VERSABUILT ROBOTICS

VBX-160 CONFIGURATION AND PROCESS CONTROL MANUAL SOFTWARE VERSION 3.2

In an effort to provide the best user interface and experience possible, Versabuilt Robotics is contentiously updating and upgrading the VBX-160 software.

Although, the functionality will remain the same, be aware that some of the contents in this manual may differ from the previous or later versions of software.

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Summary

The purpose of this manual is to:

1. Introduce machinists or programmers to the VBXC Configuration Screen.
2. Provide guidance and review options in the Jaw and Part Definition sections.
3. Include examples for using CNC G-Code routines in coordination with the VBXC part configuration to provide options for process automation.

The Configuration and Process Control Manual provides background for Machinists, Manufacturing Engineers and Process Engineers to define, run and fine-tune the processing of parts using a VBXC controlled system.

Configuration Screen

The VBXC Configuration screen is composed of 4 sections:

1. Jaws – to define a vise jaw to be used in the handling of a part.
2. Parts – to define the steps for processing a part.
3. Processes – to define the steps in a general way that the part goes through when being machined. Many processes are preloaded to streamline the part configuration process.

> Note: If you need additional processes or modifications to existing processes, please contact VersaBuilt Robotics by email helpdesk@versabuilt.com, by phone 208.629.5914 or open a Help Desk Tick in the About Screen.

4. Shelf Configuration - designate templates for shelf slots for Jaw and part placement

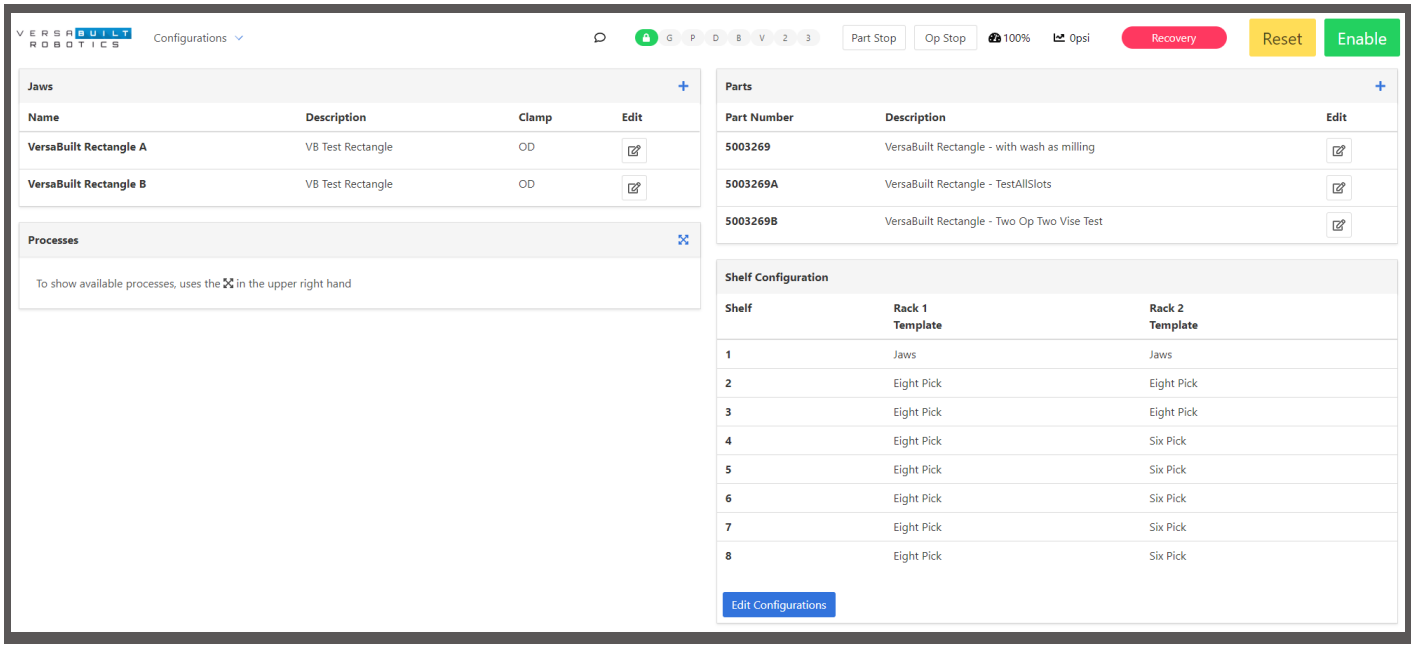

FIGURE 1. VBXC CONFIGURATION SCREEN

Manually Machining New Jaws and Parts

Are the MultiGrip™ Jaws defined and proven when manual machining?

Have you successfully manually machined the parts you are going to automate?

Prior to configuring your parts for the VBX-160 workholding it is necessary to manually proof out your parts. It is critical for successful introduction of robot tending to first prove out good parts with manual loading. This step will help ensure you have a viable working CNC process and help successful introduction to processing.

Jaw Definitions

The Jaws section is used to add, edit or delete MultiGrip™ Jaws to the VBXC configuration. Defining jaws requires the following:

1. MultiGrip™ Jaw Name
   - Recommend a unique part number for the jaws that can also be machined, etched or labeled on the MultiGrip™ Jaws to match the VBXC user interface when an Operator is prompted to find and use the jaws.
2. MultiGrip™ Jaw Description
   - Recommend making this descriptive for operators that may not have complete familiarity with the part.

   Example: OP2 Jaws for XYZ Part, ID Jaws
3. Select OD or ID jaws
   - This selection will direct proper function of robot motion and vise and gripper actuation.

Examples of Jaw Definition Naming Structures

- Engrave or label each jaw with an unique numbering/naming system or name to minimize operator error during job set-up
- Description should be useful in identifying the MultiGrip™ Jaws for the application.

