GIBBSCAM 2025 CAM for Production Machining

Version 2025 : September 2024

Universal Kinematic Machine (UKM)

GIBBSCAM

Contents

Introduction: UKM

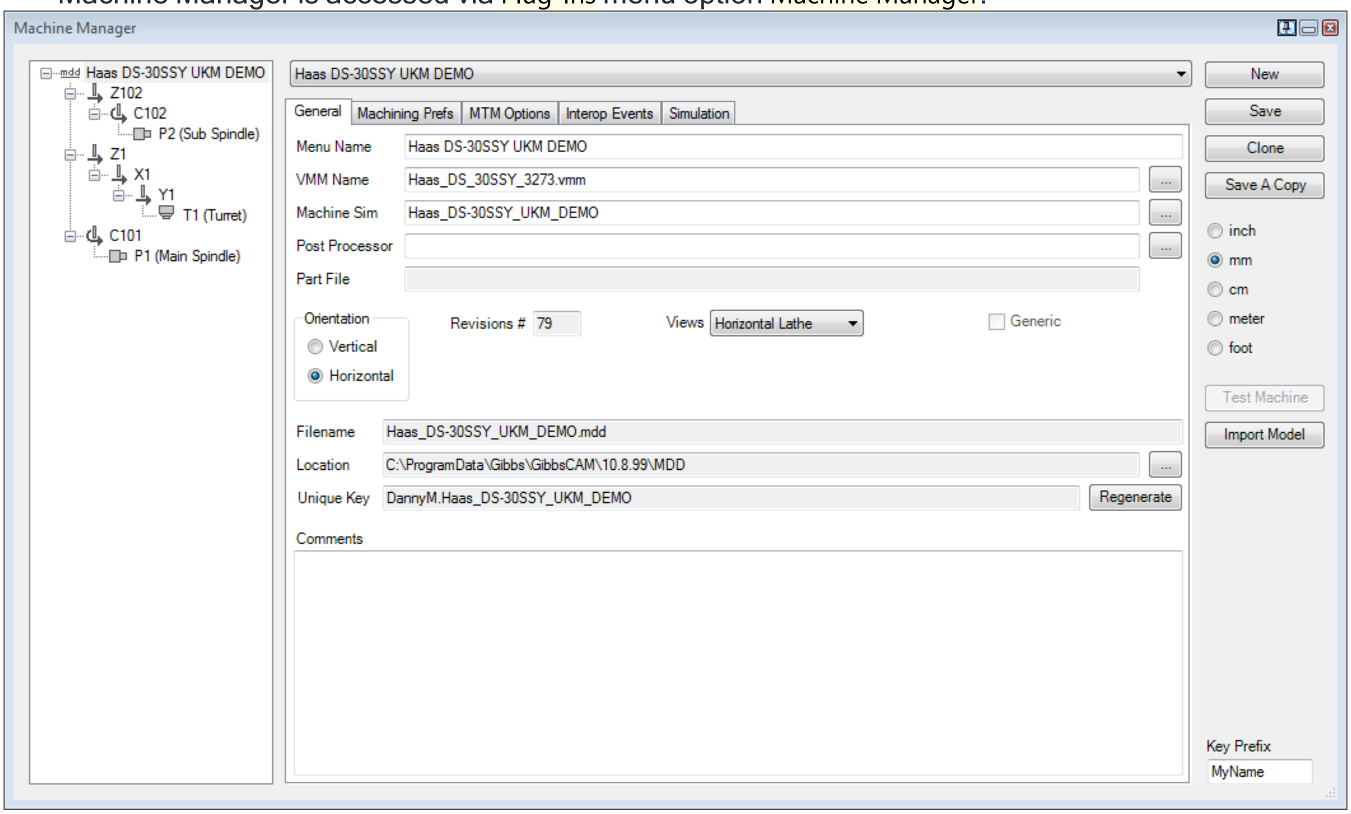
UKM (Universal Kinematic Machine) was introduced at GibbsCAM 2015. UKM has several interrelated parts, as follows.

Machine Manager

Machine Manager was the biggest change, and the main subject of this book. Machine Manager itself is only the front-end GUI to the major architectural changes that allow GibbsCAM to handle any machine that consists of any combination of linear androtational axes, including: mills with 3, 4, 5, or more axes; lathes with any spindle combinations; multi-spindle / multi-flow / multi-task machines.

Machine Manager is intended mainly for developers and Resellers. It is used to create and edit MDDs (Machine Definition Documents) and to build machine-simulation models. Accordingly, it replaces the MDD Editor and the Build Machine portion of Machine Simulation.

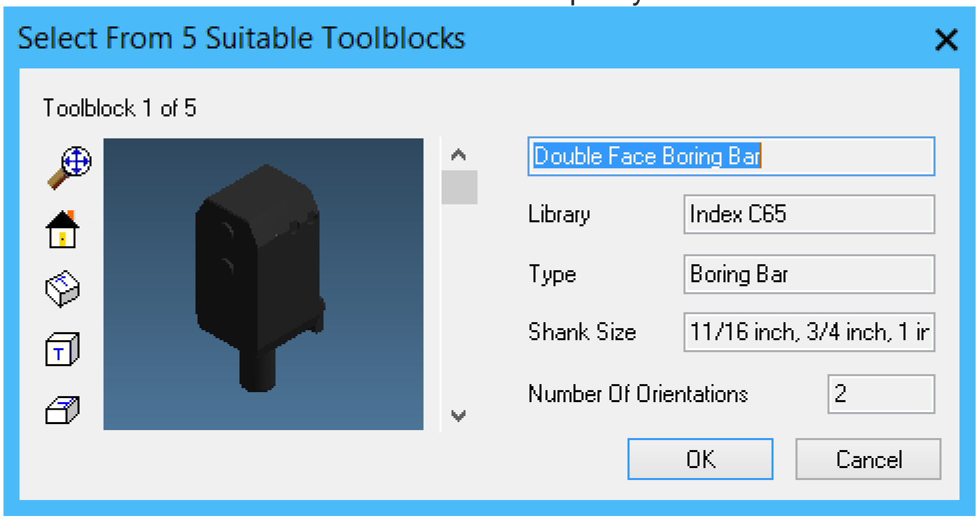
Machine Manager is accessed via Plug-Ins menu option Machine Manager.



Intermediate Tooling

Intermediate Tooling deals with items that are neither tools nor fixed portions of the machine, such as fixtures (chucks, tailstocks, steadies, collets, and so forth) and, especially, toolblocks. Three interfaces address three different types of user:

- Developers and Resellers can configure libraries of toolblocks and fixtures using File menu option Intermediate Tooling.
- Setup programmers can add, view, and validate toolblocks suitable for their current machine's toolgroups using DCD (Document Control Dialog) tab **Intermediate Tooling**.
- For a particular tool, part programmers can click a button in the **Tool** dialog that opens a dialog that lets them view and add toolblocks and specify offset tool offset data.



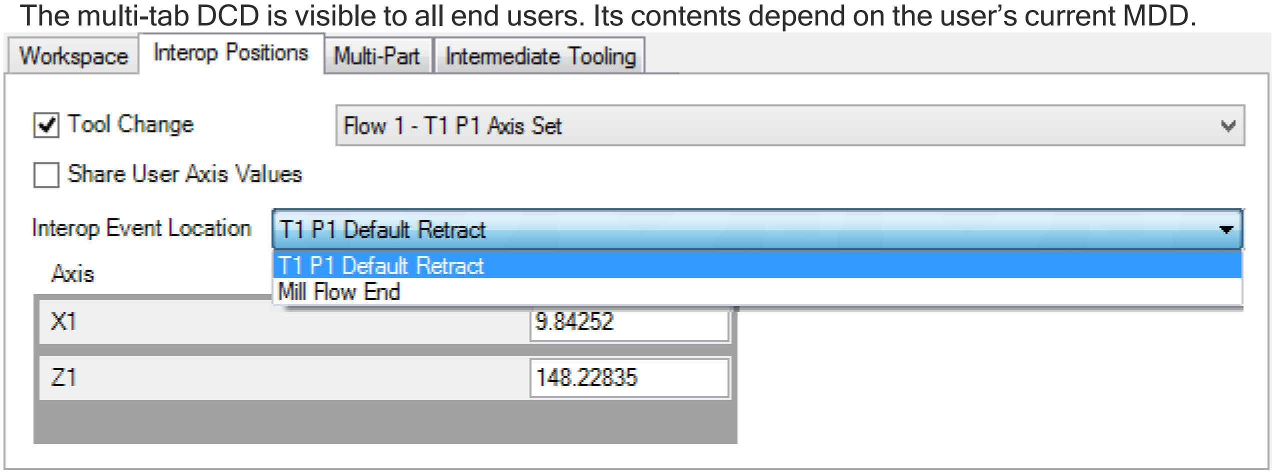
For complete information, see the *Common Reference* guide topics under "Intermediate Tooling".

Utility operations for all types of machines

Prior to UKM, utility operations were available only to turning-type MDDs. In UKM, they are a function of the MDD and associated VMM (virtual machine macro). This change is visible to end users when their parts reference an MDD / VMM that supports utility operations.

Revamped DCD: Document Control Dialog

The multi-tab DCD is visible to all end users. Its contents depend on the user's current MDD.



For more information, see DCD-related topics in the following guides: *Getting Started*, *Mill*, and *Turning*.

Abbreviations, Terminology, and Concepts

Abbreviations include acronyms and initialisms. They are a shortening of a commonly used word or phrase.
Terminology refers to words and phrases used in a special way within UKM, GibbsCAM, CAM, or software.

Abbreviations

ATC (CAM)
automatic tool changer.
FAS (GibbsCAM UKM)
flow axis set.
GUI (software)
graphical user interface. Standard software abbreviation.
MDD (GibbsCAM)
Machine Definition Document.
PS (GibbsCAM UKM)
part station. Previously called “workpiece” in some contexts.
TG (GibbsCAM UKM)
toolgroup
VMM (GibbsCAM)
virtual machine macro

Terminology

assembly file (GibbsCAM Machine Simulation)
An assembly file is now a general term that can mean either an *.asy file (pre-UKM, used in Machine Simulation) or an *.xasy file in UKM (also called a body association file).
axis, linear (CAM)
A linear axis is a direction along which something slides lengthwise.
For linear axes, generally: HVD (horizontal|vertical|depth) is a right-hand orthogonal coordinate system. XYZ is an unrotated HVD whose origin is (0,0,0).
axis, rotary (CAM)
A rotary axis is a pivot around which something turns, revolves, or rotates.
For rotary axes, generally: The A-axis is perpendicular to the YZ plane; positive A is clockwise around the X vector. The B-axis is perpendicular to the ZX plane; positive B is clockwise around the Y vector. The C-axis is perpendicular to the XY plane; positive C is clockwise around the Z vector.
flow (GibbsCAM UKM)
A flow, sometimes called a channel, is a particular sequence of operations — and, possibly, interop moves — that occur on a machine. Machines that allow two more simultaneous flows are called multi-flow or multi-task machines. In GibbsCAM UKM, a flow might use multiple toolgroups, but each toolgroup participates in only one flow at a time.
Example. For a particular multi-flow machine, Flow 1 starts at time06 and ends at time13. The machining operations in Flow 1 use tools from toolgroup 4 and tools from toolgroup 2. Flow 2 starts at time03 and ends at time11. Operations in Flow 2 use tools from toolgroup 1

and tools from toolgroup 5. The two flows might be working on different parts, or they might be working on the same part, such as simultaneous OD and ID operations.

To ensure proper sequencing and to avoid collisions, syncs (synchronizations) are required at op-start or op-end for some or all machining or utility operations in the flows.

flow axis set (GibbsCAM UKM)

A flow axis set (abbreviation: FAS) is the group of axes that can be controlled by a flow at any given time. For a particular operation, a flow axis set consists of all axes that are involved in the operation. At all times, every axis in a machine must be assigned to one and only one flow axis set.

Important: An axis that belongs to a flow axis set is not necessarily used in the flow; for example, it might remain “parked” throughout the flow. However, an axis belonging to one flow axis set is unavailable to any other flow axis set.

machine space (CAM, GibbsCAM)

In machine space, locations and orientations are relative to the machine. One example could be a toolgroup’s home position. Another could be the location of a spindle face.

Compare part space, shop space, and toolgroup space.

MDD (GibbsCAM)

The MDD, or machine definition document, specifies machine information used by GibbsCAM for simulation, toolpath, and posting.

MDD, custom (GibbsCAM)

A custom MDD is an MDD that models a specific machine.

MDD, generic (GibbsCAM)

A generic MDD is one that can model any machine in the same class.

node (software)

Within a hierarchical tree, a node is branchpoint or terminal point. A node is an object that contains a value or condition, or represents a separate data structure. Each node in a tree has zero or more child nodes below it and, except for the root node, each node has exactly one parent.

Also see *root node*, *terminal node*, *tree*.

nominal axis (CAM)

The nominal axis is the axis most similar to the axis being defined. The nominal axis must not be orthogonal to the actual linear motion.

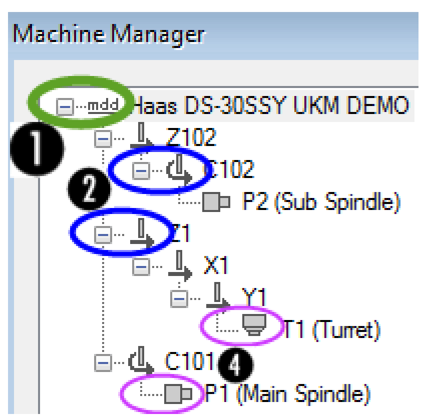
part space (CAM, GibbsCAM)

In part space, locations and orientations are relative to the part origin (designated X0,Y0,Z0). In G-code, part space is G54.

