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CNC AUTOMATION CHECKLIST

FOR MILL & LATHE AUTOMATION SYSTEMS

The following is a comprehensive checklist for **CNC Mill and Lathe Automation**, covering topics for preparation and implementation. Whether you plan to self-integrate, hire an external integrator, or purchase a complete solution, the this document outlines the essential topics for successful.

Preparing for CNC Automation

Automation Need: When planning and preparing for automation, it's important to define the scope of components and CNC's you want to automate, and define what is most important to you (e.g., continuous runtime, extra-shift production, lights-out, speed/throughput, quick part change-over for a high-mix environment, etc.). Determine the most significant bottlenecks or constraints and work your way through priorities. And remember, automation does not necessarily need to run continuously or overnight to be a success.

Component Selection: Evaluate complete system solutions (VersaBuilt, Automation Within Reach, RoboJob, etc.), and individual component solutions: robot types, carts/infeed options, CNC communication, grippers, pneumatic and electrical controls. Familiarity of options is important, whether implementing a complete solution, hiring an integrator, or doing a home-grown solution.

Installation/Integration: With a new system, a ramp-up process is important to find the proper settings and for process control. Key points:

- Aim for reliability as the first priority, then start increasing speed or adding features/processes.
- Invest in CNC and Automation Tools for quality control, in-process adjustments, and to prevent damage to the equipment. Tools such as Spindle Probes and Tool Probes can be invaluable.

Process Monitoring: Regular maintenance is essential for long-term performance and reliability.

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Best Practices for CNC Automation

Start Simple, Aim for Reliability: Reliable automation delivering steady parts ensures long-term success. Focus on simpler, dependable systems.

Minimize Variables: Prove out parts manually before automating and ensure each device in the system can be tested to streamline troubleshooting.

Control Chips: Chip buildup, under parts, on or under workholding, wedged into door rails, or obstructing spindle probes, can cause machine stoppages; implementing a chip management process and maintenance routine minimizes downtime.

Prioritize Maintenance: Keep systems and CNC machines clean with regular maintenance for extended reliability.

Troubleshoot Strategically: Robots are excellent at repeating commands and following programmed instructions; identify what changed when issues arise.

CNC Automation Checklist Topics

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CNC & Robot Communication:
Key Considerations & Solutions

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CNC and Automation Systems need to have signals between them for a back and forth hand-off of part processing. The minimum "handshake" is:

1. A signal from the Automation to the CNC to cycle start after part loading
2. A signal from the CNC to the Automation indicating the end of the cycle

There's also considerations for Program Selection, control of workholding and other CNC buttons, such as Door Interlock Release and Pallet Ready. For electrical signals from the Automation to the CNC buttons or foot pedals, we recommend a 2-wire 24VDC relay output from the automation controller wired into the button or pedal. Closing the contact at the relay closes the button circuit, which is equivalent to pushing the button (no voltage or current to the CNC).

Connection Options Are:

Cycle Start:
- 2-wire 24VDC relay output from the automation controller wired into the cycle start button.
- Robot or actuator push the physical cycle start button directly (e.g., Robotiq button pusher).

Cycle End:
- VersaBuilt's Robot2CNC unit through an ethernet or RS-232 connection (Universal Robots with Haas or Fanuc Focus controls),
- 2-wire output from a CNC 24VDC M-code or stack light to automation controller Digital Input.
- Stack-light sensor to an automation controller Digital Input (e.g., Robotiq Stack Light sensor)

Program Selection:
- VersaBuilt's Robot2CNC and VSC support Haas and Fanuc Focus controls with Universal Robots. CNC Program Selection, Cycle Start with relay output, and end-of-program via Ethernet or RS232 connections.

Chuck Open / Close:
- 2-wire relay output from the automation controller wired into the foot pedal or CNC I/O module. Closing the contact on the relay is equivalent to depressing the foot pedal.
- Actuator pushing foot pedal (e.g., Robotiq pedal pusher).

Vise Open / Close:
- Pneumatic valves controlled by automation or CNC M-Codes

Other buttons (e.g., Pallet Ready, Door Interlock):
- 2-wire relay output from the automation controller wired into the button.
- Robot or actuator push the button (e.g., Robotiq button pusher).

