



CNC MACHINE TENDING

*HOW TO AUTOMATE YOUR CNC WITH
COLLABORATIVE ROBOTS*

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TABLE OF CONTENTS

What Is Robotic Machine Tending?	1
<i>Automated CNCs vs. Robot CNC Systems</i>	
<hr/>	
Why Use Robots for CNC Machine Tending	2
<i>Increase Productivity</i>	
<i>Cost Savings Over Time</i>	
<i>Worker Safety</i>	
<i>Increased Reliability</i>	
<hr/>	
Potential Challenges of CNC Robots	3
<i>Robot-Machine Interface</i>	
<i>Efficient Robot Redeployment</i>	
<i>Integration Between Multiple Machines</i>	
<i>Achieving Lights Out Automation</i>	
<hr/>	
When is a CNC Robot Right for Your Machine Tending Operation	5
<i>You Need Faster and More Efficient Production</i>	
<i>You Are Struggling with an Unstable Labor Pool</i>	
<i>You Must Reduce Labor Costs</i>	
<hr/>	
CNC MACHINE TENDING INTEGRATION CHECKLIST	6
Major Components of CNC Machine Tending Cell	6
<i>Robot</i>	
<i>Tooling</i>	
<i>Base</i>	
<i>Automated Vises</i>	
<i>Door Systems</i>	
<i>Robot-to-CNC Connection</i>	
<hr/>	
Connect a Collaborative Robot to Your CNC Machine	9
<i>CNC Auxiliary Functions</i>	
<i>Why a Strong Connection Between UR and CNC Matters</i>	
<i>- Simple Ways to Control a CNC with UR</i>	
<i>- A Better Way To Control Your CNC</i>	

TABLE OF CONTENTS

FIND YOUR CNC MACHINE LOADING SOLUTIONS	12
<i>Working with Integrators</i>	
<i>Deciding to Do-It-Yourself</i>	
<i>Choosing Off-the-Shelf CNC Automation Solutions</i>	
<hr/>	
INTRODUCING THE FLEXXCNC™	14
How Does It Work?	15

CNC robotic machine tending is a growing trend in manufacturing today. In a highly competitive market, manufacturers are looking for every advantage. So why are manufacturers looking to robotic automation for machine tending tasks?

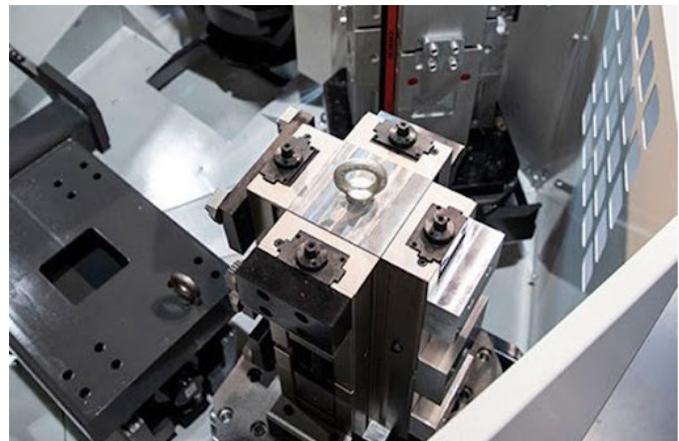
What Is Robotic Machine Tending?

Robotic machine tending uses a robot to at least partially operate a machine. Typically, these are machines like CNC machines, mills, presses, etc. A robot can perform primitive tasks like loading, unloading, and up to more in-depth tasks like fully operating a piece of equipment. CNC robot machine tending is this concept applied exclusively to CNC machines. Therefore, these robots are found in any industry where CNC machines are used.

Collaborative robots have been particularly efficient for CNC machine tending over the last years. Manufacturers like Universal Robots have been a big player in the CNC machine tending application space, and many third-party companies have also developed standardized solutions to facilitate the integration with CNC machines.