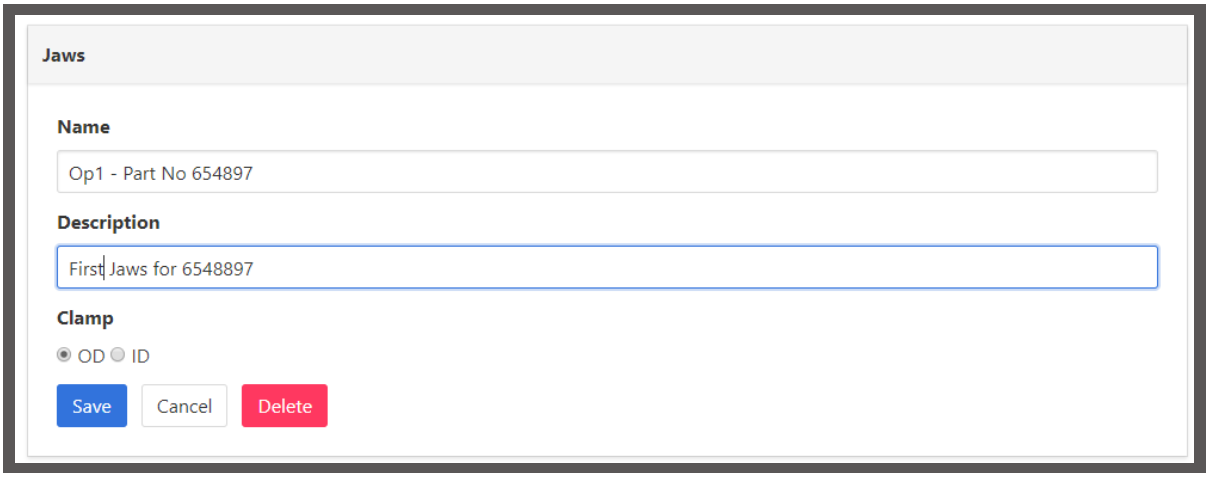

FIGURE 2. JAWS CONFIGURATION SCREEN

Determining Part Configurations

The definition of parts and the meaning of the selections is detailed in the section below, with a number of possibilities of processing a part with a VBX-160 system. The general purpose of the part definition is to name a part and define the steps required to process the part,

1. Does the part have defined shelf locator's or a known shelf template (picks per shelf)? Reference Table 1.
2. Do the MultiGrip™ Jaws include clearance to avoid interference with neighboring parts during shelf picking?

PICKS PER SHELF	PART SPACING	MAX PART WIDTH/DIA.
3	12.2125	10.5
4	9	8
5	6	5
6	4.5	3.5
8	3	2.5
18	2.5714	2

TABLE 1. STANDARD LOCATOR OPTIONS

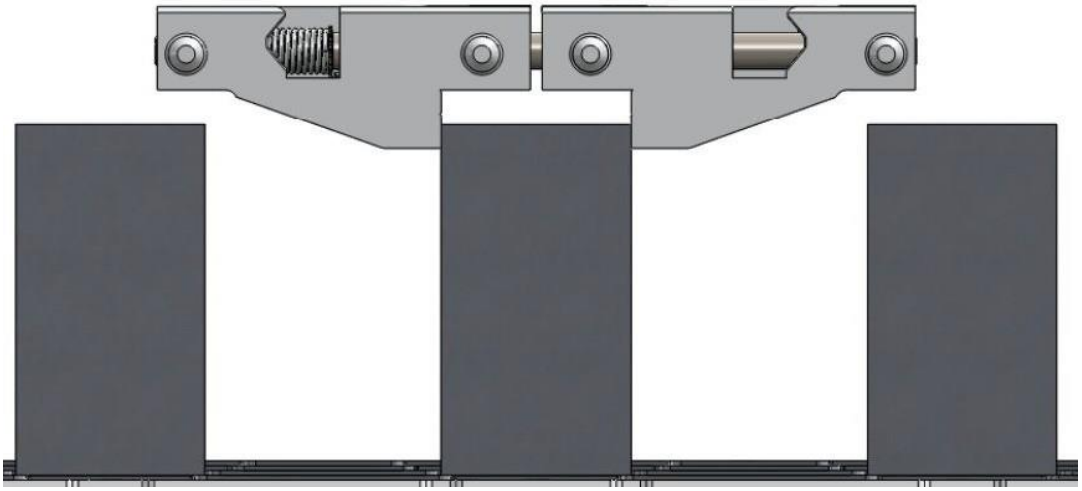

FIGURE 3. JAWS IN PROXIMITY TO NEIGHBORING PARTS ON SHELF

3. What is the Pick Height? Pick height consists of **First Operation Jaw + Raw Material + Shelf Locator thickness**.

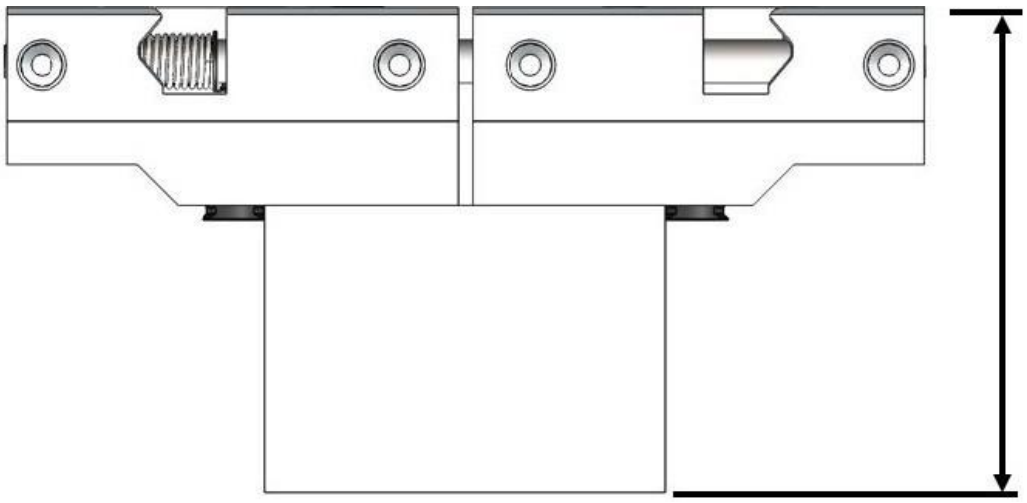

FIGURE 4. PICK HEIGHT IS FIRST OPERATION JAW + RAW MATERIAL + SHELF LOCATOR THICKNESS

SHELVES PER RACK	STANDARD ENTRY HEIGHT	MAX ENTRY HEIGHT
4	10.8”	12.3”
5	7.6”	9.1”
6	5.7”	7.2”
7	4.4”	5.9”
8	3.5”	5.0”
9	2.8”	4.3”

TABLE 2. VBX-160 SHELF CONFIGURATION

4. When placing finished part back on the shelf, what is the Place Height? Place height consists of **Last Operation Jaws + Finished Part + Shelf Locator thickness**.