Compare machine space, shop space, and toolgroup space.

root node (software)

In a tree-like hierarchy like the kinematic tree, the root node (item 1 in the illustration) is the topmost parent node, and is the only node without a parent node. All other nodes are descendants of the root node via some unique path.



shop space (CAM, GibbsCAM)

In shop space, locations and orientations are in the real world, and not relative to the machine or any portion of it. In shop space, gravity points towards -Z.

Compare machine space, part space, and toolgroup space.

terminal node (software)

In a tree-like hierarchy like the kinematic tree, a terminal node (or leaf node) (items 4 in the illustration) is a bottommost node, with no child nodes beneath it.

toolgroup space (GibbsCAM)

In toolgroup space, locations and orientations are relative to the current toolgroup. This is particularly helpful when describing the orientation of a tool station.

Compare machine space, part space, and shop space.

tree (software)

A tree is a structure consisting of a root node and its descendant nodes. Each node except the root has exactly one parent node.

user name (software; GibbsCAM)

The user name for an object is a name for it that is user-friendly, or at least user-understandable. Some examples of user names: “Lower Turret” (instead of “T2”); or “Main Spindle” (instead of “P1”).

vector (CAM)

A vector is the direction or orientation of an axis.

For *linear axes*, generally:

- HVD (horizontal|vertical|depth) is a right-hand orthogonal coordinate system.
- XYZ is an unrotated HVD whose origin is `(0,0,0)`.

For *rotary axes*, generally:

- The A-axis is parallel to the YZ plane; positive A is clockwise around the X vector.
- The B-axis is parallel to the ZX plane; positive B is clockwise around the Y vector.
- The C-axis is parallel to the XY plane; positive C is clockwise around the Z vector.

virtual machine macro — see VMM.

VMM (GibbsCAM)

A VMM, or virtual machine macro, specifies the types and functions of utility operations and machine modes available on a specific machine. (VMMs also have much more advanced capabilities, and can substitute for plug-ins in some circumstances.) A particular VMM can be referenced by one or more custom MDDs.

Machine Manager

Machine Manager is the interface used to create GibbsCAM MDDs and Machine Simulation models. It is intended mainly for developers and Resellers, but can be used by clients who wish to create their own custom MDDs and Machine Simulation models.

CAUTION: Using an incorrect MDD can cause catastrophic errors with your machine. Always take great care to thoroughly validate any new or changed MDD before performing any actual machining.

Machine Manager models all aspects of a CNC machine that GibbsCAM needs, wants, and requires or expects. The interface presents you with what you need to define for the class of machine you are working on.

When you define an MDD, keep your machine's manual close at hand, and consult it frequently.

The following presents reference information on Machine Manager capabilities and its user interface. For a step-by-step tutorial, see " Creating a Sample Machine " on page 20.

Topics in this chapter include:

About MDDs

Generic MDDs and custom MDDs have the same file extension – `*.mdd` –, but present somewhat different appearances within Machine Manager.

Generic MDDs

A *generic MDD* can model any machine in the same class. For example: A generic 4-axis mill can model any 4-axis mill (with appropriate settings provided by the end user in the DCD and in the dialog box **Rotary Axis Setup**). Generic MDDs present a simple interface in the Machine Manager because some information is suppressed or hidden.

A generic MDD cannot reference a VMM (virtual machine macro).

Custom MDDs

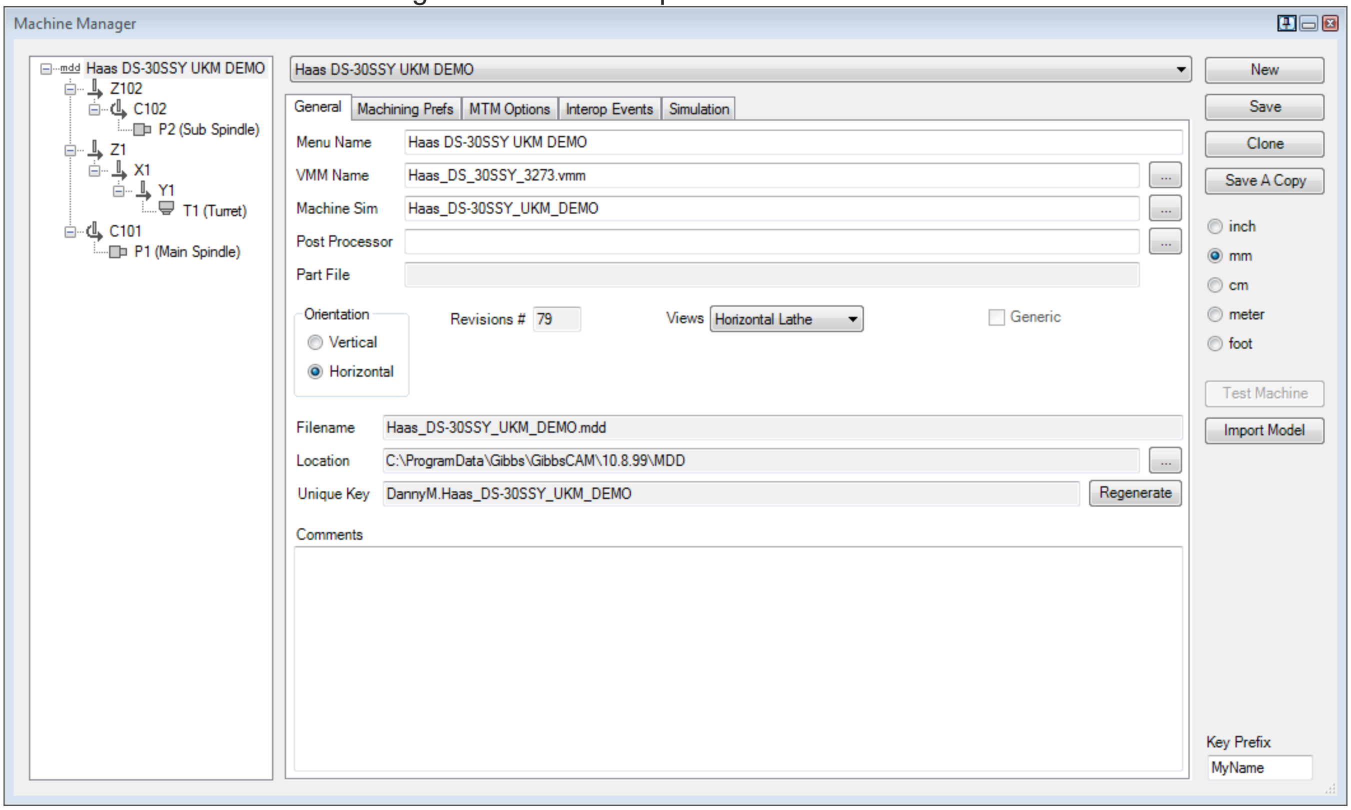
A *custom MDD* is machine-specific, created to match a particular machine and capture its capabilities and limitations. For example, custom MDDs would be used in all the following cases: for MTM-class machines, for Machine Simulation, for non-standard machines, and for situations where the end-user may want a more powerful MDD with a custom-matched post processor.

Custom MDDs have certain information hard-coded so it is no longer user-accessible from GibbsCAM.

Only a custom MDD can reference a VMM (virtual machine macro).

Machine Manager Interface

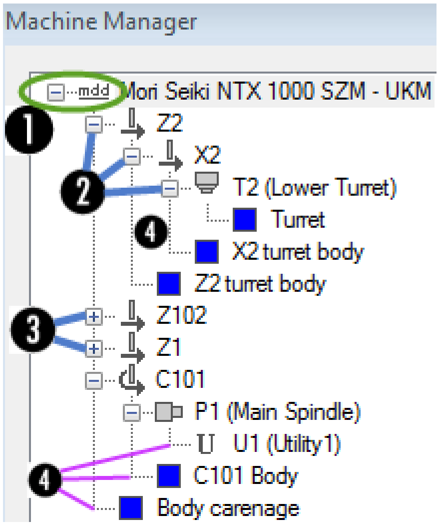
The interface for Machine Manager has three main parts:



- The kinematic tree (left pane) provides a graphical representation of the machine model. As in Windows Explorer, container nodes contain subnodes, and the [-] / [+] icons allow you to suppress or display the subtree. Right-clicking a node opens a context-sensitive pop-up menu for that node type.
  For more information, see “ Kinematic Tree ” on page 10.
- The file controls along the right allow you to choose, change, or test the entire current MDD.
  For more information, see “ File Controls ” on page 12.
- The tabs in the center pane provide controls that apply to the selected node. This portion of the interface is the most complex.
  For more information, see “ Tabs for the Root Node ” on page 13.

Kinematic Tree

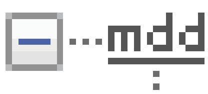
The leftmost pane of the Machine Manager GUI is the kinematic tree, which resembles the folder/file list in Windows Explorer. The Kinematic Tree is a hierarchical representation of the components of the MDD that is being described.



Typical kinematic tree:

1. Root node, shown open (⊟···mdd) so as to display its children nodes.
2. Non-root parent nodes, open (⊟···).
3. Non-root parent nodes, closed (⊞···).
4. Terminal (leaf) nodes (└···).

Root Node



The topmost part of the tree is the *root node*. Its label is the name of the MDD. The root node is a *parent node*; it contains nodes that constitute the kinematic model for this MDD. To define the MDD, the machine's components must be added as child nodes of the root node or of another node.

When the root node of a *generic* MDD is selected, the following tabs are available:

General	Machining Prefs		Interop Events		...

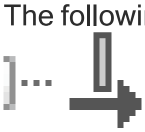
For the root node of a *custom* MDD, other tabs become available, such as:

		MTM Options		Simulation	...

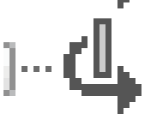
Child Nodes

A *child node* is any node other than the root. Some types of child node can have child nodes themselves; other types cannot, and are called *terminal nodes* or *leaf nodes*.

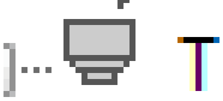
The following are all examples of child nodes:



Linear Axis node, typically labeled X*<n>*, Y*<n>*, or Z*<n>*. This node type can be a parent of any other node type except root. The **Linear Axis** tab provides controls for modifying the axis.

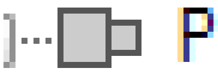


Rotary Axis node, typically labeled A*<n>*, B*<n>*, or C*<n>*. This node type can be a parent of any other node type except root. The **Rotary Axis** tab provides controls for modifying the axis.



Toolgroup node, labeled **T***<n>*; note that the T prefix cannot be changed. This node type can be a parent, but only of terminal nodes such as Utility Station and Simulation Body. Three tabs provide controls for modifying the toolgroup:

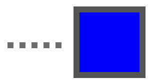
Toolgroup	Orientation	Tool Station			



Part Station node, labeled **P**<*n*>; note that the P prefix cannot be changed. This node type can be a parent, but only of terminal nodes such as Utility Station and Simulation Body. Two tabs provide controls for modifying the part station:

Part Station	Orientation				

Utility Station node, labeled **U**<*n*>; note that the U prefix cannot be changed. It cannot be a parent node. The Utility Station tab provides controls for modifying the utility station. As a parent node, it can specify general information to be accessed or inherited by all its children nodes, such as table slant.



Simulation Body node, which can be labeled anything not already in use. It cannot be a parent node. The Simulation Body tab provides controls for modifying the simulation body.

File Controls

New

Create a new MDD. You are given the option of creating a new file from the currently selected MDD, or you may create a completely new MDD.
Templates are provided to help you with various machine types, such as:

- 3-Axis Mill
- 4-Axis Mill, with three subtypes (A | B | C Table)
- 5-Axis Mill, with six subtypes (AB | AC | BC Table, and AB | AC | BC Head)
- 2-Axis Lathe, with three subtypes (Fixed Spindle | Swiss | Motile)
- Mill-Turn, with eight subtypes (C | YC | BC | BYC Fixed; C | YC Swiss; and C | YC Motile)
- Empty

Save

Save the current file, overwriting the previous version of it, if any.

Clone

Make an identical copy of the original file.

Save a Copy

Save the current file under a different name.

Units

This item allows you to specify what the input units are for the current MDD. In addition to the units specified (Inch, Millimeter, Centimeter, Meter and Foot), various sections of the MDD Editor may expect input in minutes or degrees.

MDD Menu

This is a list of the MDDs in the current installation directory.

Key Prefix

In this field you may set a string of text that will appear before the Unique Key. A period is automatically inserted between the prefix and the key.
Each and every MDD that is created must be unique. To help identify the creator of an MDD a prefix is added to help identify the company or individual who created the MDD. The Key Prefix should contain a unique identifier of your choice. Among other things, the Key Prefix helps Technical Support keep track of your MDD, if any difficulties are later encountered.

Tabs for the Root Node

When the root node is selected, Machine Manager offers controls and parameters in the following tabs:

- General
- " Machining Prefs " on page 14
- *(available only for custom MDDs)*" MTM Options " on page 16
- " Interop Events " on page 16
- *(available only for custom MDDs)*" Simulation " on page 17

General

This tab is presented only when the root node is selected. It provides controls for defining the MDD as a whole and for defining what end users will see within GibbsCAM when their part references this MDD.

Menu Name

This is the name of the MDD (Machine Definition Document) seen by the end user. It should be descriptive of the machine that is being defined. This value you provide in field will appears not just as a file control within Machine Manager, but also to the end user, in the DCD (Document Control Dialog), Machine Type section.