AUTOMATED CNCs VS ROBOT CNC SYSTEMS

It is important to make the distinction between automated CNCs and robot CNC systems. Automated CNCs refer to CNC machines with certain add-on components like pallet loaders and part feeders. These components are useful for automation but lack the flexibility and functionality of CNC robot arms.



***For Example:** CNC automation systems often solve a very specific problem. This might be something like a part feeder. However, if the part changes or a need arises to feed and unload a variety of parts, this system will not be able to handle this task. On the other hand, a machine*

tending robot is more robust in that it can be reprogrammed for a variety of tasks and redeployed across several use cases. This makes it a more valuable piece of equipment for dynamic manufacturing environments. It also allows companies to have a better return on their investment since they can [maximize the utilization rate](#) of their robot.

Why Use Robots For CNC Machine Tending?

CNC machine tending robots offer certain advantages for manufacturers. These benefits can be especially useful in dynamic manufacturing environments. Such benefits include:



**INCREASED
PRODUCTIVITY**



**COST SAVINGS
OVER TIME**



**WORKER
SAFETY**



**INCREASED
RELIABILITY**

Increased Productivity:

CNC machine tending robots offer increased productivity over human operators. They often work faster and more efficiently. They also make fewer mistakes which saves material, increases productivity, and justifies the cost of robotics.

Cost Savings Over Time:

Robots can eventually save manufacturers money over time when placed in the right situation. This is certainly dependent on the application being right for the robot. If the robot is misapplied, it might not be producing at a very high level. For example, consider a machine tending robot that is deployed in a low-volume machine tending task. In this scenario, it might not produce enough to justify its cost. This is why redeploying the robot to other tasks, or even other CNC machines can drastically increase savings. However, a robot in the right application can be very productive and generate enough revenue to pay off its cost in a short amount of time. An example of this could be a machine tending robot deployed in a high-volume machine loading task that technicians struggle to keep up with and their other duties. The industry standard ROI has been reduced to 6-18 months especially with collaborative robots like Universal Robots.

Worker Safety:

Worker safety is typically a primary consideration for manufacturers. Direct contact with machines is often the most dangerous place in a facility. Therefore, it makes sense to redeploy human operators to safer and more complex tasks.

Increased Reliability:

CNC machine tending robots are also very reliable. Since robots don't get injured or become sick, you can expect less downtime due to human factors. Robots have incredible uptime and can perform just as well at the end of the day as at the beginning.

Potential Challenges of CNC Robots

Some challenges come with CNC robots that you should be aware of. Being able to take on these challenges will allow you to reap the benefits this technology offers.

These challenges include:



**ROBOT-MACHINE
INTERFACE**



**EFFICIENT ROBOT
REDEPLOYMENT**



**INTEGRATION B/T
MULTIPLE MACHINES**



**ACHIEVING LIGHTS
OUT AUTOMATION**

Robot-Machine Interface:

The link between robots and CNC machines has traditionally been a challenge. This is because most CNC machines are designed with human operators in mind.

Nowadays, we are seeing more and more companies releasing robot interfaces, but they are either costly and/or non-retrofitable between CNC manufacturers. It is possible to find solutions from integrators or even your own DIY projects when needed, but these solutions can be costly and time-consuming.



Efficient Robot Redeployment:

We know that to maximize the potential of your UR robot investment, being able to redeploy it to different tasks and CNC machines is a must. However, robot redeployment comes with challenges.

When a robot is redeployed, it might not end up in the same location it was programmed in. This means you might need to reprogram your robot. This is very inefficient, so being able to reference the program to the machine is a solution to consider.

The [FlexxReference™](#) is, then, a must-have for your robot redeployment. It is a mechanical reference used for this purpose. It updates all the existing waypoints so you don't have to spend time reprogramming your robot for a task it is already programmed for.



Integration Between Multiple Machines:

Next, even if you solve the robot-to-CNC communication problem, the issue compounds when tending to multiple CNC machines. Since manufacturing facilities with multiple CNC machines are likely to have several controller brands, repeating this integration is more complex than copy-pasting.

