



Mastercam[®] X4
Focus Series Tutorials

FBM Drill

FBM Drill

October 2009

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Mastercam® X4 FBM Drill

Date: October 2009

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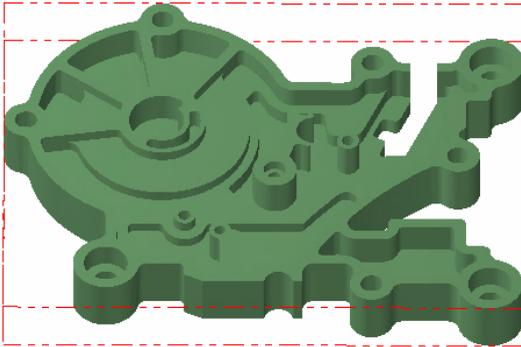
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INTRODUCTION

Mastercam's Feature Based Machining (FBM) eliminates many manual processes involved in identifying features for programming milling operations and drilling cycles on prismatic solid parts.



Features define a solid part's topology. They describe the part's physical properties including its faces and shapes, size, location of holes, slots, pockets, bosses, and other characteristics.

You use a single FBM Mill or FBM Drill operation—available with Mill Level 1 or Mastercam Router or higher—to analyze solid models and generate all of the geometry, tool planes, and toolpaths needed to machine detected features.

FBM Drill—the focus of this tutorial—detects hole features and generates drilling cycles and hole milling toolpaths (circle mill or helix bore). Hole detection can include blind, through, coaxial, and split holes. FBM Drill recognizes counterbore and countersink holes with chamfers, and also reads hole data from solids created with the SolidWorks® Hole Wizard®.

FBM Drill WorkFlow

Within a single FBM Drill operation, you perform the following basic functions:

- Detect holes in a solid, based on specified criteria.
- View the detected features list, and suppress or delete features.
- Edit hole type and tool assignments before generating toolpaths.
- Automatically generate a complete series of toolpaths for the selected features.
- Modify the FBM Drill parameters, redetect features, and regenerate the toolpaths as needed.

FBM Drill property pages let you add and define deep drilling, spot drilling, pre-drilling, and hole milling operations. You can choose to group FBM-generated operations in the Toolpath Manager by tool or by plane.

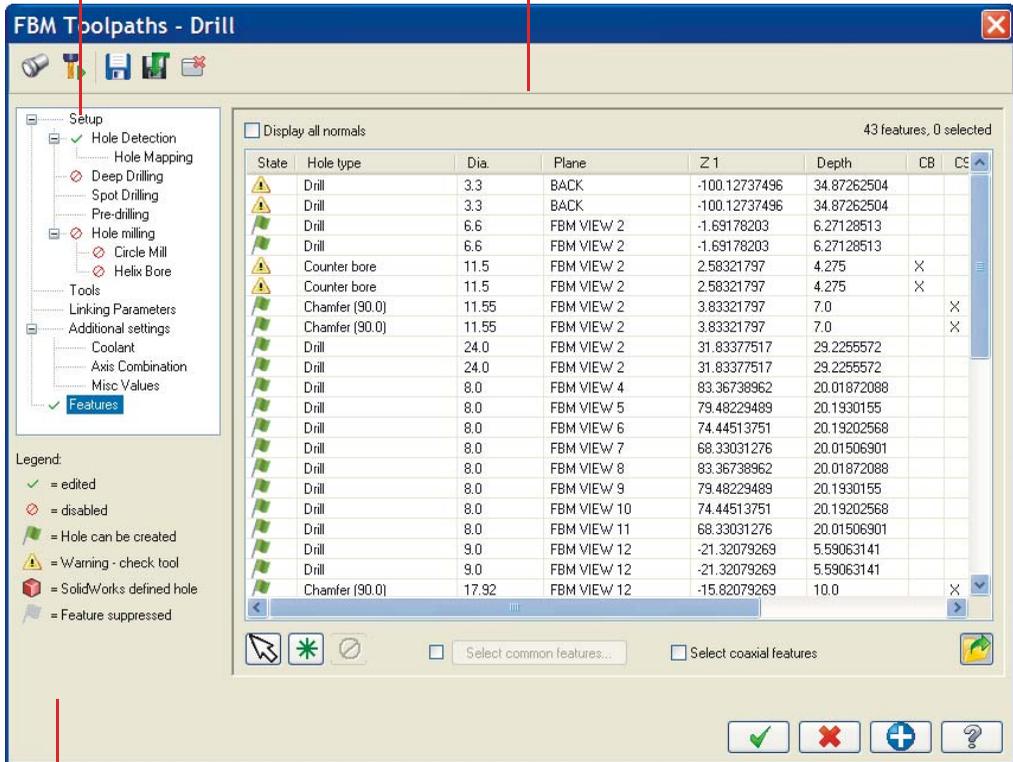
You control tool selection by using tools already in the MCX file, choosing a tool library, and by allowing Mastercam to create tools, when necessary. FBM Drill lets you build and assign a hole mapping table (MAP file) so that when FBM Drill detects a specific hole size, it automatically assigns a designated hole type, drill cycle, and tool.

FBM Drill Interface

The FBM Drill dialog box uses a tree-style interface made up of three distinct areas: *Tree View*, *Properties Page*, and *Legend*.

Tree View area

Properties page area



Legend area

Tree View—Displays a list of all of the available dialog box property pages.

Properties Page—Changes with each choice you make in the Tree View area.

Legend—Defines the icons used in the Tree View area. When you select the Features page in the Tree View list, the legend includes icons that display in the Features page **State** column.

FBM Drill Tutorial Requirements

- Mastercam X4 with Mill Level 1 or Mastercam Router and higher
- Mill or Router machine definition (select from the **Machine Type** menu)
- At least one solid part model in the current MCX file with one or more holes
- SolidWorks 2008 or higher, optional - needed to complete Lesson 8 (page 183)

Tutorial Goals

The *FBM Drill Focus Series* tutorial has one goal: teaching you how to configure FBM Drill operations and generate drilling cycles and hole milling toolpaths that meet your machining objectives.

To achieve this goal, work through the lessons and their exercises to learn key concepts and build fundamental skills. Each lesson introduces new concepts and skills, while reinforcing those taught in a previous lesson. A Skills Challenge, included at the end of most lessons, encourages you to independently test what you have learned.

For best results, perform the lessons and exercises in the order in which they appear.

Before You Begin

This is a module of the *Mastercam Focus Tutorial Series*. The series focuses on a specific Mastercam feature—for example, Setup Sheets or FBM Drill, and teaches basic and advanced skills. Other tutorial series include:

- *Getting Started Series*: Introduces general Mastercam functions and teaches basic skills for getting started with Mastercam.
- *Exploring Series*: Explores a single Mastercam product—for example, Mill, Solids, or Wire, and teaches in-depth skills for working with the product.

The Mastercam tutorial series is in continual development, and we will add modules as we complete them. For information and availability, please contact your local Mastercam Reseller.

Note: Screen colors in the tutorial pictures enhance image quality; they may not match your Mastercam settings.

General Tutorial Requirements

All Mastercam tutorials have the following general requirements:

- You must be comfortable using the Windows® operating system.
- The tutorials cannot be used with Mastercam Demo/Home Learning Edition (HLE). The Demo/HLE file format (EMCX) is different from Mastercam (MCX), and basic Mastercam functions, such as file conversions and posting, are unavailable.
- Each lesson in the tutorial builds on the mastery of preceding lesson's skills. We recommend that you complete them in order.
- *Focus Series* and *Exploring Series* tutorials require, at minimum, a mastery of the basic Mastercam skills taught in the *Getting Started Series* modules. A general knowledge of machining principals and practices is also required.
- Additional files may accompany a tutorial. Unless the tutorial provides specific instructions on where to place these files, store them in a folder that can be accessed from the Mastercam workstation, either with the tutorial or in any location that you prefer.

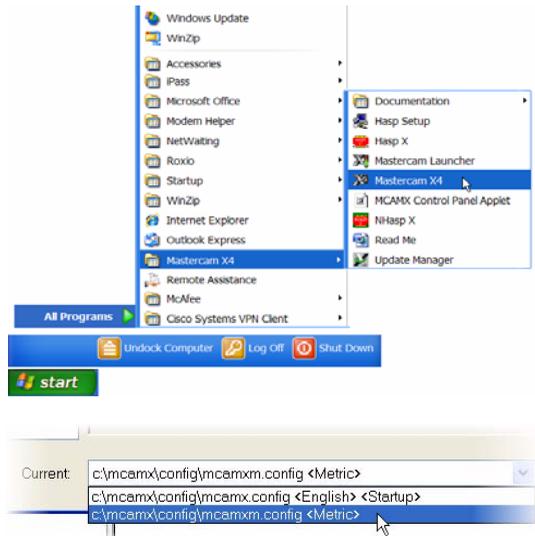
4 • FBM DRILL

- The *Getting Started Series* tutorials are available in an Adobe® Flash® compatible video format. Additional tutorial videos may also be available. Contact your local Mastercam Reseller for more information.
- You must install Adobe Flash Player to display tutorial videos. You can download Adobe Flash Player from www.adobe.com.
- You must configure Mastercam to work in metric units. Complete the instructions in the following section **Preparing for a Tutorial** to set Mastercam to metric.

Preparing for a Tutorial

Before you start a tutorial, be sure you have completed the following tasks:

- 1 Start Mastercam using your preferred method:
 - ♦ Double-click Mastercam's desktop icon.
 - Or
 - ♦ Launch Mastercam from the Windows Start menu.
- 2 Select the metric configuration file:
 - a Select **Settings, Configuration** from Mastercam's menu.
 - b Choose `..\config\mcamxm.config` <**Metric**> from the **Current** drop-down list.
 - c Click **OK**.



If You Need More Help

There are many ways to get help with Mastercam, including the following:

- *Mastercam Help*—Access Mastercam Help by selecting **Help, Contents** from Mastercam's menu bar or by pressing [**Alt+H**] on your keyboard. Also, most dialog boxes and ribbon bars feature a Help button  that opens Mastercam Help directly to related information.
- *Online help*—You can search for information or ask questions on the Mastercam Web forum, located at www.emastercam.com. You can also find a wealth of information, including many videos, at www.mastercam.com and www.mastercamedu.com.
- *Mastercam Reseller*—Your local Mastercam Reseller can help with most questions about Mastercam.
- *Technical Support*—CNC Software's Technical Support department (860-875-5006 or support@mastercam.com) is open Monday through Friday from 8:00 a.m. to 5:30 p.m. USA Eastern Standard Time.

- *Documentation feedback*—For questions about this or other Mastercam documentation, contact the Technical Documentation department by email at techdocs@mastercam.com.
- *Mastercam University*—CNC Software sponsors Mastercam University, an affordable online learning platform that gives you 24/7 access to Mastercam training materials. Take advantage of more than 180 videos to master your skills at your own pace and help prepare yourself for Mastercam Certification. For more information on Mastercam University, please contact your Authorized Mastercam Reseller, visit www.mastercamu.com, or email training@mastercam.com.

Additional Documentation

You can find more information on using Mastercam in the following materials, located in the \Documentation folder of your Mastercam installation:

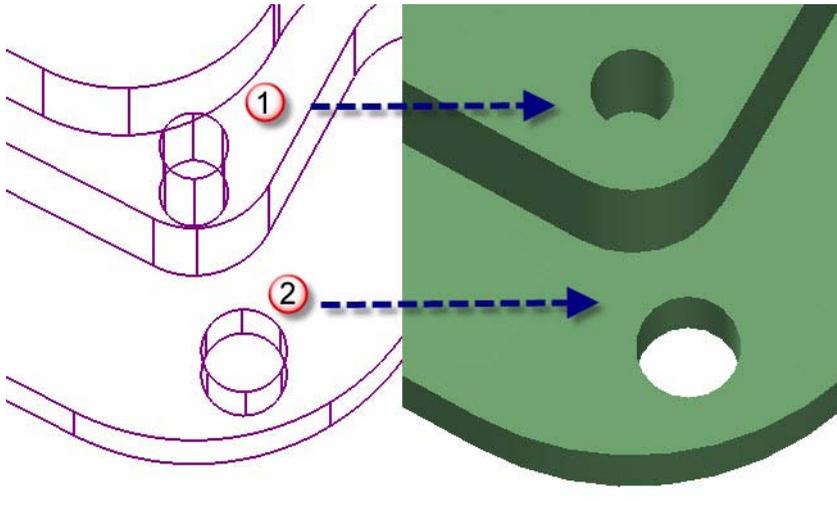
- *Mastercam X4 Installation Guide*
- *Mastercam X4 Administrator Guide*
- *Mastercam X4 Quick Start*
- *Mastercam X4 Reference Guide*
- *Mastercam X4 Transition Guide*
- *Mastercam X4 Quick Reference Card*
- *Mastercam X4 Wire Getting Started Guide*
- *Version 9 to X Function Map*

LESSON 1

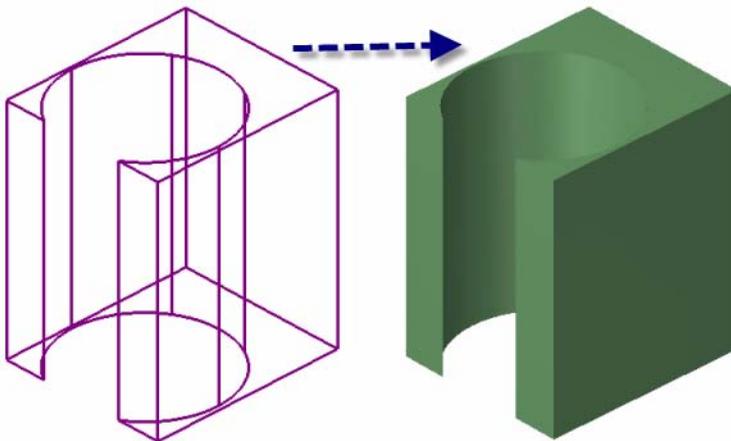
Working with Solid Models and FBM Drill

This lesson demonstrates how FBM Drill detects hole feature types in a solid model based on the hole detection settings you define. The types of hole features you can detect and machine with FBM Drill include:

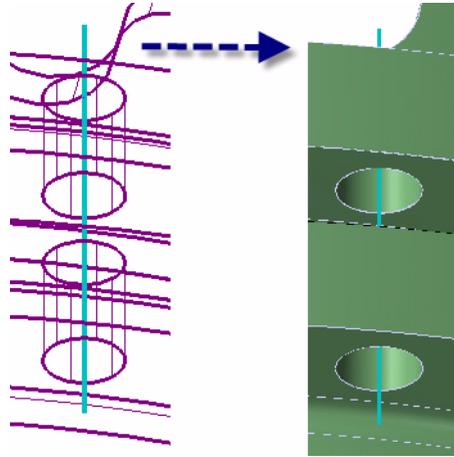
- Blind flat-bottom(1), Through (2)



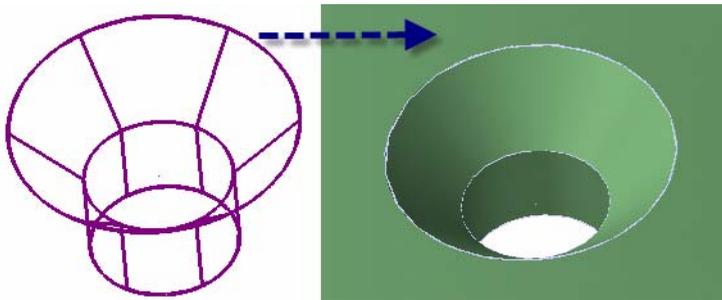
- Split



- Coaxial (shared drill vector)



- Countersink (chamfered)



Lesson Goals

- Import a solid CAD model from a STEP file.
- Analyze the model's hole features and create a summary document.
- Detect only $\text{Ø}16.0\text{mm}$ coaxial holes. Create the toolpaths needed to machine them from different planes.
- Modify the FBM Drill operation to change the tools used, and the way FBM generates toolpaths.
- Learn to isolate specific types of hole features.

Exercise 1: Importing a Solid Model (No History)

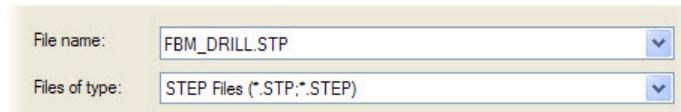
Solid models are often designed in CAD applications other than Mastercam. When you open an external CAD file in Mastercam—for example, a SolidWorks, STEP, or Parasolid[®] file—the imported solid model appears in Mastercam as a single solid body. With the exception of SolidWorks files, the data used to define each of the model's features in the external CAD application does not convert to the Mastercam part file format.

Note: In addition to Mastercam, if your workstation includes a licensed installation of SolidWorks, you can import SolidWorks history from a SolidWorks part into a Mastercam file. FBM Drill also imports SolidWorks Hole Wizard data. Lesson 8, “Using SolidWorks Hole Wizard Data” on page 183 shows how to do this.

In this exercise, you import a STEP file into Mastercam and use different techniques to view the solid model’s features.

► Import the STEP File

- 1 From the Mastercam menu, choose **File, Open**.
- 2 In the Open dialog box, do the following:



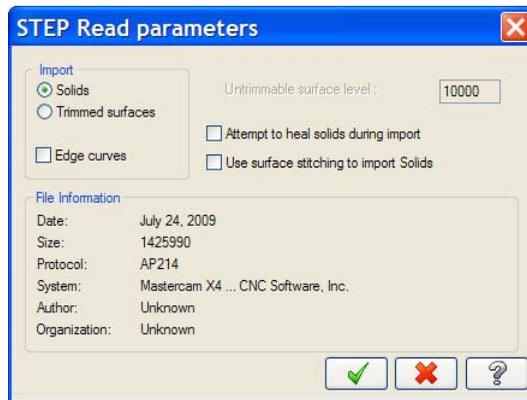
- a From the **Files of type** drop-down list, choose **STEP Files (*.STP, *.STEP)**.
- b Open `FBM_DRILL.STP`, which was provided with this tutorial.

- c Click the **Options** button.



The STEP Read Parameters dialog box opens.

- 3 In the STEP Read Parameters dialog box, set your parameters to match the following picture. Then click **OK**.

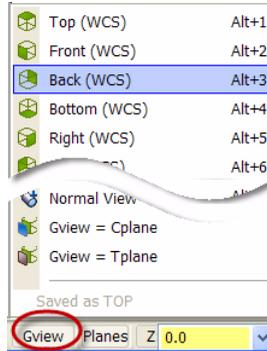


- 4 Click **OK** in the Open dialog box.

Note: If a “zero length arc” warning displays, verify that you have loaded Mastercam’s default metric configuration file, as instructed in “Before You Begin” on page 3.

► Examine the Imported Model

- 1 From the Status bar **Gview** menu, choose **Back (WCS)**.

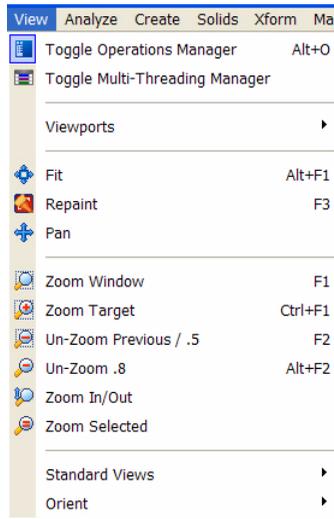


- 2 Fit the part to the screen  and shade it. 

- 3 Use functions in the **View** menu to dynamically rotate, spin, and pan the part in the graphics window to examine its features.

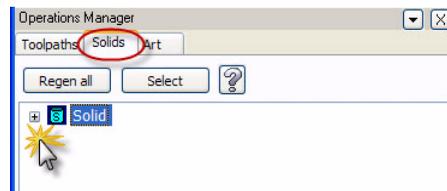
The model has many holes.

Position the part in the graphics window so that you can see all or most of the holes.

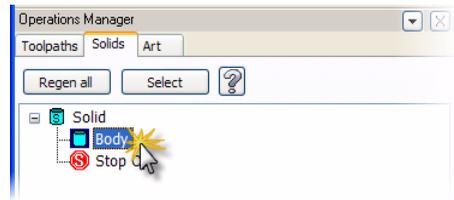


- 4 Choose the **Solids** tab in the Operations Manager, and then click the plus sign (+) to expand the Solids tree.

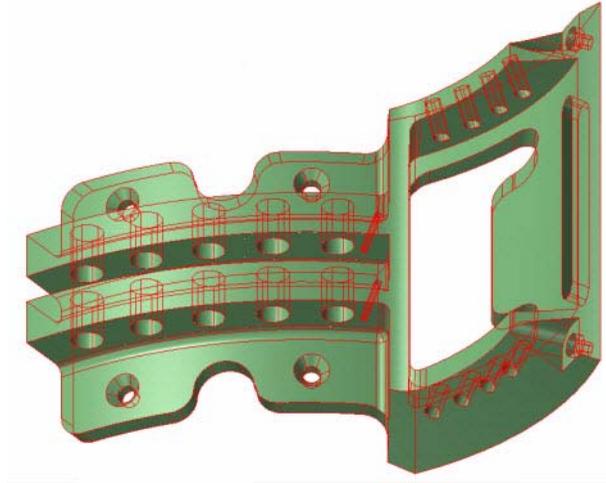
The solid is defined in Mastercam as a single body. No feature detail is available from the imported STEP file.



- 5 Click **Body** to automatically highlight in the graphics window the wireframe geometry associated with the solid model's faces.



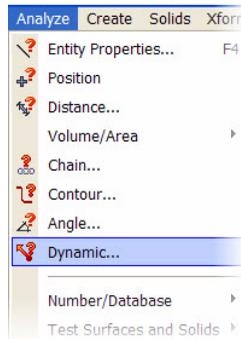
A wireframe view can improve your understanding of the types of features in the model.



- 6 Change your shade settings to **Wireframe**.



- 7 From the Mastercam menu, choose **Analyze, Dynamic**.