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These proven setup and connection techniques ensure seamless communication between the CNC and robot, optimizing automation workflows.

Robot Specifications:
Key Considerations & Solutions

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Robot Selection:

When selecting the robot for your application, the key considerations are Payload, Reach and IP protection. For machine tending, we recommend collaborative robots with "drag to teach" functionality to reduce setup and re-setup time. To-date, VersaBuilt Systems have included the UR 3e, 10e, 20 and 30 robots.

Payload:

- Must exceed the combined weight of the gripper and maximum part weight, with a safety margin.
- **Recommended:** 10kg or greater.

Reach:

- Distance from the robot's center mount to the CNC load/unload location.
- Account for feed distance to/from load points.
- **Recommended:** 1200mm or greater. **depending on CNC method of processing parts*

IP Protection

- **Recommendation:** IP54 or higher for better durability.

Example Cobots for Machine Tending:

Universal Robots:

- **UR3e:** 300mm reach, 3kg payload
- **UR5e:** 850mm reach, 5kg payload
- **UR10e:** 1300mm reach, 12.5kg payload
- **UR20:** 1750mm reach, 25kg payload
- **UR30:** 1300mm reach, 35kg payload

Doosan Cobots:

- **M1013:** 1300mm reach, 10kg payload

Fanuc Cobots:

- **CRX-5iA:** 994mm reach, 5kg payload
- **CRX-10iA:** 1249mm reach, 10kg payload
- **CRX-20iA/L:** 1418mm reach, 20kg payload
- **CRX-25iA:** 1889mm reach, 25kg payload

StandardBots:

- **R01:** 1300mm reach, 18kg payload

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Choose a robot that meets your application needs for payload, reach, and protection, ensuring success for the CNC and parts you plan.

Programming:
Key Considerations & Solutions

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Programming Options & Solutions:

Options include self or custom integrated automation and standard automation. With standard automation, knowledge of robot programming is not required. With custom, the system can be made to your exact requirements. Available skill sets, time, cost and reliability are the primary decision factors.

Robot & CNC Programming:

- **Programming:** Includes tasks like robot and CNC programming to command robot motion and coordinate functions and movement of the CNC equipment for automation.
- **Simulating manual tending:** CNC functions and communication with automation to do tasks that an operator may have performed (e.g., seating the part in Z with a mallet).

Programming Options:

- **Integrator:** Custom programming for specific parts or part families.
- **Pre-Programmed Systems:** Ready-to-use solutions from providers like VersaBuilt or Automation Within Reach do not require robot programming knowledge.
- **DIY Programming:** Develop from scratch or from template programs, like VersaBuilt's Ready-to-Run program for UR.

Available from VersaBuilt:

- **Standard Pre-Integrated Systems:** Off-the-shelf automation that does not require end-user programming
- **Customized Pre-Integrated Systems:** Customizations to the standard systems, retaining the user interface and does not require end-user programming.
- **Robot2CNC:** URCap plus cycle start, program selection and end of program monitoring
- **Ready-to-Run:** Machine Tending template program for the Do-It-Yourselfer.

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Choose the option that fits your needs for cost, effort, flexibility, efficiency and ease of implementation.

Gripper Selection:
Key Considerations & Solutions

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Gripper Selection:

Finding / Designing a gripper for your machine tending application can be one of the most challenging steps. The gripper often needs to accommodate multiple raw material sizes, plus the challenge of the unique geometry of the finished or partially finished part. Considerations include: Stroke and Clamping force.

Stroke:

- Accommodate variety of part shapes and sizes
- Ensure max opening avoids collisions during part picking.
- Determine if your application requires OD (outside diameter) and ID (inside diameter) picking.

Clamping Force:

- Should be 5–10x the part weight to handle low-friction, coolant-covered parts.
- For pneumatic actuators, verify maximum air pressure requirements.

Example Gripper Brands for Machine Tending:

VersaBuilt MultiGrip Gripper, for Mill tending: Workholding as an end-effector, where the gripper picks MultiGrip Jaws (soft or hard jaws) and uses the jaws to pick the parts. Why? it takes advantage of the already existing requirement to develop workholding for machined parts, therefore one gripper for all parts and operation transfers/flips become easy and do not require a regrip station. Flexibility for a mix of parts and multiple operations.