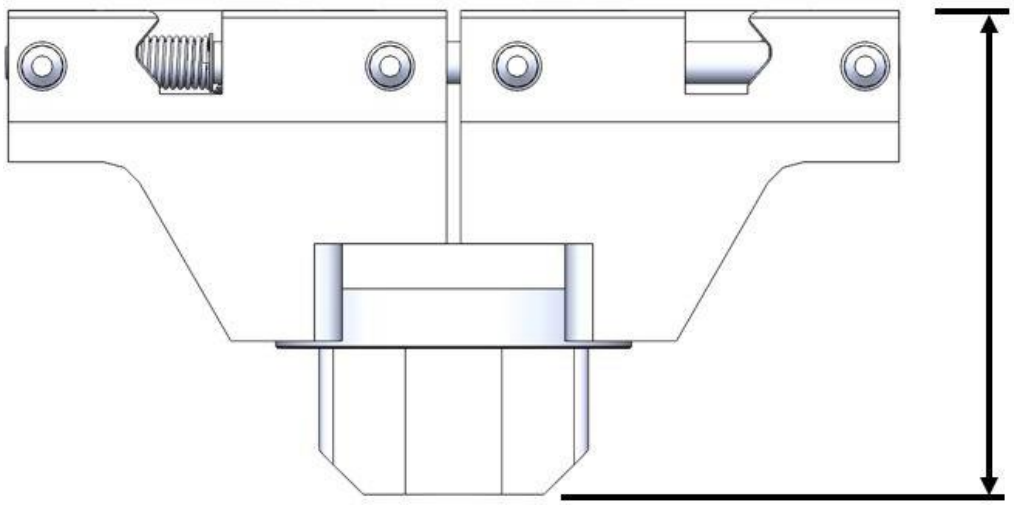

FIGURE 5. PLACE HEIGHT
LAST OPERATION JAWS + FINISHED PART + SHELF LOCATOR THICKNESS

5. Does the part require an index or settle against a Y-datum before machining, for any operation?
   - If yes, there are options in the G-Code commands with a Y-Push tool. See Note.
6. Does the part require seating against the Z-datum before machining, for any operation?
   - If yes, there are options in the G-Code commands with a Z-Push tool.

Note: G-Code Vise Control - A VBXC software option to open and close vises or control vise pressure with G-Code during a CNC Program. This feature may not be available for all CNC brands.

7. Are MultiGrip™ Jaws the workholding used during machining or are they used to pick and drop off the part into other workholding (e.g., collet chuck)?
   a. Jaw Load = Part plus MultiGrip™ Jaws into MultiGrip™ Vise workholding.
   b. Part Load = Part only into workholding (including MultiGrip™ Jaws, 3 jaw chuck, collet chuck, etc.).

8. If there are more than 1 operation, what is the Op-to-Op transfer height(s)?
   - Current Operation Jaws + Partially Complete Part + Next Operation Jaws.

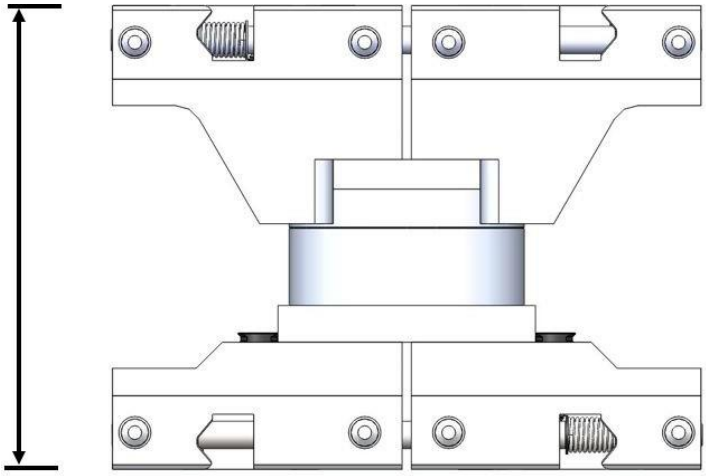

FIGURE 6. OP-TO-OP TRANSFER HEIGHT
CURRENT OPERATION JAWS + PARTIALLY COMPLETE PART + NEXT OPERATION JAWS

9. When using the VBXC it is necessary to break-up the CNC program into individual programs.
   a. Op1 Program
   b. Op2 Program
   c. Op3 Program… etc.
   d. Table and Vise Wash Program(s)
   e. Table Load Program(s)
10. Change all G-Code programs, add M98 P9004 before the M30.
    - 9004 will communicate to the VBX-160 that the program has completed successfully.
11. If using MultiGrip™ Vises, has the vise pressure range been defined for each machining operation? Reference Table 3.

Notes: *VBX-160 systems use plant air regulated to ≤110 psi

**Vise Pressures >110 psi are available with VBX-160 Pressure Doubler
1 Vise System - P/N 5002212
2 Vise System - P/N 5003419
3 Vise System - P/N 5003420

Examples for Part Definitions Naming Structure

- Part Identifier should match documentation of paperwork.
- Description should be useful in identifying the part.

AIR PRESSURE	CLAMPING FORCE (LBF)
10	344
20	689
30	1033
40	1378
50	1722
60	2067
70	2411
80	2756
90	3100
100	3444
125	4306
150	5167
175	6028
200	6889
225	7750

TABLE 3. VISE PRESSURE TO CLAMPING FORCE VALUES

Example Part Configuration

One Op Process

1. **Part Number** – or Part Name
2. **Part Description** – Part Description should be detailed to easily identify the part.
3. **Select Process** – One Op process script.
4. **Shelf Template** – reference Table 1 to determine template needed.
5. **Process Instructions** – A customizable statement to give the Part Configurator information to determine if this is the correct Process Script.
6. **Jaws** – Choose appropriate Jaws from the dropdown. These are configured in the upper left card on the Configuration page.
7. **CNC Wash Program** – CNC Wash program that will clean the vises. This field will automatically fill with the default value from the Settings page.
8. **Shelf Entry Height** – reference Table 2 to determine Max Entry height. This field will automatically fill with the default value from the Settings page.
9. **Vise** – Enter a number indicating the vise to run this One Op part on. 1 will be filled in by default.
10. **Vise Table Load Program Number** – enter the CNC program number that positions the table properly for loading and unloading the chosen vise.
11. **Pick Height** – Add Jaw height + Raw Material height.
    - **Pick Offsets** – check this box if the part to be picked is not centered in the shelf locators then enter the appropriate X and Y offsets.
12. **Robot Settle** – check this box to indicate the robot should settle the part before loading it into the vise.

