotic applications, you may want to do a couple of simulations before bringing a die cast into your machine frame, right? So companies are developing software that is specific to machine tending operations. A program like this allows you to have a faster startup time and to, of course, reduce your risk of error.

Security is always a concern when talking about machine tending. Make sure to do a proper risk assessment and to secure the working area of the robot. Make sure to verify the applicable norms for industrial robots. Design the security perimeter taking into consideration your machine. In fact, maintenance is critical for the quality and functionality of your machine. Your security devices (if applicable) allow the operator to change tools when necessary and to do complete maintenance when needed.

The machine-robot compatibility needs to be considered in the integration of your cell. Most of the time, the machinery is already in the shop, so choose a robot that is well-suited to your machine.

Floor management should also be considered in your robotization concept. Can you do your machine tending on two different machines using the same robot? Do you want to use a rail to move your robot from one machine to another? Is it more appropriate to use a robot that is upside down? Do you want to use a conveyor or not? These are all different questions that you need to ask yourself when you are thinking about machine tending. You want to reduce the footprint on your floor by being more efficient. Machine doors also needs to be automated too. This step is usually simple to integrate as newer machines are usually already equipped with this device.

2. Flexibility

The question still remains: Is there an issue with automating machine tending operations? The answer might still be yes... and no.

Yes, because machine tending applications often have to deal with a high-mix of parts. For larger companies having to handle similar parts or a high volume of different parts; while this issue might only be a technical issue that can be solve by designing custom robot tooling, considering the cost efficiencies of flexible machine tending solutions might still provide a better payback. However for smaller businesses dealing with high-mix, low-volume parts the issue is not only on the technical side, but also on the financial side. Indeed, the low-volume of different parts to be machined are often not profitable if we must design custom robotic tooling. In these cases flexible solutions are a necessity.

No, because now flexible solutions such as our [Robotic Grippers](#) are designed for industrial applications. With the arrival of flexible robot grippers it is possible to handle a wide variety of part shapes and sizes with no compromise on precision – Read our [white paper](#) about it. The financial aspects can then be easily solved, leaving you to work on the technical aspects. To be able to use a single robot gripper to handle many different parts represents a huge advantage whether you are a SME or not.

3. Customer Example

[Inertia Switch](#), an American manufacturer of all kinds of switches for high-tech industries and a full-service manufacturing provider in aerospace, mechanical and electrical products, used the full benefits of automation for a machine tending application involving the Robotiq Adaptive Gripper and Universal Robots.



At the time they started to automate the process, they decided to go ahead with a conventional workcell, fully guarded, that cannot easily be reprogrammed for their needs. The current pneumatic grippers are limited to a few parts, and since Inertia Switch makes over 1,000 parts, they needed a more flexible solution to optimize their machine tending production process.

The Challenge - Optimizing Machine Tending Production Processes

- Inertia Switch needs to do more with less
- Any machinist should be able to easily manage the robot system and the gripper
- A minimum setup time and fast turnarounds are essential
- 1 year payback

The Solution - Making Robotic Flexibility Accessible To Everybody

- 2-Finger 85 Adaptive Gripper paired with a Universal Robots arm for quick and easy programming
- No additional cost or special expertise necessary to install the Robot Gripper
- Easy production setup for CNC machinists
- Ability to manage short runs of 100 parts with a fast turnaround
- Only solution that fits with almost all of their parts

The Results - Production Improvement and a New Tool for R&D!

- A single robot and gripper system to handle almost all their parts
- Time saved on changeovers and robot setup
- Less than 1 year payback
- New robot application opportunities using the 2-Finger 85 Adaptive Gripper and UR Robot
- Only 1 day of training for a machinist to operate the robot and Gripper



The cell that Inertia Switch is using includes a Universal Robots and a Robotiq [2-Finger 85 Adaptive Gripper](#), simply fixed on a table. The robot has no fencing because it **is force limited**. This means that the robot can detect if an impact occurs. The co-workers can work alongside the robot without undue risk. The Gripper used for this application is **flexible** which means that it can handle a fair number of different shapes, dimensions and materials without any modifications. So with a simple collaborative robot and a flexible Gripper you can feed your machine without touching anything.