8 Click on an arc.

The arc properties display in the Analyze Dynamic dialog box. (Your values will differ from the sample picture.)

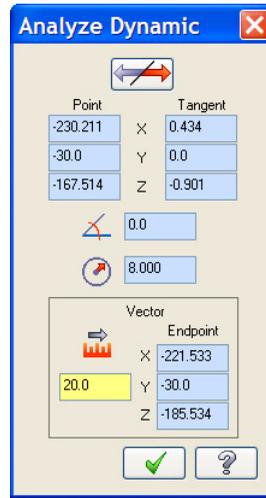
Use the cursor to move the arrow endpoint to the position you want to analyze. Click to choose another entity.

Continue clicking different geometry to view more information about the model's features.

9 When finished examining the part, click

OK. 

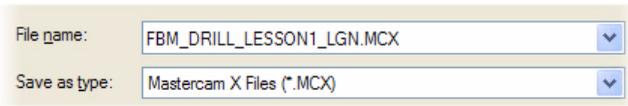
The Analyze Dynamic dialog box closes.



► Save the Imported Model

1 Choose **File, Save As**.**2** In the Save As dialog box, do the following:**a** Add “Lesson1” and your initials to the tutorial part **File name**—for example:

FBM_DRILL_LESSON1_[your initials].MCX

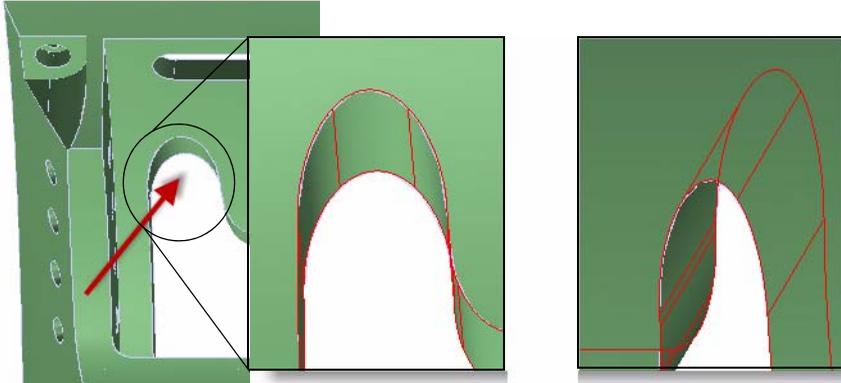
b Verify that the **Save as type** is **Mastercam X Files (*.MCX)**.**c** Click **OK**  to save the file. This completes the exercise.

Exercise 2: Detecting Features and Creating a Summary

FBM Drill uses *automated feature recognition* to provide data on all of the detected solid hole features in a Mastercam file. In addition to detecting hole features, FBM Drill attempts to match them with the appropriate drill cycles and tools using settings you define. It also creates any non-standard views necessary to machine the detected features.

In this exercise, you use FBM Drill to analyze the solid model and detect all features. A number of detected features are split holes. Split holes are incomplete because their top and bottom

boundaries intersect an edge of the part. The sample pictures shows one of the split holes detected in the model (TOP and BOTTOM Gviews).

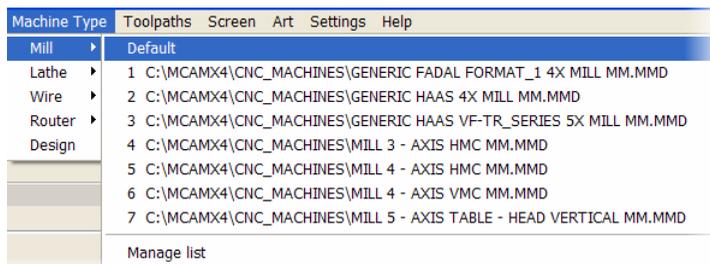


After the first detection, you eliminate split holes from hole detection criteria and redetect features. You then create a summary document of features and the tools needed to machine them.

You do all this *without* creating an FBM Drill operation.

► Detect All Features

- 1 Open the MCX part file you saved on page 12 in Exercise 1, for example–
FBM_DRILL_LESSON1_[your initials].MCX.
- 2 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

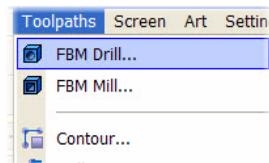


This creates a Machine Group in the Toolpath Manager.

Note: The list of Mill Machine Types can be customized, so yours may differ from the sample picture.

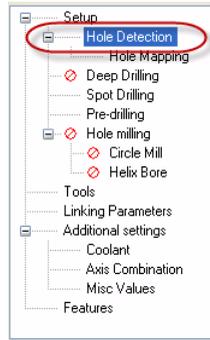
- 3 Choose **Toolpaths, FBM Drill**.

The FBM Drill dialog box opens to the Setup page parameters. Do not modify them.



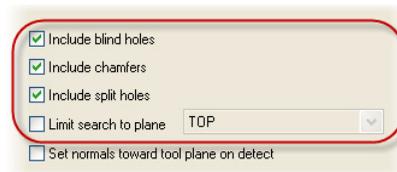
- 4 Choose **Hole Detection** in the Tree View pane.

The Hole Detection parameters display.



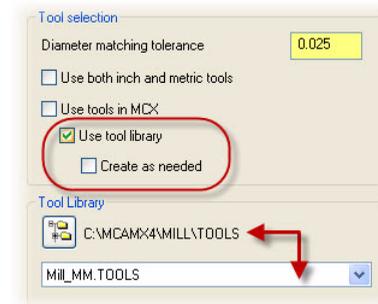
- 5 In the Hole Detection page, enter the following settings:

- a Select **Include blind holes**.
- b Select **Include chamfers**.
- c Select **Include split holes**.
- d Deselect **Limit search to plane**.
- e In the **Co-axial holes** group box, set **Machine co-axial holes with gaps to From 2 planes** using the drop-down list.



- 6 Choose **Tools** in the Tree View pane.

- 7 In the Tools page, deselect **Create as needed** and verify that the selected tool library is **Mill_MM.TOOLS**.



- 8 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

FBM Drill analyzes the solid model based on your selections.

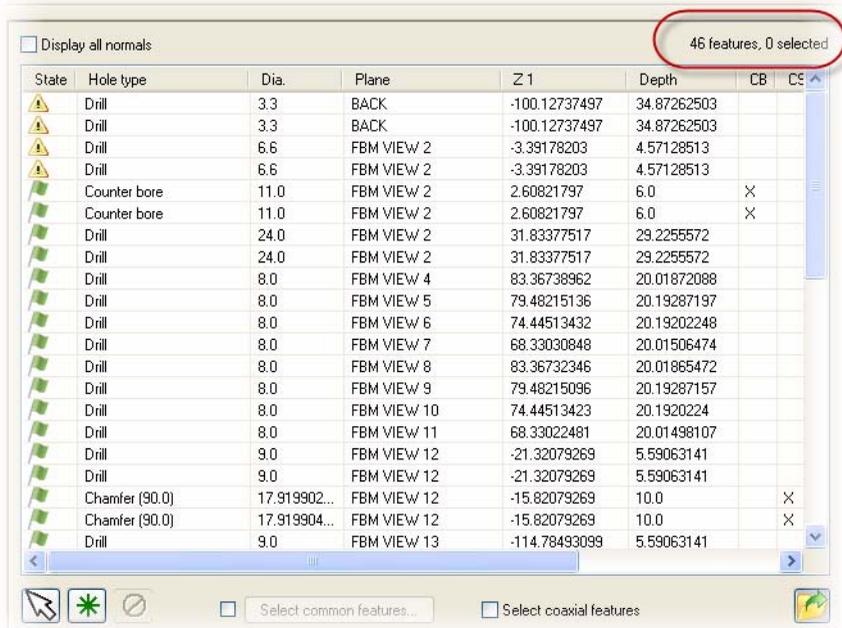


Notes:

- FBM Drill does not detect the model's hole features or list them in the Features page until you choose the **Detect** button or click the **OK** button in the FBM Drill dialog box.
- The Detect button has two states, dirty  and clean. 
- A dirty state indicates that detection is required because it has not yet been run, or changes were made to the FBM Drill operation's parameters since the last feature detection. In this state, the Features page is not synchronized with the current FBM Drill operation settings.
- A clean state indicates that the Features page contains the most current list of features and machining information, based on the current FBM Drill settings.

When finished analyzing features, FBM Drill displays the Features page.

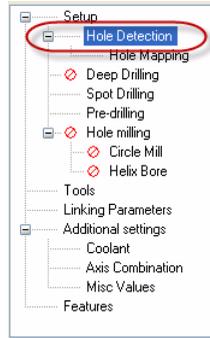
In the Features page, you see the result of FBM Drill's automated feature recognition. The upper right corner shows the total number of detected features.



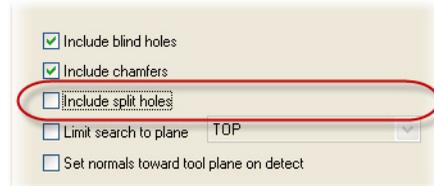
► Eliminate Split Holes from Detection

- 1 Choose **Hole Detection** in the Tree View pane.

The Hole Detection parameters display.



- 2 In the Hole Detection page, deselect **Include split holes**.



- 3 Click the **Detect** button  to analyze the solid model based on your changes.



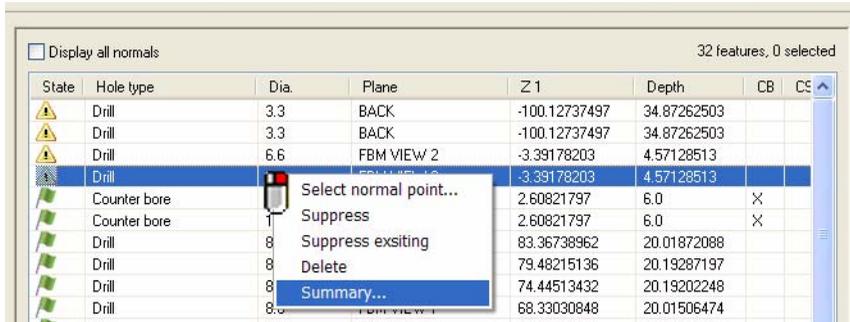
When finished analyzing features, FBM Drill displays the Features page. The number of detected features changes because you eliminated split holes from the hole detection parameters.

A screenshot of the 'Features' page in the software. At the top right, a status bar indicates '32 features, 0 selected'. Below is a table with columns for State, Hole type, Dia., Plane, Z 1, Depth, CB, and CS. The first four rows show 'Drill' features with yellow warning icons, and the last two rows show 'Counter bore' features with green checkmark icons.

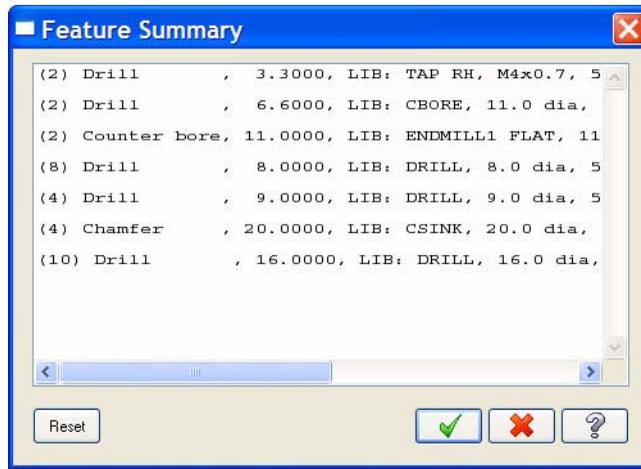
State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	6.6	FBM VIEW 2	-3.39178203	4.57128513		
	Drill	6.6	FBM VIEW 2	-3.39178203	4.57128513		
	Counter bore	11.0	FBM VIEW 2	2.60821797	6.0	X	
	Counter bore	11.0	FBM VIEW 2	2.60821797	6.0	X	

► Create the Features Summary Report

- 1 Right-click in the Features page and choose **Summary**.



The Feature Summary dialog box opens.

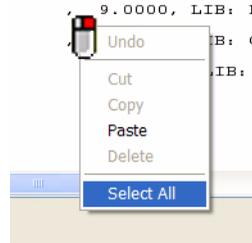


The Feature Summary dialog box contains a list of all detected features grouped by hole type, diameter, and assigned finish tool.

Notes:

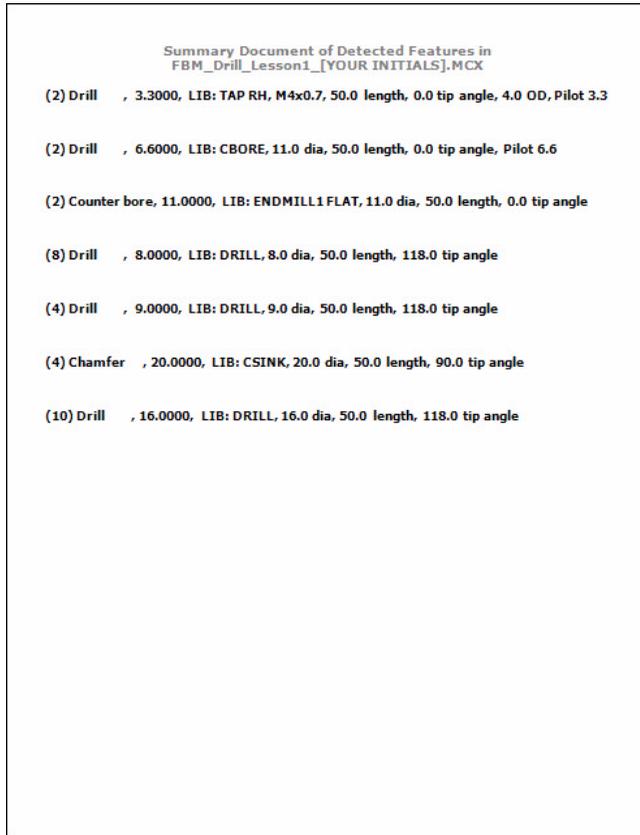
- Different options display when you right-click in the **Hole type**, **Plane**, and **Finish tool** columns.
 - The Features page contains many powerful options. Lesson 6, “Working in the Features Page” on page 137 teaches how to use them.
-

- 2 Right-click in the Feature Summary dialog box and choose **Select All**.



- 3 Right-click again and choose **Copy**, or press [Ctrl+C].
- 4 Open your preferred word processing application—for example, Microsoft® Word® or Notepad®—and then create a new document.
- 5 Paste the text you copied in Step 3 into the new document.

Here is a sample document containing the feature summary.



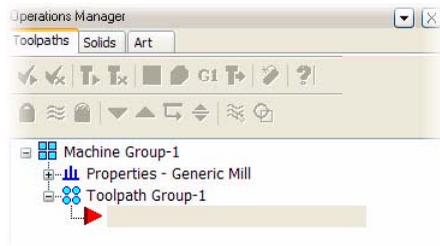
Each line summary contains the following information:

- ◆ Number of detected features in the summary group

- ◆ Tool diameter
- ◆ Tool source – **MCX** (part file), **LIB** (tool library), **XLS** (FBM standard tool definitions file used when FBM is allowed to create tools)
- ◆ Hole type
- ◆ Tool definition

Note: The tool source is based on your tool selection settings in the FBM Drill Tools page. You learn more about tool selection in Lesson 4, “Assigning Tools” on page 81.

- 6 Print the document and optionally save it.
- 7 In Mastercam, click **Cancel**  to exit the Feature Summary dialog box.
- 8 In the FBM Drill dialog box, click **Cancel** to close and exit *without creating an FBM Drill toolpath* in the Toolpath Manager. This completes the exercise.



Take a closer look at the summary document you printed to become familiar with the types of hole features in the model and the tools needed to machine them. Then continue with the next exercise.

Exercise 3: Creating an FBM Drill Operation

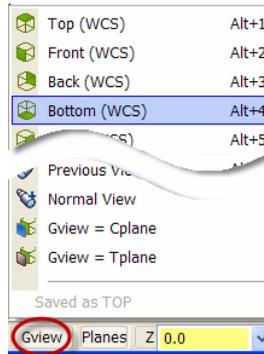
In this exercise, you isolate five pairs of Ø16.0mm coaxial holes located in the Top and Bottom views. You use FBM Drill to detect these holes and create the toolpaths to machine them from different planes.

Note: This exercise uses an MCX part file provided with the tutorial, FBM_DRILL_LESSON1_EX3.MCX. It does not use the file you saved on page 12 in Exercise 1.

► Examine the Coaxial Features

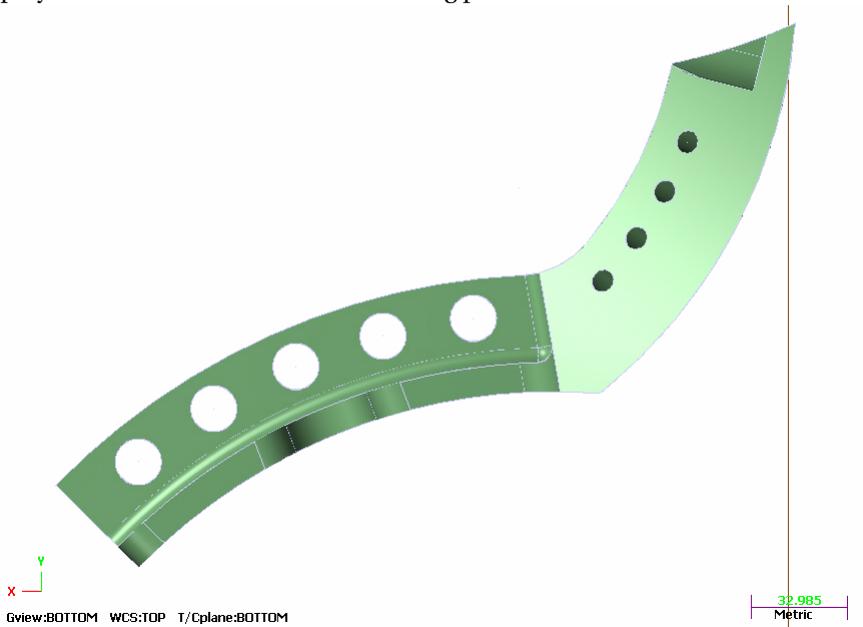
- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part: FBM_DRILL_LESSON1_EX3.MCX
- 3 If a message informs you that the file used in the previous exercise has changed and asks if you want to save the changes, click **No**.

- 4 From the Status bar **Gview** menu, choose **Bottom (WCS)**.

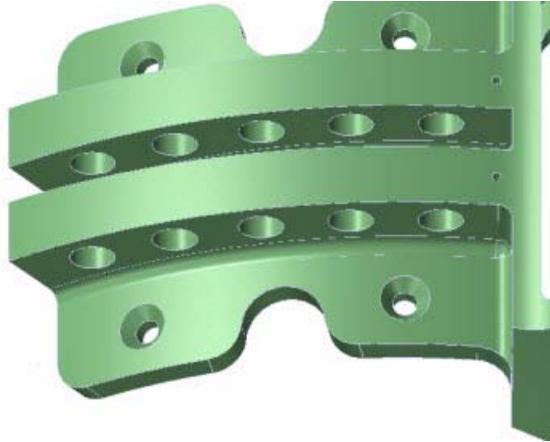


- 5 Fit the part to the screen  and shade it. 

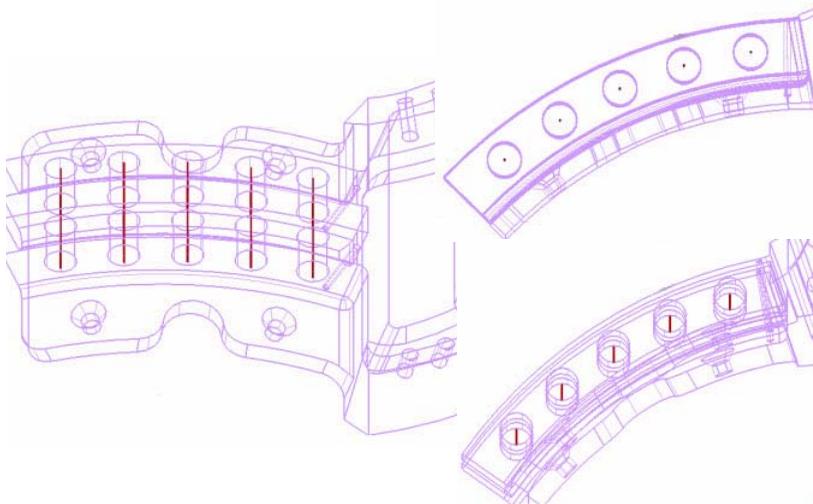
- 6 Press **F9** to display the coordinate axes in the graphics window. Your graphics window part display should look similar to the following picture:



- 7 Dynamically rotate the part until you also see the five holes on the other side. Each pair of holes share the same axis, making them coaxial holes.

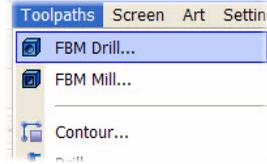


- 8 Change your shade settings to **Wireframe**  to get a better view. In the sample pictures below, a vector was drawn through the holes to help you see the shared axis in different rotated views.

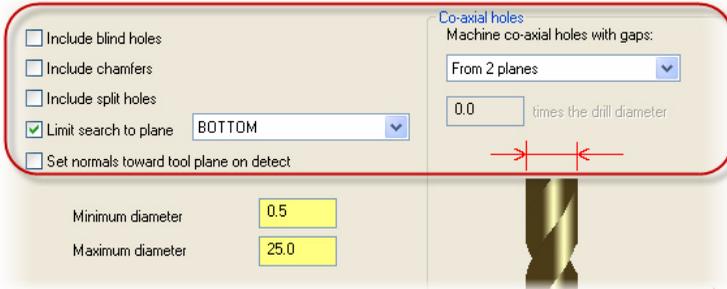


► Create the FBM Drill Operation

- 1 If necessary, create a machine group in the Toolpath Manager by choosing **Machine Type, Mill, Default** from the Mastercam menu.
- 2 From the Mastercam menu, choose **Toolpaths, FBM Drill**.
- 3 Choose **Hole Detection** in the Tree View pane.
The Hole Detection parameters display.