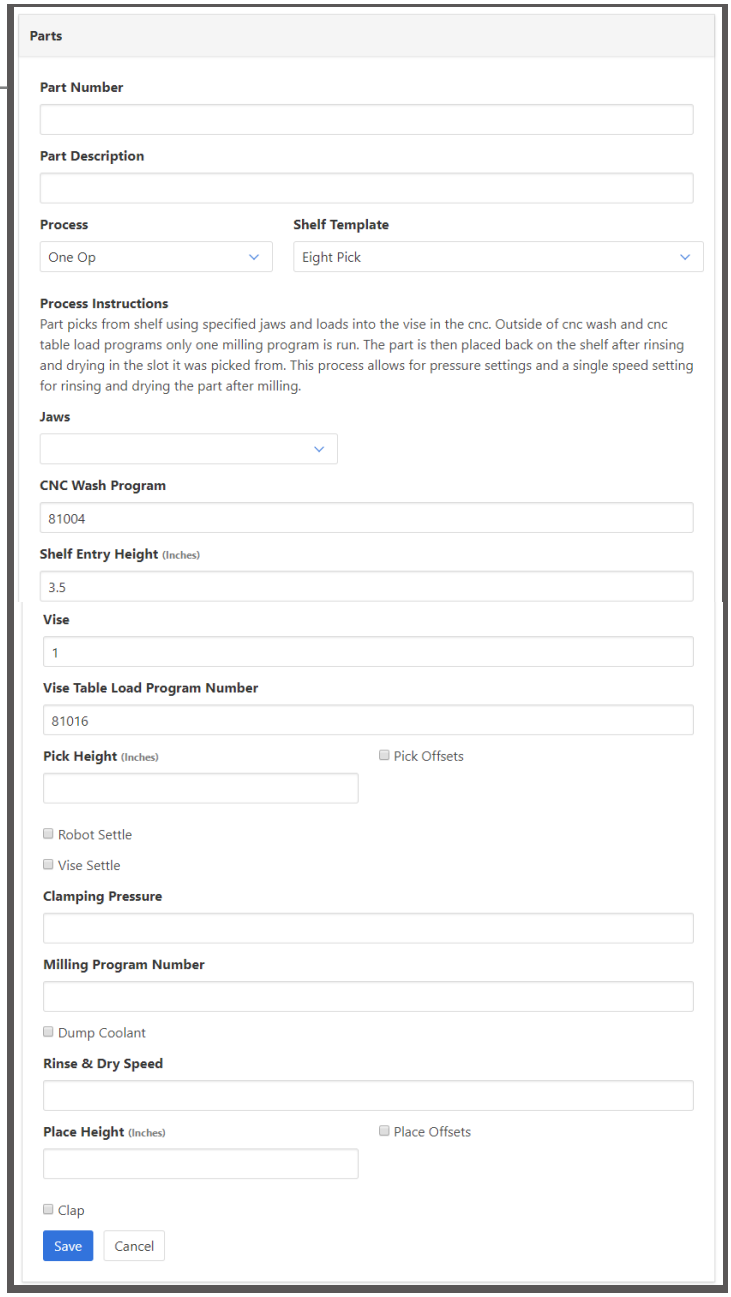

FIGURE 7. ONE OP PROCESS PART CONFIGURATION SCREEN

13. **Vise Settle** – check this box to indicate the vise should open and close to settle the part using gravity in the vise after the part is loaded.
14. **Clamping Pressure** – Vise pressure for creating this part. By default, pressure range is ±10 psi of set pressure. Reference Table 3.
15. **Milling Program Number** – Enter the CNC program number that will run to cut the part.
16. **Dump Coolant** – Check this box to instruct the robot to rotate after the part is milled to let the coolant drip into the CNC.
17. **Rinse & Dry Speed** – Speed at which the part is cleaned in the wash bucket. Enter a value between 1 and 100, which will be a % of full speed that jaws will move through the wash bucket.
18. **Place Height** – Add Jaw height + Raw Material height + a buffer to release parts above the shelf.

(see next page for Place Offsets and Clap)

Two Op Two Vise Process

(items identical to One Op Process from previous page are not repeated here)

This Part Configuration is divided up by Op and includes Op specific options to match. This behavior is inherited from the Two Op Two Vise Process Script.

In the Op2 area:

- **Different Table Programs for Each Op?** – Check this box if the vises are setup to use different Table Load programs. After checking this box, enter the Op2 Table Program Number that will be run anytime the robot needs to load or unload Op2.
- **Vise 1 Unload Transfer Height** – This label assumes that Op1 Vise is Vise 1. Enter into this box the total height of Op1 Jaws + Half Completed Part + Op2 Jaws.

In the Place area:

- **Place Offsets** – Check this box if when placing the finished material back on the shelf, something off center is desired. This is most often used to place a longer part back further into the shelf so it doesn't stick out.
- **Clap** – Check this box to instruct the robot to quickly open and close the gripper when placing the part back on the shelf. This is most often used to overcome surface tension on lightweight parts.