VersaBuilt DuoGrip Gripper, for Mill and Lathe tending: Double-headed pneumatic gripper ideal for transferring parts between infeed and actuating vises or chucks. Double-headed makes for efficient transfers, plus design includes options for quick change to different sizes and shapes of parts. DuoGrip 400 and DuoGrip 2000 models are available for different applications.

Other options include those made by: ROBOTIQ Schunk SMC FESTO PIAB

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Select a gripper suited to your parts and machining needs for reliable performance.

Infeed / Outfeed Setup:
Key Considerations & Solutions

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Infeed / Outfeed / Cart / Pedestal Considerations:

Space Requirements:

- Assess available space for front or side loading of your CNC and user access to machine.

Part Capacity and Run Time:

- Calculate the maximum number of parts the infeed can hold.
- Estimate runtime by multiplying infeed capacity, machining cycle time, and door open time during robot processing.
- Determine if capacity and run time meet your requirements.

Part setup / Changeover:

- Assess how the new/raw parts will be loaded and finished parts will be unloaded.
- Can parts be loaded and unloaded while the automation is running?
- Does the system require fixturing or hardware to locate the part, or can they be placed visually?
- Flat table or Shelving/Drawers? Flat tables offer simplicity and more reliability. Shelving and drawers offer increase capacity, with height restrictions and complexity.
- Part feeders/singulators (pez-dispenser style) are useful for space constraints, but are geometry specific.

Solutions:

- VersaBuilt VersaCart 1300 & 1700 with visual infeed options with optional custom locators.
- Vention Carts
- Easy Robotics Systems
- Standard pedestals and carts (e.g., McMaster-Carr)
- Custom pedestal/infeed/outfeed

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Choose a solution that fits your space and production needs for efficient automation.

Vises & Workholding for Mill Automation:
Key Considerations & Solutions

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Material Loading Options:

Pallets / Vise Loading:
- Load and unload vises or pallets with pre-fixtured parts
- Simple, reliable automation for single operation parts.
- Pallet loading options:
  - Pallet pools (Horizontal or Vertical Machining Centers)
  - Robot pallet exchange systems
- Zero-point solutions, with robot gripper picking vises with cleat or gripper interface, with vise products such as 5th Axis or Lang

Part Loading into Actuating Vises:
- Load and unload parts with a robot gripper picking parts and loading them into vises.
- Offers load/unload (with double-headed grippers for faster processing) with option for multiple operation parts with a regrip station to flip the part from operation to operation.
- Requires workholding change from part to part, as needed
- See section 4 for Gripper selection options.
- Vise stroke needs to be greater than part tolerance + robot accuracy/repeatability. Consider a lead-in chamfer on the workholding to allow the part to “find” its way into the pocket, for tight fits.
- Actuating vises for direct part placement, such as:
  - VersaBuilt MultiGrip Vises with MultiGrip Jaws
  - Air Vise
  - Schunk Vise
  - Kurt Air Vise

MultiGrip:
- Pick and Place parts with workholding
- Capable of processing a mix of parts with multiple operation parts.
- Options with MultiGrip:
  - VersaBuilt Mill Automation System
  - Gosiger RCX
  - Okuma ORL-MC
  - Custom programmed system with algorithm for gripper sequence available from VersaBuilt

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Choose the Vise and workholding that best suits machining requirements, part mix (size and shape), and number of operations.

Chuck Types for Lathe Automation:
Key Considerations & Solutions

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Options & Considerations:

General Automation Considerations:

- Chuck needs to have open and close actuation, with signal from foot pedal or CNC I/O
- Chuck stroke needs to accommodate part tolerance variation + robot accuracy
- Where you can, maximize chuck opening for easier loading.
- Add a Z-stop surface, if z-location is critical for application.
- Add a Z-Push tool (rubber ended or spring loaded) to the tool turret or tail stock to push/seat parts at the start of programs..

Collet Chuck:

- Add a heavy chamfer to the inlet edge for smooth part loading, as these are typically a tight-fit for loading and the chamfer helps accommodate part and robot loading variation.
- Consider quick-exchange collet chuck systems if application includes part variation.