VMM Name

This is the name of the VMM (virtual machine macro) associated with this MDD. To find an existing VMM and associate it with this MDD, click the [...] button to browse through folders and files.

Machine Sim

This information points to a default Machine Assembly folder. To select a folder, click the [...] button to browse. When an end user uses Machine Simulation rendering, the body files in this folder will be loaded.

Post Processor

This is the default post processor associated with the MDD. Any part created using this MDD will use this post processor automatically. Users may still select a different post before post processing the part file. Click the Browse button to select a file.

Orientation

The Vertical or Horizontal orientation affects display only, such as the setup layout in the DCD (for generic MDDs only), or the direction of the shadow.

Examples:

For a generic mill, the shop floor is below it at -Z for vertical mills, or -Y for horizontal mills.

For a generic lathe, the shop floor is below it at -X for vertical lathes, or -Z for horizontal lathes.

Revisions #

This is how many times the MDD has been modified. It is a read-only value that is incremented when the file is saved. This is checked by part files when they are first opened. If a part file uses the same MDD but a different revision, the user will be prompted with what to do.

Views

This menu lets you choose the default view set for the MDD. The preset choices include Vertical Mill, Horizontal Mill, Vertical Lathe, Horizontal Lathe, and Horizontal Swiss. Selecting Other lets you define a custom set of views by clicking the Set Views button.

Set Views

Clicking the Set Views button lets you define a custom set of views for the MDD. To do this, you must specify the object space vectors. The object space vectors are the orientations of the axes for the Top, Front, Side and Iso views.

When setting the Top, Front and Side views, the Up Vector and Right Vector are determined by which axes are given a vector value. That value must be -1 (negative axis) or 1 (positive axis). An axis given a value will be used for alignment. Axes used for alignment must be perpendicular. By entering a value (1 or -1) you specify which axis aligns to this view. Please note that vector values must be a positive or negative 1. Any other value entered will automatically default to 1.

Filename

Displays the filename of the MDD. Cannot be edited. (But see “Clone” and “Save A Copy”).

Location

This is the current location of the open file. To open this location, click the [...] button to browse through folders and files.

Unique Key

This is how the MDD is identified to the system, and it is not visible to the end user. The Unique Key cannot be changed except for the prefix, which is set in the Key Prefix field. It is possible for two or more MDDs to have the same menu name even though the machines are very different. Therefore, each MDD must have its own unique key. This allows the system and parts to differentiate between MDDs and to use the correct one. The Revision # field provides a further refinement. Each part file contains within it a copy of the MDD. Because of an MDD’s potential to “break” a part file, it is crucially important for each part to use the correct MDD. When a part is opened, GibbsCAM compares the part's MDD with the MDDs that are known to the system. If the part has a newer MDD ID, it will use the internally saved MDD. If the application has a newer version of the MDD, the user will be prompted to choose which MDD should be used. Clicking the Regenerate button will create a new unique key.

Comments

Comments may be added about the MDD. This is the only place the information is displayed. Please use this field freely to provide a description and revision history of the MDD.

Machining Prefs

This tab presents controls that reflect extended, optional, or potential capabilities of your machine. Choose the settings that match how machining is done in your shop using this MDD.

Extended Drill Cycles

This area contains this machine's non-standard drill cycles. Clicking the Add or Edit buttons, or double-clicking on an entry, opens a dialog that allows the definition of a drill cycle. T he available choices include FI Stop Off Wall RO, FI Stop RO, Back Bore, FI Stop Man Out, FIRIFIRO, and Custom.

Custom Name. For simplification, each cycle can be given a custom name that is displayed within GibbsCAM. The posted output does not use or recognize the custom name of the drill cycle. Instead, it uses the name of the cycle type selected in this menu.

Macro ID.

Coolants

This area contains the machine's available coolant choices. Clicking the Add or Edit buttons, or double-clicking on an entry, opens a dialog that allows the definition of a coolant. The available choices include Flood, Mist, Thru Spindle, High Pressure, Pulse, Flood Thru Spindle, and 14 custom types.

Custom Name. For simplification, each coolant can be given a custom name that is displayed within GibbsCAM. The posted output will recognize the custom name of the coolant.

Work Areas

The values supplied for Work Area limits do not override the machine's hard limits, but rather, set a preferable soft limit. The work area is designed to give the system a hint or suggestion on which solution to perform (when multiple solutions exist) . The work area does not change the actual toolpath generated by the machining operation, just the way the tool approaches the work piece. The system will ignore work areas if they are outside the machine's hard limits defined in the MDD.

Checkboxes

Select zero or more of the following capabilities.

Extended Tool Change

Checking this item will embed all tool change data in the MDD. The end-user will have no control over the tool change position. This creates an Extended MDD which will try to reference a VMM.

Smart Exit Clearance

This option compares the clearance value of the current operation with the approach clearance of the next operation. The Smart Exit Clearance will use the higher (safer) value of the two clearances.

Angle Minimization

Select the behavior to be used when GibbsCAM must reposition rotary axes between cutting sequences, such as between operations. This is also used for repositioning while cutting when “singularities” are encountered.

Minimize 1st Rotary Axis

- **Minimize 1st Rotary Axis:** Use the rotary solution that causes the smallest rotation of the axis “closest to the part”.
- **Minimize 2nd Rotary Axis:** Use the solution that causes the smallest rotation “farthest from the part”. This is the default, and corresponds to the behavior of all GibbsCAM versions before 2015.
- **Minimize Sum of Rotary Axes:** Use the solution that causes the smallest “combined rotation”. The rotation angles of both rotary axes are added to produce the combined rotation.
- **Minimize Max Delta:** Use the solution that causes the largest rotation to be as small as possible.

Example: If A, B, C, D were all candidates, where

A = `30,120`; B = `135,15`; C = `45,90`; D = `75,75`,

then:

- A minimizes the first, because 30 < (135, 45, or 75);
- B minimizes the second, because 15 < (120, 90, or 75);
- C minimizes the sum, because 135 < (150, 150, or 150); and
- D minimizes the largest, because 75 < (120, 135, or 90).

Clearances

Select the behavior that to be used when the tool is retracted to a clearance plane:

- **Traverse at Part Clearance Volume:** The tool remains at or outside a volume that keeps it just clear of the part.
- **Traverse at Bounding Volume:** The tool remains at or outside a volume that surrounds the part.
- **Legacy Clearance Behavior:** Enables the Behavior button, which allows you to specify clearance behaviors as in versions prior to GibbsCAM 2015. For example, for a machine

with mixed axis types, you can specify the axis move order (rotary first, linear first, or simultaneous); and for a machine with multiple clearance planes, you can specify the retract level (CP3, global CP1, or local CP1).

Fast Feeds

This section allows you to specify whether and how rapid moves are converted to fast feeds.

Convert Interop Rapids

Select this checkbox if you want both ordinary and interop rapid moves to be converted.

Fast Feed

Enter a value for fast feed rate.

Convert

Choose from the drop-down list:

- None:
- All Rapids:
- All Rotary Rapids:
- All 5-Axis Rapids:
- Only Connect Rapids:
- Only Rotary Connect Rapids:
- Only 5-Axis Connect Rapids:
- Custom: This choice allows you to specify the details of how each kind of rapid move (Intraop, Approach/Retract, Inter-depth, Inter-origin, and Inter-rotation) is converted to one of four kinds of feed (Linear, Polar, Wrapped, or IJK).

MTM Options

This tab is available only for a custom MDD that references a VMM. Generally, its kinematic tree contains multiple toolgroups, multiple workpieces, or both.
The contents of this tab allow you to define Flow Axis Sets and Interpolation Sets – in other words, the linear and rotary axes in play for operations on this machine.

Interop Events

The controls in this tab allow you to specify the types and parameters of machine behavior that occurs between operations.

Actions

Add: Create a new event location, specifying its axes, move type, position, and order.
Edit: View or modify parameters for the selected event location.
Clone: Create an exact duplicate of the selected event location.
Delete: Delete the selected event location.

Event Placement Amongst Operations

Place Before / Place After:
Candidate Placements: Operation Change Types
After Part Station Jump *(only if utility ops are available)*:
Go To On-Part Op:
Go To Off-Part Op:
Program Stop:
Flow End:
Non-Tool Utility Op *(only if utility ops are available)*:
Toolgroup Change:
Tool Position Change:

Tool ID Change:
Tool Offset Change:
Turning/Milling Transition *(turning-type machines)*:
Different Second Angle *(only if utility ops are available)*:
Before Part Station Jump *(only if utility ops are available)*:

Simulation

This tab is available only for a MDDs.
The items found in the Simulation Tab are used for grouping machine components together.
There are two types of groups: "Collision Groups" and "Visibility Groups".

Collision Groups

In this section you can create, edit, and delete groups that will be used when Collision Checking is active in simulation. Items within a component group will not be checked against each other (beyond the normal tool/part interference), but the group as a whole can be tested against tool and part interference as well as against groups consisting of things that are not ordinarily tested, such as steadyrests, the machine’s sheet metal, the table, or chucks.
It is recommended that all items within a flow that are connected together, such as a chuck, spindle, x-axis and z-axis on a common 3-axis mill, should be put in the same Collision Group.
An example of the groups a twin-turn machine might have would be: Turret 1, Turret 2, Spindle 1, Spindle 2, and Sheet Metal. As previously stated, items within a group are not checked against each other.
Note: In this section you are creating the groups, not defining the members of each group.

Visibility Groups

In this section you can create, edit and delete groups of bodies in the kinematic model that can quickly and easily be shown or hidden during simulation. Machine Component Visibility is one of the options available in the right mouse menu when you are in Simulation.

Working With Nodes

This section discusses the steps for adding, renaming, editing and deleting Machine Manager nodes.

Adding Nodes

Child nodes are added by right-clicking on an existing node. You will be prompted to define the node's Label and User Name. The Label is an incremental name used for identifying the node, such as X1, X2, Y1, Y2, Z1, Z2, P1 and P2.
Each label must be unique. For more information on how labels are set, see Simple Node Labels and MTM Axis Labels, below,
The User Name field is optional. The text entered here will be displayed inside of GibbsCAM instead of the node label. This is particularly useful for toolgroups and part stations, because

terse labels like T1, T2 and T3 are less useful to users than descriptive names like "Upper Turret", "Lower Turret", and "Gang Slide".

Renaming Nodes

Right-clicking a node allows you to rename the node. You can modify the Label and the User Name.

Editing Nodes

When you select a node in the Kinematic Tree, the interactive tabs are updated to show the relevant information for that node type.

Deleting Nodes

Right-clicking on a node and choosing Delete Selected will remove the node from the Kinematic Tree. All references to this node are removed from the MDD.
Use this option with great care!

Simple Node Labels

Each node must have a label, which is a unique identifier. A label normally consists of a letter and number, depending upon the type of being created.

Labels for Axes

When defining a moving component you must specify the axis in which the component moves. Axis labels must be a letter with a number, such as X1, Y1, Z1; or X3; or Z9. Or even (not recommended) Q44.

Labels for Part Stations

A part station is given the label Pn (P1, P2, P3 ...) . The prefix **P** is supplied by the system, and cannot be changed. The number increments automatically as each new Part Station node is added.

Labels for Toolgroups

A toolgroup is given the label Tn (T1, T2, T3 ...). The prefix **T** is supplied by the system, and cannot be changed. The number increments automatically increments as each new Toolgroup node is added.

MTM Axis Labels

If a machine has more than the standard X, Y, Z, A, B, C axes, then it qualifies as an MTM-class machine and the axis labelling becomes more complex. The standard 6 axis labels are replaced by the following conventions. There are naming conventions for Toolgroups, Spindles, and Auxiliary axes.

Axis Labels for Multiple Toolgroups

Axes under different Toolgroup use axis labels X through C and 1 through 99. If a machine has two Toolgroups, the first uses the labels X1, Y1, Z1, A1, B1, C1 and the second Toolgroup uses the labels X2, Y2, Z2, A2, B2, C2. This allows a theoretical limit of 99 individual Toolgroups:

- X1, Y1, Z1, A1, B1, C1 = Axis labels for Toolgroup 1
- X2, Y2, Z2, A2, B2, C2 = Axis labels for Toolgroup 2
- X3, Y3, Z3, A3, B3, C3 = Axis labels for Toolgroup 3

  ...
- X99, Y99, Z99, A99, B99, C99 = Axis labels for Toolgroup 99

Axis Labels for Multiple Spindles (Part Stations)

Axes under different spindles (part stations) use axis labels X through C and 101 through 199. If a machine has two spindles, the first uses the labels X101, Y101, Z101, A101, B101, C101, and the second spindle uses the labels X102, Y102, Z102, A102, B102, C102. This allows a theoretical limit of 99 individual spindles:

- X101, Y101, Z101, A101, B101, C101 = Axis labels for Spindle 1

  ...
- X199, Y199, Z199, A199, B199, C199 = Axis labels for Spindle 99

Note: Although up to six axes can be defined, most spindles have only a C-axis and sometimes a Z.

Auxiliary Axes

Auxiliary functions are typically set through Utility operations. Each auxiliary function, such as a bar feeder or part catcher, has its own set of axis labels, X through C. The number that follows defines the type of auxiliary function:

- X201, Y201, Z201, A201, B201, C201 = Axis labels for Manual Loaders/Unloaders
- X301, Y301, Z301, A301, B301, C301 = Axis labels for Auto Bar Feeders
- X401, Y401, Z401, A401, B401, C401 = Axis labels for Auto Chucks
- X501, Y501, Z501, A501, B501, C501 = Axis labels for Bar Feeders
- X601, Y601, Z601, A601, B601, C601 = Axis labels for Bar Pullers/Grippers
- X701, Y701, Z701, A701, B701, C701 = Axis labels for Robot Arms
- X801, Y801, Z801, A801, B801, C801 = Axis labels for Part Catchers
- X901, Y901, Z901, A901, B901, C901 = Axis labels for Tailstocks
- X1001, Y1001, Z1001, A1001, B1001, C1001 = Axis labels for Steady Rests
- X1101, Y1101, Z1101, A1101, B1101, C1101 = Axis labels for Part Indexers

Note: Although up to six axes can be defined, most auxiliary component assemblies generally only have one or two axes.