Robotiq also provides a kit with everything you need to integrate the Gripper on the UR robot very easily. The ROI (Return On Investment) is fast. Most of the companies who have bought a Universal Robots for machine tending applications claim to have payback within 12 to 16 months.

To view the machine tending application in progress check out the following [video](#). The Gripper and UR combination is even used to open and close the door on the CNC machine. For further information on this machine tending application read the complete [case study](#).

4. Why Use a Robotiq Gripper for Machine Tending?

With the release of our new [2-Finger 85 Adaptive Gripper](#) we have noticed an increased interest by end-users for machine tending. In fact, we have seen several applications of our Gripper paired with a Universal Robots used in the loading and un-loading of CNC machines. Why is the Robotiq Gripper currently so popular for this application? Here's a list of 5 advantages to consider which will answer this question.

1. Wide Programmable Stroke

One of the main advantages of Robotiq Grippers is that they can grasp a very wide variety of objects. In fact, the [2-Finger 85 Adaptive Gripper](#) can grasp objects with any geometry within the 0 to 85 mm range. With the use of the encompassing mode, this Gripper can also grasp cylinders from 43 to 85 mm wide. So with a single Gripper, you can grasp a wide range of geometries and dimensions. This means that a high mix of parts can be machined using the same Gripper for machine tending applications. Since the stroke is programmable, it can be



optimized to reduce cycle time. For example, if an object is 25mm wide, it is possible to open the Gripper to 30 mm to grab hold of the object. This means that the Gripper only has to perform a 5 mm stroke instead of a 60mm stroke during the grasping operation. And the same thing occurs once the object is released. These specifications mean that a couple of seconds are saved by each pick and place operation which at the end of the day will result in a reduction of cycle time.

2. Built in Feedback

The 2-Finger 85 Gripper has a built-in object detection device. So the Gripper can send a message of "YES, I have the part" or SHOUT, "NO, We just missed it". Seriously, the Gripper can detect the presence of a part and by knowing the approximate position of where it should be for any given part, the Gripper knows if the part has been grasped or not. Thanks to motor encoders, the Gripper can determine if an object is grasped with a resolution of less than 0.3mm. However, it was not designed to measure parts.

During the motion from the pick layout to the CNC machine, the Gripper can detect if the part has been dropped. In fact, because coolants from the machining process are often transferred to the finished part, these parts can be slippery and this is why this feature has been incorporated into our Grippers. For example if a part is dropped, the Gripper can detect this and can give feedback to the robot. Either the robot can try to pick another part or it can literally stop.

3. Self-Adaptation

The interesting thing about the Gripper is that there is no need to know the geometry of the part you will pick. In fact, since the Gripper is force limited, you can set a certain force and close the Gripper on the object. Whatever the size or shape of the parts, the Gripper will adapt its fingers to it. Regardless of whether it is round, square, jagged, uneven, etc.



The Gripper can also grasp an object via its internal diameters. Note that the force applied on the outside diameters (O.D.) is the same amount of force that can be applied on the internal diameters (I.D.). So the Gripper is efficient in both directions.

4. Easy to Modify Fingertips



We have noticed that machine tending operations sometimes use custom fingertips on our Grippers. Since a robot is usually paired with a machine that accomplishes a particular task or set of tasks on a certain part or a certain group of parts, fingertips can be adapted to perfectly fit these parts. The Gripper can be provided with flat aluminum fingertips or silicone covered ones. Because many applications are unique, we have many different fingertips that can be adapted to many different types of applications, ask our sale representatives about the options available.

Sometimes when a custom fingertip is mounted on our Gripper, the design is done by the user in-house. In order to facilitate this process we provide all the technical data needed to produce your own custom fingertips. See our [instruction manual](#) for more information or consult the following [blog post](#).