3-Jaw Chuck:

- Provides the most clearance and is simple to load.

Automation Tools:

- VersaBuilt Accu-Z Lathe Push Tool - Spring Loaded tool for seating parts
- VersaBuilt Chuck Actuation Cable (see CNC and Robot communication section)
- Robotiq foot switch activator

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Note: Implement the chuck and tools for best workholding, flexibility, and reliability

Pneumatic Valves for Automation Devices:
Key Considerations & Solutions

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Vises, Pneumatic AutoDoors, Grippers, & Wrist Air Options:

The following are recommended valve types:

Vises: Choose valves that will hold pressure if the signal is dropped to the valve

- 5-port, 2-position spring return solenoid valve
  - Can be configured for Normally Open or Normally Closed
- 5-port, 3-position, Center-Closed spring return solenoid valve
  - Standard for VersaBuilt Vises**

Gripper:

- 5-port, 2-position spring return solenoid valve
  - For applications where dropping a part during power loss is a concern
- 5-port, 3-position, Center-Exhaust spring return solenoid valve
  - Standard for VersaBuilt Grippers**
  - Allows for "floating" for applications where flexibility is needed

Pneumatic AutoDoor:

- 5-port, 3-position, Center-Exhaust spring return solenoid valve
  - Allows manual override of door when power is removed
  - Standard for VersaBuilt AutoDoors**

Wrist Air:

- 5-port, 2-position valve + High-Flow air-piloted valve
  - Standard for VersaBuilt VersaBlast systems**

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** VersaBuilt kits with prepped flying leads are available for easy integration.

Tubing & Cable Wiring:
Key Considerations & Solutions

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Actuating Vise Tubing or Cable Routing:

Air Line & Cable Routing:

- Route air lines and cables into the CNC, options:
  - Through the top cable opening.
  - Through casting under table or rotary

Rotating Tables (4 & 5-Axis Applications):

- If included with the rotary, rotary unions are useful for setup and easy connections.
- For systems without rotary unions, options:
  - Limit axes rotation to ±720° and use coiled tubing routed through the rotary bore.
  - Off-the-shelf rotary unions are available, typically require custom mounting hardware.

Reference: VersaBuilt Automation Manuals at **https://www.versabuilt.com/resources/**

Manually Tending with Automation in Place:
Key Considerations & Solutions

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Options & Solutions:

Hand Valves for Vises:

- Consider a layout for the automation that will allow manual access for maintenance, tool change, cleaning and part prove-out.
- Options include, offset location of automation with space for access, or moving system in/out with repeatable mounting.

Hand Valves for Vises:

- Use 5-port, 3-position center-closed valves plumbed in parallel with solenoid valves to allow manual operation when needed.

Foot Pedal Access:

- Wire the foot pedal to the chuck or vise through automation or CNC I/O for seamless manual actuation. See CNC and Robot Communication Section.

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Chip Management / Chip Control:
Key Considerations & Solutions

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Options & Solutions:

CNC Coolant or Air Blasting:
- Use coolant to clean chips before and after part pick-and-place. Coolant is more effective than air blasts or air fans, as the coolant moves the chips down to the bottom of the CNC rather than pushing them, as air does, in unpredictable ways.
- For dry-machining, air blasts or chip fans are effective but require caution to prevent chip redeposition on the vise or chuck. Testing and troubleshooting is needed to validate reliable chip removal

Wrist Air:
- Consider Air Amplifiers with high-flow valves to provide a powerful blast for grippers, improving chip removal reliability and efficiency, with less air consumption.

VersaBuilt offers example vise wash CNC programs, VersaWash and VersaBlast DuoGrip VersaBlast.

Sensor Integration:
Key Considerations & Solutions

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Options & Solutions:

Gripper Sensors:
- Built-in options are common; external part presence sensors can also be used.
- Electric Grippers include gripper finger location detection (Robotiq)
- Pneumatic Grippers include option for magnetic piston for sensors (SMC, Festo)

Vise Sensors:
- Readily available for 3-axis; 4 and 5-axis setups may require special consideration.