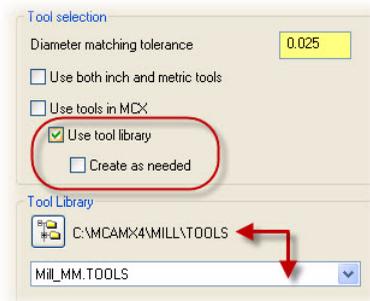


- 4 In the Hole Detection page, enter the following settings:



- a Deselect **Include blind holes**.
 - b Deselect **Include chamfers**.
 - c Deselect **Include split holes**.
 - d Make sure **Limit search to plane** is selected, and then change the plane to **Bottom** using the drop-down list.
 - e In the **Co-axial holes** group box, set **Machine holes with gaps** to **From 2 planes** using the drop-down list.
- 5 Choose **Tools** in the Tree View pane.
The Tools parameters display.

- 6 In the Tools page, deselect **Create as needed** and verify that the selected tool library is **Mil_MM.TOOLS**.



- 7 Click the **Detect** button  to analyze the solid model based on your selections.



When finished, FBM Drill displays the Features page.

Note: After detecting features, the “dirty” detect button updates to a “clean” state,  indicating that the information in the Features page is based on the current FBM Drill settings.

► Generate FBM Toolpaths

- 1 Your features list should match the following picture.

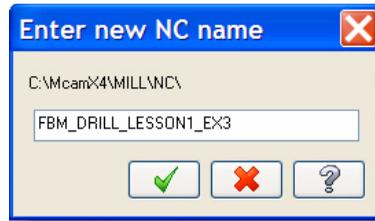
Display all normals 10 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
	Drill	16.0	BOTTOM	30.0	22.14697299		
	Drill	16.0	BOTTOM	30.0	22.25328805		
	Drill	16.0	BOTTOM	30.0	22.43397598		
	Drill	16.0	BOTTOM	30.0	22.6855199		
	Drill	16.0	BOTTOM	30.0	23.00302378		
	Drill	16.0	TOP	30.0	22.14697299		
	Drill	16.0	TOP	30.0	22.25328805		
	Drill	16.0	TOP	30.0	22.43397598		
	Drill	16.0	TOP	30.0	22.6855199		
	Drill	16.0	TOP	30.0	23.00302378		

Select common features... Select coaxial features

Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

- 2 If the Enter new NC name dialog box displays, click **OK** to accept the default NC file name.



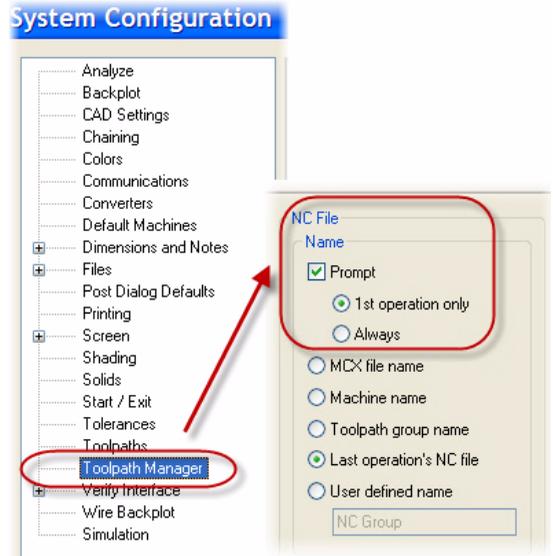
Notes:

- For the rest of the exercises in the FBM Drill tutorial, a separate step will not be provided for the Enter new NC name dialog box. If the dialog box displays after completing a step, press **OK** and continue with the next step in the exercise.
- See the **TIPS** below for information on configuring this dialog box.

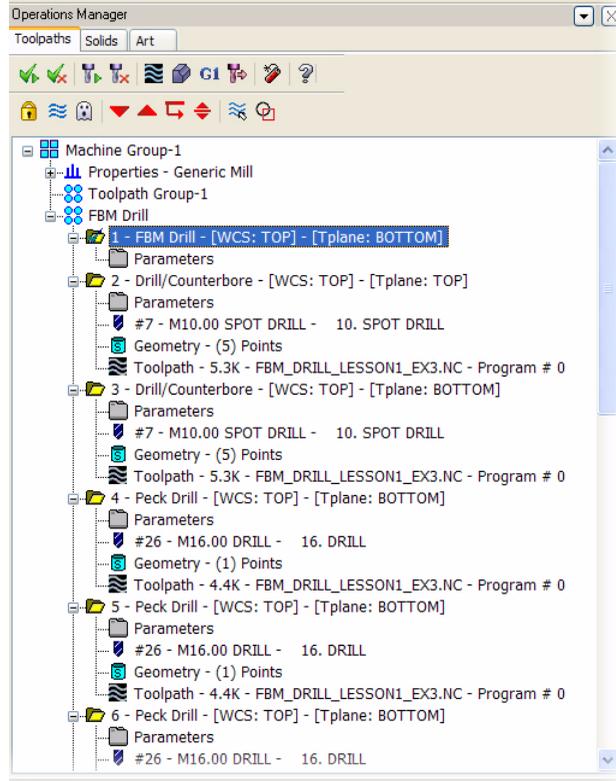


TIPS: Your configuration file settings determine if the **Enter new NC name** dialog box displays when you create toolpaths. To enable/disable this dialog box:

- a From the Mastercam menu, choose **Settings, Configuration**.
- b In the System Configuration dialog box, choose **Toolpath Manager** from the Tree View pane
- c Select/deselect the **NC File Name Prompt** check box.
- d **Apply** or **Save** your changes to the configuration file.



3 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.



You should see the following:

- ♦ One FBM Drill operation in the machine group (#1)
- ♦ Two Ø10.0mm spot drill cycles, one for each set of five holes in each plane (TOP, BOTTOM) (#2-3)
- ♦ A series of Ø16.0mm drill cycles comprising five sequential operations to drill each hole in the BOTTOM plane (#4-8), and five more for drilling the holes in the TOP plane (#9-13)

4 Choose **File, Save As**.

5 In the Save As dialog box, do the following:

- a Add your initials to the tutorial part name, for example:
FBM_DRILL_LESSON1_EX3_[your initials].MCX
- b Click **OK** to save the file. Continue with the next exercise.

In the next exercise, you set different FBM Drill parameters to change the way the toolpaths for coaxial holes are generated, creating more streamlined results.

Exercise 4: Modifying an FBM Drill Operation

In this exercise, you modify the FBM Drill parameters to drill the coaxial holes from a single plane. You also change the tool assigned to the drill cycle, and learn to minimize the FBM Drill dialog box so that you can work with functions in the graphics window.

► Change Detection Settings

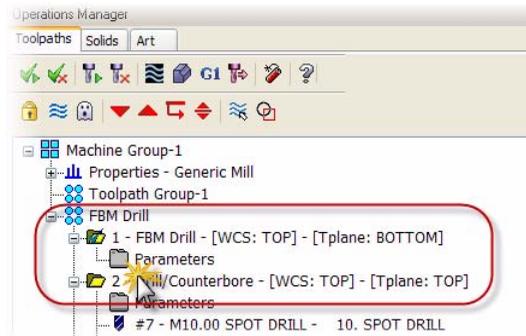
1 Open the MCX part file you saved on page 25 in Exercise 3—for example, FBM_DRILL_LESSON1_EX3_[your initials].MCX.

2 From the Status bar **Gview** menu, choose **Top (WCS)**.

3 Fit the part to the screen  and shade it. 

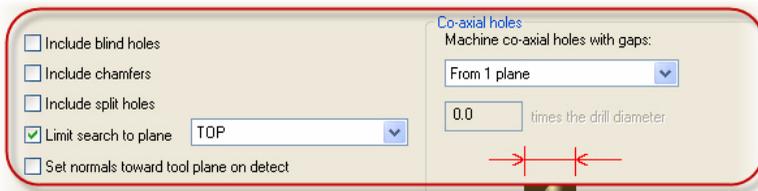
4 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.



5 Choose **Hole Detection** in the Tree View pane.

6 In the Hole Detection page, enter the following settings:



a Deselect **Include blind holes**.

b Deselect **Include chamfers**.

c Deselect **Include split holes**.

d Make sure **Limit search to plane** is selected, and then change the plane to **TOP** using the drop-down list.

e In the **Co-axial holes** group box, set **Machine holes with gaps** to **From 1 plane** using the drop-down list.

7 Click the **Detect** button  to analyze the solid model based on your selections.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

Display all normals 5 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
⚠	Drill	16.0	TOP	30.0	60.0		
⚠	Drill	16.0	TOP	30.0	60.0		
⚠	Drill	16.0	TOP	30.0	60.0		
⚠	Drill	16.0	TOP	30.0	60.0		
⚠	Drill	16.0	TOP	30.0	60.0		

Select common features... Select coaxial features

FBM Drill detects five Ø16.0mm holes, rather than the 10 it detected in the previous exercise. This is because you chose to machine the coaxial holes from one plane. Each pair of coaxial holes is effectively one hole.

► Troubleshoot a Tool Selection Problem

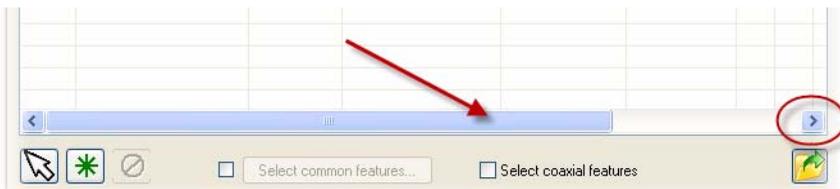
- 1 The warning icon ⚠ in the Features page indicates that a problem exists with the tool assigned to the detected feature.

Hover your mouse over the icon until the error message displays. This tool is too short.

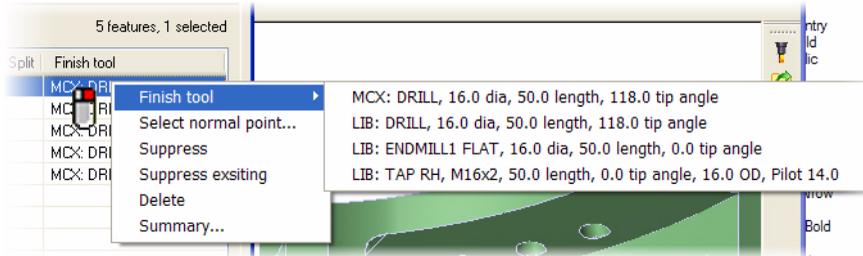
Display all normals

State	Hole type	Dia.
⚠	Drill	16.0
⚠	Drill	16.0
⚠	1-TOOL: tool too short	16.0
⚠	Drill	16.0
⚠	Drill	16.0

- 2 Move the slider at the bottom of the page to the right in order to view the **Finish tool** column.



- 3 Select any feature in the list. Then right-click in the Finish tool column and choose **Finish tool**.



The available tools in the list are all 50.0mm long. The value in the Depth field of the Features page is 60.0mm. This value is the total distance between the top of the first coaxial hole and the bottom of the second coaxial hole.

- 4 Here is another way to determine the coaxial hole's total depth.

In the FBM Drill dialog box menu, click the **Hide dialog** button.



The dialog box minimizes in the lower left area of the Mastercam window.

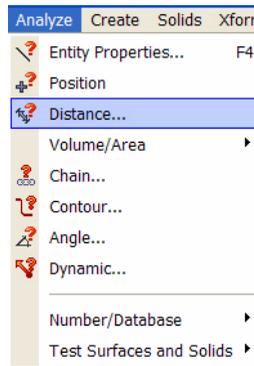


TIP: Minimizing the FBM Drill dialog box to work with functions in the graphics window is a technique you use often to change your view of the model, and to get more information on its properties.

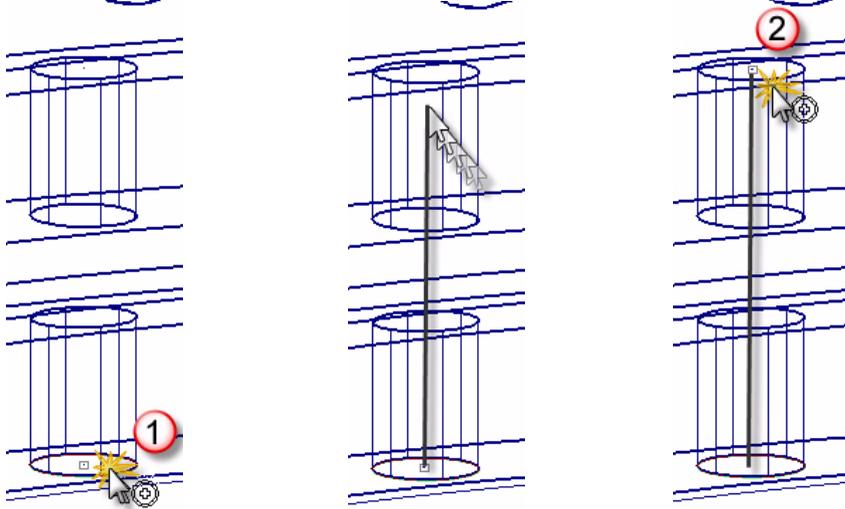
- 5 Change your shade settings to **Wireframe**.



- 6 From the Mastercam menu, choose **Analyze, Distance**.



- 7 Using the AutoCursor and view manipulation functions, select the centerpoint of the bottom and top arcs of a pair of coaxial holes, as shown in the following pictures.

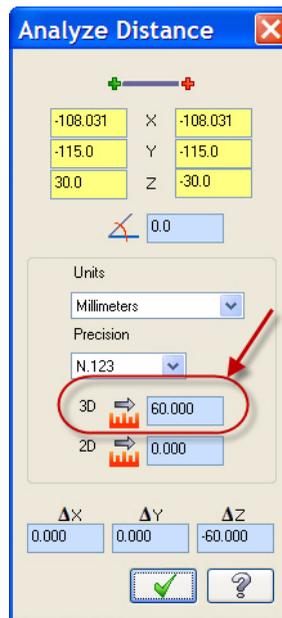


- 8 The Analyze dialog box opens.

The distance between the two selected points is 60.0mm. You need a tool capable of drilling this distance.

Click **OK** to close the dialog box.

- 9 Press **[Esc]** to maximize the FBM Drill dialog box in the Mastercam window.



► Change Tools Settings

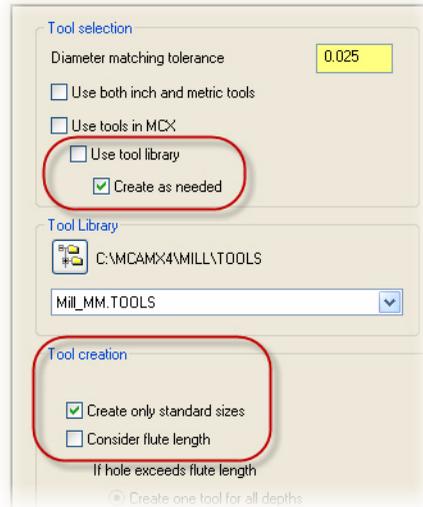
- 1 Choose **Tools** in the Tree View pane.

2 In the Tools page, do the following:

- a Select **Create as needed**.
- b Deselect **Use tool library**.
- c Select **Create only standard sizes**.

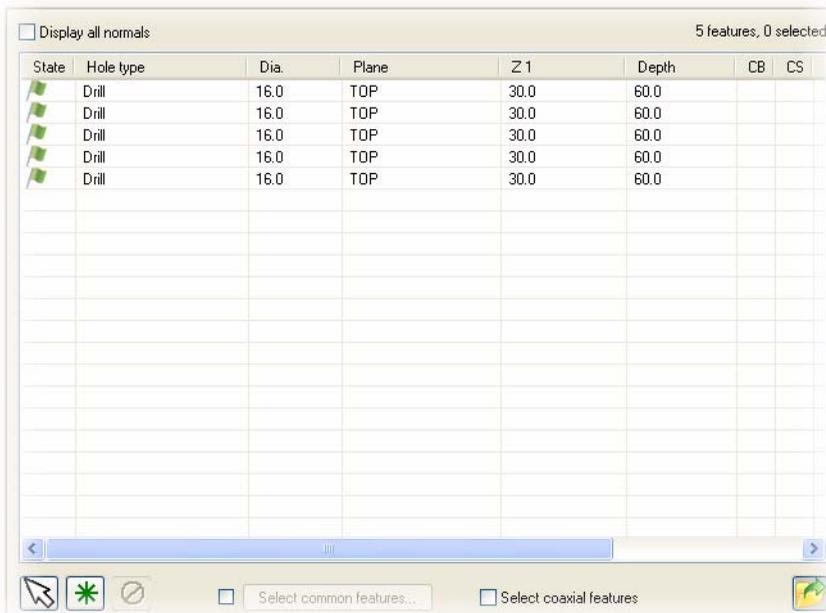
Notes:

- FBM Drill uses a special tool table file installed in the Mastercam \common\FBM folder to create standard-sized tools.
- The file is formatted as a Microsoft Excel® spreadsheet (FbmToolTable.XLS) and, for workstations that do not include Excel, a comma-delimited file (FbmToolTable.CSV) is also provided.
- You learn more about the tool table file in Lesson 4, “Assigning Tools” on page 81.



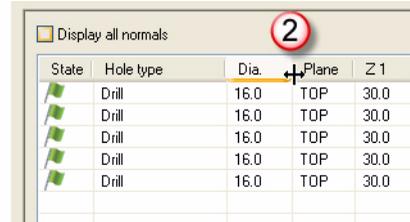
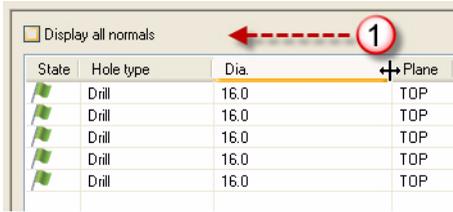
3 Click the **Detect** button  to analyze the solid model based on your tool selections.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

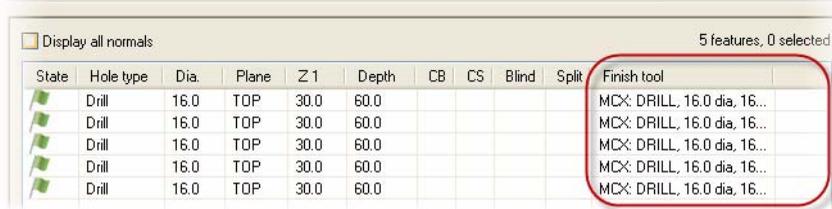


The green icon  in the Features page indicates that the features can be machined with the assigned tool.

- 4 Instead of moving the slider at the bottom of the page to view the Finish tool column, reduce the size of the other columns in the page until the Finish tool column is visible.
 - a In a column header row, hover the mouse over the column border until the cursor displays a resize icon. 
 - b Click and drag the column border to the left.

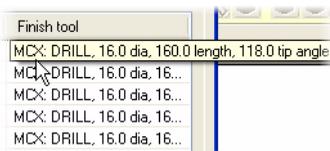


- c Release the mouse button when the column is the size you want.
 - d Repeat Steps a – c until the Finish tool column appears in the Features page display.

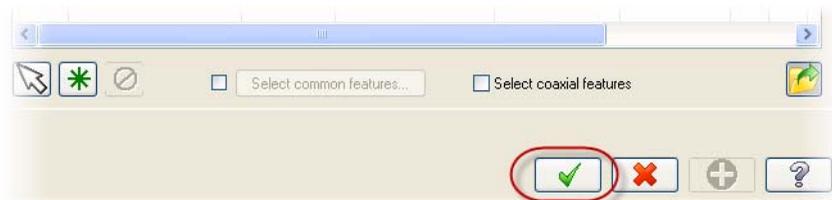


- 5 In the Finish tool column, hover the mouse over any feature in the list to display information about the assigned tool.

The 160.0mm tool length resolves the short tool issue.



- 6 Click **OK** to accept the changed parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One $\text{Ø}10.0\text{mm}$ spot drill cycle in the TOP plane for all five coaxial holes (#2)
- ◆ One $\text{Ø}16.0\text{mm}$ drill cycle in the TOP plane for all five coaxial holes (#3)

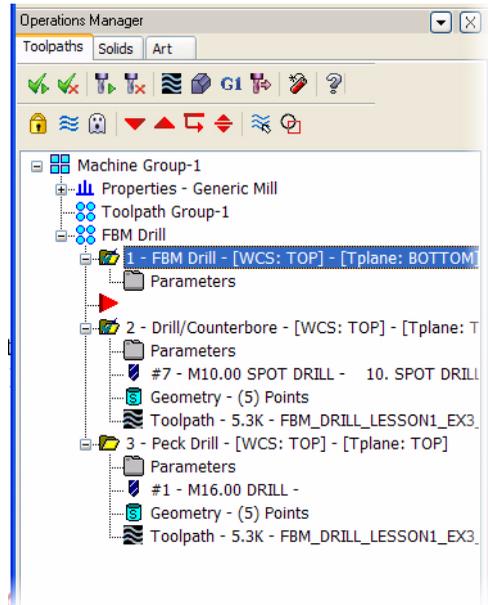
- 3 Choose **File, Save As**.

- 4 In the Save As dialog box, do the following:

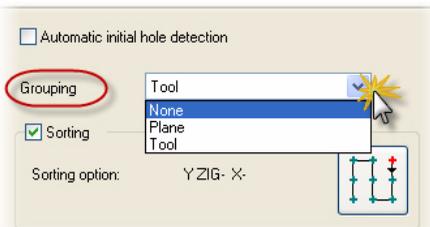
- a Change the exercise number in the file name from 3 to 4, for example:

FBM_DRILL_LESSON1_EX4_[your initials].MCX

- b Click **OK** to save the file.