Creating a Sample Machine

Summary of Steps

Before you begin

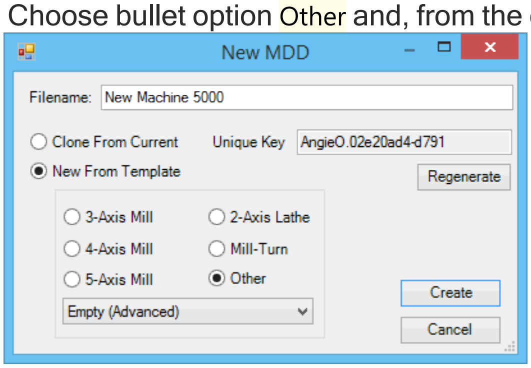
Start GibbsCAM 2025.
No part is open. The most recent MDD is remembered and loaded in the background.

Step 1: Start Machine Manager and initialize a new MDD

1. Go to Plug-Ins > Machine Manager. (If you see no such menu item, use Plug-In Manager to activate it.)
   Machine Manager opens, showing the most recent MDD.
2. Change machine type to 3-Axis Vertical Mill.
   This is the simplest machine to start with.
3. Click New to create a new MDD.

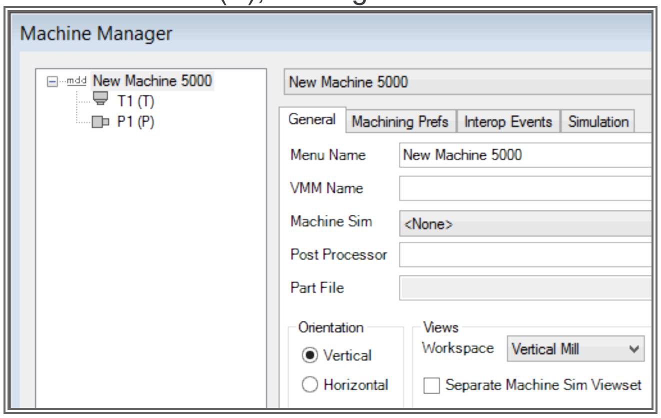
We now have a 3-axis mill MDD that we can customize.

4. Type in Filename:`New Machine 5000`.
5. Choose bullet option New From Template.
6. Choose bullet option Other and, from the dropdown, select Empty.



7. Click Create and the Machine Manager dialog opens.

The Kinematic tree contains the minimum it could possibly contain: one Toolgroup (T) and one Part Station (P), nothing else.

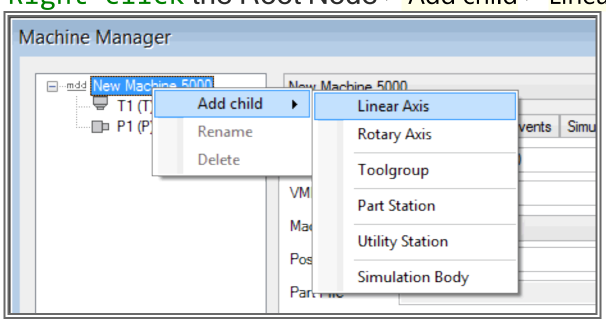


Step 2: Add and configure the three linear axes

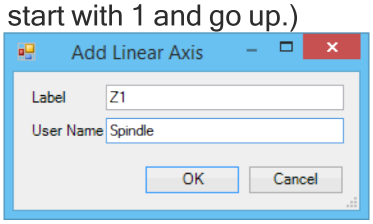
Z Axis

First, we will add the Z axis. It is not necessary to add items in any particular order. We will begin with the Z axis because it is on the tool branch and it addresses the part.

1. `Right-click` the Root Node > Add child > Linear Axis.

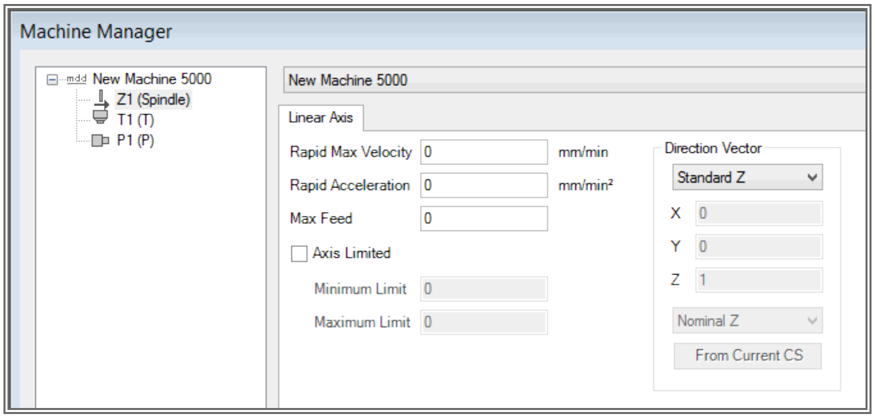


2. Enter details as shown. Label: `Z1`. User Name: `Spindle`. (The convention for Tool axes is to start with 1 and go up.)



> **Please Note:** The User name of an axis entered here will appear throughout Machine Manager (including Test Machine and MTG) and also in Render Tracking.

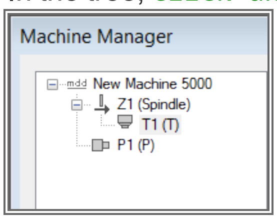
3. Click OK and see the result:



- Tree has Z1 directly below root (sibling with T1 and P1) and is selected.
- The Linear Axis tab opens and shows what options you have for a linear axis.

Now we will configure the Z axis.

4. In the Direction Vector area, a pulldown menu provides options for X,Y,Z, Standard and Reversed vectors, plus a Custom option. Retain the default (Standard Z).
5. In the tree, `click and drag` T1 onto Z1.



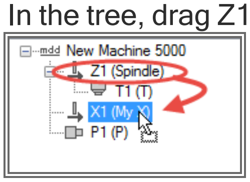
X Axis

Next, we will add the X axis.

`Right-click` Root > Add child > Linear Axis. Label it `X1`, user Name: `My X`.

We will now configure the X axis:

6. In the Direction Vector area, again retain the default (Standard X) from the pulldown menu.
7. In the tree, drag Z1 onto X1.



Notice how the subtree (T1) comes along.

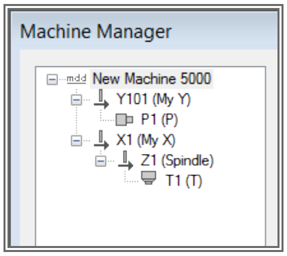
Y Axis

Finally we will add the Y axis.

8. `Right-click` Root Add child> Linear Axis. Label: `Y101`. (The convention for Part axes is to start with 101 and go up.) User Name is `My Y`.

We will now configure the Y axis.

9. In the Direction Vector area, pulldown menu, retain the default (Standard Y).
10. In the tree, drag P1 onto Y101.

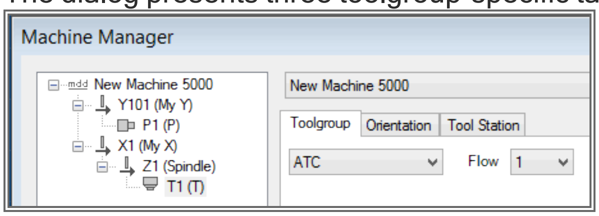


11. Save the MDD.

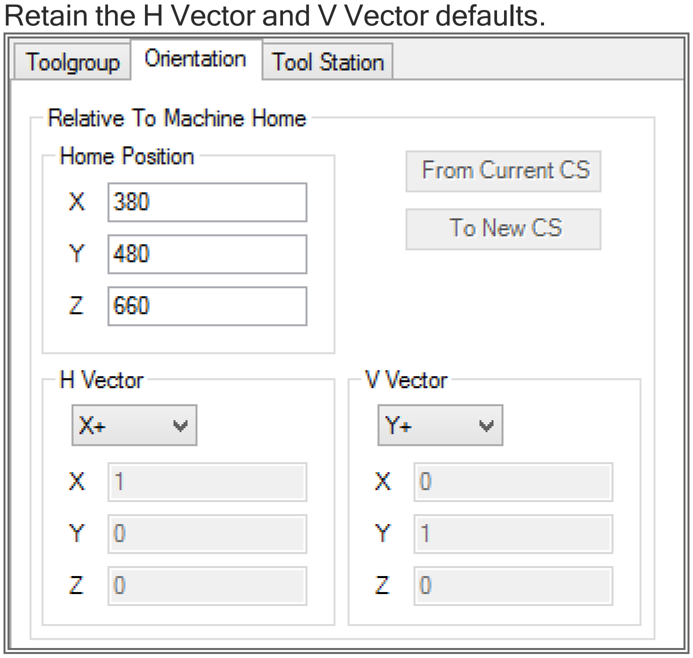
We have created a very basic 3-axis machine but it needs much more detail. The next item we will configure for this example machine is an ATC toolgroup.

Step 3: Configure the toolgroup

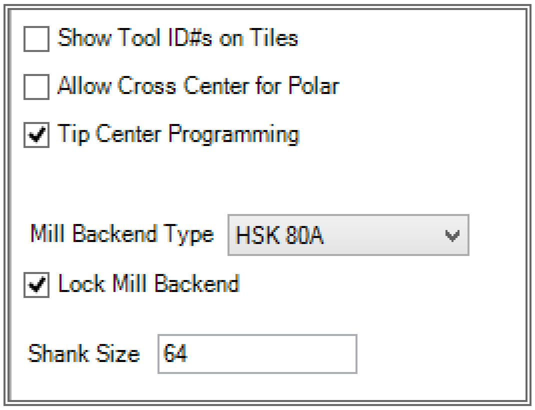
1. In the Kinematic tree, click T1.
   The dialog presents three toolgroup-specific tabs.



2. Select the second tab (**Orientation**), double-check that the dimension is set to mm, and enter the following:
   Retain the H Vector and V Vector defaults.



   Select the first tab (Toolgroup) and:
3. In the pulldown menu, change the type to ATC (Automatic Tool Changing head).
   Notice that many other controls on the tab just go away, as they are not needed.
4. Change the other options as shown below:



We checked the box for Lock Mill Backend because only one backend will ever be encountered (as is the usual case). The value entered into the Shank Size box represents a maximum shank size. In this case it will be no greater than 64mm.

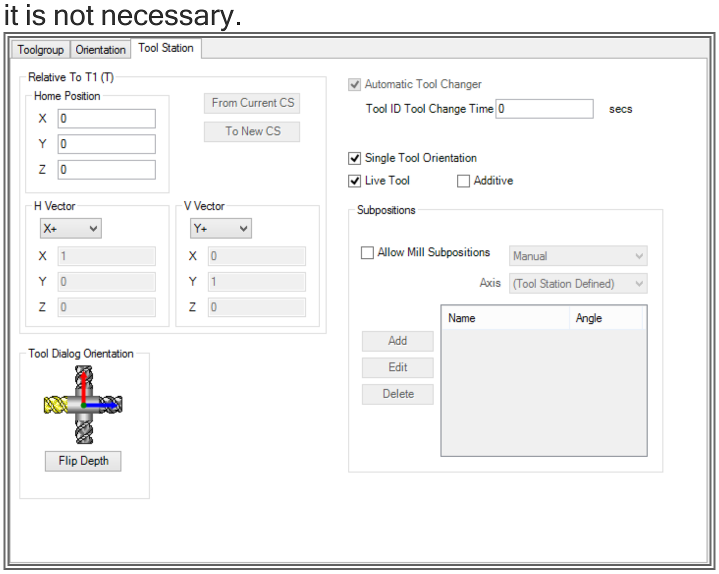
5. Select the Tool Station tab and enter the following:

- Retain values for "Home Position".
- Select the checkbox for Single Tool Orientation.

This means that when users see the tool dialog, they will not have to choose from the stations on the tool cross.

- Retain the selected status for the Live Tool checkbox.
- Retain default choices for vectors.

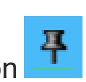
Note: If your machine had right-angle heads, these would have to be configured. In this case it is not necessary.



6. Save the MDD.

We still have the rotary axes to add, but before we do, we will create some Simulation bodies so that we can start using Test Machine.