CNC Tool Probes (e.g., Renishaw):
- Ensure part presence, location, offsets, and detect issues for precise operation.
- Excellent alternative to Vise sensors, especially for 4 and 5 axis applications where routing an electrical cable to sensors is difficult or not feasible.

CNC Tool Setters:
- Perform unattended tool checks to prevent scrap parts and machine damage.

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Electrical Requirements:
Key Considerations & Solutions

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Electrical Considerations:

Power Connections:
- Verify power connections and compatibility for the robot, controller, and all peripheral devices.
- Do not connect power from CNC to automation, as the power supply can fluctuate during processing.

Power Supply:
- Ensure sufficient power supply for the automation system, planning for load use fromrobot and devices at their stated values.

Safety Options:
- Enclude de-energization and Lock-Out-Tagout options for safety.

Compressed Air Setup:
Key Considerations & Solutions

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Options & Solutions:

Meet Standards:
- Ensure shop air meets ISO 8573-1:2010 [7:4:4] standards with filters and moisture separators to protect valves and actuators.

Pressure & Air Consumption:
- Maintain pressure between 90-120 psi.
- Plan for air consumption of 15-20 scfm, depending on actuator size and wrist blow-off needs.

Connection & Maintenance:
- Use filters, regulators, moisture separators, and pneumatic quick disconnects for easy connection and maintenance.

Safety Consideration:
- Include de-energization and Lock-Out-Tagout options for safety.

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CNC AutoDoor Options:
Key Considerations & Solutions

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Options & Solutions:

Factory AutoDoor:
- CNC's with Factory AutoDoors can make the implementation more streamlined.
- Check to see if the CNC can be configured to Close the Door on a Cycle Start command and Open the Door on a Cycle End Command. This will simplify the automation signalling.

Aftermarket AutoDoor (e.g., Midaco, VersaBuilt VersaDoor):
- Determine signal integration with automation and CNC, CNC fit, and required stroke distance.
- Consider how the CNC will be used during automation and manual tending.
- Examples include, VersaBuilt VersaDoor, Midaco

Use the Robot to Open and Close the door:
- A cost-saving option but less efficient, with variable payload potentially causing robot stops.

Note: Regular door maintenance and chip management are essential for all options.

Using the CNC to Assist with Automation:
Key Considerations & Solutions

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Options & Solutions:

Seat Parts & Move Parts Precisely:
- Investigate how the automation system can control control Vise/Chuck Open/Close during processing. This is useful for:
  - Seating parts in X, Y, Z
  - For milling, open the vise or exhaust the air supply to the vise, then push the part into position with a CNC tool.
  - For lathes, unclamp the part while engaging with a CNC tool.
- Use the CNC as an automation tool, with multiple axes and precise motion to work in tandem with the automation system.

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Process Considerations:
Key Considerations & Solutions

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- **The process and automation approach may be dependent on the type of parts, number of operations required, and how many parts are intended to be added to the automation**
- **Pallet and Vise Loading are automation simple and reliable automation solutions for single operation parts.**
- **Part picking allows flexibility for single and multiple operation parts.**
- **VersaBuilt solutions:**
  - **MultiGrip based Systems for multi-operation parts, as well as High-Mix**
  - **DuoGrip based Systems for efficient part exchange with single or multiple operations**
- **Consider the time and cost for initial implementation and required time and cost for new part introduction.**

Support Before, During, & After Installation:
Key Considerations & Solutions

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Robot Warranty:

- Verify coverage and field service support from the robot maker or distributor.

Remote Support or Remote Monitoring:

- Remote monitoring can be done with software solutions or simply a low-cost webcam with the CNC stack light and automation system in view.
- Investigate options for remote connectivity for troubleshooting, software updates, etc..

VersaBuilt Expertise:

- Support is available for warranty support and on a project basis or hourly as needed.

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CNC AUTOMATION NEXT STEPS

CONTACT THE VERSABUILT TEAM

Ready for Seamless CNC Automation?

Ready to take the next step toward seamless CNC automation? Whether you need guidance on selecting components, implementing a complete system, or fine-tuning your automation process, VersaBuilt is here to help.

Contact us today to schedule a consultation, explore our solutions, or get started on transforming your CNC operations. Let's make automation work for you!

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