TIP: You can change how FBM-generated toolpaths are grouped in the Toolpath Manager. To do this, in the FBM Drill **Setup** page, choose to group toolpaths by **Plane** or by **Tool**. Then regenerate the FBM Drill operation to see the results in the Toolpath Manager.



► Backplot the FBM Drill-Generated Toolpaths

- 1 In the Toolpath Manager, click the **Select all operations** button. 



All three toolpath folders display a green check mark.

- 2 Make sure that all toolpaths are set to display in the graphics window.

In the Toolpath Manager, click the **Toggle toolpath display** button  until the selected toolpaths display in the graphics window.



TIP: You can also press **[Alt+T]** to toggle on and off the display of toolpaths in the graphics window.

- 3 Set up the part display in the graphics window.

a Change the Gview to **Back (WCS)**.

b Set shade settings to **Wireframe**. 

c Fit the part to screen.  Then zoom out to about 40% and position the part lower in the graphics window.

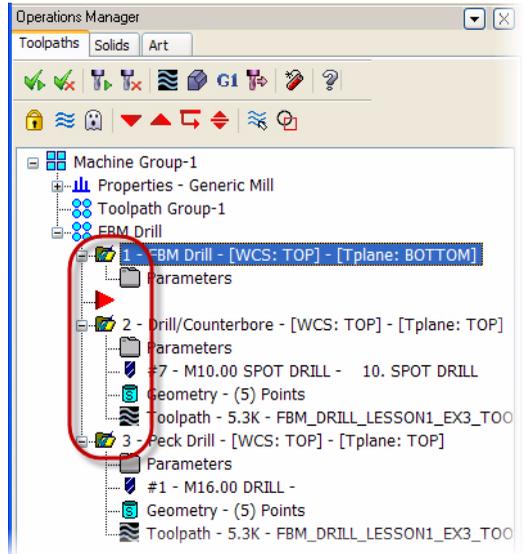
This allows you to view the entire tool in the graphics window during Backplot.



TIP: At any time during Backplot, you can pause and then use view manipulation functions to change your view of the part in the graphics window before resuming play.

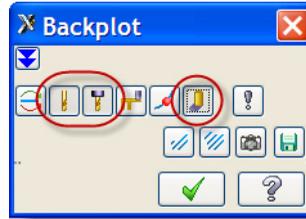
- 4 In the Toolpath Manager, click the **Backplot selected operations** button. 

The Backplot dialog box and Backplot VCR bar open.



- 5 In the Backplot dialog box, select the **Display tool**, **Display holder**, and **Quick verify** buttons.

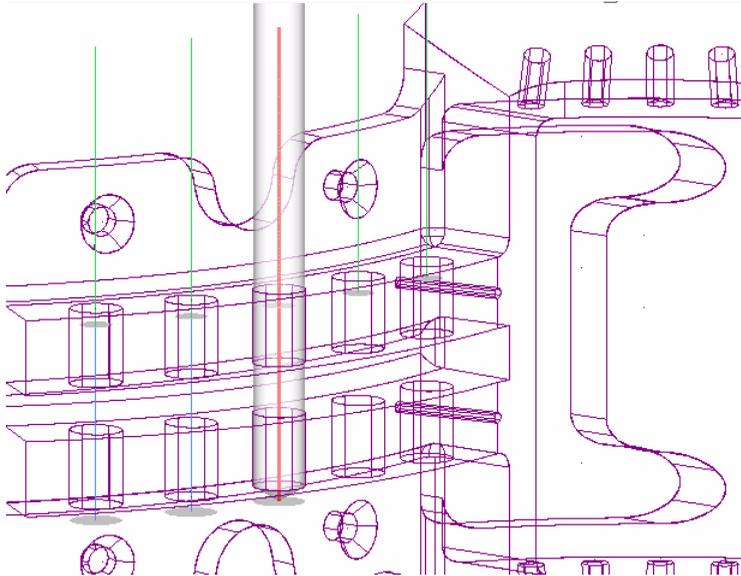
These options display a simulation of a tool and holder during backplot, and shade the toolpath.



- 6 Use the buttons and sliders on the Backplot VCR bar to backplot the operations.



Click **Play**  to begin the backplotting action. Here is a sample picture of the part (slightly rotated) during the backplot.



- 7 When finished, click **OK** in the Backplot dialog box to exit the Backplot function. This completes the exercise.



TIPS:

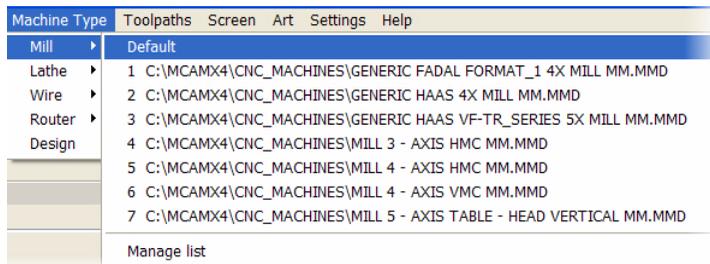
- Click the **Help** button on the VCR bar for more information on each of the controls.
- The Backplot display is easily customizable. See the Mastercam Help for details on each of the buttons, fields, and display options in the Backplot and the Backplot Options dialog boxes.

Exercise 5: Limiting Detection by Hole Type and Plane

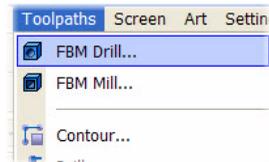
In this exercise, you limit detection to only two pairs of blind and counterbore holes created in a non-standard plane. These features were designed to fit M6 socket head cap screws.

► Use FBM Drill to Analyze Features and Create Custom Views

- 1 Open the MCX part file you saved on page 12 in Exercise 1—for example:
FBM_DRILL_LESSON1_[your initials].MCX.
- 2 From the Status bar **Gview** menu, choose **Back (WCS)**.
- 3 Fit the part to the screen  and set shade settings to **Wireframe**. 
- 4 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu to create one.

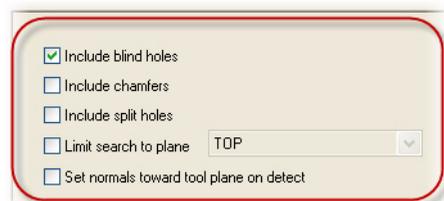


- 5 Choose **Toolpaths, FBM Drill**.



- 6 Choose **Hole Detection** in the Tree View pane.
- 7 In the Hole Detection page, enter the following settings:

- a Select **Include blind holes**.
- b Deselect **Include chamfers**.
- c Deselect **Include split holes**.
- d Deselect **Limit search to plane**.



- 8 Click the **Detect** button  to analyze the solid model based on your selections.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

Display all normals 23 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
⚠	Drill	3.3	BACK	-100.12737497	34.87262503		
⚠	Drill	3.3	BACK	-100.12737497	34.87262503		
🟢	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
🟢	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
🟢	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	
🟢	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	
🟢	Drill	8.0	FBM VIEW 2	83.36738962	20.01872088		
🟢	Drill	8.0	FBM VIEW 3	79.48215136	20.19287197		
🟢	Drill	8.0	FBM VIEW 4	74.44513432	20.19202248		
🟢	Drill	8.0	FBM VIEW 5	68.33030848	20.01506474		
🟢	Drill	8.0	FBM VIEW 6	83.36732346	20.01865472		
🟢	Drill	8.0	FBM VIEW 7	79.48215096	20.19287157		
🟢	Drill	8.0	FBM VIEW 8	74.44513423	20.1920224		
🟢	Drill	8.0	FBM VIEW 9	68.33022481	20.01498107		
🟢	Drill	9.0	FBM VIEW 10	-21.32079269	5.59063141		
🟢	Drill	9.0	FBM VIEW 10	-21.32079269	5.59063141		
🟢	Drill	9.0	FBM VIEW 11	-114.78493099	5.59063141		
🟢	Drill	9.0	FBM VIEW 11	-114.78493099	5.59063141		
🟢	Drill	16.0	TOP	30.0	60.0		
🟢	Drill	16.0	TOP	30.0	60.0		
🟢	Drill	16.0	TOP	30.0	60.0		

Select common features...
 Select coaxial features

The two Ø6.6mm blind holes to isolate in this exercise are included in the list with all through holes. The blind holes are “paired” with the two Ø11.0mm counterbore holes that follow them in the list. This entire set of holes is in a non-standard plane (FBM View 1).

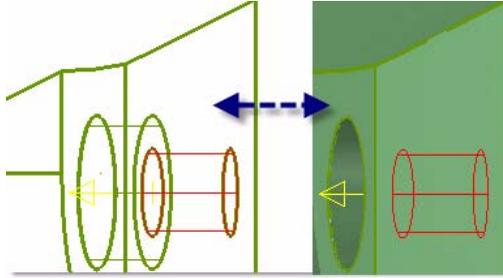
Note: During detection, FBM Drill created all of the non-standard planes in the list that begin with “FBM View”.

9 Select the first Ø6.6mm hole in the Features page list.

Display all normals 23 features, 1 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
⚠	Drill	3.3	BACK	-100.12737497	34.87262503		
⚠	Drill	3.3	BACK	-100.12737497	34.87262503		
🟢	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
🟢	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
🟢	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	
🟢	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	

The hole's normal and surface edge features display in the graphics window (sample pictures show shaded and wireframe views).

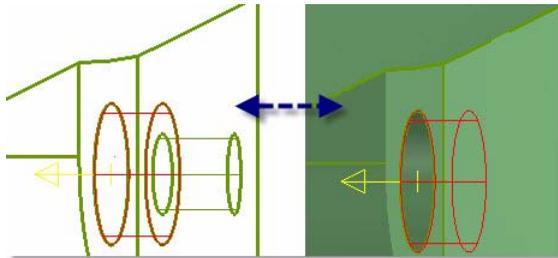


- 10** Repeat Step 9 but this time, select the first $\text{\O}11.0\text{mm}$ counterbore hole in the Features page list.

Display all normals 23 features, 1 selected

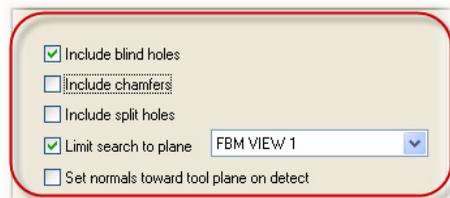
State	Hole type	Dia.	Plane	Z 1	Depth	CB	CE
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	
	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	X	
	Drill	8.0	FBM VIEW 2	83.36738962	20.01872088		

The selected feature's normal and surface edges display.



► Isolate Hole Features by Plane

- 1 Choose **Hole Detection** in the Tree View pane.
- 2 In the Hole Detection page, select **Limit search to plane**, and then change the plane to **FBM View 1** using the drop-down list. Your settings should match the picture shown.



*Note: Values in the **Co-axial holes** group box do not affect the detection because you are limiting the plane to FBM View 1 and no coaxial holes exist on this plane.*

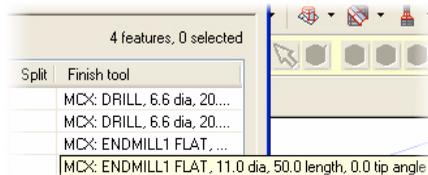
- In the FBM Drill dialog box menu, click **Detect** to analyze the solid model based on your modifications.

In the Features page, your list should match the following picture.

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
	Drill	6.6	FBM VIEW 1	-3.39178203	4.57128513		
	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	×	>
	Counter bore	11.0	FBM VIEW 1	2.60821797	6.0	×	>

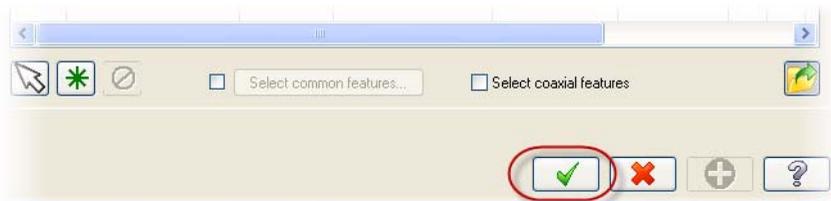
The icon  in the Features page indicates that the features can be machined with the assigned tools.

- In the **Finish tool** column, hover the mouse over one of the Ø11.0mm counterbore holes to view all tool information.



▶ Accept the FBM Drill Operation and Generate Toolpaths

- Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.



The FBM Drill dialog box closes.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following:

- ♦ One FBM Drill operation in the machine group (#1)
- ♦ One Ø10.0mm spot drill cycle for the two blind holes (#2)
- ♦ One Ø6.6mm drill cycle for the two blind holes (#3)
- ♦ One Ø11.0mm drill cycle for the two counterbore holes(#4)

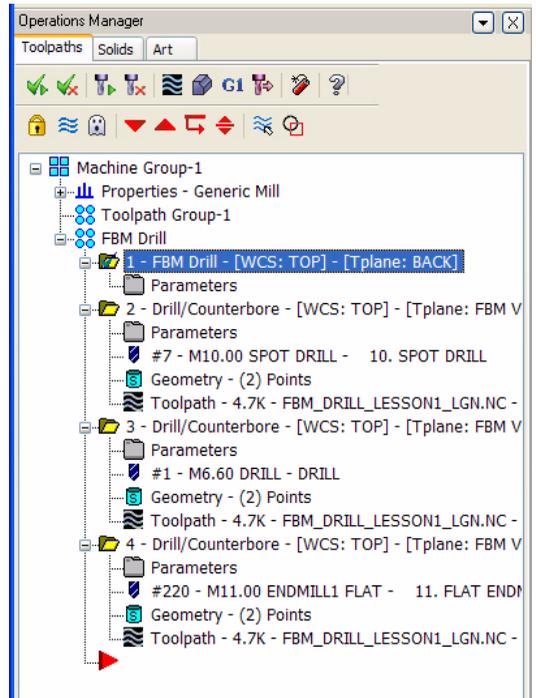
- 3 Choose **File, Save As**.

- 4 In the Save As dialog box, do the following:

- a Add the exercise number and your initials to the tutorial part name, for example:

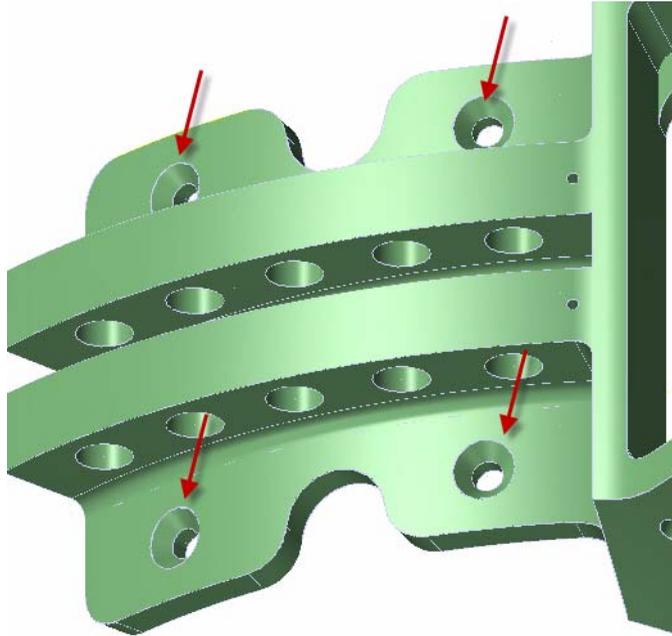
```
FBM_DRILL_LESSON1_EX5_[your initials].MCX
```

- 5 Click **OK** to save the file. This completes the exercise.



Exercise 6: Limiting Detection by H3ole Type and Size

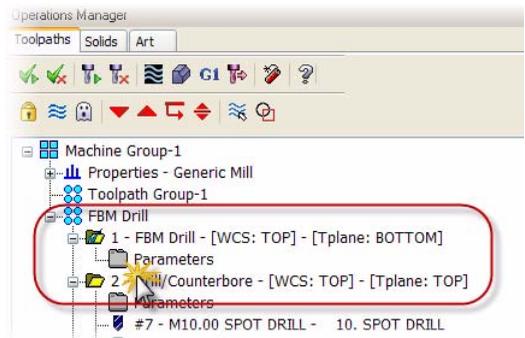
In this exercise, you limit hole detection by *size* (min/max diameter) to isolate four Ø9.0mm through holes, and also by *type* to include their corresponding chamfers.



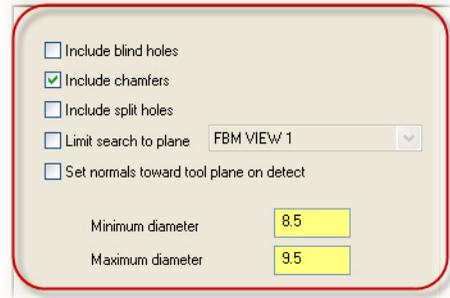
- 1 Open the MCX part file you saved on page 39 in Exercise 5—for example, FBM_DRILL_LESSON1_EX5_[your initials].MCX.
- 2 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.

- 3 Choose **Hole Detection** in the Tree View pane.

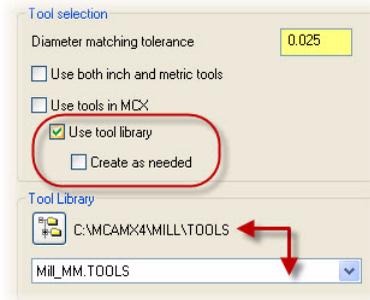


- 4 In the Hole Detection page, enter the following settings:
 - a Deselect **Include blind holes**.
 - b Select **Include chamfers**.
 - c Deselect **Include split holes**.
 - d Deselect **Limit search to plane**.
 - e In the **Minimum diameter** field, type **8.5**.
 - f Set the **Maximum diameter** to **9.5**.



FBM Drill detects only features that fall within the specified size range.

- 5 In the Tools page, deselect **Create as needed** and verify that the selected tool library is **Mill_MM.TOOLS**.
- 6 In the FBM Drill dialog box menu, click **Detect**  to analyze the solid model based on your changes.



In the Features page, your list should match the following picture.

Display all normals 8 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
	Drill	9.0	FBM VIEW 10	-21.32079269	5.59063141		
	Drill	9.0	FBM VIEW 10	-21.32079269	5.59063141		
	Chamfer (90.0)	17.919902...	FBM VIEW 10	-15.82079269	10.0		X
	Chamfer (90.0)	17.919904...	FBM VIEW 10	-15.82079269	10.0		X
	Drill	9.0	FBM VIEW 11	-114.78493099	5.59063141		
	Drill	9.0	FBM VIEW 11	-114.78493099	5.59063141		
	Chamfer (90.0)	17.919801...	FBM VIEW 11	-109.28493099	10.0		X
	Chamfer (90.0)	17.919802...	FBM VIEW 11	-109.28493099	10.0		X

The Features page shows four pairs of $\text{Ø}9.0\text{mm}$ holes and their associated chamfers. The features can be machined with the assigned tools.

- 7 In the **Finish tool** column, hover the mouse over any of the holes in the list to view tool information.
- 8 Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

The FBM Drill dialog box closes.

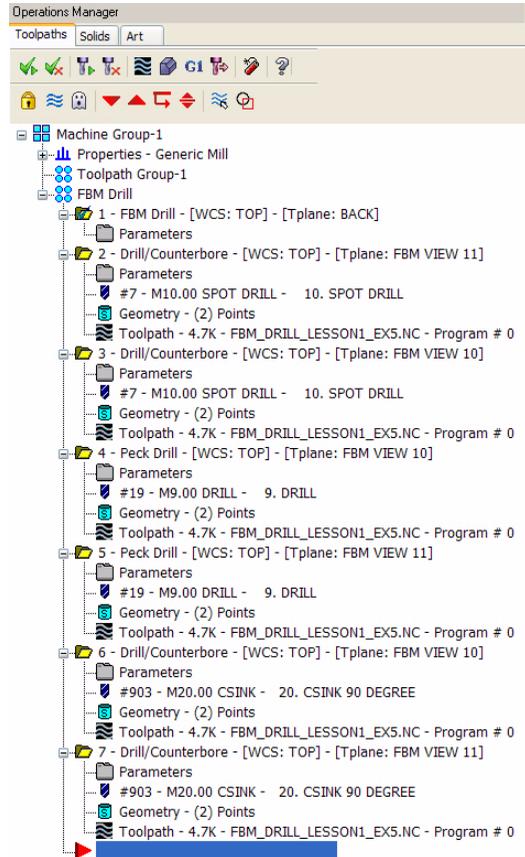
- 9 In the Toolpath Manager, click the **Regenerate all dirty operations** button.



Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

10 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following series of operations:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Two Ø10.0mm spot drill cycles for the Ø9.0mm holes, one in each of the non-standard views, **FBM View 11** and **FBM View 12** (#2-3)
- ◆ Two Ø9.0mm drill cycles, one for each pair of holes in each non-standard plane (#4-5)
- ◆ Two Ø20.0mm countersink (90 degree) drill cycles, one for each pair of chamfers in each non-standard plane (#6-7)



11 Choose **File, Save As**.

12 In the Save As dialog box, do the following:

- a Change the exercise number in the file name from 5 to 6, for example:
FBM_DRILL_LESSON1_EX6_[your initials].MCX
- b Click **OK** to save the file. This completes the exercise.

Skills Challenge

Congratulations! You have completed Lesson 1, “Working with Solid Models and FBM Drill”.

As a challenge to the skills you learned in this lesson, try the following exercise suggestion.

Using the file you saved in Exercise 6 (page 40):

- 1** Backplot the toolpaths.
- 2** Modify the FBM Drill parameters to group the operations by plane.
(Hint: **Setup** page parameters).
- 3** Regenerate the toolpaths and view the results in the Toolpath Manager. How did they change? How could you use this technique to make job setup easier?

Adding Drill Cycle Operations

This lesson teaches how to configure specific drilling cycles for detected features. You learn to work with the parameters for spot and pre-drill cycles, and to configure deep drilling cycles for your FBM Drill-generated toolpaths.