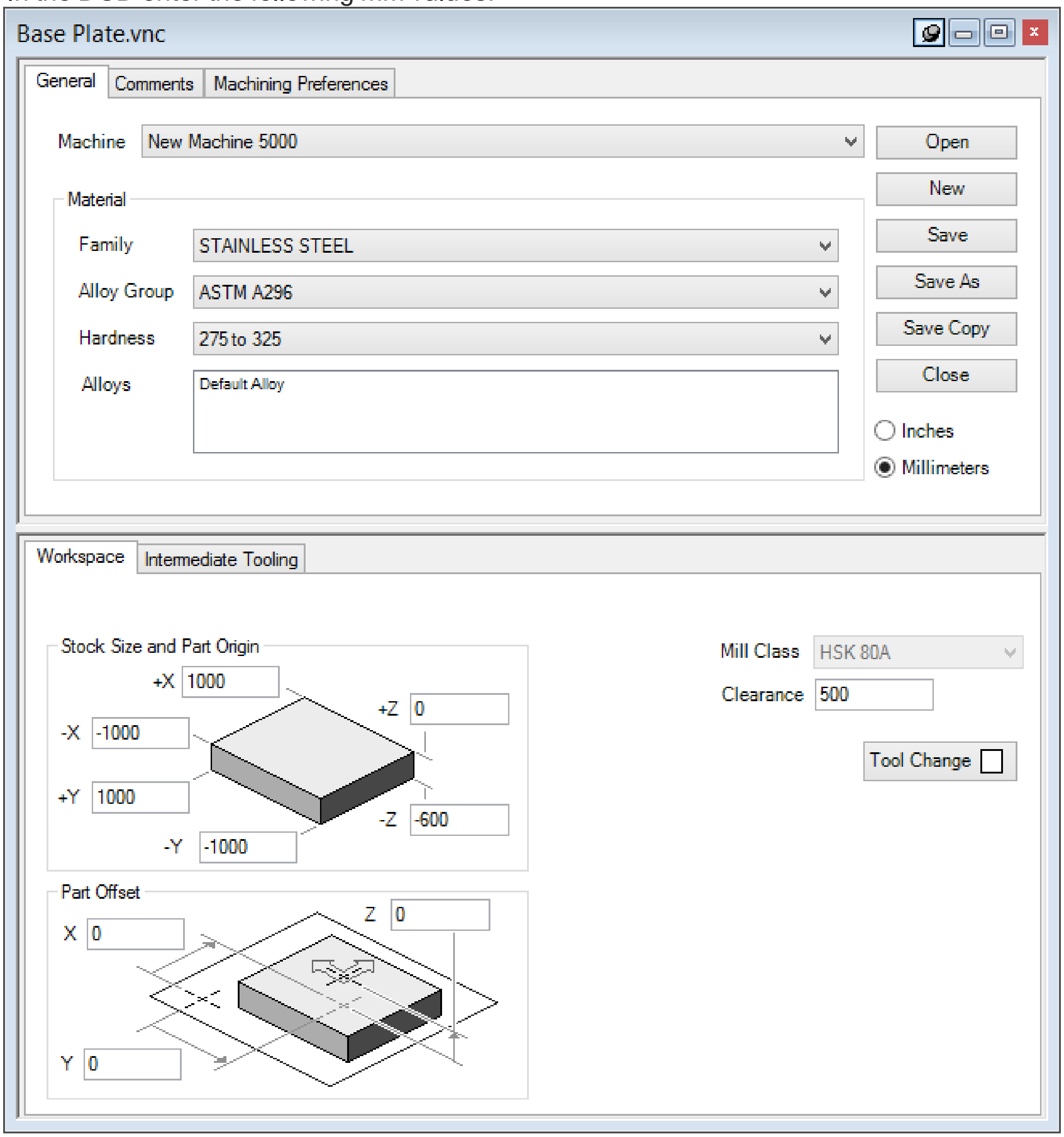
First we will add a base plate and color it black, and then add a cylinder to represent the spindle, which will be red.

Move the Machine Manager dialog to the top of the workspace and `Click` the roll-up icon  on the title bar to hide the dialog.

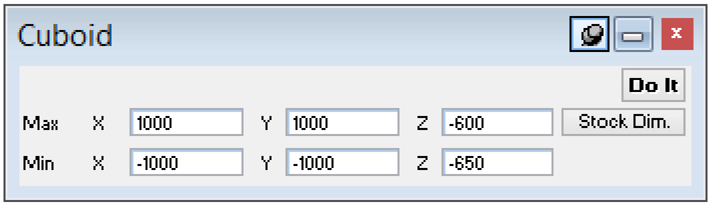
Step 4: Add the first two simulation bodies and test the machine

First we will make a black Base Plate which will be used only for simulation purposes.

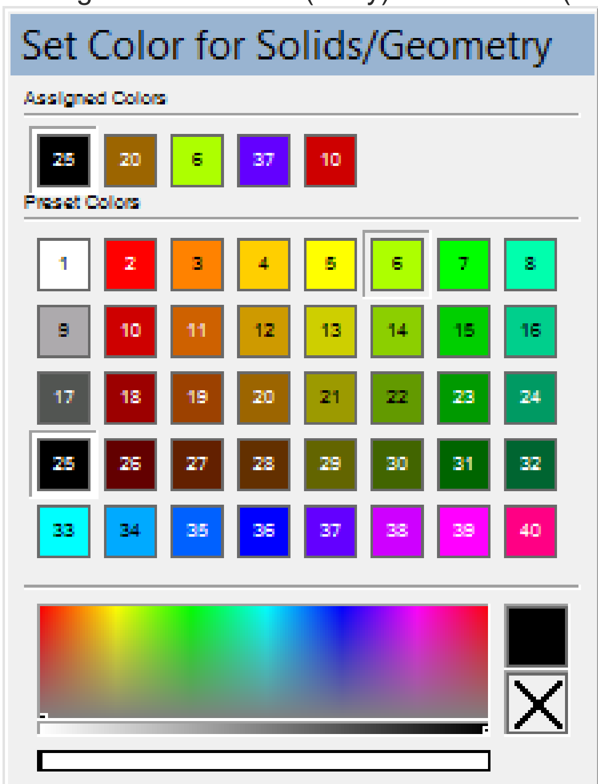
1. File > New. Call the file `Base Plate` and save it in your preferred tutorial directory.
2. In the DCD enter the following mm values:



3. Close the DCD dialog.
   In the part file, make sure you are in isometric view. We will now create a large cuboid.
4. Open the Create Solid dialog and choose Cuboid. (Solid Modeling > Create Solid > Cuboid).
5. In the Cuboid dialog, click the “Stock Dim” button. This will supply most of the dimensions you need. Now change Max Z = `-600` and Min Z = `-650`.



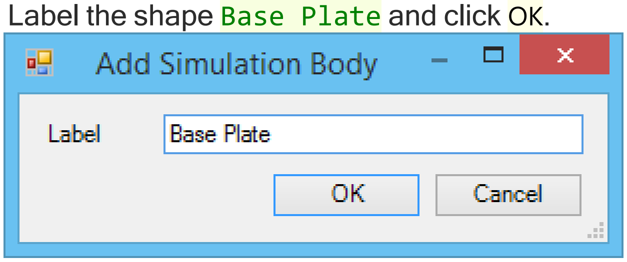
6. Click Do It.
7. Right-click on the unselected body and choose > User Color from the menu.
8. Change the color of #0 (Body) to Color #25 (black), and then close the attribute dialog.



9. Open the CS list dialog. You will be watching it in the next step.
10. Save the part file.

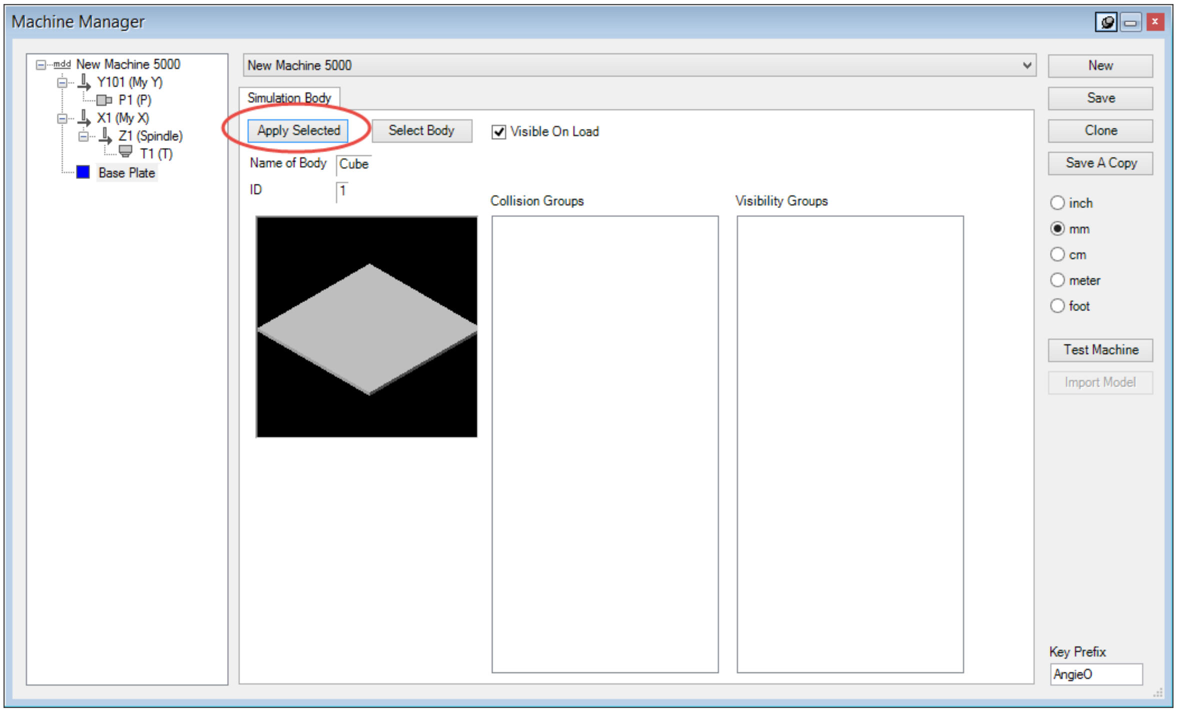
We will now add the base plate body as a Sim body in Machine Manager.

11. Unroll Machine Manager by hovering the cursor over the visible title bar.
12. Right-click the Root and choose Add child > Simulation Body.
13. Label the shape Base Plate and click OK.

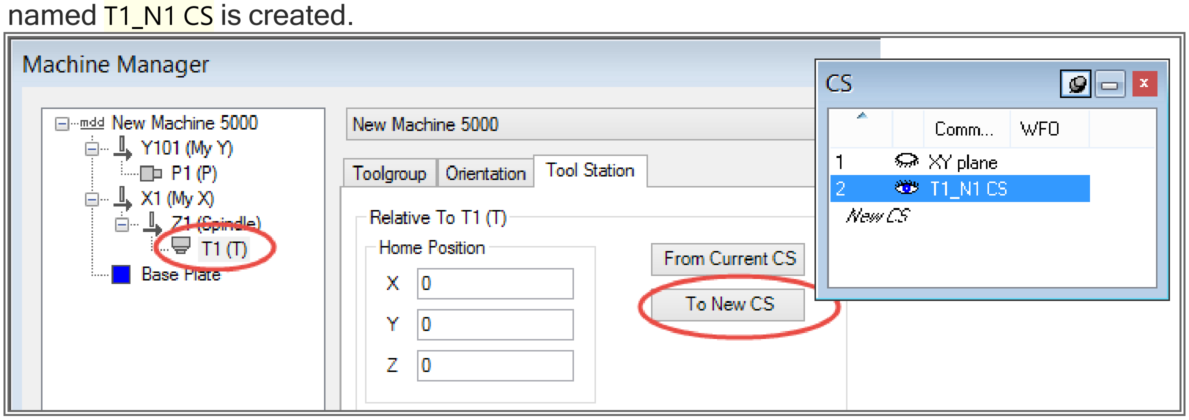


The Simulation Body tab opens, prompting you to configure the body.

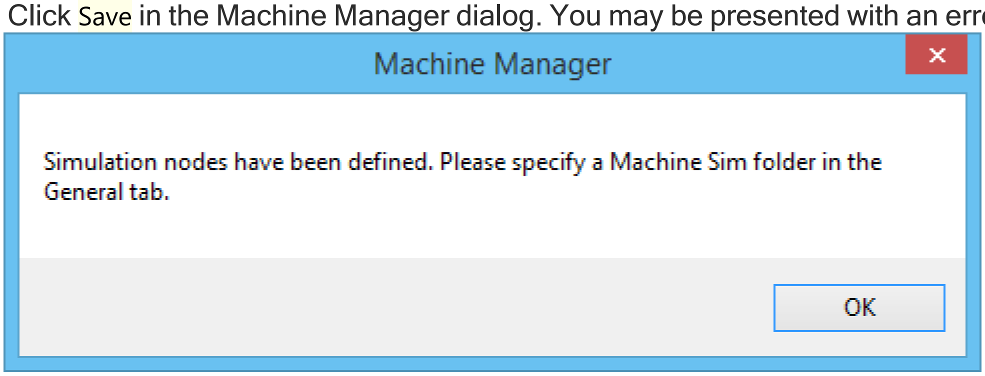
14. Ensure the body in the workspace is selected, and then click Apply Selected. The image appears in the first column.