5. Simple Control

Since most of the companies that are doing machine tending with our Grippers are not specialized robotic companies, we have made a conscious decision to try to reduce their programming time and effort. So we offer software with easy installation and simplified commands for control methods, so that the Gripper is easy to use for everyone. As I said, the Gripper doesn't need to know what the geometry of the part is, a simple "go to" command can be sent to the robot to close its finger around the object. The Gripper is also force limited which means it can't damage a part if the force is correctly set. To simplify the robot cycle, instead of waiting to make sure the robot has grasped the part, the Robotiq Gripper has built-in object detection which can give direct feedback to the robot program. If the part is grasped, the robot is now sure that everything is fine and that it can continue in its path.

Bonus

The [2-Finger 85 Adaptive Gripper](#) is well adapted to CNC operations, in fact, since there are a lot of fragile parts that come out of CNC machines, you want to be relatively careful with them. With the possibility to adjust the force of the Gripper, it is really easy to grasp parts without damaging thin walls or delicate structures, for example. Robotiq also provides a software package especially for machine tending operations. We have built kits for Fanuc and Universal Robots. These kits make the installation on the robot easier and the integration of routines as simple as 1-2-3.

The idea is to provide to end-users all the tools necessary to make machine tending easy. Since introducing robots to a workshop can be complicated on many different levels, we really want to reduce the setup time and provide flexible cells that are easy to work with. Our Grippers are designed to be easy to use on a wide variety of parts, with all their specifications, they are the right Grippers for machine tending applications.

5. What About the Operator?

Some people might be thinking, 'I bet the robot took the place of that machinist and now this guy is out of a job'. NO! The goal of collaborative robots is to do more of the manual tasks and free up the human worker for more oversight, other tasks or more supervisory tasks. In fact, the worker can now focus on quality and parts verification. Instead of providing the physical labor he can optimize the process and make sure the production is running smoothly. Tasks such as equipment maintenance can be done more often and all of this without having to worry about whether or not the machine is getting fed. So the employee can:

- Focus on process optimization
- Focus on product quality and verification
- Prepare setups
- Be redirected to more important or pressing tasks
- Work is a more stimulating environment

The operator can constantly learn new things and not just stand in front of the machine waiting for the next part. The job is more stimulating for the worker and the quality and consistency of the products improves.

Everywhere managers are complaining about not having enough time to do maintenance or to verify every part... well, here you go, this gives you time right there. Most of the operators will also have relocated tasks, in fact even if you don't need a full-time programmer, you will still need someone to manage the robot and to make sure everything is working fine. This is the case for Slobodan Todoric, a former machinist who switched to collaborative robot programmer. Actually, he is still a machinist, but now he also does root programming.



Slobodan is a machinist that works for [Inertia Switch](#). The New York based company wanted to increase the output and efficiency of its production. As robots are getting cheaper and easier to use, the most logical decision was to put a robot in place to do the machine tending without affecting jobs. Take a look at the [following video](#) to see what he really thinks about his new job. With a [constantly evolving workforce](#), it might be the time to move to automation.

At the end of the day, the manager has better production, happier employees and a more stimulating working environment. It's a win-win situation.

CONCLUSION

As you can see, machine tending is way easier than you thought. The new generation of robots and grippers allows the end-user to have a highly mixed production and still be able to use a robot. With the 2-Finger 85 Adaptive Gripper and Universal Robots team it is now easier than ever to load and unload a CNC machine. Your employees are redirected to more important jobs and can add value to your product without extra work. With the increasing demand of customers and shorter lead times, maybe it is time to make your machine work around the clock.

Ask...

You should definitively ask your gripper representative or application engineer if your applications are suited for certain types of grippers. Some gripper manufacturers can make customized grippers or gripper parts (customized fingertips, customized opening range) depending on your request. You should definitively tell the representative what your applications are and work around them instead of adapting your operations to the robot and gripper.

For further information, feel free to visit our website: www.robotiq.com

ABOUT ROBOTIQ

Robotiq designs and manufactures flexible robot grippers. We aim to give to industrial manufacturing – from large businesses to SMEs – flexible peripheral solutions to optimize automated processes by providing universal, agile and rugged robotic tools.

We work with robot manufacturers, system integrators and end-users to enable new applications and improve productivity.

We are Robotiq. We make tools for agile automation.

TO LEARN MORE

For any questions concerning robotics and automated handling or if you want to learn more about the advantages of using flexible electric handling tools, contact us.

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