Achieving Lights Out Automation:

Lights-out manufacturing, the ability to continue production with little to no human supervision, is the most sought-after goal for CNC automation. This is a common advantage of robotics in certain applications. For example, this is possible for CNC machine tending applications as long as there is communication between robot and CNC machine.

To truly run a robot on a CNC machine lights out you need to automate all aspects which may include executing **G-Code/M-Code, operating vises, opening/closing doors, operating chucks, managing stop/start cycles, and operating other types of peripherals.**

If you want to avoid manual interference then, you need a robot to CNC to Robot interface to

manage all of these aspects. However creating an interface can be complex, time-consuming, and costly. Not to mention you need a different interface for each CNC machine you need to interface to.

When is a CNC Robot Right For Your Machine Tending Operation?

The challenges and benefits of CNC robot machine tending systems are clear. So how do you know if this technology is right for you? This is a complicated question to answer, but a few key considerations might lead you to think deeper about the possibility of automating.



You Need Faster and More Efficient Production:

Speed is a common catalyst for automation.

Human operators have a limit to how fast they can work. Fatigue can lead to slower production, mistakes, and wasted material. You can see how these problems can lead to lost revenue. CNC robots are able to perform faster than human technicians. Additionally, they can keep up this pace for as long as there is material to feed it. This allows them to outproduce humans at a more efficient rate in many cases.

Even if a robot can't go faster than your human operators, its capability to work unattended and lights out will bring more productivity. This is as long as your unattended setup is efficient.

You Are Struggling with an Unstable Labor Pool:

Finding great employees in manufacturing seems to be more difficult than ever before. Gaps in your workforce are detrimental to your ability to maximize production and revenue. CNC robots help to fill this gap and stabilize your workforce. They will also empower your actual workforce to evolve and learn to work with that new technology, especially collaborative robots. It will bring them more valuable knowledge and motivation to stay with your company longer.

You Must Reduce Labor Costs:

In a highly competitive manufacturing industry, companies are looking for a competitive edge everywhere they can. Robotics reduces the cost of employment to your bottom line. This

includes both wages and other “hidden” costs such as healthcare and other benefits. The large up-front cost of robotics is eventually offset by the relief of employment costs in the right application. The minimal expenses post-integration like maintenance are considered minor compared to the cost of employing a workforce.

When we understand the benefits and challenges of CNC machine tending, a successful automation project needs the right products and tools. First, you need to take into consideration the CNC park that your company has. Then, you may need to integrate the chosen robot into many different machines to make it profitable.

Now that we understand the challenges and when to automate your CNC machine tending application with robots, what’s next? We will cover the integration checklist when you are automating your CNC.

CNC MACHINE TENDING INTEGRATION CHECKLIST

If you’ve never automated a CNC machine loading process, all the steps may not be obvious. Let us guide you through all the components and steps to consider when integrating a robot into your CNC.

Major Components of CNC Machine Tending Cell

Robot:

Of course, the main component of a CNC machine loading system is the robot. The robot is responsible for carrying out the systematic loading and unloading of material from the CNC machine. Its advantages over an automated feeding system are its flexibility and the possibility of redeploying it as a tool on multiple machines.

While comparing all types of robots isn’t the scope of this eBook, it is common to use collaborative robots for this task. [Universal Robots](#) have proven time and time again that they are a great solution for CNC machine tending due to their flexibility, ease of programming, and safety features.

Tooling:

Tooling, sometimes called the end-effector of end-of-arm tooling, is the component that manipulates the workpiece, like grippers, suction cups, electromagnets, and more. It is a critical component of a machine tending system. Choosing the right tooling should consider all the different machining steps and part setups.

Base:

The robot needs to be mounted reliably and sturdily on a base. There are stationary bases such as pedestals and mobile bases. Mobile bases can be manual or automated and allow easier robot redeployment between workstations.

Whichever you choose, you must make sure the robot will be steady enough to stay precise and repeatable during production. If you want to know more about the basis of robot installation for CNC machine tending, read this article.