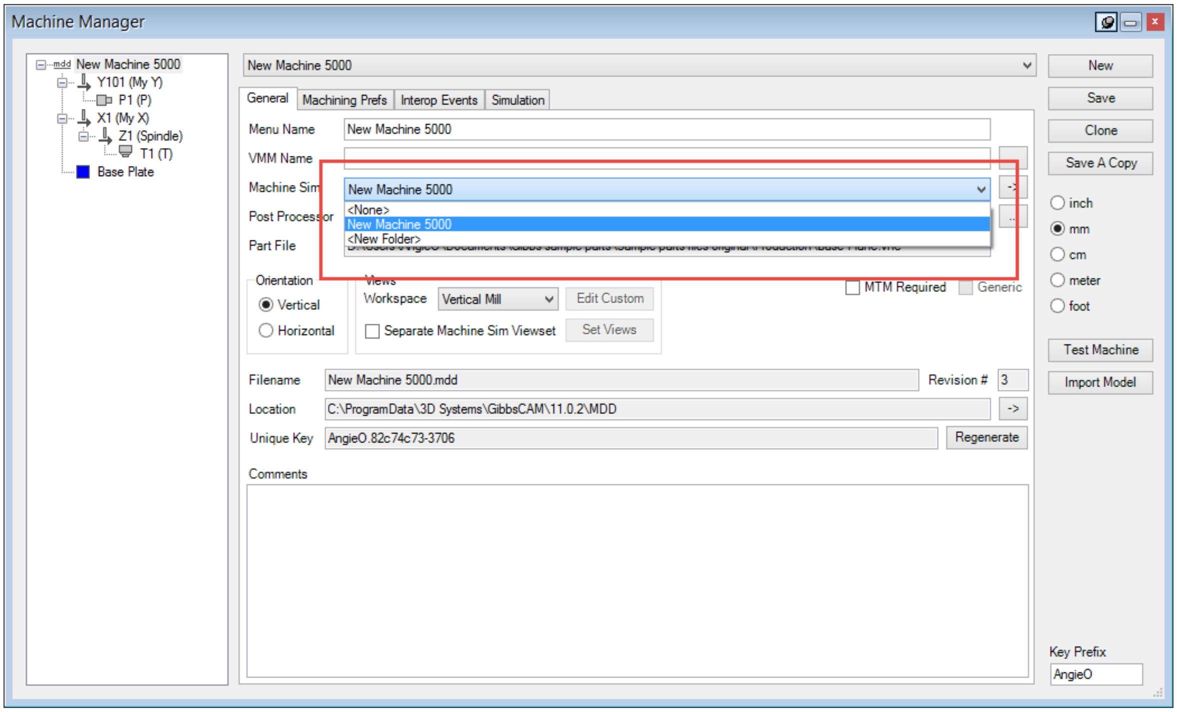
15. `Click` toolgroup node T1, and in the Tool Station tab click To New CS. Notice a new CS named T1_N1 CS is created.



16. Click Save in the Machine Manager dialog. You may be presented with an error message:



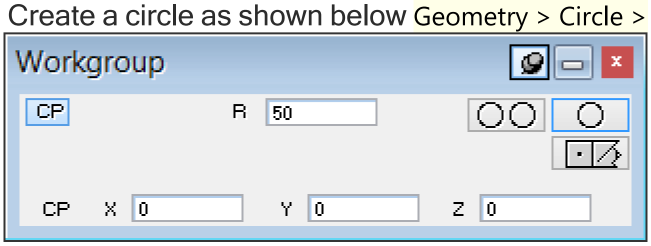
17. Click OK and use the dropdown menu in Machine Manager to choose the Machine Sim subfolder `...\<version>\MachineSim\NewMachine5000`. All Simulation parts will now be saved to this location.



18. Roll up Machine Manager by moving your cursor out of the dialog.

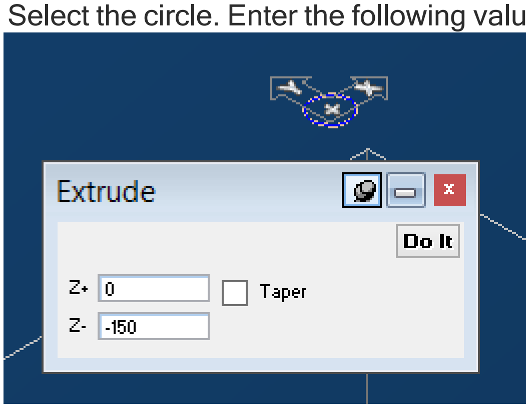
We will now make a second Sim body in the Base Plate file, a basic spindle:

19. Change CS to the newly created T1_N1 CS.
20. Create a circle as shown below Geometry > Circle > (center and radius).



This circle will be used to create an extruded body to represent the spindle.

21. (Create Solid >) Extrude:
22. Select the circle. Enter the following values and click Do it.



23. Right-click the unselected body and choose User Color. Set the color of #0 (Body) to Color #10 (red).
24. Select the new solid body.

25. Save the part file.

Now we will add the cylinder as a Sim body in Machine Manager.

26. Hover over the rolled up Machine Manager to open it.
27. Right-click Z1 Add child > Simulation Body. Call it `Tool Spindle` and ensure Apply Selected is checked, then click OK.
28. Verify that the image is as you expected.
29. Save the MDD.

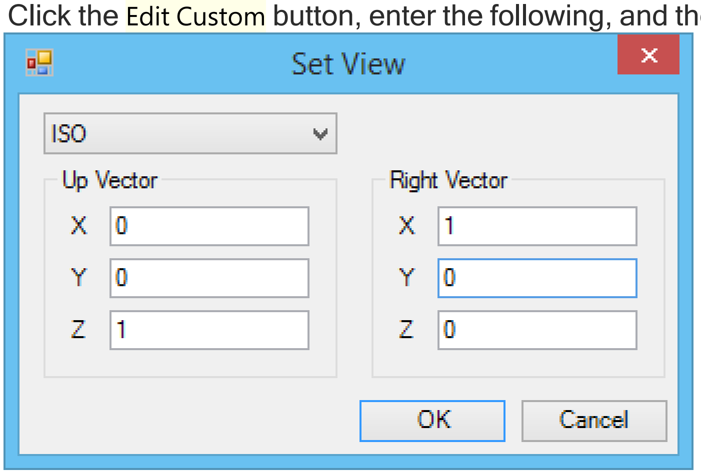
We are now able to use the Test Machine function for a very basic test.

1. Click Test Machine. (If prompted to do so, save the current MDD.) Move the curser out of the Machine manager dialog to re-pin it. The Test Machine dialog and Machine Sim Rendering palette will be visible.
   - On the Test Machine dialog, slide the X1 slider and the Z1 slider and see how the "spindle" moves and the base plate does not.
   - Slide the Y101 slider and see how nothing moves.
   - Close the Test Machine dialog.

You may have noticed that the machine's ISO view is different from the GibbsCAM display. We will be fixing this in the next step.

Step 5: Set the machine's ISO view to reversed

1. In Machine Manager, click the Root node (and then, if necessary, the General tab).
2. Click the Workspace pull-down in the Views section and select Custom.
3. Click the Edit Custom button, enter the following, and then click OK.

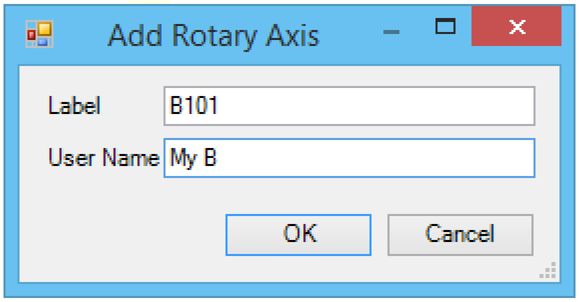


4. Save the MDD.
5. Click Test Machine and press `CTRL+I` to change to the new machine-ISO view.
6. Slide the X1 slider and note the corrected behaviour. Close the Test Machine dialog.

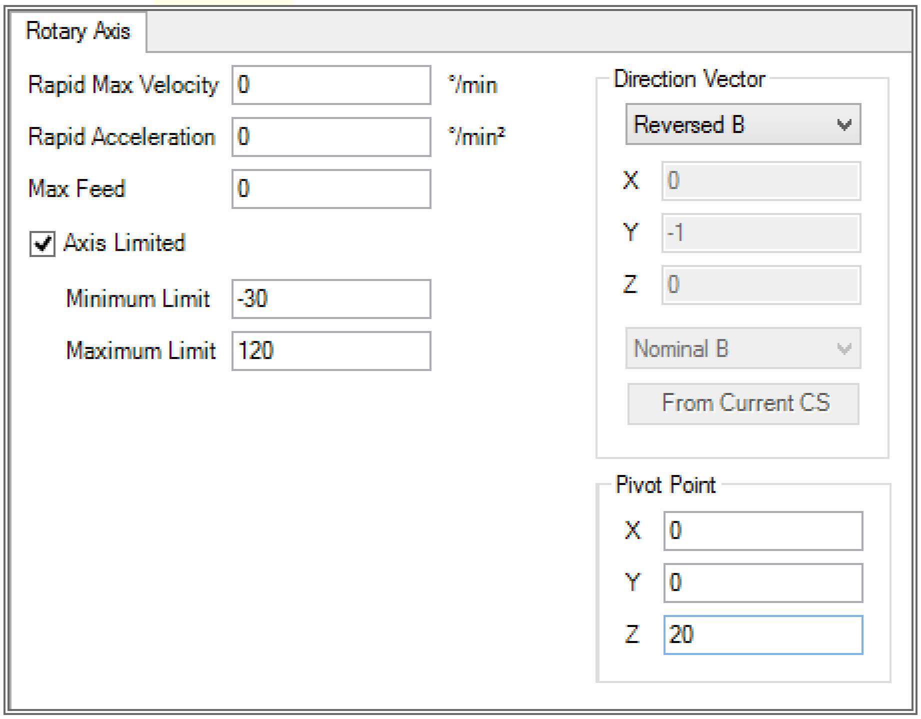
Step 6: Add another axis and Sim body, and test the machine

Now we will add the first rotary axis.

1. In Machine Manager, right-click Y101 and Add child > Rotary Axis. Enter details as follows then click OK.



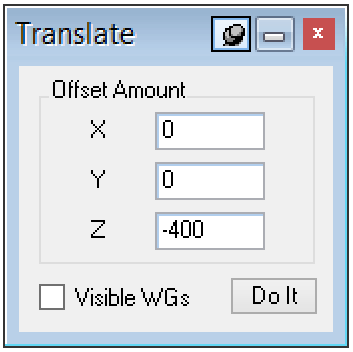
2. In the Rotary Axis tab, change the Direction Vector to Reversed B. (Remember that this machine's ISO is reversed.)
3. Select the "Axis Limited" checkbox and set the values as shown.



4. Save the MDD and roll up Machine Manager.

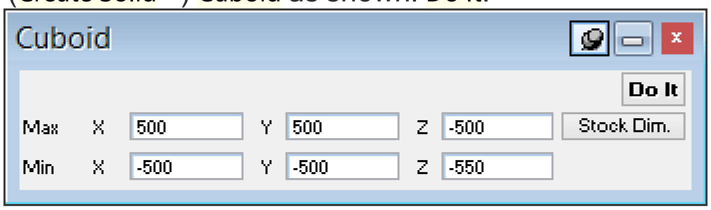
We will now create the third Sim body, the brown Table in the part file.

5. Select CS: XY plane.
6. Select the base plate and move it down out of the way: using Modify > Translate as shown below. Do it.



Now we will create a cuboid to represent the table:

7. (Create Solid >) Cuboid as shown. Do It.



8. Right-click (unselected body) you just created. Select User Color and change the #0 (Body) to Color #20 (brown).
9. Save the part file.

Return to Machine Manager and add the new brown cuboid as a Sim body.

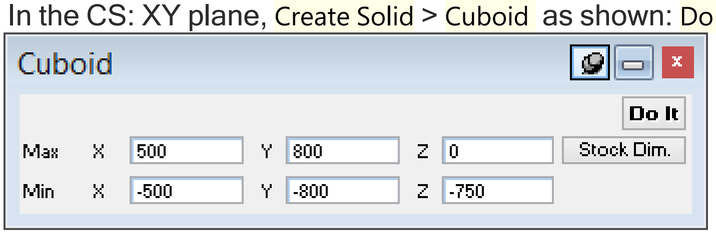
10. Select the brown body, and then unroll Machine Manager.
11. Right-click B101: Add child > Simulation Body. Call it `Table` and ensure Apply Selected is checked, and then click OK.
12. Verify that the image is as you expected.
13. Save the MDD.

Click Test Machine again and notice the new B101 slider. Experiment with the B rotations and Y slides, and then close Test Machine.

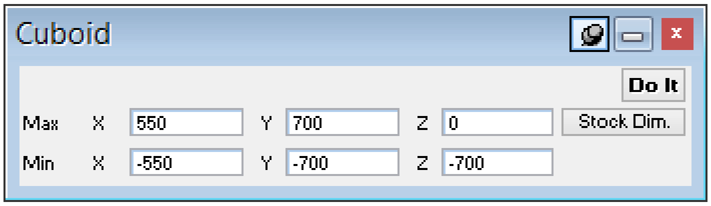
Step 7: Add remaining axis and sim body, and test the machine

In the part file we will create two cuboids whose intersection will represent the fourth Sim body, a trunion:

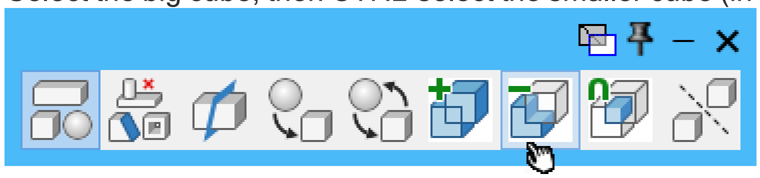
1. In the CS: XY plane, Create Solid > Cuboid as shown: Do it.