Note: The drill cycles used in each operation are determined by the cycle stored with each tool definition. Mastercam uses only cycles that have been enabled in the active control definition on the Machine Cycles page. For more information on control definitions, refer to the Mastercam Help.

Lesson Goals

- Add spot drill cycles, assign a specific tool to use for all of them, and combine spot drill cycles that share common parameters.
- Create pre-drill cycles using tools no smaller than a specified diameter.
- Create deep drill cycles based on a defined hole length-to-diameter ratio, and use a custom tool to drill the detected deep holes.

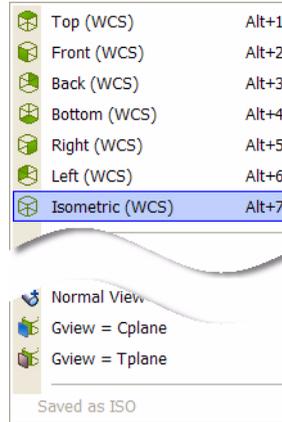
Exercise 1: Adding Spot Drill Cycles

In this exercise, you create spot drill cycles for an FBM Drill operation and assign a specific tool to them. You then modify the FBM Drill parameters to combine spot drill operations that share common parameters.

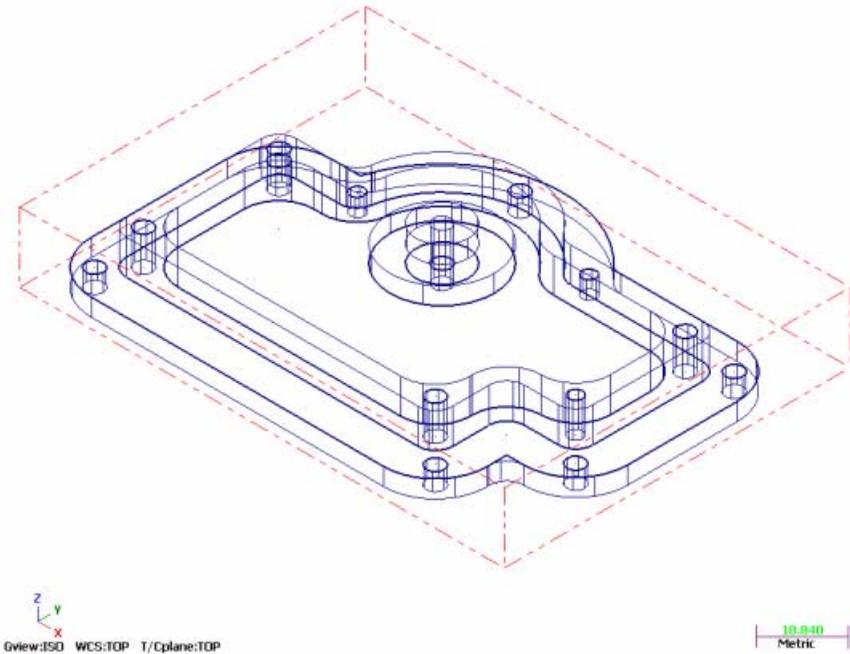
► Create the FBM Drill Operation

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: FBM_DRILL_LESSON2.MCX.

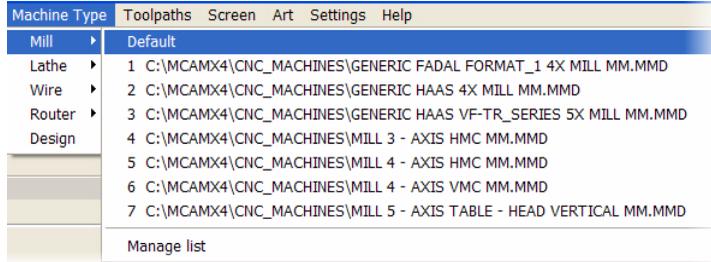
3 From the Status bar **Gview** menu, choose **Isometric (WCS)**.



4 Fit the part to the screen,  and then change your shade settings to **Wireframe**. 
Your part should look similar to the following picture:



- 5 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

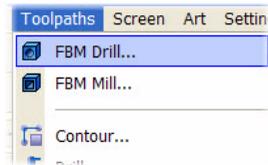


This creates a Machine Group in the Toolpath Manager.

Note: The list of Mill Machine Types can be customized, so yours may differ from the sample picture.

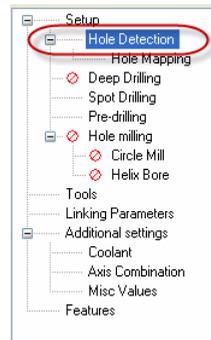
- 6 Choose **Toolpaths, FBM Drill**.

If the FBM Drill dialog box opens to the Setup page parameters, do not modify them.

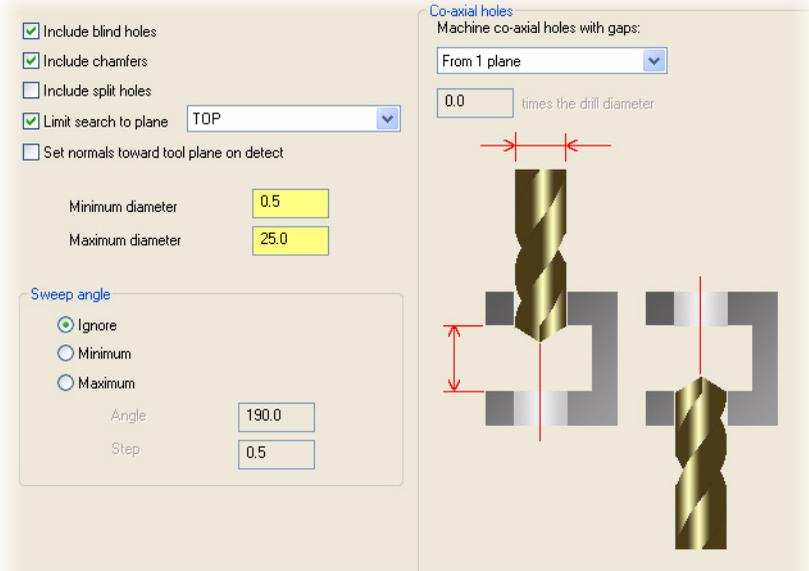


- 7 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.

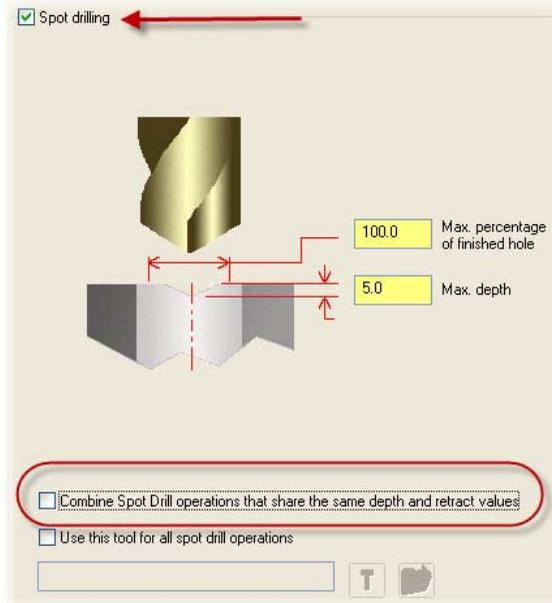


8 In the Hole Detection page, make sure that your parameters match the following picture:



9 Choose **Spot Drilling** in the Tree View pane.

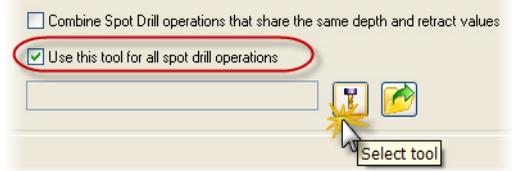
10 The Spot Drilling page is activated by default (**Spot drilling** is selected). Deselect the option to **Combine Spot Drill operations that share the same depth and retract values**.



► Assign a Spot Drill Tool

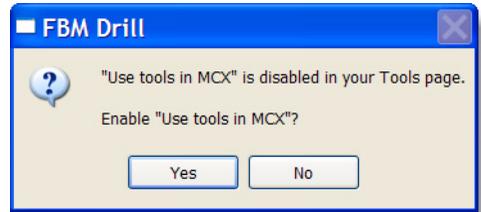
- 1 Select **Use this tool for all spot drill operations**.

- 2 Click the **Select tool** button. 



A message informs you that a setting on the Tools page currently does not allow the use of tools in the MCX file. It asks if you want to enable that option.

- 3 Click **Yes** to activate this parameter in the Tools page.

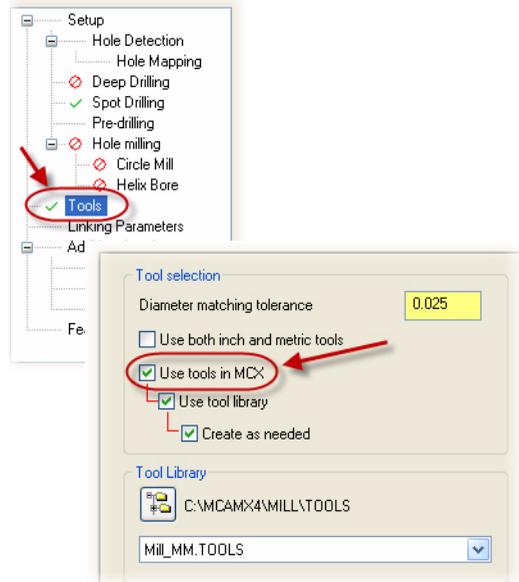


The message dialog box closes.

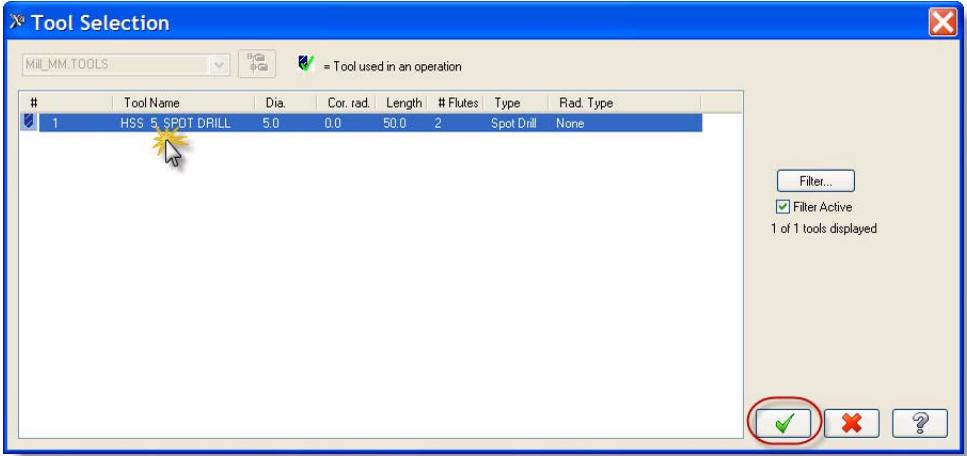
The Tool Selection dialog box opens.

Notes:

- In the Tree View pane, the Tools page updates with a green check mark, indicating that the parameters changed when you clicked **Yes**.
- The Tool selection picture to the right shows the actual parameter that was activated in the Tools page.
- You learn more about tool selection in Lesson 4, “Assigning Tools” on page 81.

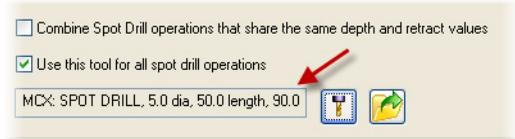


- In the Tool Selection dialog box, select the **5mm HSS SPOT DRILL** defined in the tutorial part file database (MCX). Then click **OK**.



The Tool Selection dialog box closes.

- In the Spot drilling page, the selected tool displays.



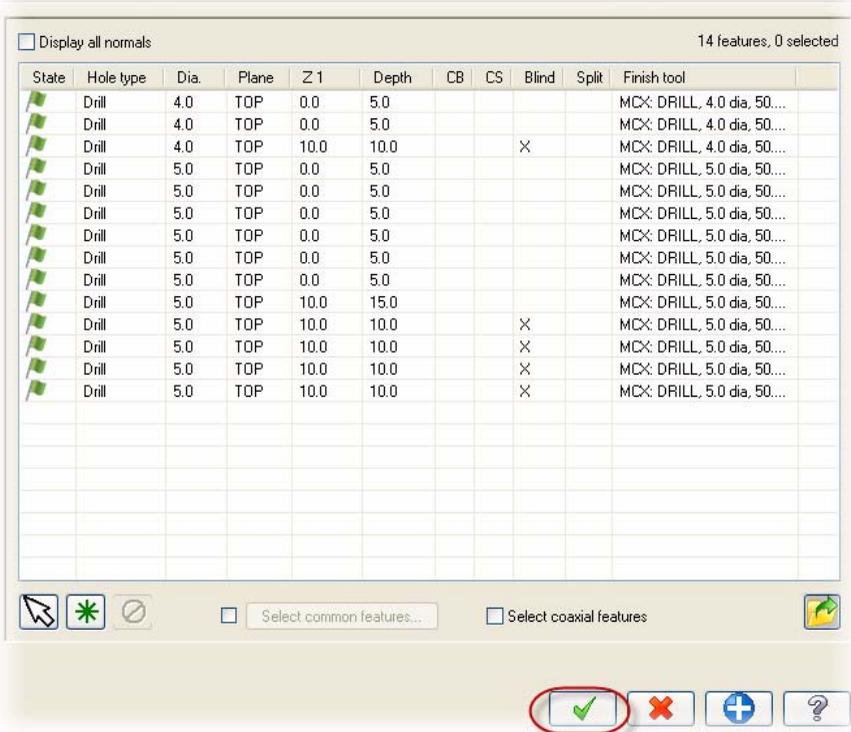
- In the top left corner of FBM Drill dialog box, click the **Detect** button. 



FBM Drill analyzes the solid model based on your selections.

When finished analyzing features, FBM Drill displays the Features page.

7 Your features list should match the following picture.

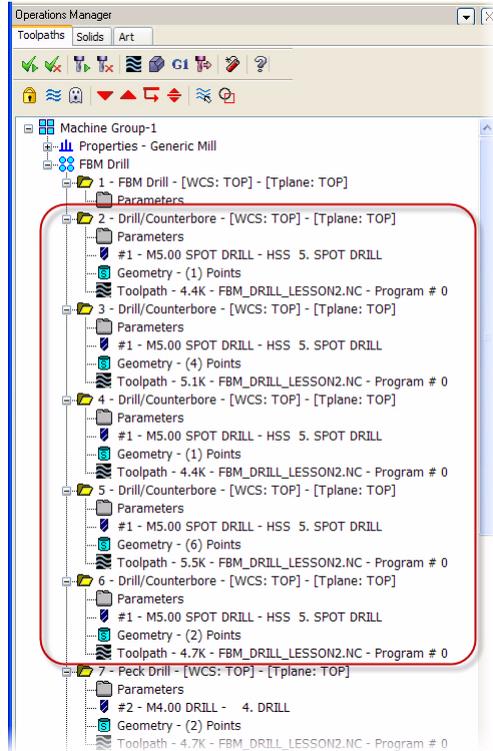


Click **OK**  in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

8 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Five spot drill operations (#2-6)
- ◆ Five finish drill operations (#7-11)

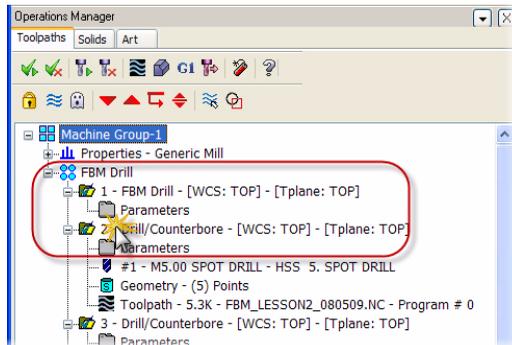


► Combine Spot Drill Cycles

1 In the Toolpath Manager, click the FBM Drill **Parameters**.

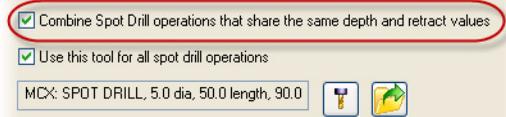
The FBM Drill dialog box opens.

2 Choose **Spot Drilling** in the Tree View pane.

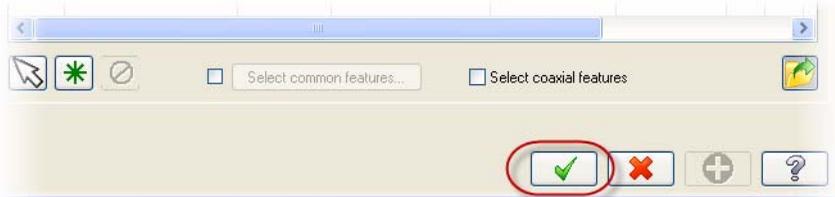


3 In the Spot Drilling page, select the option to **Combine Spot Drill operations that share the same depth and retract values**.

This option lets FBM Drill combine spot drill operations that share the same values for the following set of parameters:



- ◆ View number
 - ◆ Tool
 - ◆ Clearance modes (on/off and abs/inc), and clearance value
 - ◆ Retract mode (abs/inc), and retract value
 - ◆ Depth mode (abs/inc), and depth value
- 4 Click **OK** to accept the changed parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

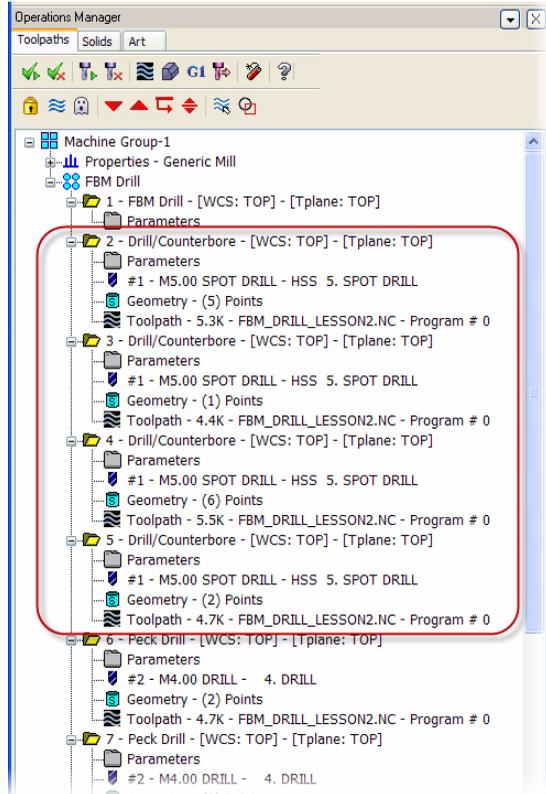
- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button.



Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

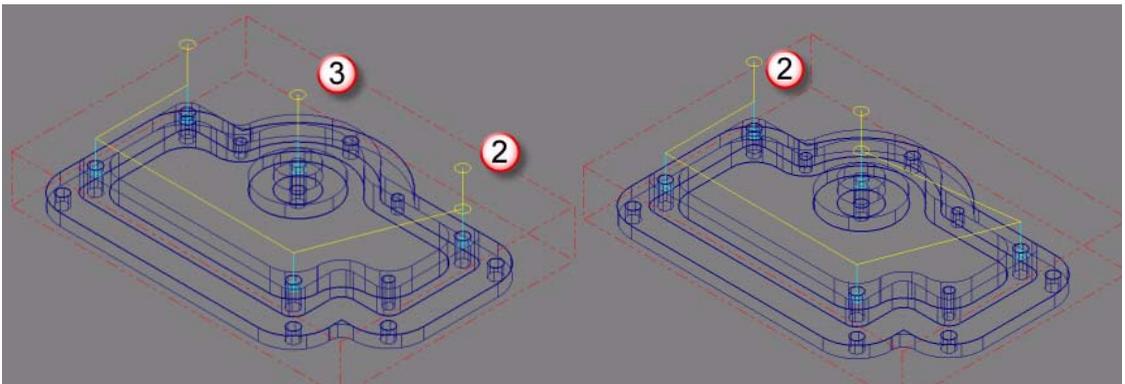
2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four spot drill operations (#2-5)
- ◆ Five finish drill operations (#6-10)



FBM Drill combined the Ø5.0mm spot drill operations that were numbered 2 and 3 in Step 8 on page 52 into a single operation here (#2) because they share the same depth and retract values.

The following pictures show the backplot of the spot drill operations for these holes, before combining them (#2 and #3) and after (#2).



3 Choose **File, Save As.**

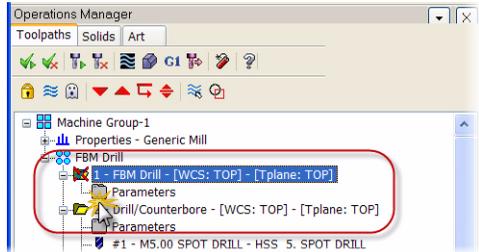
- 4 In the Save As dialog box, do the following:
 - a Add your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON2_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise.

Exercise 2: Adding Pre-drill Cycles

This exercise teaches how to configure pre-drill cycles for your FBM Drill operation. You learn how to include/exclude pre-drill cycles based on tool definitions, and to set a minimum tool diameter requirement for pre-drilling cycles.

