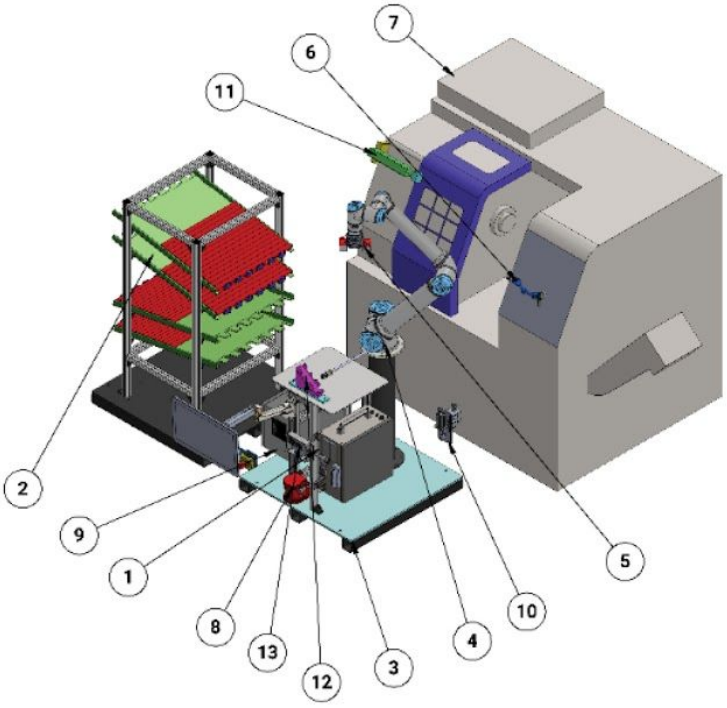
Getting Started: CNC Lathe Automation Guide

The Easy, Yet Flexible Way to Automate CNC Lathes



READY ROBOTICS

Introduction

Automation of CNC lathes, including the loading and unloading of parts, has been difficult to implement in the past because of the amount of variety in the machines, high changeover in most applications, and the need for high speed and precision. Fortunately, there is now a standardized solution enabling the robotic automation of CNC lathes. CNC lathes can be automated by using READY's standard, yet flexible, solutions. Most importantly, the automation can be done with an ROI in less than 12 months, and often in as little as 3-4 months.

All of the automation tasks, including the loading and unloading of parts, can be implemented by your team or a READY Certified Installer using our READY Made Turnkey Solution for CNC lathes and our easy to use robot programming application, Task Canvas. Where the READY solution differs from others on the market is that:

- Our visual programming application, Task Canvas, makes it easy to develop and maintain the automation tasks. The primary benefit being that the CNC programmer, maintenance technician, or machine operator can program the robot, not just the select few who managed to attend the training (or the integrator you have to have on call).
- Our operating system, Forge/OS, enables you to choose the right robot, at the right price, for your task. Supported robot brands are FANUC, Kuka, Universal Robots, ABB, and Yaskawa.
- The READY Teach Pendant replaces the difficult to use teach pendant that comes with the robot. The READY Teach Pendant is easier to use since its touch screen enables you to access all of the Task Canvas features without a difficult to use keypad.
- You can maintain the automated solution on your own without having to attend expensive, and lengthy, training from the robot vendor
- The solution is flexible since it is easy to modify Task Canvas programs. Task Canvas programs have building blocks that make it simple to support new part requirements when they come up. Multiple SKUs can be easily handled from one run to another by loading another plan into the Task Canvas application.
- Peripherals, PLCs, and EOAT from other vendors can be added to the solution based on your specific requirements. This ability to configure the solution ensures it can grow with your operations.

Our READY Made Turnkey solutions are easily repeatable and scalable. If you have many cells performing the same process, you only need to program the task once and then deploy it to similar work cells.

Requirements for Automating a CNC Lathe

The table in this section lists the requirements to automate a CNC lathe. For many of you, these requirements are obvious. However, we've found that during implementations, especially with cobot applications, there is not a clear understanding of every aspect of the workcell that needs to be automated. It's important that all areas are evaluated based on your application and the make and model of your machine tool.