TIP: When installing the base or redeploying it in front of another CNC machine, having a referenced program is important to save re-programming time. Mechanical machine reference tools like the **FlexReference™** allow any operator to conduct a robot redeployment efficiently. It uses an intuitive interface and locking mechanism to let the robot know its position in reference to the CNC machine.



Automated Vises:

Vises maintain the parts in the CNC machine during machining. In a traditional CNC machine, those will be manual vises. However, when integrating a robot, the opening and closing of those vises need to be automated. This will ensure minimal operator interaction and a system that will be autonomous.

The best way to automate the vise is to invest in an automatic vise, either hydraulic or pneumatic, and use a robot signal.

Door Systems:

The CNC door will need to open and close automatically to achieve unattended operations. Although we sometimes see the robot arm open and close the door, this isn't the best automation method because it reduces the robot production time and can sometimes cause robot faults. The best installation you can have is an automated door system that can receive a robot signal.

Robot-to-CNC Connection:

Establishing communication between your robot and your CNC machine is necessary to optimize your workflow. Then, your robot can send M-code/G-code to the CNC machine, letting it know to execute its tasks. But is it as easy as connecting your robot to your CNC?

Unfortunately, there aren't easy ways to interface between your robot and CNC machine. Many different CNC interfaces exist, so finding a standard solution that can work in most cases has always been a big challenge in the industry. This leads to frustrations for manufacturers and lost opportunity for optimization.

TIP: From experience, we recommend using the robot as the server of the system and the CNC as the client. It means that the robot will send the G-code/M-code signals to the CNC. The robot, along with 3rd party products designed for the application, will often have an easier-to-program UI than the CNC controllers. This setup will also replicate the operator-CNC interaction, which is already proven to work well.

Moreover, manufacturers often have multiple CNC brands on their shop floor. So when investing in a machine tending robot, [the redeployment](#) of more than one machine can be challenging. So up to now, a custom integration was needed when you needed to integrate your UR robot to a new CNC machine which is costly and complex.

Next, let's give you a better understanding of what needs to be done when connecting your robot to your CNC machine.

Connect a Collaborative Robot to Your CNC Machine

Automating your CNC machine with a collaborative robot offers you the potential to run lights-out production. This maximizes your CNC's utilization rate and leaves nothing on the table when it comes to production efficiency. However, the robot to CNC communication challenge has typically been one that is difficult to overcome in order to get to this level of production.

CNC AUXILLARY FUNCTIONS

Most experienced CNC technicians understand how their CNC machines work. CNC machines are fairly standardized in their basic operating parameters. However, it is worth pointing out some key integration points when connecting your UR to a CNC.

G-Codes:

G-Code is the programming language used by modern CNC machines. G-Codes are the core of the CNC program and define how the part should be cut. They work together with M-Codes and macros to achieve a functional and flexible program.

For Example: The M08 code is used on some machines to activate the coolant. In the middle of a cycle, subroutines can be called using M98 which can be combined with macros for flexible programming between jobs. provides-Codes like these provide modern automation solutions for dynamic manufacturing environments.

Since G-Codes inform how parts are being cut and take time to develop and test, it's a big ask to make changes to production code. Solutions that require changes to the core G-Code programming can involve a significant lift for engineers and technicians. However, it's sometimes necessary to add new M-Codes and subroutines to add new functionality to these jobs.

Flexxbotics solutions are built around ease of use: leaving the core G-Code programming intact while adding automation functionality makes the automation process faster and easier. The FlexxCNC™ makes use of macros to work in concert with the existing G-Code without requiring changes to how the CNC cuts.

M-Codes:

M-codes are the commands for all other auxiliary operations controlled by the CNC machine. These operations include starting the machine and starting the spindle. This is important for robotic automation as these auxiliary functions will have to be automated as well.

The different functions that will need to be automated to maximize the robot cell efficiency are:

- *Operating Vises and Chucks*
- *Opening and Closing Doors*
- *Start and Stop Cycles*

Some CNC machines will already have those controls integrated through their M-codes; it depends on the machine options and manufacturer.