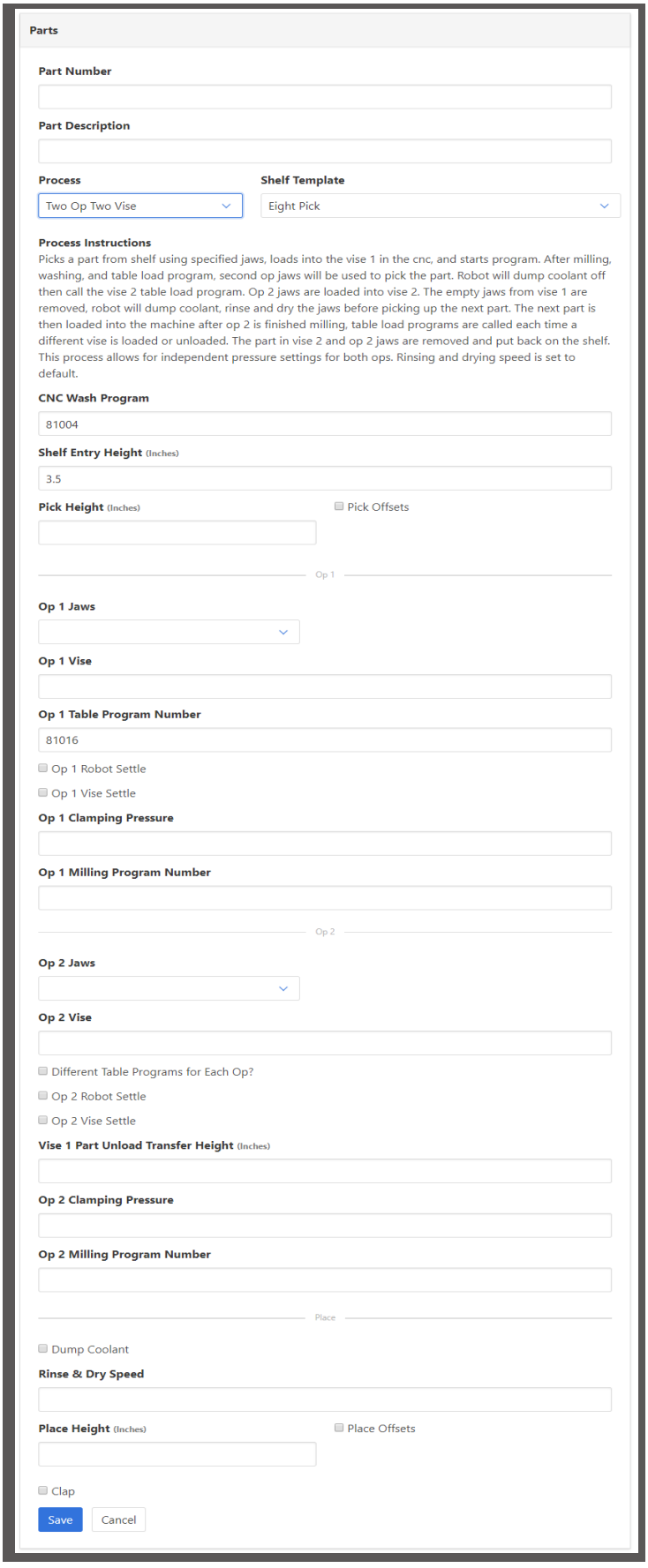

FIGURE 8. TWO OP TWO VISE PROCESS

Process Panel

VBXC comes preconfigured with default processes scripts and default parts.

In the Part Configuration panel, you can select a Process from the drop-down menu. The Names of the process describe the performance at a high level. When a process is selected a description will appear under the drop-down detailing all the steps that will be executed.

Processes are written in a scripting language and can be changed and edited to fit your needs. Entirely custom processes can also be added. The scripting language is fully defined at www.versabuilt.com/pages/resources: **VBXC 3.0 Process Scripting**

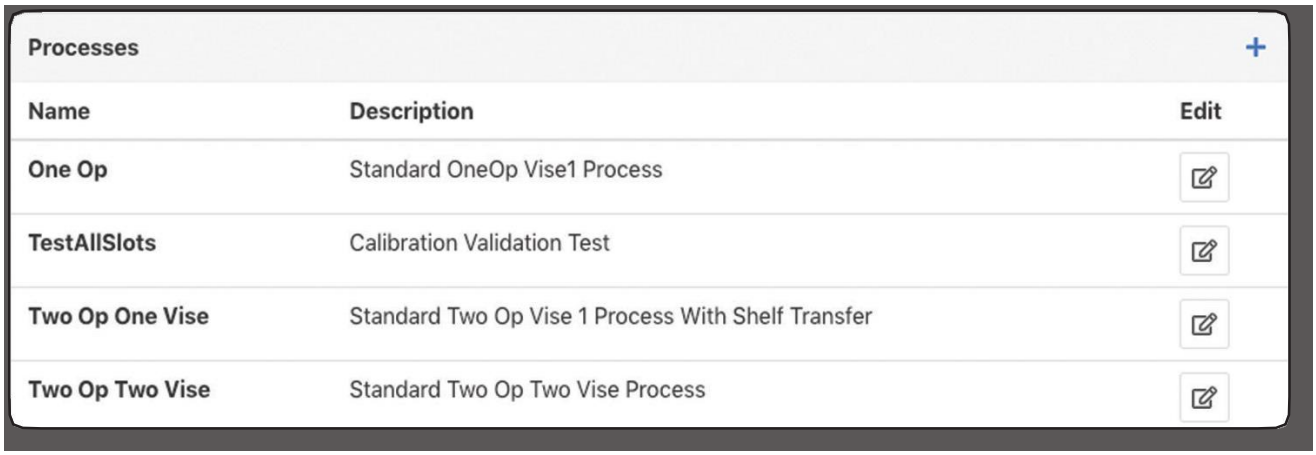

FIGURE 9. PROCESS PANEL

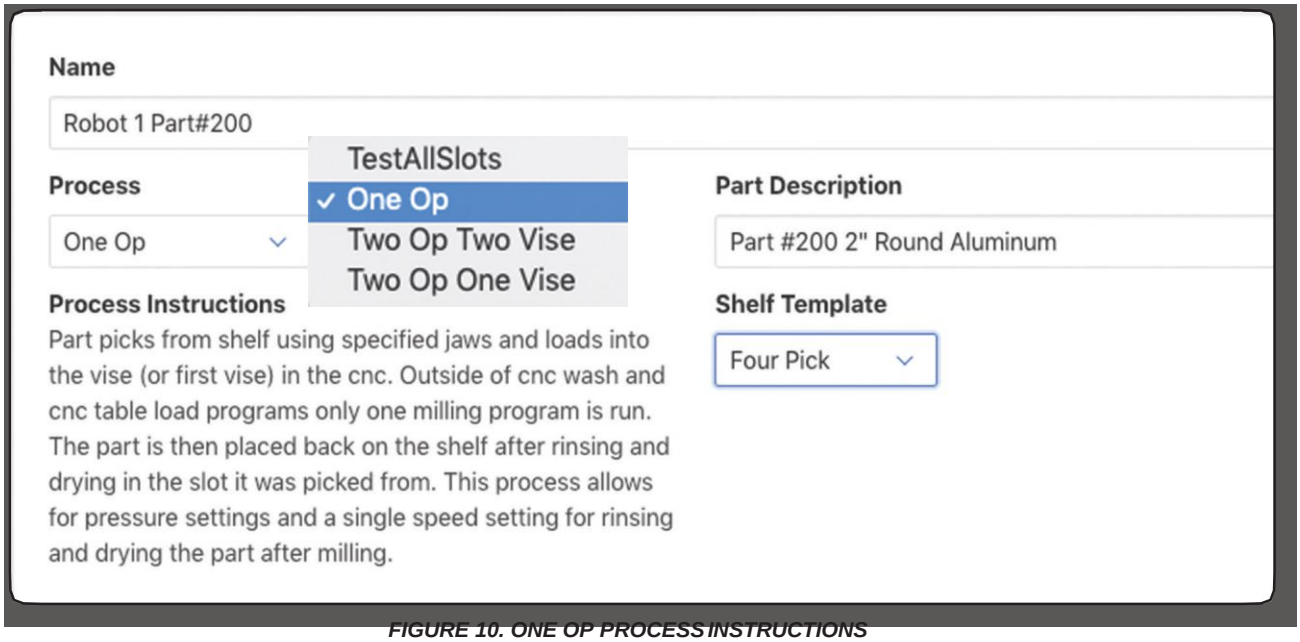

FIGURE 10. ONE OP PROCESS INSTRUCTIONS

Shelf Configuration

After configuring jaws and parts select the correct shelf template. Table 2, also shown on page 6, illustrates Pick Height. Pick Height determines the shelf template used to successfully pick raw material and place finished parts.