Requirement	Description
Feeding parts	Parts need to be made available to the robot arm and allow for: - Easy reloading of the parts by an operator for each run. - The task to run unattended for long periods of time. - A predictable location for the robot arm to find a part in the right orientation.
Part picking	To pick a part, the automation program must: - Know that a part is available to be picked from the feeder. - Identify the location of a part. - Command a tool to pick up the part.
Placing the part in the lathe	To place a part in the lathe: - The robot arm must reach into the lathe and insert it into the chuck. As part of the design of the solution, calculations must be done to ensure that the combination of the robot arm, the gripper, and the part has enough space to fit into the lathe. The available space dictates what is known as the "work envelope" of the robot arm. - The part placement must be done precisely with little to no variation between each cycle. This precision is sometimes ensured by using a backstop, but can also be reliant on the robot's positioning of the part
Securing the part in the lathe	Once the part has been inserted into the chuck or collet of the lathe, the part needs to be secured. The securing is often accomplished by using one or more foot pedals to close/open the chuck or collet.
Closing the lathe's door	In cases where starting the cycle does not automatically close the door, the door needs to be closed another way before the cycle is started.
Starting the cycle	The cycle needs to be started on the lathe. The capabilities of the machine need to be investigated to determine if digital I/O can be utilized or if another method is required.
Determining the machining is completed	The automation plan needs to determine when the machining is complete based on the capabilities of the machine. Some machines have digital signals that can be used to identify when the machining is complete.
Opening the door	The door needs to be opened so that the arm can retrieve the part.

Retrieving the part	The part can be retrieved after the machining is completed. To retrieve the part: - The arm reaches back into the machine to get in place to retrieve the part. - If required, performs a finishing process, such as blowing away chips, while the part is still secured in the machine. - The gripper grabs the part securely so that the part can be removed from the machine. - The chuck or collet is released
(Optional) Flipping the part and machining the other side.	For some tasks, the part must be removed, re-oriented, and placed back into the machine. Depending on the requirements, a fixture where the part is temporarily placed may be needed to assist with this action.
Removing the part from the lathe	The finished part needs to be removed from inside the machine by the robot arm.
(Optional) Inspecting the parts	Depending on your requirements, a parts inspection process could be implemented. The requirements for part inspection should be understood so the appropriate type of solution can be added, such as a vision system.
Placing the finished part in the output location	The part is placed in an appropriate output location. If the optional parts inspection process is implemented, then the output location may change
Checking if a part is available for another cycle	If a part is available, then the automation plan can begin another cycle. Part availability can be determined by: - Having a sensor on the part feeder - Using a counter to keep track of the number of parts that have been processed

Diagram of a CNC Lathe Automated for Loading and Unloading

Diagram of a CNC lathe that has been setup for automated loading and unloading is shown in Figure 1. We will describe each component of the automation in the next section.