***For Example:** A lathe is more likely to have its chuck and door automated than a milling machine. However, in many cases of retrofit, you will have to automate these with third-party systems.*

Macros:

Macros provide a way to reuse common functions as versatile subprograms within your main codebase. Macros are a type of modifiable value that operates within the main program. They are written with variables in mind and can be added, subtracted, and otherwise modified by the main program.

It's clear that macros save a significant amount of programming time required to rewrite common code. For robot users, this means that common robot functions work together with macros, driving further efficiency within your work cell. For example, Macros can be used to trigger common robot functions like a part flip or debris blow-off. This functionality allows you to write highly-dynamic code that incorporates commands for two different machines and in some cases even passes values from a networked CMM to a CNC macro!

WHY A STRONG CONNECTION BETWEEN UR AND CNC MATTERS

There are different methods to have a UR robot interact with a CNC machine. The choice is yours, but the goal is always to maximize the robot utilization rate.

The initial challenge is to decide if the robot should control the CNC or vice versa. It is always best to have the robot control the CNC machine.

Why?:

From experience, the robot UI is more user-friendly and easier to program than CNC controllers. Moreover, more and more third-party devices are being developed for this application and using the robot as a controller. This setup also replicates the human-CNC interaction that has already proved to work well.

This saves time and effort on your end and is a big reason why the FlexxCNC™ is designed as a robot-side tool from a UI and software perspective.

Simple Ways to Control a CNC with UR:

The most obvious form of control is simply having the UR cobot act as a human would. This means programming it to load the part and physically performing actions like closing the door, operating the chuck or vice, and pressing buttons.

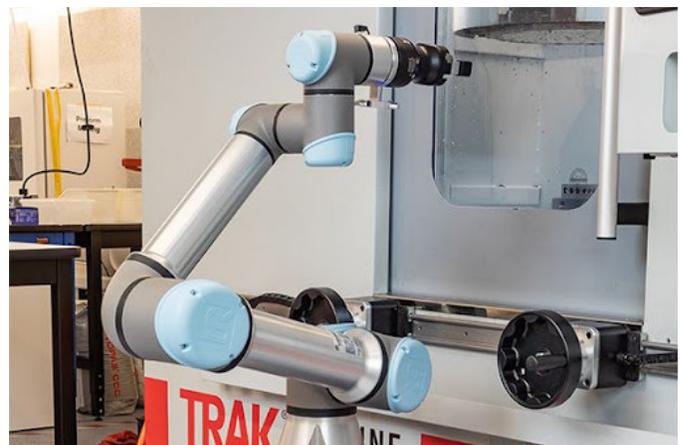
This method is mostly used in the industry to save the automation cost of adding an auto-door system and changing the vises to pneumatic ones. However, there are some glaring weaknesses with this method.

Collaborative robots, like Universal Robots, are fast enough to get the job done. However, all this wasted motion takes precious time to complete. CNC run time—or spindle time—is a key performance indicator for most manufacturers. There are even companies like [Datanomix](#) that specialize in analyzing CNC shop's production data to maximize the spindle uptime.

In this case, delays due to unnecessary robot motion reduce spindle time leading to fewer parts per day. Moreover, all that time begins to add up if you consider the door opening and closing, activation of the chuck, and others. So, next is what will maximize your efficiency.

A Better Way to Control Your CNC:

Facilitating a direct line of communication with your CNC allows for rapid response and takes advantage of automated features like auto-doors and automated chucks/ vices. Your UR robot could simply load the part, and as soon as it clears the door, send a signal to close the door and start the program. Moreover, this setup is a much simpler robot program to implement.



Manually closing vices and button sequences are additional complex motion paths for robots. All these paths need to be programmed for the robot to perform reliably. If these steps can be done via communications, it reduces this programming complexity.

It's much easier to program just the loading and unloading paths. Not to mention the spindle time saved for a workday by cutting out this extra motion.