To change the self configuration follow these steps:

1. Select Configuration Page
2. Below Parts click on Edit Configurations
3. Select the number of parts that match desired usage for a specific shelf.

SHELVES PER RACK	STANDARD ENTRY HEIGHT	MAX ENTRY HEIGHT
4	10.8”	12.3”
5	7.6”	9.1”
6	5.7”	7.2”
7	4.4”	5.9”
8	3.5”	5.0”
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TABLE 2. VBX-160 SHELF CONFIGURATION

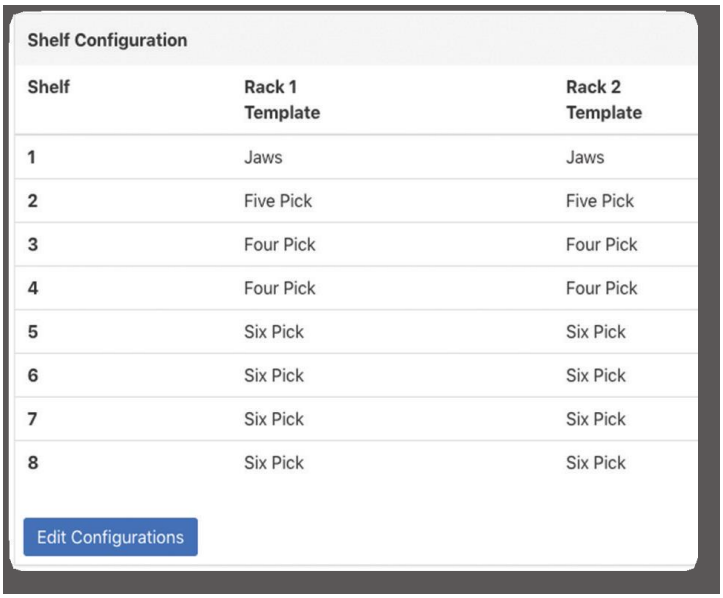

FIGURE 11. SHELF CONFIGURATION PANEL

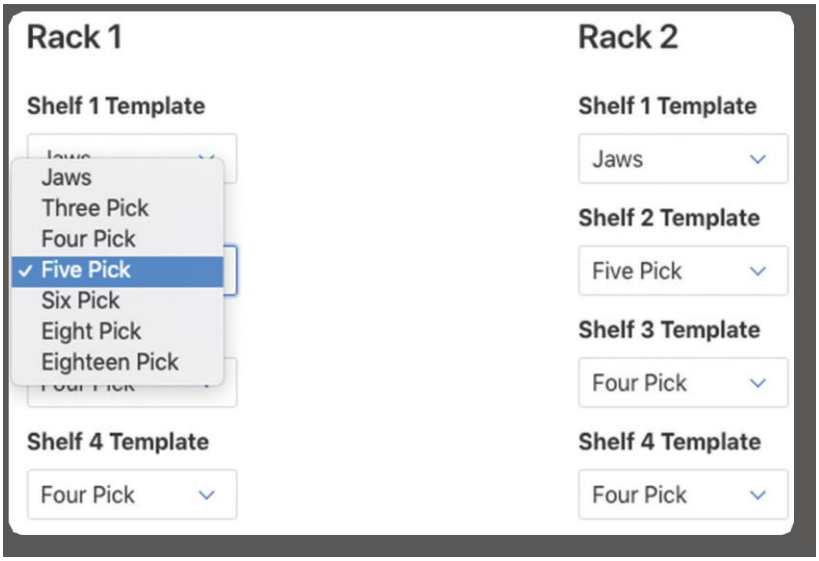

FIGURE 12. SHELF TEMPLATE

Part Fumble

The VBX-160 Gripper is equipped with sensors to detect:

- The absence of MultiGrip™ Jaws in the VBX-160 Gripper, “Jaw Fumble.”
- Fully Open MultiGrip™ Jaws, “ID Clamping Part Fumble.”
- Fully Closed OD MultiGrip™ Jaws (empty), “OD Clamping Part Fumble.”

1. The VBX-160 will detect “Fumbles” if:
   a. The robot fails to pick jaws from inside the VBX enclosure or jaws inside the CNC. This is detected if the pull stud retract sensor is triggered, indicating the absence of MultiGrip™ Jaws in the VBX Gripper.
   b. The robot fails to pick a part from the shelf or during part and operation transfer in the CNC if the closed sensor is triggered when picking OD clamped parts or if the open sensor is triggered when picking ID clamped parts.
   c. Fumble causing the VBX-160 to stop operation:
      i. If a fumble occurs when picking from the shelf, by default, the robot will continue to the next slot or part pick until there are 3 consecutive fumbles. Upon the 3rd consecutive fumble, the robot will halt operation.
      ii. If a fumble occurs picking jaws or picking parts in the CNC, the VBX-160 will stop operation, and enter “Recovery” on the Operator screen.

Note: Refer to the “How to Install or Adjust Gripper Sensors” document for more information about Gripper sensors. Document # D10020, located on our website versabuilt.com.