► Define Pre-drill Cycles

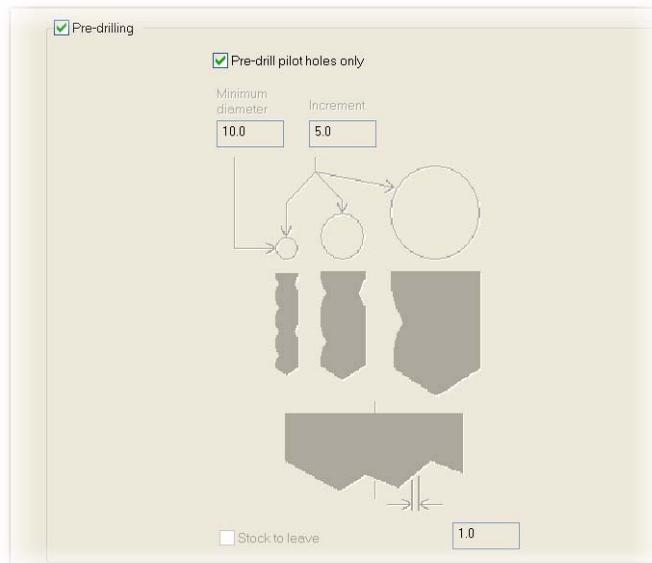
- 1 Open the MCX part file you saved on page 54 in Exercise 1—for example, FBM_DRILL_LESSON2_[your initials].MCX.
- 2 In the Toolpath Manager, click the FBM Drill **Parameters**.



The FBM Drill dialog box opens.

- 3 Choose **Pre-drilling** in the Tree View pane.

The Pre-drilling parameters display.



Pre-drilling is activated by default (**Pre-drilling** is selected). The option to **Pre-drill Pilot holes only** is also selected.

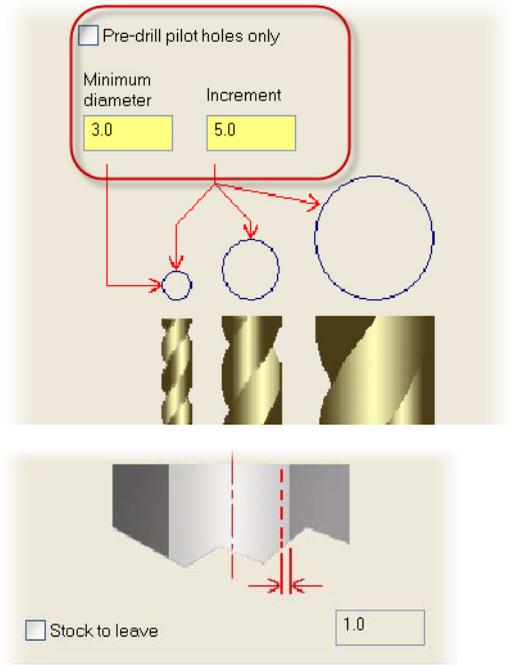
*Notes: When selected, **Pre-drill Pilot holes only** suppresses pre-drill roughing cycles except for finish drill cycles that use tools with defined pilot hole requirements. If the assigned finish tool has a pilot hole requirement in its tool definition (as shown in the following picture), FBM Drill will create a pre-drill cycle for it.*

Drill	Type	Parameters	
Peck 1 (%dia)	30.0	Dwell	0.0
Peck 2 (%dia)	0.0	Chip break (%dia)	15.0
Peck clearance (%)	15.0	Cycle	Peck Drill
Required pilot dia.	1.5	Material	HSS
Dia. offset number	3	Spindle rotation	<input checked="" type="radio"/> CW <input type="radio"/> CCW
Length offset number	3	Coolant...	
Feed rate	1833.36	<input type="checkbox"/> Inch Values	
Plunge rate	1833.36	Tool file name	C:\MCAM\4\MILL\TOOLS\DRILL Select...
Retract rate	1833.36	Tool name	3. DRILL
Spindle speed	7639	Manufacturer's tool code	
Number of flutes	2	Chuck	
% of matl. cutting speed	25.0		
% of matl. feed per rev.	25.0		

- Selecting **Pre-drill Pilot holes only** also deactivates the other parameters on the Pre-drilling page for setting minimum tool diameter and increment, and stock to leave on walls.
- No pre-drill cycles were generated when we used this part in Exercise 1, "Adding Spot Drill Cycles". Although **Pre-drill Pilot holes only** was selected for that FBM Drill operation, no pilot hole requirements were defined in any of the tools assigned to its finish drill cycles.

- 4 Deselect **Pre-drill Pilot holes only**.
- 5 Type **3.0** in the **Minimum diameter** field.

FBM Drill will not assign a tool with a diameter smaller than 3.0mm to the pre-drill cycles it generates.



*Note: Do not select **Stock to leave**. If selected, FBM Drill leaves the specified amount of stock on the walls after the pre-drill cycles are complete.*

- 6 Click **OK** to accept the changed parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

The FBM Drill dialog box closes.

2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four spot drill operations (#2-5)
- ◆ Three pre-drill operations (#6-8)
- ◆ Five finish drill operations (#9-13)

Note: FBM Drill assigned $\varnothing 3.0\text{mm}$ drills to all of the pre-drill cycles.

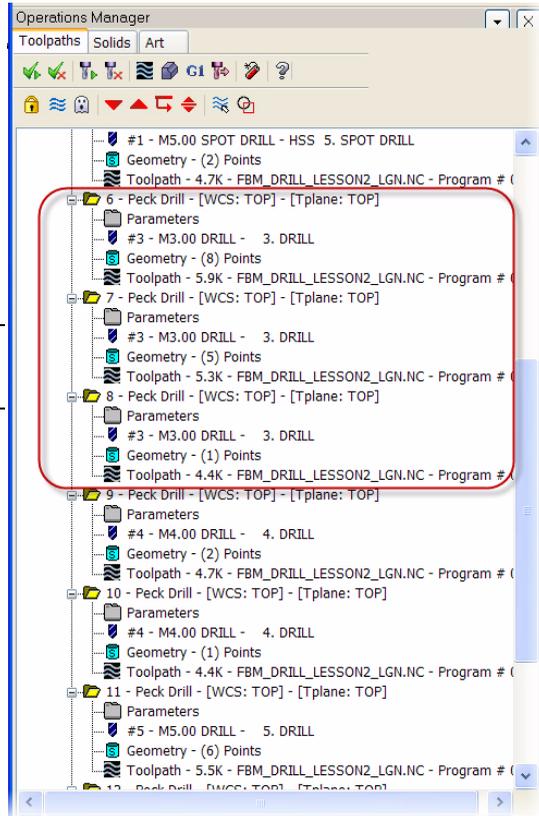
3 Choose **File, Save As**.

4 In the Save As dialog box, do the following:

a Add **EX2** to the tutorial part **File name**—for example:

FBM_DRILL_LESSON2_EX2_[your initials].MCX

b Click **OK** to save the file. This completes the exercise.



Exercise 3: Configuring Cycles for Deep Drilling

Deep drilling is typically defined as hole depths that are at least three times greater than the tool diameter. In this exercise, you set deep drilling requirements for the FBM Drill operation and review available parameters.

Note: This exercise uses an MCX part file provided with the tutorial, FBM_DRILL_LESSON2_EX3.MCX. It does not use the file you saved in the previous exercise.

► Identify Holes for Deep Drilling

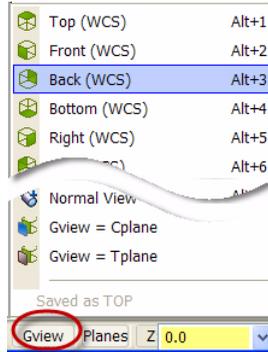
1 From the Mastercam menu, choose **File, Open**.

2 In the Open dialog box:

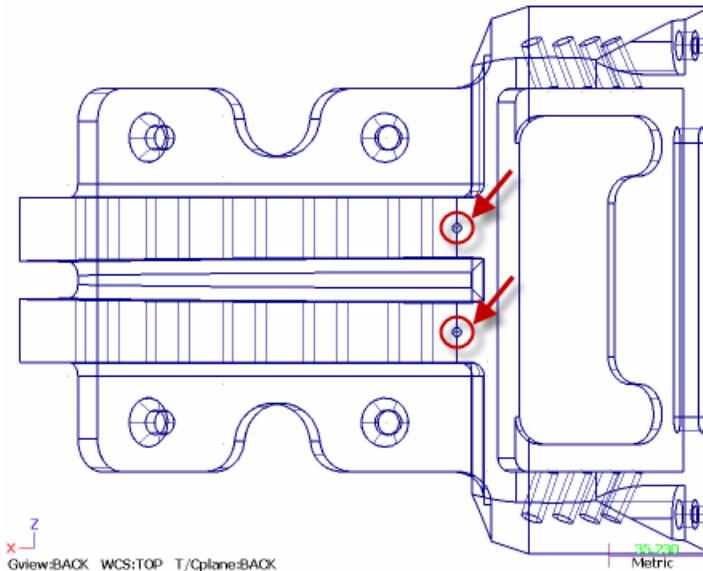
a Open the tutorial part: FBM_DRILL_LESSON2_EX3.MCX.

b Click **OK**.

- 3 From the Status bar **Gview** menu, choose **Back (WCS)**.

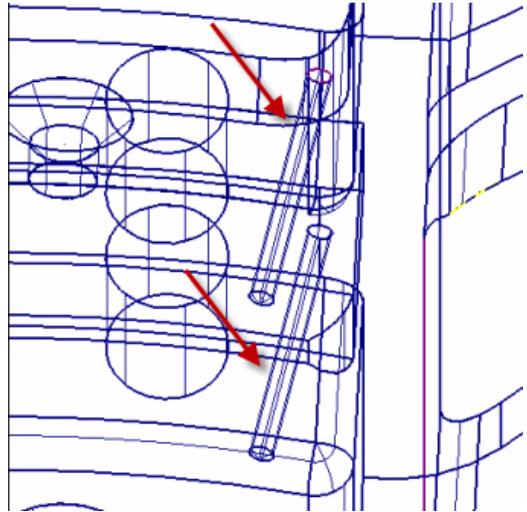


- 4 Fit the part to the screen,  and then change your shade settings to **Wireframe**.  Your part should look similar to the following picture:



The markups in the sample picture identify the two $\text{Ø}3.3\text{mm}$ holes in the model that are defined as deep holes.

- 5 Rotate the part and zoom in to get a better view of the depth of the Ø3.3mm holes.



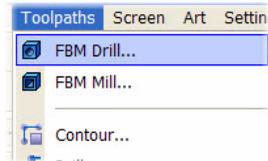
► Create the FBM Drill Operation

- 1 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

This creates a Machine Group in the Toolpath Manager.

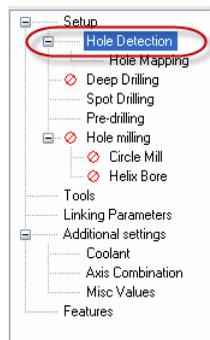
- 2 Choose **Toolpaths, FBM Drill**.

If the FBM Drill dialog box opens to the Setup page parameters, do not modify them.



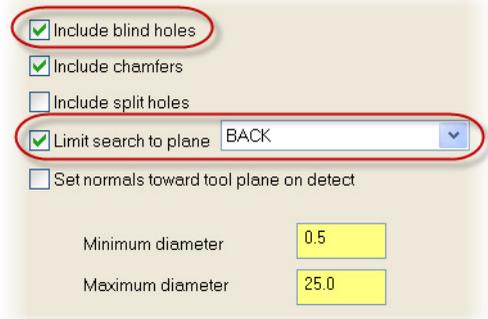
- 3 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.



4 In the Hole Detection page:

- a Make sure that **Include blind holes** is selected. The two Ø3.3mm holes to isolate are blind holes.
- b Make sure that **Limit search to plane** is selected, and then choose **BACK** from the drop-down list.



*Note: Settings for **Include chamfers**, **Include split holes**, and **Machine co-axial holes with gaps** do not affect detection for this exercise.*

5 Choose **Deep drilling** in the Tree View pane.

The Deep drilling parameters display. The default setting for this page is deactivated (the **Deep drilling** check box is unselected).



6 Select the **Deep drilling** check box to activate the function for the FBM Drill operation, and to make available the parameters on the page.

Notes:

- *A single hole may have pre-drilling cycles that qualify for deep drilling, and final drill cycles that do not. In this situation, Mastercam utilizes deep drilling parameters only for the hole's pre-drill cycles.*
 - *If deep drilling is deactivated, FBM Drill attempts to use the shortest tool possible for all holes to reduce flex or deflection, and applies normal drilling strategies.*
-

7 In the Deep drilling page, enter the following additional settings:



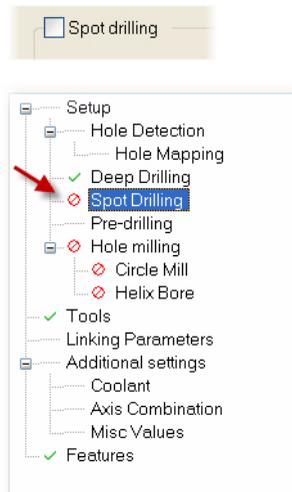
- a Set the length-to-depth ratio (**L/D**) to **8.0**. FBM Drill uses the deep drilling parameters when the ratio of the hole length to its diameter is greater than the specified L/D value.
- b From the drop-down list, choose **Cut entire hole with long drill**. (These options are explained in **About FBM Deep Drilling Strategies** on page 65.)
- c Verify that the **Deep drilling cycle** is set to **Chip Break**.

8 Choose **Spot drilling** in the Tree View pane.

The Spot drilling page displays.

9 Deselect the **Spot drilling** check box to disable these cycles in the FBM Drill operation.

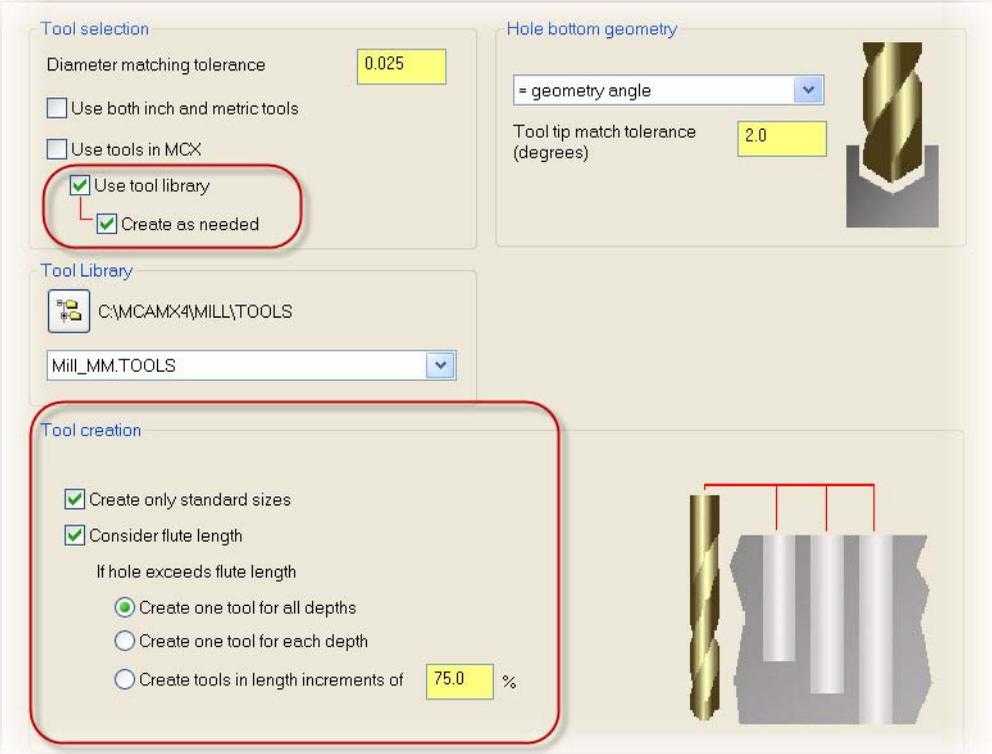
The Spot drilling page status changes to disabled in the Tree View pane.



10 Choose **Tools** in the Tree View pane.

The Tools page displays.

11 In the Tools page, enter the following settings:



- a Select **Use tool library** and verify that the selected library is **Mill_MM.TOOLS**.
- b Select **Create as needed**.
- c Select **Create only standard sizes**.
- d Select **Consider flute length**.
- e Select **Create one tool for all depths**.

12 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

FBM Drill analyzes the solid model based on your selections.

When finished analyzing features, FBM Drill displays the Features page.

13 Your features list should match the following picture.

Display all normals 2 features, 0 selected

St...	Hole type	Dia.	Plane	Z 1	Depth	C.	C.	B...	S...	Finish tool
	Drill	3.3	BACK	-100.12737497	34.87...			X		MCX: DRILL, 3.3 dia, 122.45039394 length, 118.0 tip angle
	Drill	3.3	BACK	-100.12737497	34.87...			X		MCX: DRILL, 3.3 dia, ...

The icon  in the Features page indicates that the features can be machined with the assigned tool.



TIP: The Features page picture shows how the assigned tool information displays when the mouse hovers over the **Finish tool** column.

For this operation, FBM Drill creates a custom Ø3.3mm drill 122.0mm long to drill the deep holes in a single drill cycle.

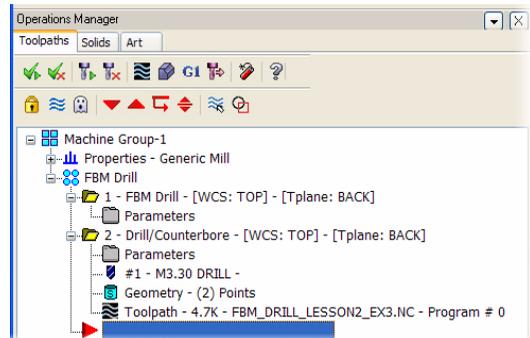
Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features with the assigned tool.

Note: You learn more about adding and modifying tool assignments in Lesson 4, “Assigning Tools” on page 81.

14 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One drill cycle to drill both Ø3.3mm holes in the BACK plane (#2)



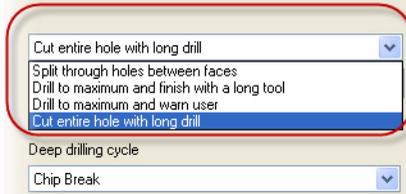
► Save the FBM Drill Operation and its Toolpaths

- 1** Choose **File, Save As**.
- 2** In the Save As dialog box, do the following:
 - a** Add your initials to the tutorial part name, for example:
FBM_DRILL_LESSON2_EX3_LGN.MCX
- 3** Click **OK** to save the file.

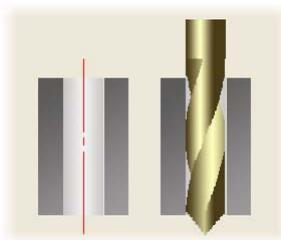
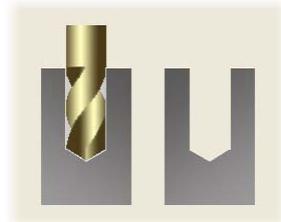
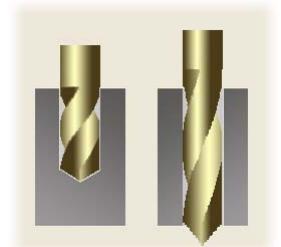
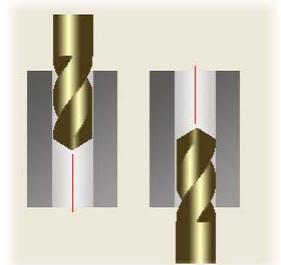
This completes the exercise.

About FBM Deep Drilling Strategies

The Deep drilling page offers the following deep drilling strategies to choose from:



- **Split through holes between faces**—Uses a shorter tool to drill through holes by approaching them from both faces. The Primary face depth percentage field lets you set the maximum amount of the hole to drill from the primary face (the face where the hole was defined). The percentage you enter also determines the minimum length of the tool used. For example, a value of 75% means that Mastercam drills 75% of the hole from the primary face and the remaining 25% from the secondary face.
- **Drill to maximum and finish with a long tool**—First drills as much of the hole as possible with the shortest tool. Then finishes the hole with longer tools utilizing the deep drilling cycle. This strategy may use several tools in an effort to maintain rigidity.
- **Drill to maximum and warn user**—Mastercam does not completely drill the hole and displays a warning in the Features page.
- **Cut entire hole with long drill**—Uses only one long drill for the entire drilling cycle.



IMPORTANT: Mastercam applies an automatic overlap to all through holes based on the additional break-through and tip compensation settings you define in the Linking Parameters page. You learn about this in Lesson 5 on page 117.

Skills Challenge

Congratulations! You have completed Lesson 2, “Adding Drill Cycle Operations”.

As a challenge to the skills you learned in this lesson, try one or more of the following exercise suggestions.

Using any of the files you saved in this lesson:

- Backplot the toolpaths.
- Modify the FBM Drill parameters to add or remove one or more types of drill cycles covered in this lesson (spot, pre-drill, and deep drill). Then regenerate the toolpaths and view the results in the Toolpath Manager. How did they change? Do you understand the change?

Using the file you saved in Exercise 3 on page 64:

- 1** Modify the Deep drilling strategy.
- 2** Regenerate the FBM Drill operation in the Toolpath Manager and view the results.
- 3** Think about how the hole L/D ratio, stock material, and available tools influence which deep drilling strategies are best for specific parts. Could you develop a few best practices based on your conclusions?

Adding Hole Milling Operations

In this lesson, you configure FBM Drill to generate large hole milling operations in addition to drill cycles. This technique solves the problem of machining holes larger in diameter than your available drills. It is also useful for creating flat-bottom holes without using mill tools with drilling cycles.

The Hole Milling parameters you define tell FBM Drill when to switch from generating a drill cycle to a hole milling toolpath, and whether to generate Circle Mill or Helix Bore toolpaths when hole milling is required.

Lesson Goals

- Use FBM Drill to generate Circle Mill hole milling toolpaths in addition to drilling cycles.
- Change the FBM Drill operation parameters to remove pre-drill cycles for Circle Mill toolpaths.
- Change the FBM Drill operation parameters to create Helix Bore toolpaths instead of Circle Mill toolpaths for large hole features.