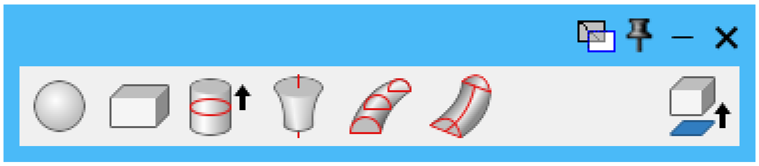


2. Now create a second cuboid as shown below: Do it.



3. Select the big cube, then CTRL-select the smaller cube (in that order); then Subtract.





4. Right-click the unselected body you just created and change the color to Color #6 (green).
5. Save the part file.

In Machine Manager, we will add the green trunion as a Sim body:

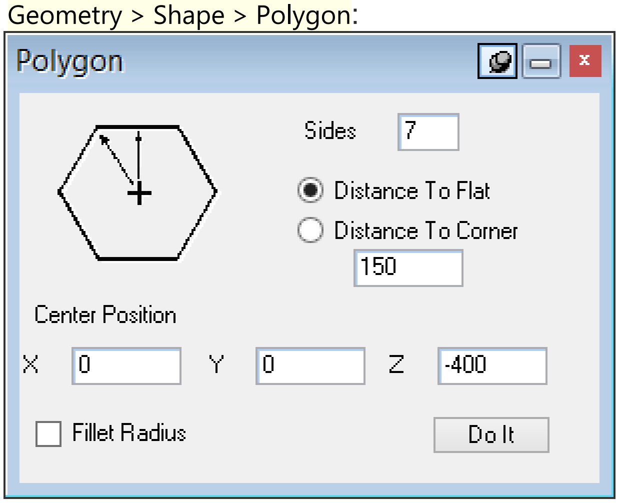
6. Select the green body, and then unroll Machine Manager.
7. Right-click Y101: Add child > Simulation Body. Call it `Trunion` and ensure Apply Selected is checked, then click OK.OK.
8. Verify that the image is as you expected.
9. Save the MDD.

And next we will add the second rotary axis:

10. In Machine Manager, right-click B101 and Add child > Rotary Axis. Label it `C101`, user name `My C`, then click OK.
    Make sure the Direction Vector is set to Standard C.. The Pivot point can remain as `0,0,0`.
11. Drag P1 under C101.

In the part file, we will create the fifth and final Sim body, a purple heptagon:

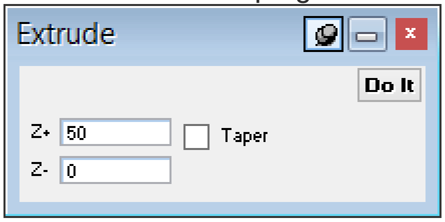
12. Geometry > Shape > Polygon:



    Use this heptagon to create an extruded body representing the rotary table:

13. (Create Solid >) Extrude:

14. Double-click the heptagon.

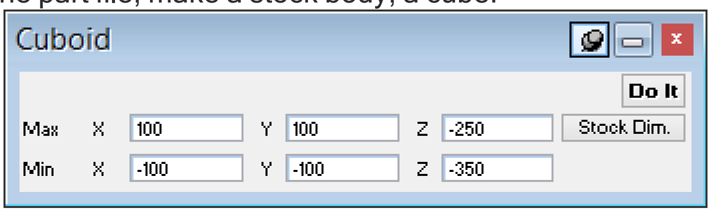


15. Right-click the body and change the color to Color #37 (violet).
16. Save the part file.

In Machine Manager, we will add the violet rotary table as a Sim body:

17. Select the violet rotary table and then unroll Machine Manager.
18. Right-click C101: Add child > Simulation Body and call it `Rotary Table`.
19. Verify that the image is as expected.
20. Save the MDD.

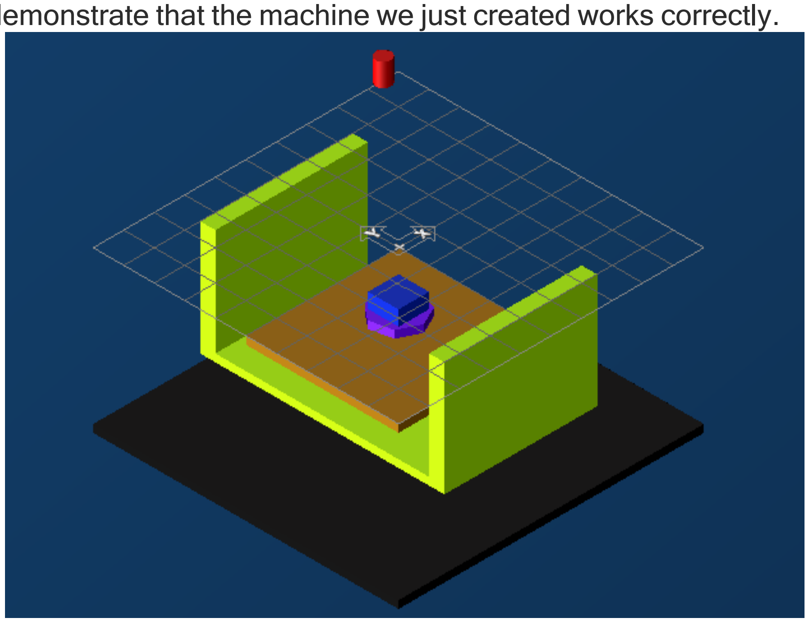
In the part file, make a stock body, a cube:



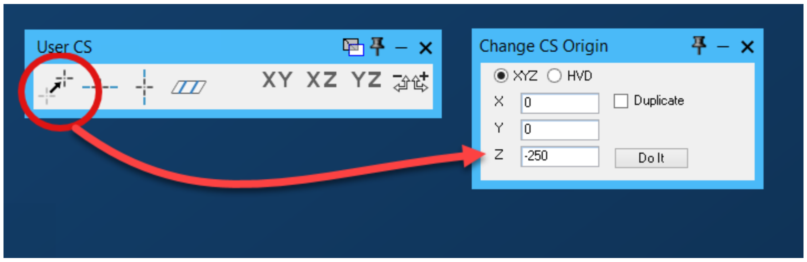
21. Right-click the new cuboid and designate it as stock > Body type > Stock.
22. Save the part file.

Step 8: Create operations

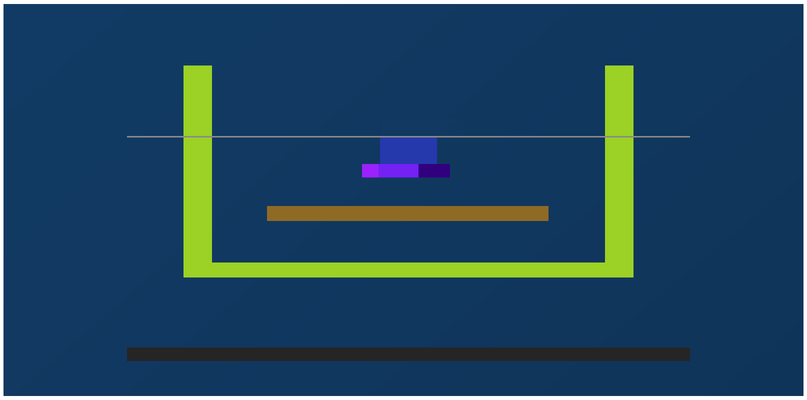
Now we will create a simple machining process that consists of pecking four holes in the stock, to demonstrate that the machine we just created works correctly.



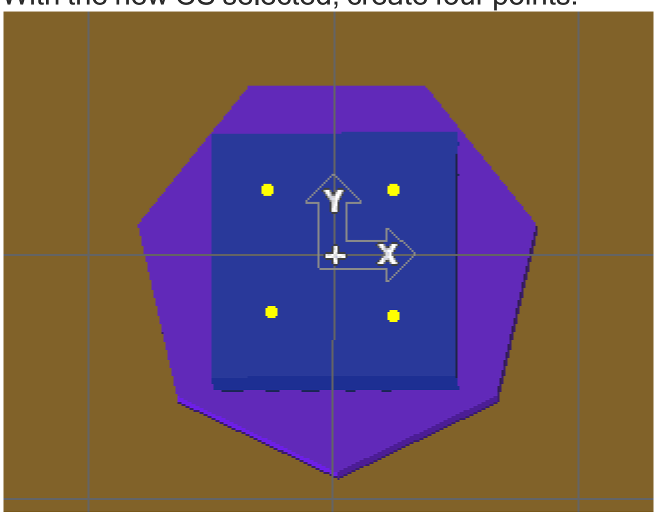
1. Create a new CS off the XY plane, to hold the geometry for the operation.
2. Move the origin to Z -250:



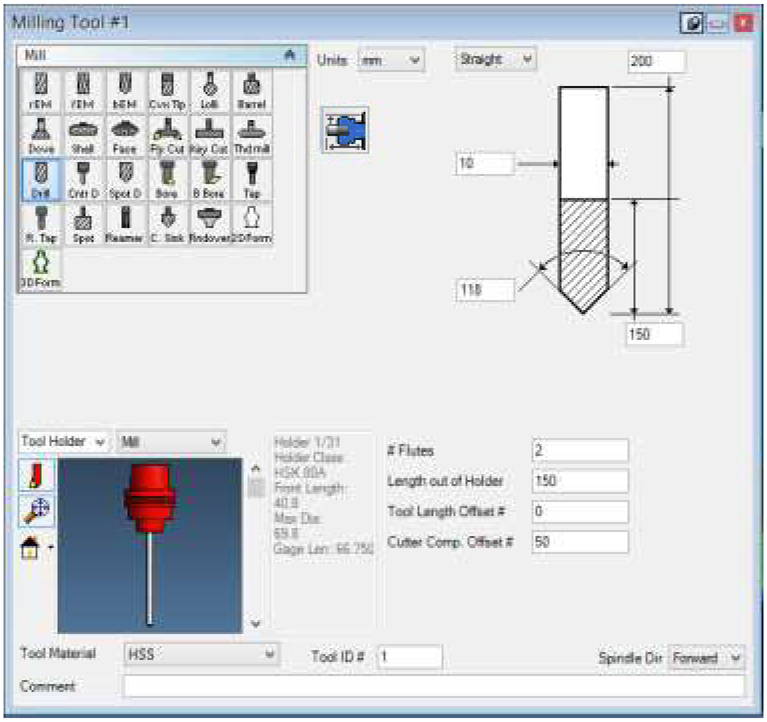
The CS is now on the stock surface.



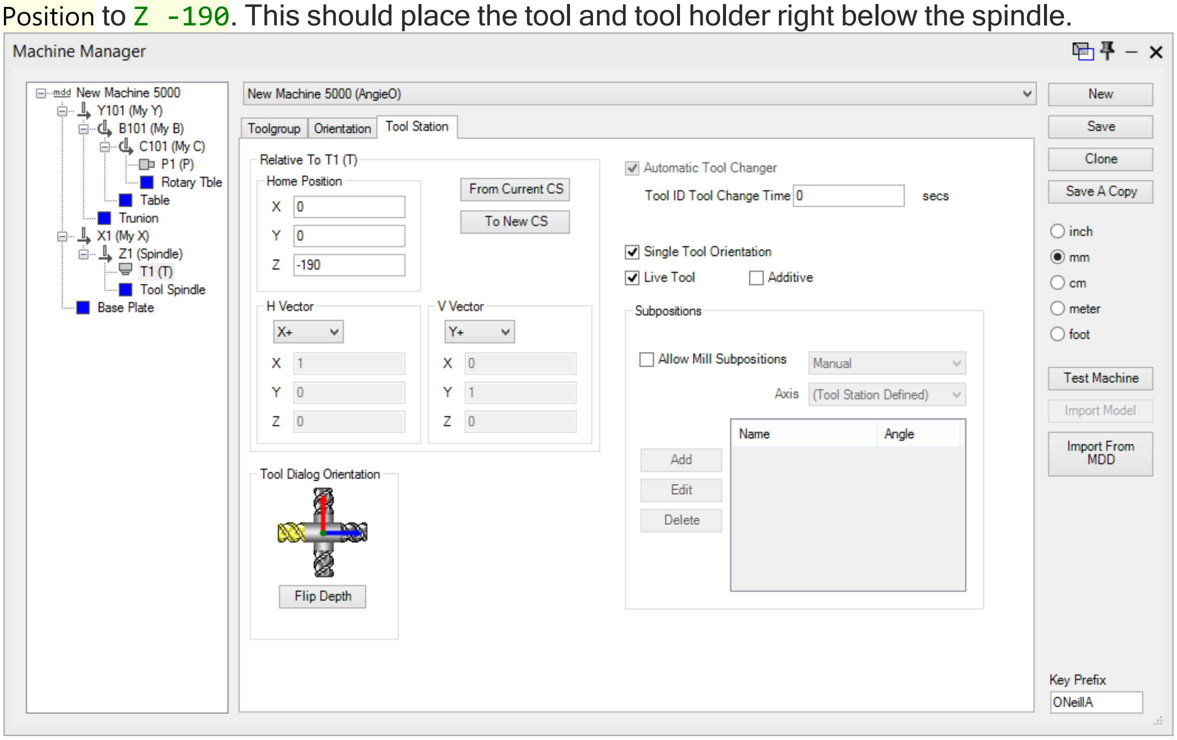
3. With the new CS selected, create four points.