This increase in [utilization rate](#) means your Universal Robot is spending less time doing things that aren't directly contributing to creating the part. Naturally, this leads to more parts produced per day. The greater this value is, the greater your return on investment will be.

There are also additional optimizations to be found here. For example, you can have the door open while the robot grabs a part. In addition, little time optimizations ultimately increase utilization rate, spindle time, and your return on investment.

You now better understand what is involved in integrating a robot to your CNC machine. At that point, you have different methods to attack the project. Either do it yourself or partner up with integrators to do the project for you.

Wait! There might be a third option... Read on!

FIND YOUR CNC MACHINE LOADING SOLUTIONS

There are plenty of options and configurations available to manufacturers for CNC machine tending solutions. These solutions come from 3 types of providers: integrators, do-it-yourself solutions, and off-the-shelf CNC automation solutions. So which one is right for you?

Working with Integrators:

Integrators are industrial providers that offer a wide range of services, including custom robot integrations. While an integrator may provide a solution for the communication between your UR robot and CNC machine, it will likely be a custom solution that won't allow for redeployment to other machines down the line. This also means paying for up-front development costs that companies offering standardized solutions like Flexxbotics have already figured out.

Deciding to Do-It-Yourself:

Do-it-yourself solutions often have the cheapest up-front cost since you don't have to hire a 3rd party (at first). However, these initial cost savings often lead to extra opportunity costs over time. Moreover, project timelines may extend due to the need to learn on the fly. During this time, the production may not be running. On top of that, there are countless horror stories of end-users taking on a DIY robot project and making so many mistakes that they have to end up hiring an expert to finish the job. This can sometimes end up being the costliest option.

Choosing Off-the-Shelf CNC Automation Solutions:

CNC automation specialists like Flexxbotics often have off-the-shelf standardized solutions for CNC machine tending projects. When DIY and integrator solutions can have long project timelines, off-the-shelf automation solutions are plug and play. Those solutions mean less uncertainty and frustration up-front than making different components work together.

We also need to mention that many CNC machines don't have standardized methods for connecting a UR robot. Additionally, this process may be different for each controller brand.

Flexxbotics is here to help.



INTRODUCING THE FLEXXCNC™

The [FlexxCNC™](#) is a standardized middleware solution for connecting your UR cobot with several CNC brands. This product removes the confusion and wasted time associated with making your UR to CNC connection.

Both do-it-yourself and integrator solutions can be time-consuming and costly. The FlexxCNC™ is simple to use and robust enough to work on multiple machines. This allows for fast and simple redeployment.



The FlexxCNC™ is a key component on the path to lights-out production for your facility.

To truly run a robot on a CNC machine lights out you need to create an interface between your robot and your CNC. **An interface gives you the ability to automate all aspects of running a CNC including...**



**LOAD
G-CODE**



**CYCLE START /
END DETECTION**



**WRITE
MACROS**



**CONTROL PERIPHERALS
(DOOR, VISE, CHUCK)**

Flexxbotics makes it as easy as possible to set up the FlexxCNC™. Spend less time with setup and more time producing. This new device centralizes the control of all the elements discussed above (G-code/M-code, vises, doors) through the middleware. It includes a standardized hardware and software interface for several major CNC brands, including:

LOKUMA

FANUC

HAAS

Mazak

DMG MORI

brother

How Does It Work?

Simply, set up the hardware, wire the connections, tell the FlexxCNC™ what your Universal Robot is connected to, then build your program and test the results.

You're then well on your way to maximizing your production. Flexxbotics provides you with everything you need to get started.



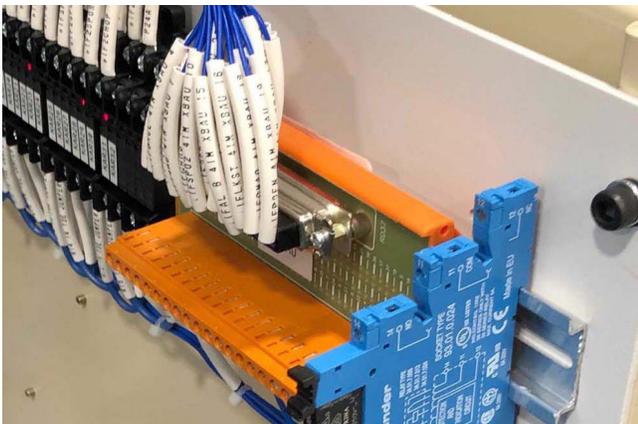
1. Upload the Executable

Use the provided USB and upload the Flexxbotics executable file onto your relevant machines.