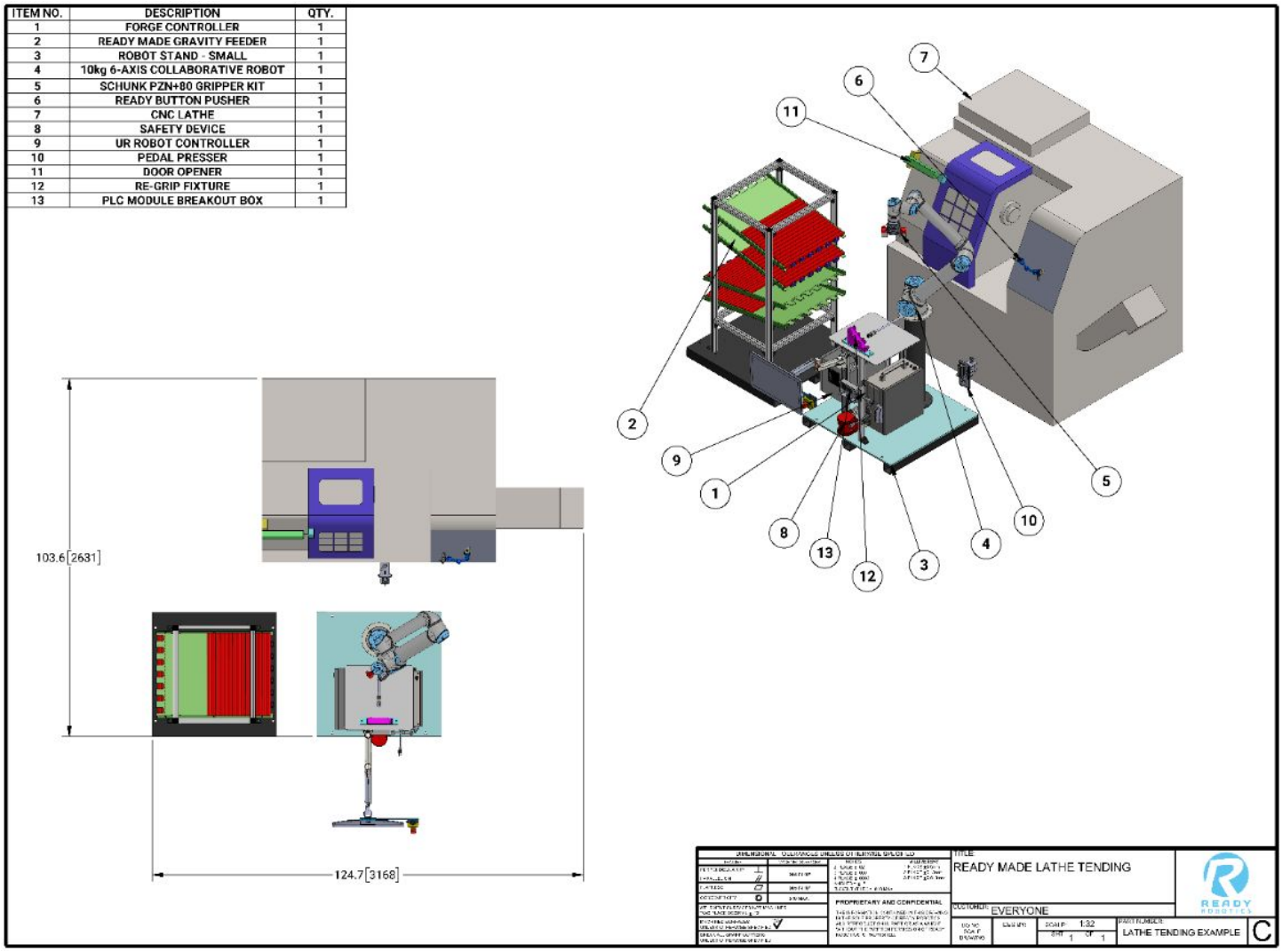


Figure 1 : READY Made Automated CNC lathe configuration with a collaborative robot

READY Made Turnkey Solution Components

READY solutions are predesigned to support the requirements for automated loading and unloading of CNC lathes. The solutions are made up of components that address the automation requirements described in the previous section. The following table provides a detailed description for each component that makes up an automated CNC lathe work cell.

Reference	Component	Description
1	The READY Forge/Ctrl	An IP54 rated controller, including I/O, that the robot, its EOAT, sensors, machine tools, and other peripherals are connected to. The Forge/Ctrl includes pneumatics, 24V I/O, EthernetIP, and Modbus.
2	Part Feeder	Part feeders come in all shapes and sizes, and the number of parts that need to be held to support unattended operation. READY sells many part feeders for common part sizes, but units from other vendors may solve specific problems with parts presentation for your application.
3	Robot Stand	A fixed stand, such as the READY Made Robot Stand, where the Robot and Forge/Ctrl is mounted. It is also common for our customers to fabricate a stand on their own to their own specifications.
4	Robot Arm	The robot itself, a 6-axis robot from FANUC, Universal Robots, ABB, Yaskawa or Kuka. Depending on the requirements of the process, such as the speed, precision, and part weight, a robot that meets the requirements must be chosen. Collaborative robots offer many benefits such as safety and enablement for a worker to be in close proximity while it operates. However, when higher speeds or moving heavier weight parts is required, a non-collaborative robot may be needed. In these cases, the addition of a safety cage and/or laser safety curtains is required. READY experts can help choose the best robot for your application.
5	End of Arm Tooling (EOAT)	For CNC lathes the EOAT is most commonly a 2 or 3 finger gripper that is used for manipulating the part. Often other components are added to the robot such as plates that are used to push a part into the lathe or to push or pull a door handle. Force sensors are also commonly used on the EOAT since they are helpful when inserting parts into the machine precisely. A force sensor can be triggered when a particular position in the machine has been reached by pushing against a bump plate. They can also be helpful when picking parts from a stack that is of unknown height.
6	Button Presser	When digital control is not available, or due to the expense of the option from the machine tool manufacturer, a pneumatically controlled button presser can be used to automate the cycle start or other machine functions. READY offers its own button presser that can be mounted to most machine tools. While the robot can be used to actuate the machine, a Button Presser results in a faster cycle time.

7	CNC Lathe	The machine tool itself. The READY Made Turnkey solutions support modern as well as older model CNC lathes.
8	Safety Devices	Based upon the results of your risk assessment of the work cell, safety devices, including the installation of a safety cage, may be required to mitigate risks. There are a variety of options available to implement safety controls based on your specific requirements. When using electronic devices, they are wired directly into the robot's safety circuit as well as safety rated I/O wiring blocks that are able to halt unsafe equipment movement in the work cell when an unsafe condition has been identified.
9	Robot Controller	The robot arm has a controller that provides power and control to the robot arm. The controllers vary in size so the design needs to account for their placement in or near the work cell. The robot controller sometimes requires certain features to be enabled, and hardware or software to be installed, to allow it to interface with Forge/OS.
10	Pedal Presser	A foot pedal is often used to actuate the hydraulics that opens and closes the chuck on a lathe. A Pedal Presser can be used to depress the pedal as part of the automation.
11	Door Opener	Depending on the machine tool's capabilities a pneumatic door opener may be required. While the robot arm can be used to close the door in some situations, a collaborative arm may not have the force necessary to open and close the door. The cycle time may also dictate a pneumatic door opener be used since it is quicker than the robot in most cases and the robot arm can move to another position in parallel with the door operation. There are off the shelf products provided by a variety of vendors, but READY also has a design for a proven and consistent pneumatic cylinder solution. The customer can assemble the components by choosing parts specific to their machine.
12	Reorientation Fixture	This operation may require more than a turn of the arm, so a reorientation fixture is used so the part can be placed down, and then be picked up in a different orientation prior to placing it back in the machine.
2	Unload Location	The location for finished parts, whose requirements are dictated by the size, shape and material of the part itself. In the configuration shown here, the part feeder is also the location for the finished parts.