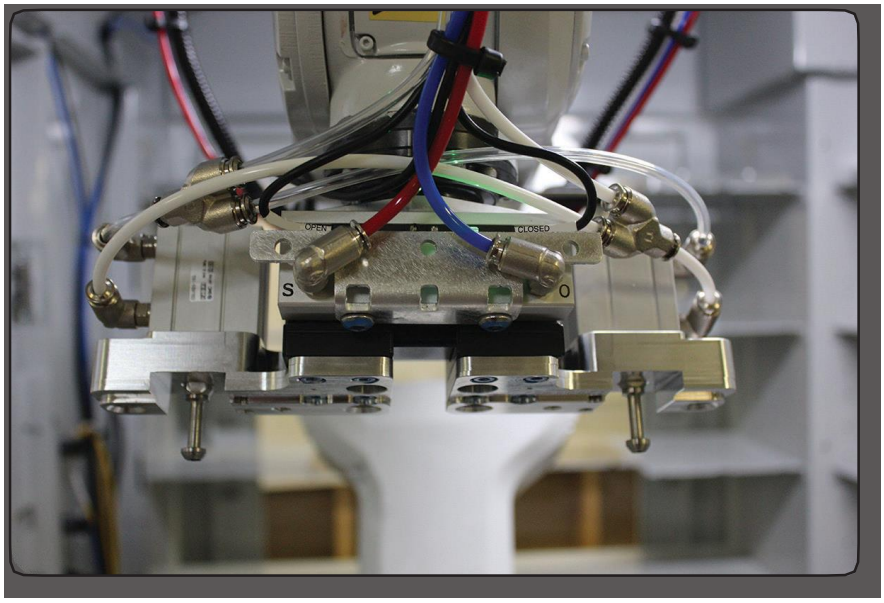

FIGURE 13. GRIPPER CYLINDER

CNC Process Control

Beyond the options in VBXC Part Configuration, VersaBuilt Robotics has software options, if available for your CNC machine, to allow G-Code in the CNC to communicate with the VBXC system and control the function of the MultiGrip™ Vises, dynamically, within a CNC program. This functionality is called “G-Code Vise Control”, allowing G-Code commands to:

- Open and Close Vises with G-Code during a CNC Program
- Regulate the Vise pressure with G-Code during a CNC Program

There are a number of applications where this can be useful:

1. Dynamically adjust vise pressure during a machining program, if needed.

Example:	A part with large material removal may require high pressure at the start of the program, but lower pressure toward the end of the program to prevent part deformation.

2. Y-Push
   a. If it is not possible to locate the Y-Datum of the part with the robot part pick, robot settle or vise settle in the MultiGrip™ Jaws. There is an option is to use a Y-Push tool, shown in Figure 16, or a custom tool to push the part.
   b. It is common to use a Y-Push tool with parts longer than 5 to 6-inches, an example is shown in Figure 24. The example shows a 11.5-inch long part, where the raw material is picked from the shelf with a Y-Offset, then is pushed into place in the vise with a Y-Push tool.
   c. To push the part, the CNC will change tools to a Y-Push tool, position the tool on one side of the part, then using G-Code Vise Control, open the vise, move the vise relative to the spindle in the Y-direction to push the part, then close the vise. It is recommend in some situations to push from both sides to get the most accurate Y-datum location.

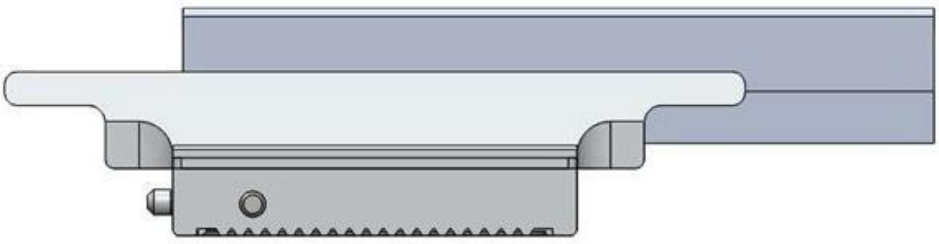

FIGURE 14. 11.5-INCH LONG PART WITH Y-OFFSET

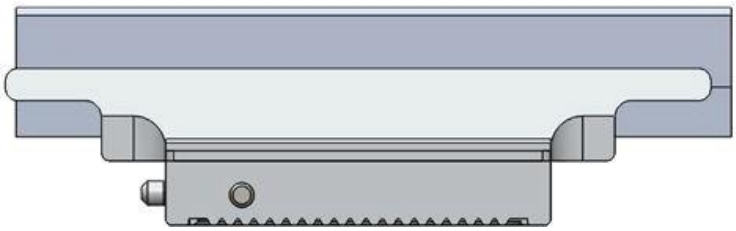

FIGURE 15. 11.5-INCH LONG PART PUSHED INTO PLACE USING Y PUSH TOOL

FIGURE 16. Y PUSH TOOL

3. Z-Push
   a. If it is not possible to effectively seat or settle the part with the robot part pick, robot settle or vise settle in the MultiGrip™ Jaws, an option is to use a Z-Push tool shown in Figure 17, or a custom tool to push the part.
   b. Z-Push becomes necessary with parts that have flatness, parallel call-outs, deform during machining from stress relief or require force (similar to using a mallet when manually tended) to fully seat the parts in the jaws.
   c. To push the part, the CNC will change tools to a Z-Push tool, position the tool above the part, then using G-Code Vise Control, lower the vise pressure to 10 psi ±10 psi, then move the spindle down to push the part, 1 or more times across the part. Once the push process is complete, the CNC program can increase the vise pressure back to the proper milling pressure.

Note: Please confirm with VersaBuilt Robotics that G-Code Vise Control is available for your CNC system.

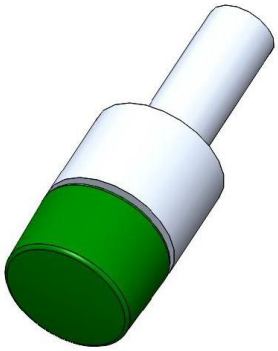

FIGURE 17. Z-PUSH TOOL

Glossary of Terms

Coolant Dump - VBXC Part Configuration option to rotate the robot left and right after picking parts or MultiGrip™ Jaws from CNC workholding to minimize coolant, chips or debris from exiting the CNC.

Default Wash Program - The generic CNC program used to clean vises or MultiGrip™ Jaws in the CNC with coolant or air. This program is used by all programs, unless "Skip Pre-Wash" is selected in VBXC Part Configuration and other wash programs are called in each configured CNC Operation.

> Example: Haas CNC machines come with a default wash program #81004.

Fumble - VBXC logic when either the VBX-160 Gripper Sensors or the Vise Sensors detect the absence of a part or MultiGrip™ Jaws when they are expected to be held by either the robot or the vises.

Fumble, Jaw - A mispick, either picking jaws from the VBX-160 shelves or picking jaws from MultiGrip™ Vises.

Fumble, Part - A mispick, either from the shelf or when picking a part from workholding.

G-Code Vise Control - A VBXC software option to open and close vises or control vise pressure with G-Code during a CNC Program.