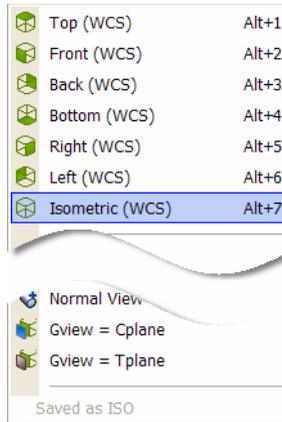
Exercise 1: Activating FBM Drill Hole Milling

This exercise teaches how to create FBM Drill-generated hole milling toolpaths in addition to drill cycles. You activate hole milling parameters, define large hole criteria, and configure Circle Mill toolpath parameters for the large holes you want milled.

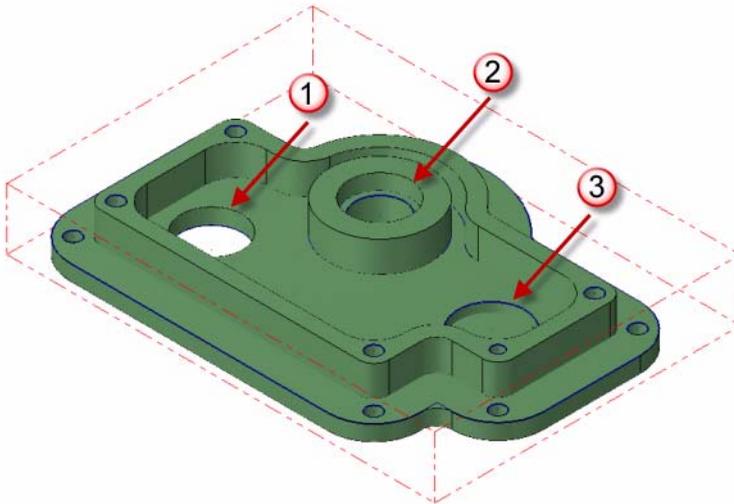
► Identify Large Holes to Mill

- 1 From the Mastercam menu, choose **File, Open**.
- 2 In the Open dialog box:
 - a Open the tutorial part file: FBM_DRILL_LESSON3.MCX.
 - b Click **OK**. 

3 From the Status bar **Gview** menu, choose **Isometric (WCS)**.



4 Fit the part to the screen  and shade it.  Your part should look similar to the following picture:

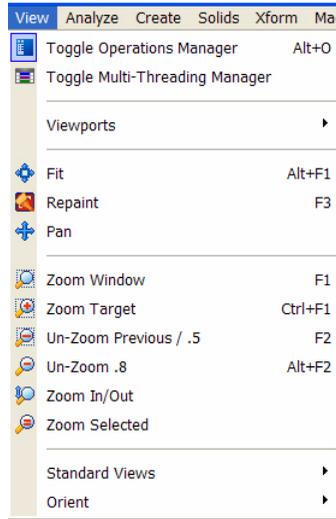


The numbers in the sample picture identify the three large hole features in the model.

- 5 Use functions in the **View** menu to dynamically rotate, spin, and pan the part in the graphics window to examine its features.



TIP: Switch to **Wireframe** shade settings to get a better view of the hole features in the model.



- 6 Use the Analyze Dynamic function demonstrated in Lesson 1, “Working with Solid Models and FBM Drill” to measure the large hole diameters.

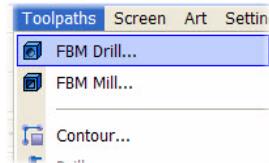
The hole features—as they are numbered in Step 4’s illustration—are defined in the part specification as follows:

- 1 Ø20.0mm through hole
- 2 Ø20.0mm counterbore hole with a Ø16 .0mm through hole
- 3 Ø22.0mm blind flat-bottom hole

► Create the FBM Drill Operation

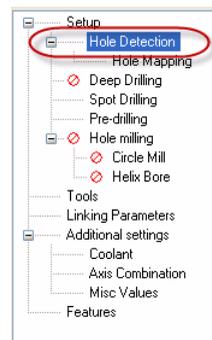
- 1 Choose **Toolpaths, FBM Drill**.

If the FBM Drill dialog box opens to the Setup page parameters, do not modify them.

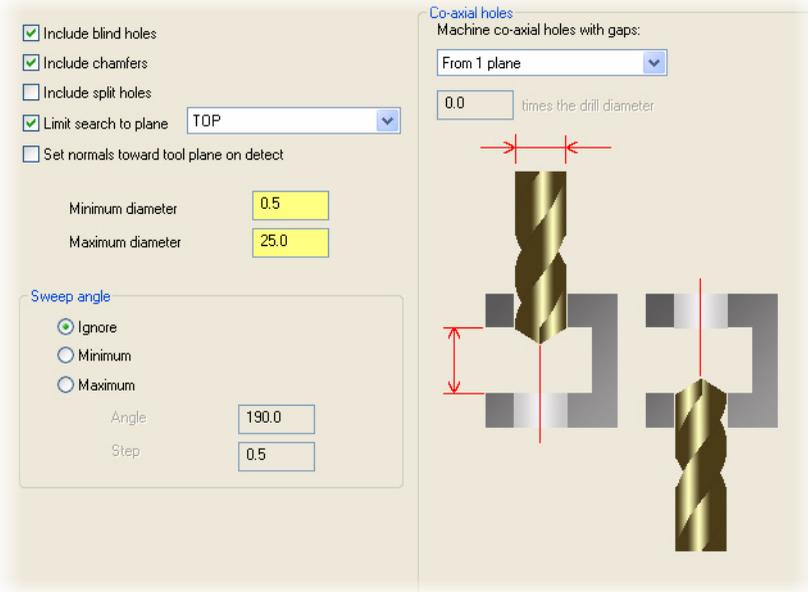


- 2 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.



3 In the Hole Detection page, make sure that your parameters match the following picture:



4 Choose **Pre-drilling** in the Tree View pane.

The Pre-drilling parameters display.

The Pre-drilling page is activated by default (**Pre-drilling** is selected). The option to **Pre-drill Pilot holes only** is also selected.

5 Make the following changes in the Pre-drilling page:

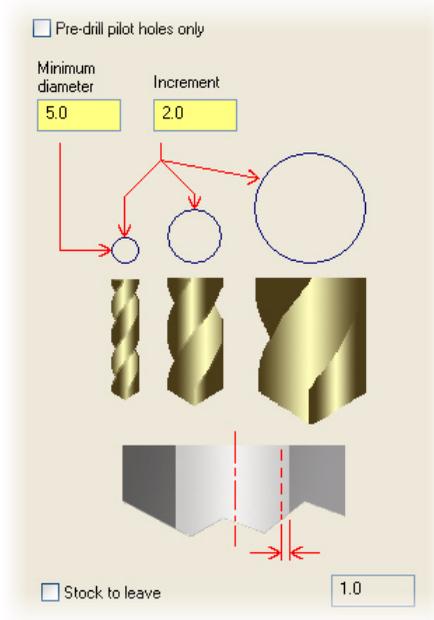
a Deselect **Pre-drill Pilot holes only**.

b Enter **5.0** in the **Minimum diameter** field.

This value defines the smallest size tool to use in pre-drill cycles.

c Enter **2.0** as the pre-drill tool **Increment**. FBM Drill will assign pre-drill tools in 2.0mm increments.

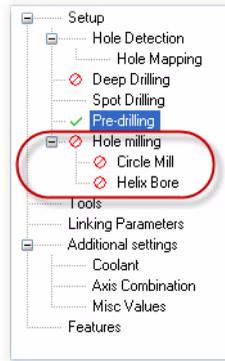
d Do not select **Stock to leave**.



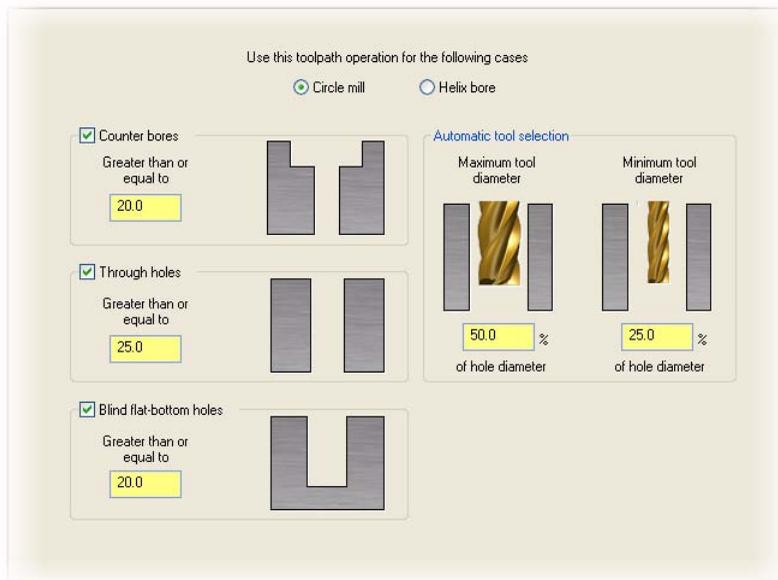
6 Choose **Hole milling** in the Tree View pane.

By default, the page and its subpages (Circle Mill and Helix Bore) are deactivated.

The Hole milling parameters display.



7 In the Hole milling page, select the **Counter bores**, **Through holes**, and **Blind flat-bottom holes** check boxes.



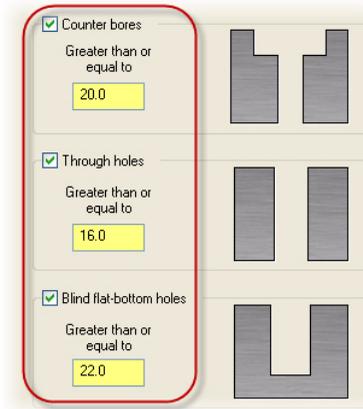
This activates the Hole milling parameters and enables FBM Drill to generate hole milling toolpaths.



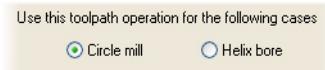
TIP: To activate the Hole milling page and the ability to generate hole milling toolpaths, you must choose at least one of the hole type check boxes (Counter bores, Through holes, or Blind flat-bottom holes).

8 Enter the following values to define minimum diameter hole milling requirements for each selected hole type:

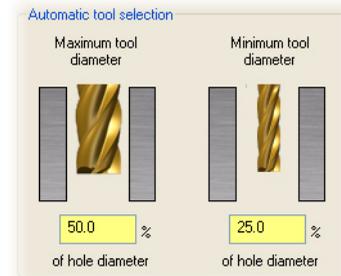
- a Counter bores: **20.0**
- b Through holes: **16.0**
- c Blind flat-bottom holes: **22.0**



d Leave the milling toolpath type setting as **Circle mill**.



e Leave the default **Automatic tool selection** settings as shown. Mastercam considers only tools that fall within the specified range when selecting tools for hole milling.



A green check mark displays next to the Hole milling page in the Tree View pane, indicating a change in its parameters.



The Circle Mill parameters subpage is available because:

- ◆ Hole milling is now active.
- ◆ Circle Mill is the toolpath type defined in the Hole milling page.

9 Choose **Circle Mill** in the Tree View pane.

The Circle Mill parameters page displays.

These parameters define Circle Mill roughing and finishing passes, and set toolpath parameters for stock to leave, depth cuts and entry/exit motion.

They also define the cutting method and the type of cutter compensation for your FBM Drill-generated Circle Mill toolpaths.

Accept the defaults. The purpose of this step is to show where to make any changes necessary for your specific application.



IMPORTANT:

- You can also customize FBM Drill-generated toolpaths by accessing their parameters from the Toolpath Manager before posting.
- If you customize FBM-generated toolpaths, do so only when you are sure that you will not regenerate the FBM parent operation.
- Regenerating the FBM parent operation creates all new toolpaths, overwriting any customizations made from the Toolpath Manager.

10 In the top left corner of FBM Drill dialog box, click the **Detect** button.

FBM Drill analyzes the solid model based on your selections.

When finished analyzing features, FBM Drill displays the Features page.

11 Your features list should match the following picture:

Display all normals 17 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	4.0	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0...
	Drill	4.0	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0...
	Drill	4.0	TOP	10.0	10.0			X		MCX: DRILL, 4.0 dia, 50.0...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	10.0	10.0			X		MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	10.0	10.0			X		MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	10.0	10.0			X		MCX: DRILL, 5.0 dia, 50.0...
	Drill	5.0	TOP	10.0	10.0			X		MCX: DRILL, 5.0 dia, 50.0...
	Circle mill	16.0	TOP	5.0	10.0					MCX: ENDMILL1 FLAT, 8...
	Circle mill	20.0	TOP	0.0	5.0					MCX: ENDMILL1 FLAT, 8...
	Circle mill	20.0	TOP	10.0	5.0	X		X		MCX: ENDMILL1 FLAT, 8...
	Circle mill	22.0	TOP	0.0	3.0	X		X		MCX: ENDMILL1 FLAT, 8...

Select common features... Select coaxial features

FBM Drill detects four features that meet the large hole criteria you defined. Their hole type in the Features page list is set to **Circle mill**. FBM Drill assigns flat endmills to the Circle Mill hole types.

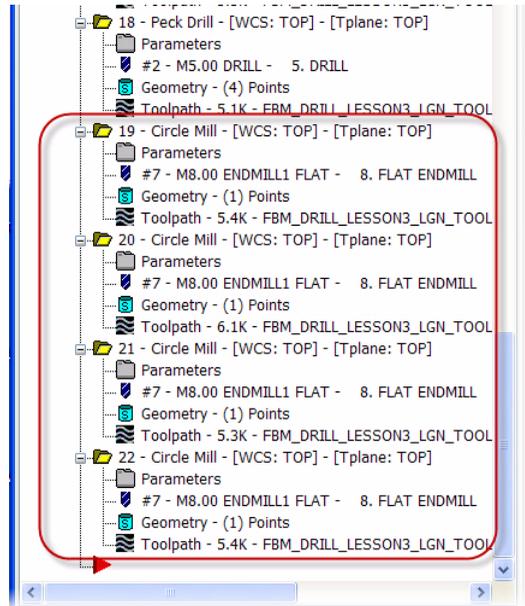
Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

12 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Seven spot drill operations (#2-8)
- ◆ Ten pre-drill and finish drill operations (#9-18)
- ◆ Four Circle Mill toolpaths (#19-22)

For each of the large hole features, FBM Drill creates one spot drill operation and two pre-drill operations.



► Backplot All Operations for Large Hole Features

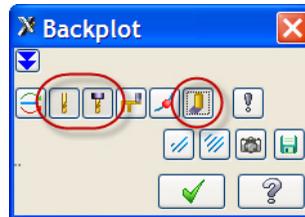
1 In the Toolpath Manager list, use the [Ctrl+Click] method to select the toolpaths numbered 4-6 (spot drills), 9-14 (pre-drills), and 19-22 (Circle Mill toolpaths).

2 In the Toolpath Manager, click the **Backplot selected operations** button. 

The Backplot dialog box and Backplot VCR bar open.

3 In the Backplot dialog box, select the **Display tool**, **Display holder**, and **Quick verify** buttons.

These options display a simulation of a tool and holder during backplot, and shade the toolpath.



4 Use the buttons and sliders on the Backplot VCR bar to backplot the operations.



Click **Play**  to begin the backplotting action.

5 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.

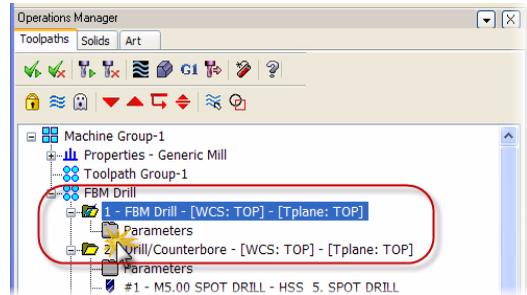
► Remove Pre-drill Cycles for the Circle Mill Toolpaths

- 1 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.

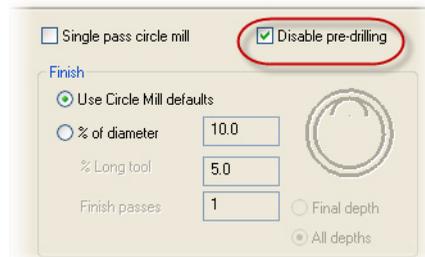
- 2 Choose **Circle mill** in the Tree View Pane.

The Circle Mill parameters page displays.



- 3 Select **Disable pre-drilling**.

This suppresses spot drill and pre-drill operations for large hole features that will be circle milled.



- 4 Click **OK**  in the FBM Drill dialog box to accept your changes.

- 5 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

- 6 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four spot drill operations (#2-5)
- ◆ Four drill operations (#6-9)
- ◆ Four Circle Mill operations (#10-13)

- 7 Backplot all operations to verify that no spot drill or pre-drill operations exist for holes machined by the Circle Mill toolpaths.

► Save the Part File

- 1 Choose **File, Save As**.

- 2 In the Save As dialog box, do the following:

- a Add **EX1** and your initials to the tutorial part **File name**—for example:

FBM_DRILL_LESSON3_EX1_[your initials].MCX

- b Click **OK** to save the file. This completes the exercise.

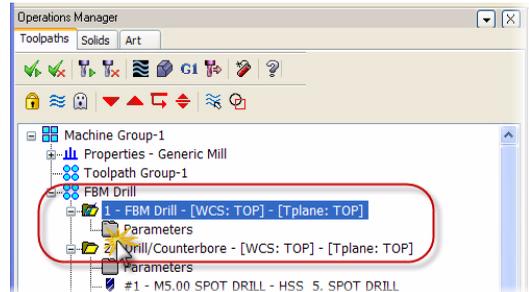
Exercise 2: Changing the Hole Milling Toolpath Type

In this exercise, you learn to change the type of hole milling toolpaths FBM Drill generates.

- 1 Open the MCX part file you saved on page 76 in Exercise 1—for example, FBM_DRILL_LESSON3_EX1_[your initials].MCX.
- 2 In the Toolpath Manager, click the FBM Drill **Parameters**.

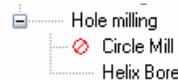
The FBM Drill dialog box opens.

- 3 Choose **Hole Milling** in the Tree View pane.



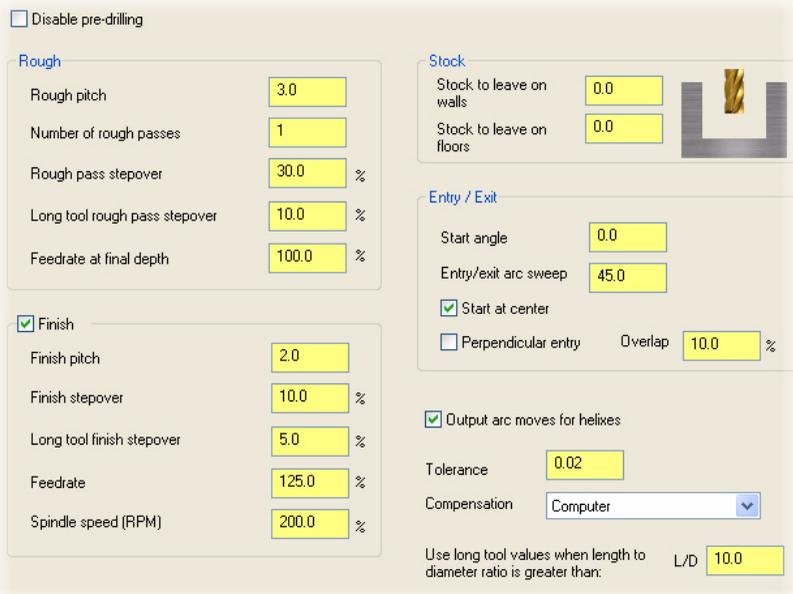
- 4 Choose **Helix bore** as the hole milling toolpath type.

In the Tree View pane, FBM Drill deactivates the Circle Mill subpage. The Helix Bore subpage is available.



- 5 Choose **Helix Bore** in the Tree View pane.

The Helix Bore parameters page displays.



These parameters define roughing and finishing passes, and the cutting parameters and compensation options for the Helix Bore toolpaths that FBM Drill generates.

The **Finish** check box makes it easy to activate/de-activate the finish pass options. Typically, if you use this option, you would set the **Stock to leave** values to 0.

You can also set feed rate overrides separately for each type of cut (rough and finish).

6 Select **Disable pre-drilling**.



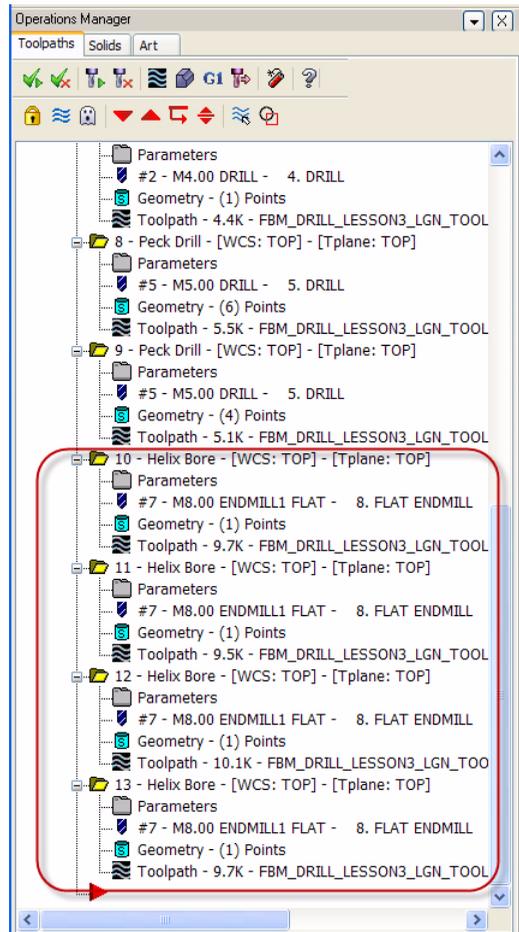
7 Click **OK**  in the FBM Drill dialog box to accept your changes.