Connecting the Components

The automation components must be integrated together so the READY Task Canvas application can automate all of the operations in the workcell. The following table outlines each component connection along with a description of what is being controlled.

From	To	I/O Type	Description
Forge/Ctrl	Robot	Ethernet	The Forge/Ctrl is interfaced to the robot controller over an ethernet connection
Forge/Ctrl	Gripper	Pneumatics or Digital	Collaborative grippers, such as those from Robotiq are electrically activated. Most other grippers used in industrial applications are actuated using pneumatics.
Forge/Ctrl	Foot Pedal Presser	Pneumatics	For CNC lathes where the chuck hydraulics are activated by a foot pedal a READY Made Foot Pedal presser is utilized.
Forge/Ctrl	Button Presser	Pneumatics	For CNC lathes where the cycle start can only be activated via a button a READY Made Button presser is utilized.
Forge/Ctrl	CNC Lathe	One of: ● 24V I/O ● EthernetIP ● ModBus	Some machine tools have modern interfaces that can be accessed via 24V I/O or one of the FieldBus protocols. However, some machine tools either do not support direct integration without expensive options, or require undocumented M codes for activating functions and receiving feedback. As such, door openers, foot pedal presser, button presser, or even the robot itself are used for all aspects of the machine integration.
Forge/Ctrl	Sensors	Various	Various sensors can be integrated to notify when a part is ready, or when a vision system has verified a part.
Robot Controller	Safety Sensors	Direct I/O	When safety systems are involved, devices specifically rated for safety I/O must be used. The robot controller always includes a safety channel that can be used as part of the solution.

Programming and Maintaining the Task

The heart of a READY Made Turnkey solution for CNC lathes is the automation task written in READY's Task Canvas application. The task is developed graphically and can be programmed by almost anyone with less than two hours of training in Task Canvas. A key aspect of the Task Canvas is that all of the I/O is controlled in the same task that is used to control the robot movements. This integration of control logic makes for a natural way to develop the tasks since all of the steps can be visualized in one place without having to rely on logic to be built in other devices such as Programmable Logic Controllers (PLCs). There are occasions where PLCs can be used and integrated with the system, but for most CNC lathe tasks all the I/O necessary to control the work cell is available on the Forge/Ctrl.

Required Safety Considerations

A required part of any robot installation, even those using collaborative robots, is a risk assessment of the work cell. For collaborative robots in particular, it is not the robot's make and model that make the task collaborative. *Whether a robot can be used in a collaborative setting is defined by the task the robot is performing and the space in which the task is being performed.*

The Robot Industries Associations (RIA), as well as other organizations, have training and standards that can be used to perform the risk assessment. For example, the RIA's book on Task Based Risk Assessment has a guideline for how to perform the assessment and comply with *Standard ANSI/RIA R15.06-2012: Industrial Robot Safety*.

The result of the risk assessment will be a determination you make with respect to what equipment and procedures are necessary to mitigate the risks you've identified. That safety equipment as noted above can be integrated in a standard way into your workcell.

Conclusion

A READY Made Turnkey solution enables a CNC lathe to be automated in days. We've walked through many requirements that need to be considered and solved to automate a workcell. Missing requirements can result in wasted time and money. However, by using a READY Made Turnkey solution, the complexity is removed, and the workcell can be automated in a predictable manner from the cost to the implementation timeline.

We hope this overview into loading and unloading automation of a CNC lathe has shown you how easily you can automate the loading and unloading of your CNC lathe.

READY

READY has developed the world's first, robot vendor agnostic, enterprise-grade, industrial operating system, Forge/OS. READY's products power standard solutions for loading and unloading of CNC lathes that dramatically reduces the time and effort to automate most work cells. Forge/OS runs on controllers made by READY such as the Forge/Ctrl that includes pneumatics, 24V I/O and Fieldbus connectors. Task Canvas is the first of many applications to run on Forge/OS that enables virtually anyone, with little to no training, to program not only the robot, but all the other devices, including the machine tool, in the workcell. READY's cloud applications such as Forge/Sight allows manufacturers to have access to their data in either raw form, or visualized, in pre-built dashboards. For more information, visit www.ready-robotics.com. READY Made Turnkey solutions can be found at READY.market.