> Note: This feature may not be available for all CNC machines.

Load and Unload, Jaws - The process of loading or unloading MultiGrip™ Jaws into MultiGrip™ Vises

Load and Unload, Part - The process of loading or unloading parts into workholding with MultiGrip™ Jaws, i.e., using MultiGrip™ Jaws as a Gripper to move parts only, not as the workholding.

Overhang - When parts will hang over the edge of the shelf.

> Example: On a standard shelf locator template, parts larger than 6-inch diameter will overhang.

Rinse and Air (Wash Bucket) - Part and Jaw cleaning station inside the VBX-160 enclosure.

Robot Settle - Open and close the MultiGrip™ Jaws in the VBX-160 Gripper, allowing the part to drop or "settle" against a Y and/or Z datum, after picked from shelf and before placing into a CNC workholding. With standard OD MultiGrip™ Jaws, the nominal gap between jaws opens from 0.125-inches to 0.52-inches.

Settle - Open and Close of MultiGrip™ Vise, VBX-160 controlled workholding or MultiGrip™ Jaws in the VBX-160 Gripper, allowing the part to drop or "settle" against a Y and/or Z datum.

Settle, Vise - Open and close a vise after the part has been placed into MultiGrip™ Vises with MultiGrip™ Jaws (or placed into another workholding) to drop or "settle" against a Y and/or Z datum. With standard OD MultiGrip™ Jaws, the nominal gap between jaws opens from 0.125-inches to 0.56-inches.

Settle, Y - The drop of a part in MultiGrip™ Jaws in the VBX-160 Gripper, with an angle to allow gravity to shift the part in the Y-direction, in the MultiGrip™ Jaws, to a hard stop in the MultiGrip™ Jaws, locating the part against a Y-datum.

Table Program - CNC Program to position the table, vise, chucks, spindles or any CNC axis, into a position for robot loading or unloading. During installation of the VBXC, each vise is calibrated to the robot with a CNC program to position the CNC table, vise or chuck into a position for loading and unloading. It is possible to have multiple "Table Programs" but the robot will have a "pre-programed" or "calibrated" position where it will move to 1 of 3 vise positions. Select a table program that matches the vise selected. Typically, a CNC table program will match with a vise number.

VBX-160 Booster - Optional equipment to accompany VBX Systems to double the pressure supplied from the VBX-160 to MultiGrip™ Vises.

> Note: The VBX-160 Booster doubles the air pressure after the regulator, therefore if you want 200 psi at the vises, select 100 psi in the VBXC Part Configuration.

VBX-160 Gripper - Gripper assembly attached to robot arm to exchange MultiGrip™ Soft Jaws .

Wash Program(s) - A CNC program used to clean vises or MultiGrip™ Jaws in the CNC with water, water and coolant, coolant or air. Wash programs are called by the VBX-160 system when defined as a step in the VBXC Part Configuration.

Y-Push - The process of moving or pushing a part held by MultiGrip™ Jaws or other workholding in the CNC, using G-Code Vise Control to open and close the MultiGrip™ Vise or other workholding, then move or push the part with a CNC tool to a datum position.

Example of a typical process in a 3-axis CNC setup with OD clamping:

1. Part and MultiGrip™ Jaws placed in MultiGrip™ Vise.
2. CNC Milling Program starts, with G-Code commands, Y-Push Tool is the active tool the in CNC spindle.
3. CNC table moves to programmed position for Y-Push.
4. Spindle lowers to place Y-push tool on one side of the part.
5. G-Code Vise control commands the MultiGrip™ Vise to open.
6. Table moves in the Y-direction to touch the Y-Push tool and move the part into position.
7. G-Code Vise control commands the MultiGrip™ Vise to close.
8. CNC table moves away from spindle.
9. Spindle moves up and out of the way, ready for tool change and milling to start.

Note: Depending on the application, it is possible to vary this process for Y-Push on both sides of the part or to lower the pressure of the vise, rather than opening the vise.

Z-Push - The process of pushing a part held by MultiGrip™ Jaws or other workholding in the CNC, using G-Code Vise Control to lower the supplied air or hydraulic pressure to the MultiGrip™ Vise or other workholding, then move or push the part with a CNC tool to a datum position. This process is analogous to manual operation with a mallet.

Example of a typical process in a 3-axis CNC setup with OD clamping:

1. Part and MultiGrip™ Jaws placed in MultiGrip™ Vise.
2. CNC Milling Program starts, with G-Code commands, Z-Push Tool is the active tool the in CNC spindle.
3. CNC table moves to programmed position for Z-Push.
4. Spindle lowers above the part.
5. G-Code Vise control commands the MultiGrip™ Vise lower the pressure to 10±10 psi.
6. Spindle moves to push the part into position.
7. After the push is complete, G-Code Vise control commands the MultiGrip™ Vise to return to milling pressure.
8. Spindle moves up and out of the way, ready for tool change and start milling.

Example VBX-160 Subroutines for Haas CNC Machines

The following CNC files are provided with VBX-160s:

81004 – Default Vise and Table Wash Program, used for chip management and cleaning the vises
81016 – Vise Table Load Program (called by the VBX to position the table for vise load and unload)
81017 – Vise 2 Table Load Program (note: if possible, only use one Table Load Program)
81018 – Vise 3 Table Load Program

Files for Communicating with the VBX-160
9000 – Dispatcher for VBX communication
9002 – Vise Open and Close command subprogram
9003 – Vise Pressure control subprogram
9004 – Completion Program to indicate the program is finished. Add M98 P9004 at the end of each program before the M30.
9123 – Test routine to check G-Code Vise control

Note these programs depend on Look Ahead being turned off.

Example G-Code Vise Control Commands for Haas CNC Machines

The following subroutines or lines of code can be inserted into milling programs for pushing the part (y-datum), seating the part (z-settle), or adjusting the pressure during the machining process

1. G-Code Vise Control Set Vise Pressure to 40 ±10 psi
2. G65 P9003 S40. H50. U30. (Vise Pressure 40)
3. Set Vise Pressure to 100 ±5 psi
4. G65 P9003 S100. H105. U95. (Vise Pressure 100)

Closing Vises

G65 P9002 D1. C0. (Vise 1 Close)

G65 P9002 D2. C0. (Vise 2 Close)

G65 P9002 D3. C0. (Vise 3 Close)

Opening Vises

G65 P9002 D1. C1. (Vise 1 Open)

G65 P9002 D2. C1. (Vise 2 Open)

G65 P9002 D3. C1. (Vise 1 Close)