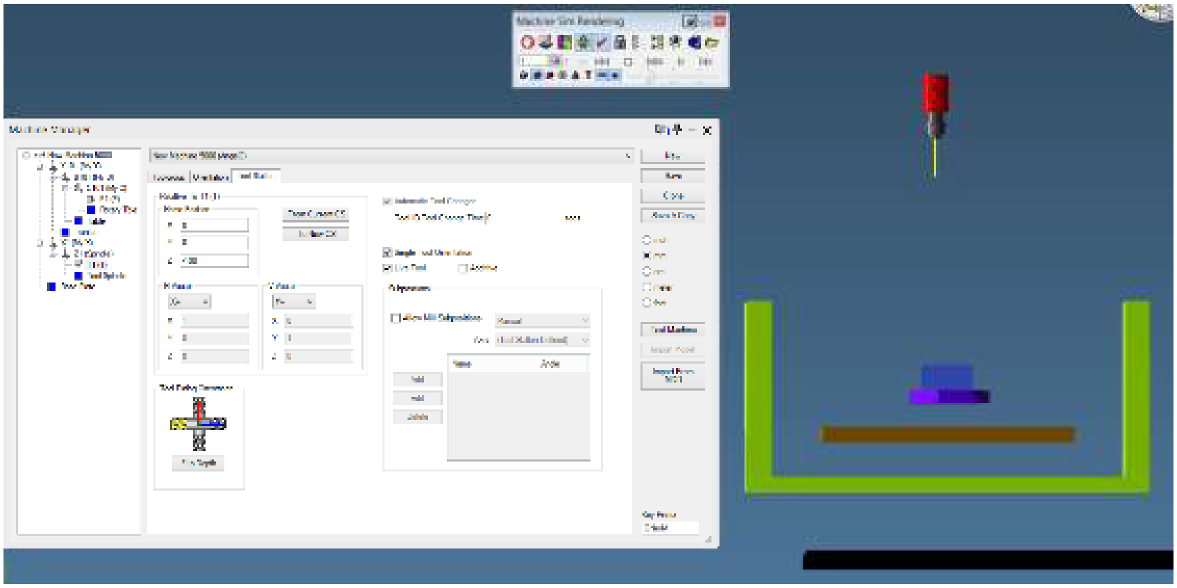


4. Create the tool, using values as shown:



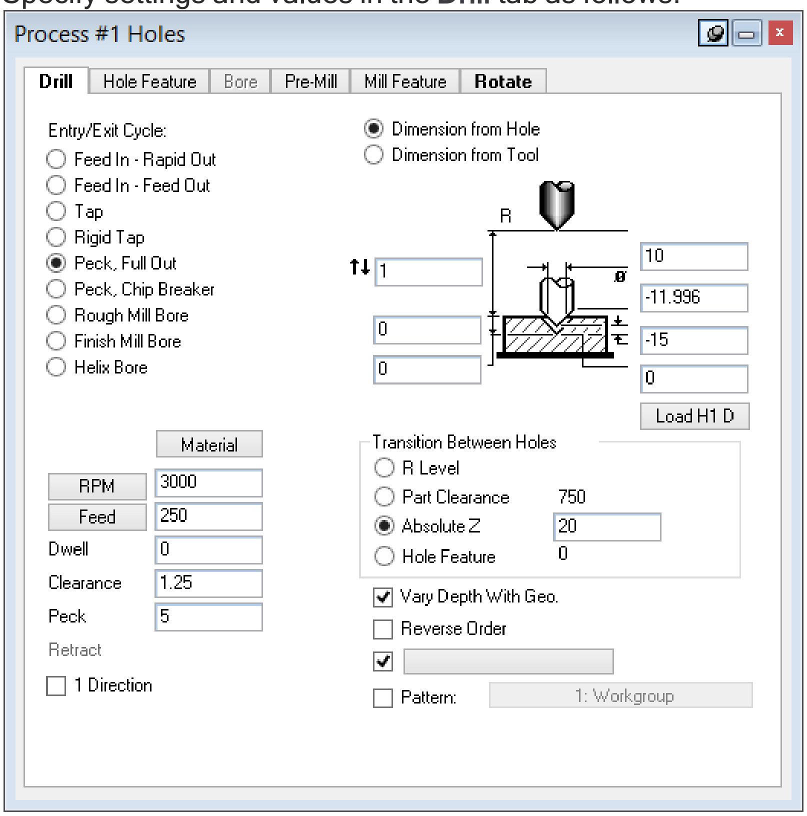
5. Now, set the Home position of the tool. In Machine Manager, **Tool Station** tab, set the Home Position to `Z -190`. This should place the tool and tool holder right below the spindle.



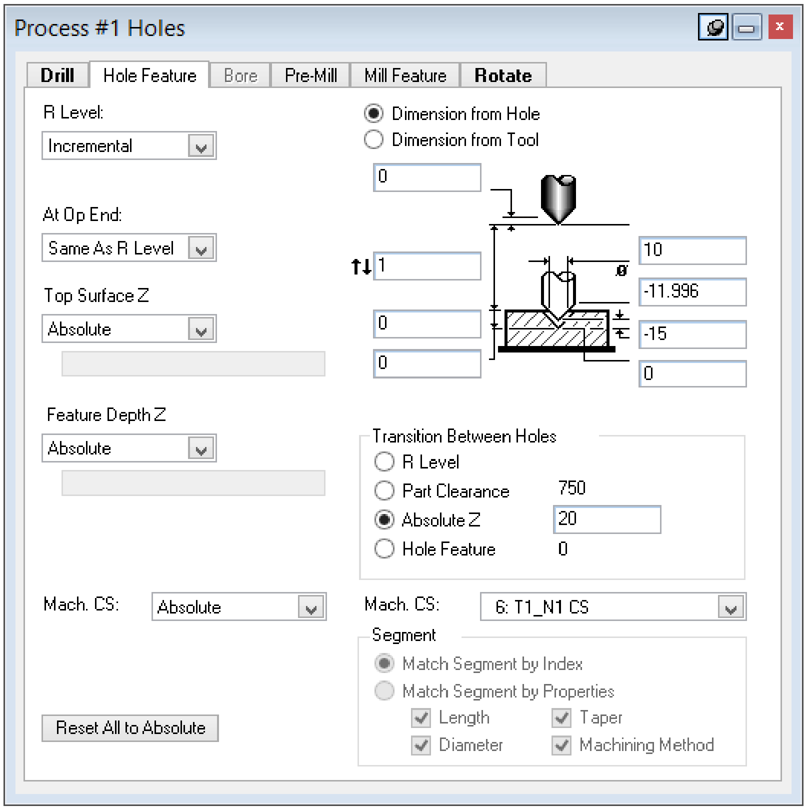


Next, we will set up a Holes process using the **Drill** tab, the **Hole Feature** tab, and the **Rotate** tab.

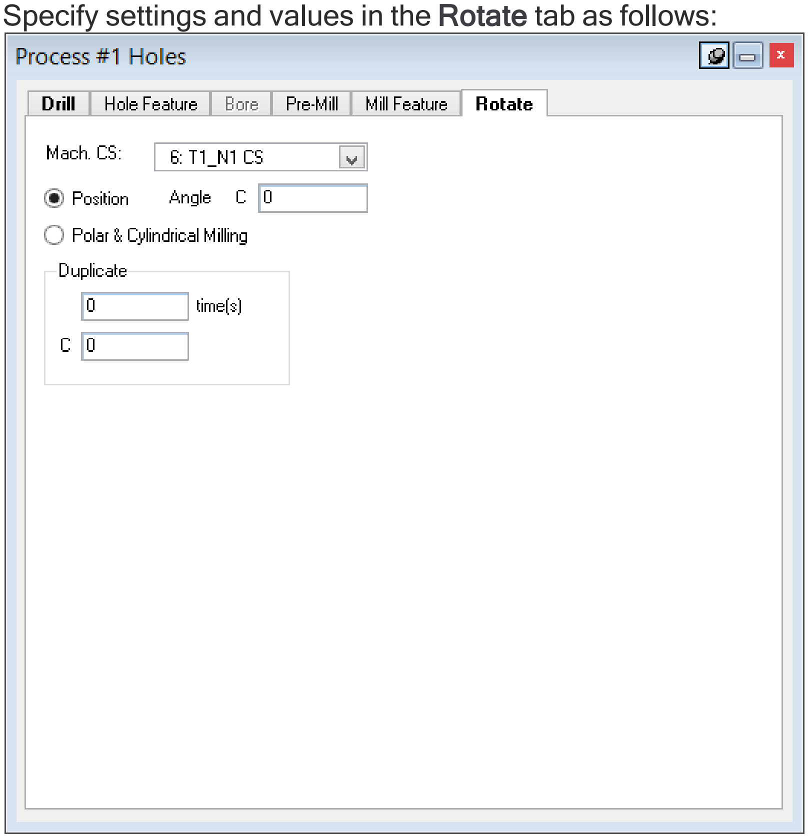
6. Specify settings and values in the **Drill** tab as follows:



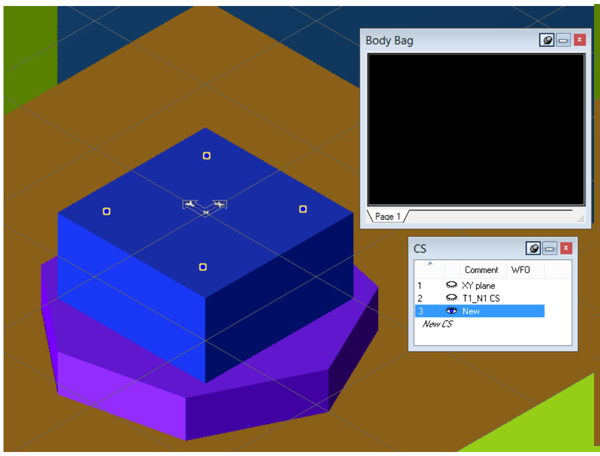
7. Specify settings and values in the **Hole Feature** tab as follows:

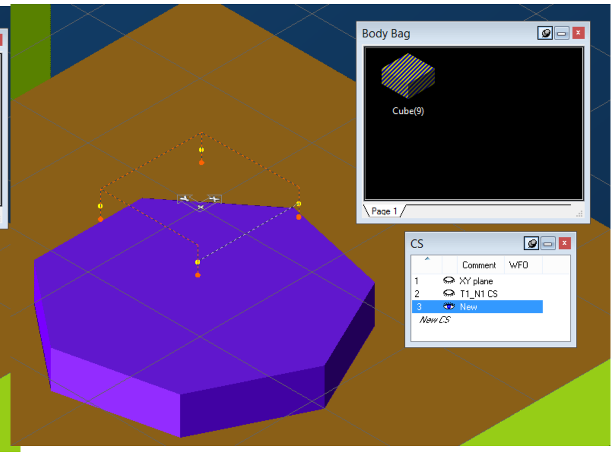


8. Specify settings and values in the **Rotate** tab as follows:

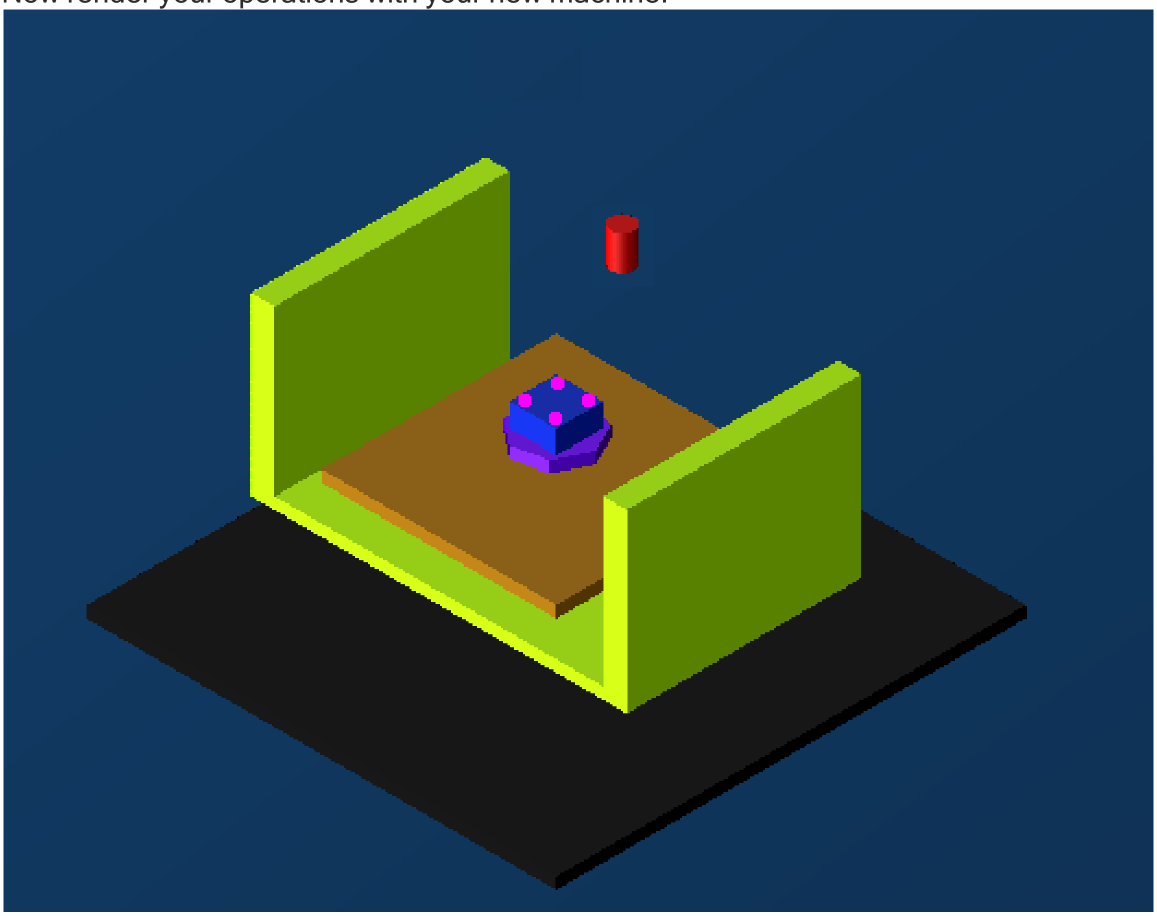


9. In the workspace, select all four of the points on the stock and click Do it. In the screenshot on the right, the stock has been placed in the body bag to show the toolpath.





10. Now render your operations with your new machine.



To use this machine for rendering operations, load your own Mill part file, select Machine Sim Rendering, and then click the load machine icon on the Machine Sim palette. Now choose New Machine 5000 from the list and click Load Machine.