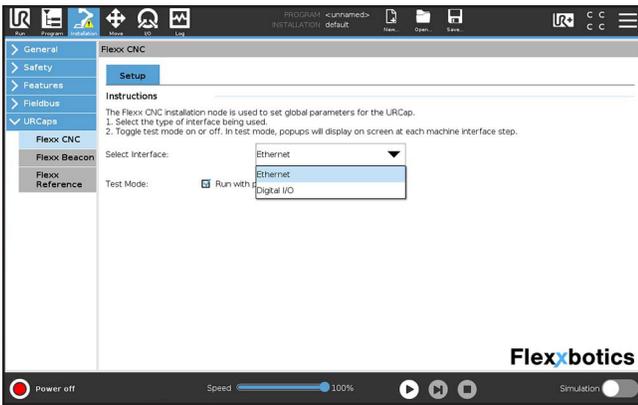
2. Mount the Middleware

Mount the Flexxbotics Middleware box onto your robot pedestal.



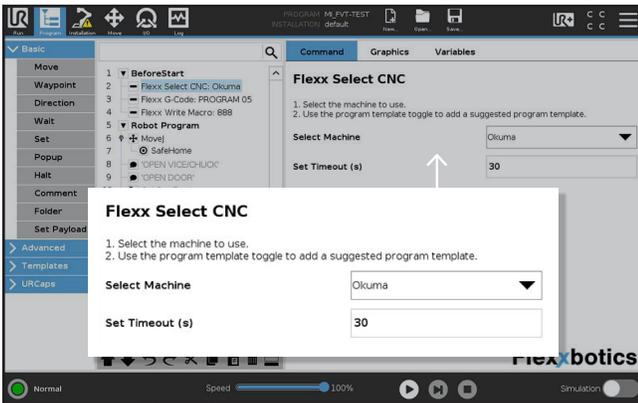
3. Make All Necessary Connections

Use the provided USB and upload the Flexxbotics executable file onto your relevant machines.



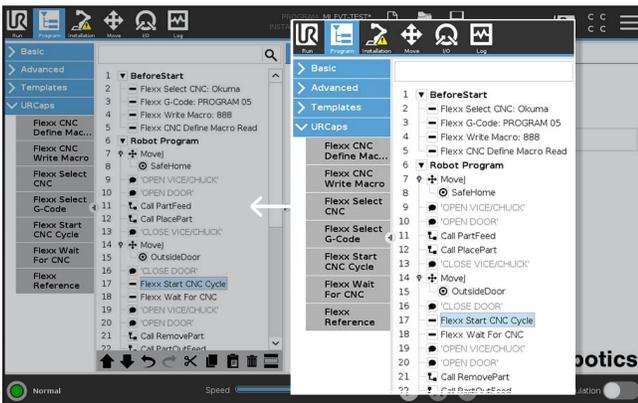
4. Choose Your Interface

We provide both an option to choose an Ethernet or DIO interface to your UR and CNC. Select which one you are using in the Flexxbotics provided URCap.



5. Select Your CNC

Choose which machine you are running on within the URCap.



6. Build Your Program

Use the Flexx CNC nodes in the URCap to build your Universal Robot program.



7. Run Your CNC

You can now easily run your CNC machine unattended with a Universal Robot with all aspects being automated.

READY TO GET STARTED WITH YOUR CNC MACHINE TENDING APPLICATION?

Reach out to our team and we will validate if FlexxCNC™ is the best fit for your operations!

[REQUEST A DEMO](#)

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