8 In the Toolpath Manager, the FBM Drill operation is marked “dirty” because you modified its parameters. Click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

9 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four spot drill operations (#2-5)
- ◆ Four drill operations (#6-9)
- ◆ Four Helix Bore toolpaths (#10-13)



10 Choose **File, Save As**.

11 In the Save As dialog box, do the following:

a Change EX1 to **EX2** in the tutorial part **File name**—for example:

FBM_DRILL_LESSON3_EX2_[your initials].MCX

b Click **OK** to save the file. This completes the exercise.

Congratulations! You have completed Lesson 3, “Adding Hole Milling Operations”.

Assigning Tools

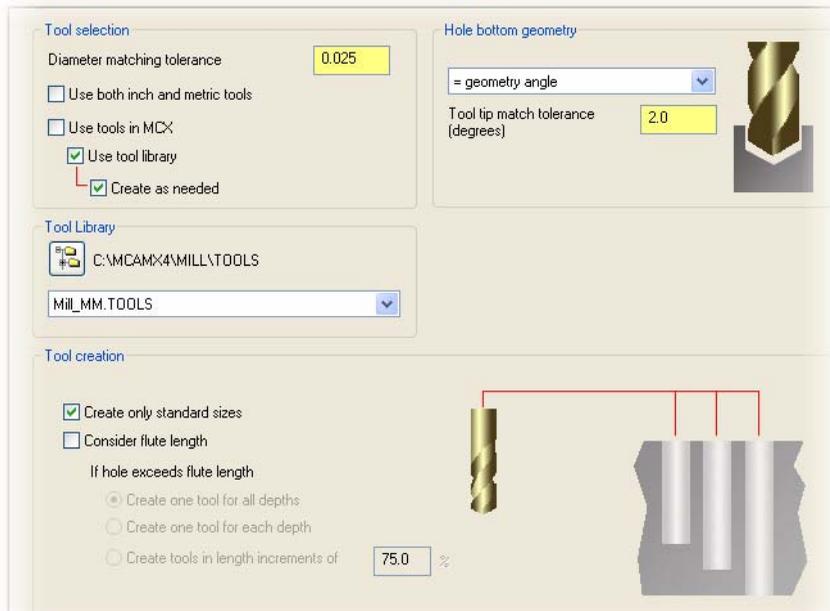
In this lesson you manage FBM Drill's automatic tool assignment using options in the Tools page and in the Hole Mapping page. These options control the tool sources FBM Drill can access, and the tools it selects or creates for detected features. You also override automatic tool assignment by manually assigning tools in the Features page.

Lesson Goals

- Review FBM Drill's tool source and tool selection hierarchy.
- Choose a tool library for an FBM Drill operation.
- Use the Features page to change automatic tool assignments, including a standard tool that FBM Drill creates.
- Activate hole mapping for an FBM Drill operation, load and then modify a MAP file.
- Add a custom tool to the FBM Drill standard tools table file, and then use it in an FBM Drill operation.

Tool Sources

In the Tools page, you define the tool sources available to the FBM Drill operation.



You can use tools already in the Mastercam part file and tools in a selected tool library. You can also allow Mastercam to create standard- or custom-sized tools when necessary, based on the parameters you define.

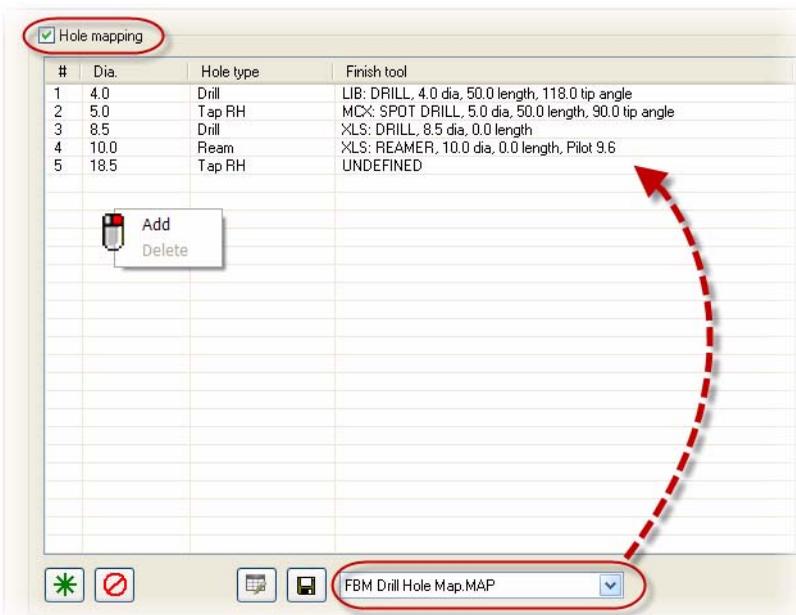
FBM Drill accesses a special tool table file installed in the Mastercam \common\FBM folder when creating tools. The file is formatted as a Microsoft Excel spreadsheet (FbmToolTable.XLS) and, for workstations that do not include Excel, a comma-delimited file (FbmToolTable.CSV) is also provided.

Note: You can customize the FBM tool table files by editing them in Excel or in a text editor. However, they should be synchronized, and they must retain their default installed names, format, and paths. Mastercam may be open during your tool table file editing session. However, you must restart Mastercam for your changes to take effect. You learn more about this in Exercise 4, “Customizing FBM Drill’s Standard Tool Table” on page 103.

Hole Mapping

A hole mapping file is a simple customizable data file that associates a diameter and hole type combination with a specific tool. You activate FBM Drill’s hole mapping feature in the Hole Mapping page. When you activate the Hole mapping feature/page, you can create, edit, or load a hole mapping file for use in the current FBM Drill operation.

FBM Drill uses data in the selected hole mapping file (MAP) to automatically assign specific tools to specific hole features (as defined by a combination of diameter and hole type).



FBM Drill Tool Selection

Tool selection can be limited to any combination of the following sources (shown here in hierarchical order):

- 1 Tools from an activated hole mapping file (MAP).
- 2 Tools assigned to spot drills in the FBM Drill operation.
(You learned about this in Lesson 2, “Adding Drill Cycle Operations” on page 45.)
- 3 Tools defined in the Mastercam part file. (MCX)
- 4 Tools in a selected tool library (TOOLS).
- 5 Standard- or custom-sized tools that FBM Drill creates by referencing the standard tools table (XLS/CSV).

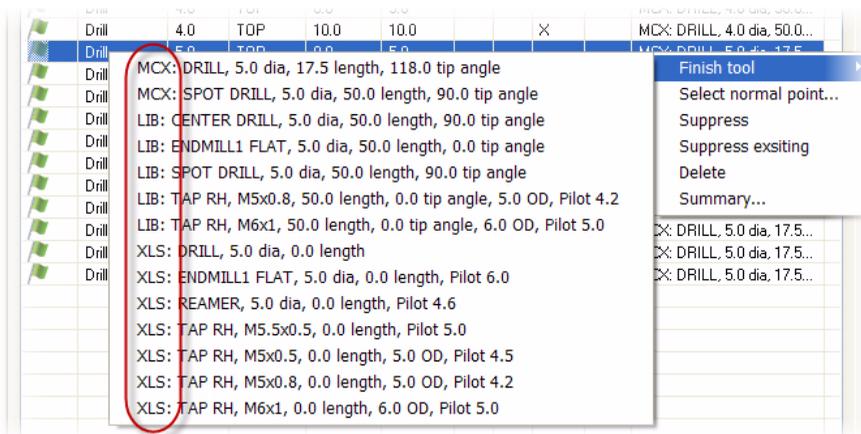


TIPS:

- In the Tools page, red lines connecting the tool source check boxes show the hierarchical order in which Mastercam searches for tools to assign. It assigns the first suitable tool it finds.



- The Features page Finish tool column and its right-click menu option lists tools with a prefix. The prefix identifies the tool source—**MCX** (Mastercam part file), **LIB** (selected tool library), and **XLS** (created using FBM Drill’s standard tool table file).



When assigning tools, FBM Drill attempts to match the hole diameter with the closest sized tool, using the tool sources and parameters you define. If the hole diameter does not match the diameter

of any available tool, FBM assigns the next *smallest* tool. However, this does not guarantee that the hole can be successfully machined and that all material will be removed.

Note: FBM assigns a tool larger than the defined hole diameter only when the hole size matches the tool's pilot hole diameter.

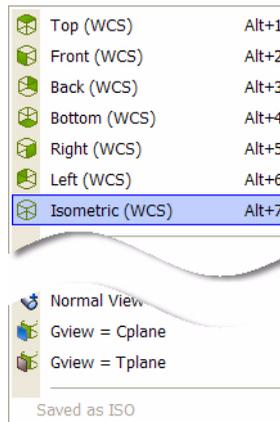
Exercise 1: Selecting a Tool Library

In this exercise, you create an FBM Drill operation and limit FBM Drill tool selection to a specified tool library.

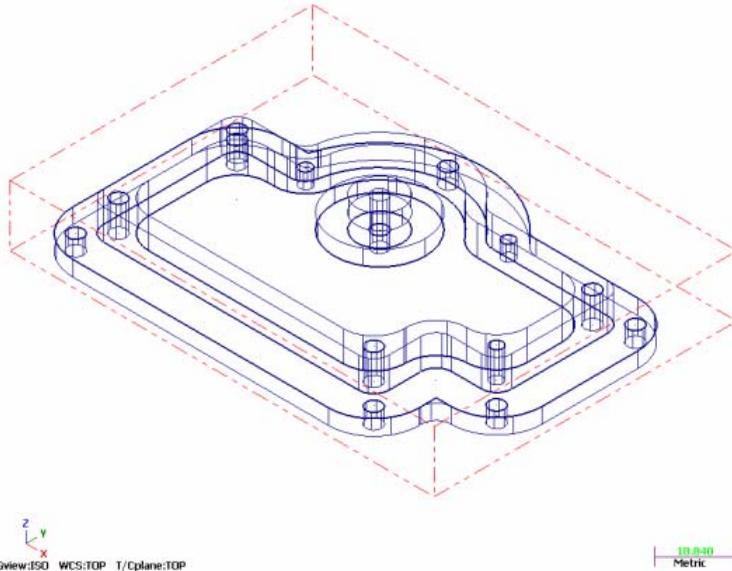
- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: FBM_DRILL_LESSON2.MCX.

Note: This is the same file used in Lesson 2 (page 45).

- 3 From the Status bar **Gview** menu, choose **Isometric (WCS)**.



- 4 Fit the part to the screen,  and then change your shade settings to **Wireframe**. 
Your part should look similar to the following picture:

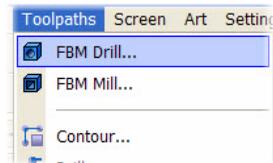


- 5 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

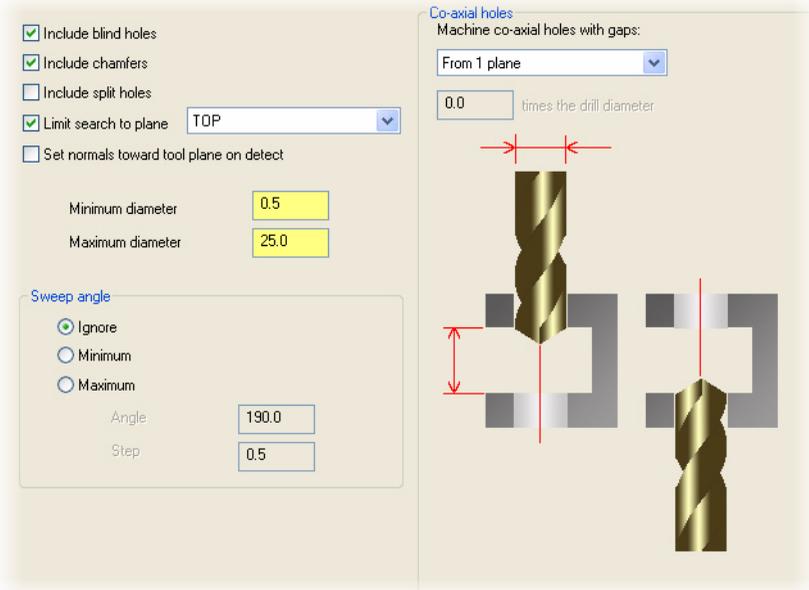
This creates a Machine Group in the Toolpath Manager.

- 6 Choose **Toolpaths, FBM Drill**.
7 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.



8 In the Hole Detection page, make sure that your parameters match the following picture:

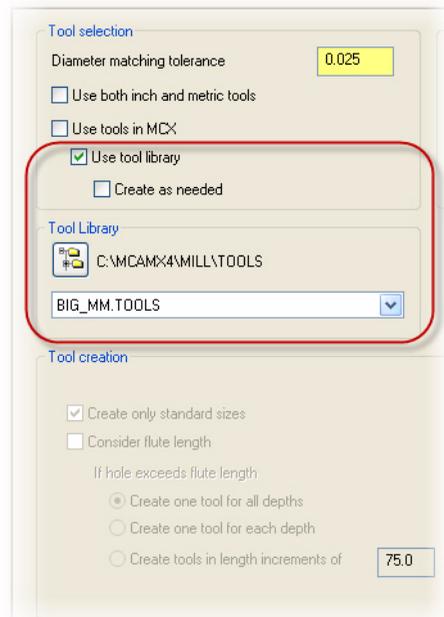


9 Choose **Tools** in the Tree View pane.

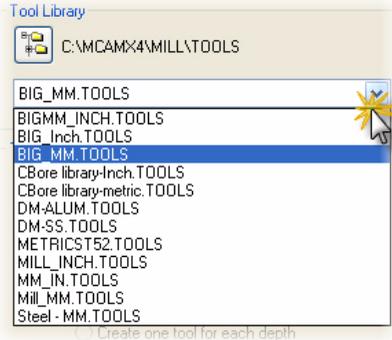
The Tools page displays.

10 In the Tools page, enter the following settings:

- a Select **Use tool library**.
- b Deselect **Create as needed**.



- c Choose **BIG_MM.TOOLS** from the Tool library drop-down list.
- d Makes sure all other options in the Tools page are deselected.



- 11 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

FBM Drill analyzes the solid model based on your selections.

When finished analyzing features, FBM Drill displays the Features page.

Your features list should match the following picture.

The screenshot shows the 'Features' page of the FBM Drill dialog box. It contains a table with 14 rows of detected features. The table has columns for State, Hole type, Dia., Plane, Z1, Depth, CB, CS, Blind, Split, and Finish tool. A red circle highlights the 'Finish tool' column, which contains the text 'LIB: DRILL, 4.0 dia, 50.0 length, ...' for each feature. The 'State' column shows green flag icons for all features.

State	Hole type	Dia.	Plane	Z1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 length, ...
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 length, ...
	Drill	4.0	TOP	10.0	10.0			X		LIB: DRILL, 4.0 dia, 50.0 length, ...
	Drill	5.0	TOP	0.0	5.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	0.0	5.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	0.0	5.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	0.0	5.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	0.0	5.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	10.0	15.0					LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	10.0	10.0			X		LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	10.0	10.0			X		LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	10.0	10.0			X		LIB: DRILL, 5.0 dia, 50.0 length, ...
	Drill	5.0	TOP	10.0	10.0			X		LIB: DRILL, 5.0 dia, 50.0 length, ...

FBM Drill detects 14 features in the model, 11 Ø5.0mm holes and three Ø4.0mm holes.

The **LIB:** prefix in the Finish tool column shows that all of the assigned tools were selected from the library you specified in the Tools page.

The icon  in the Features page indicates that the features can be machined with the assigned tools.

This completes the exercise. Please leave your screen as is, and continue with the next exercise in the lesson.

Exercise 2: Reassigning Tools in the Features Page

This exercise is a continuation of Exercise 1, “Selecting a Tool Library”. In Exercise 2, you override FBM Drill’s automatic tool selection by manually assigning tools in the Features page, including a custom tool FBM Drill creates.

Although the Features page indicates that detected features can be machined with the tools assigned in Exercise 1, there are problems with the tool assignments.

These problems are not caused by FBM Drill, nor are they caused by your tool selections. They occur because the CAD model does not provide the same information as the part specification. FBM Drill can read only the CAD model; it relies on you to read the specification so that you can make any necessary adjustments.

- The Ø5.0mm holes in the CAD model define the *minor* diameter of 6.0mm tapped holes listed in the part specification. These holes should be machined with a M6x1 tap.
- The Ø4.0mm holes in the model define reamed holes. These holes should be machined by a Ø4.0mm reamer defined with a Ø3.6mm pilot hole.

► Activate Select Common Features

- 1 At the bottom of the Features page, select the **Select common features** check box, and then click the button.



The Feature selection filter dialog box displays.

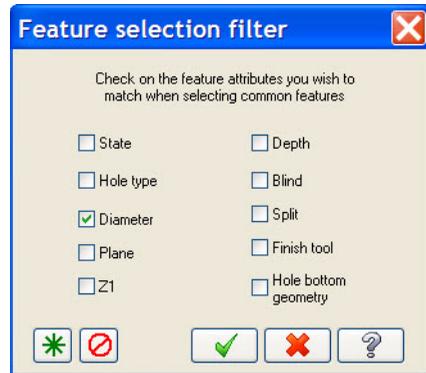
- 2 In the Feature selection filter dialog box:

a Click the **Unselect all** button. 

b Select only **Diameter**.

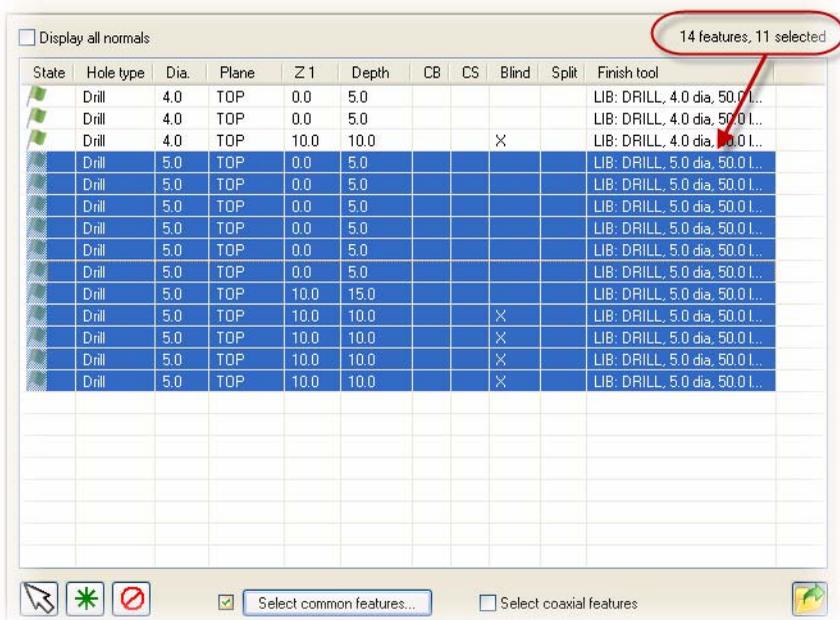
c Click **OK**.

The Feature Selection Filter dialog box closes.



► Assign a Tap to All Ø5.0mm Holes

- 1 In the Features page list, select *one* of the Ø5.0mm holes.



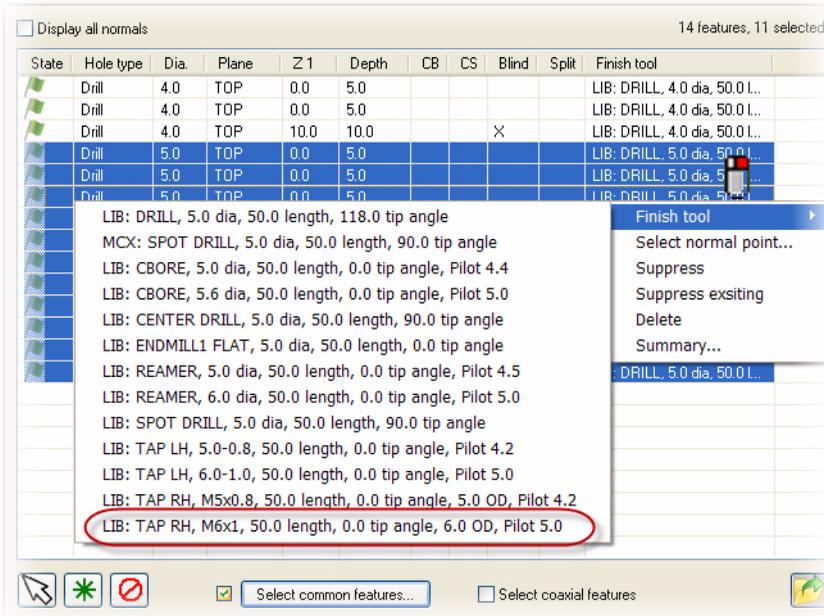
FBM Drill selects all 11 Ø5.0mm holes in the list based on your Feature selection filter settings.



TIP: Use the **Select common features** function and **Feature selection filter** dialog box to quickly select all holes in the Features page list with matching attributes. This selection technique makes it easy to review and edit features as a group using the Features page right-click menu options.

- 2 Position the cursor in the **Finish tool** column of one of the selected holes.
 - a Right-click and choose **Finish tool**.

- b Select **LIB: TAP RH, M6x1, 50.0 length, 0.0 tip angle, 6.0 OD, Pilot 5.0** from the drop-down list.



FBM Drill assigns the selected tool to all Ø5.0mm holes, and changes the Hole type to **Tap RH**.



Note: The tool FBM Drill assigns from the library is saved to the Mastercam part file (MCX). This is standard Mastercam functionality. When you select a tool for a toolpath, Mastercam copies the definition to the machine group. This allows someone without access to your tool libraries to open your part file and use it.

- 3 In the Features page list, select one of the **Ø4.0mm** holes.

FBM Drill selects all three Ø4.0mm holes in the list.

Display all normals 14 features, 3 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 l...
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 l...
	Drill	4.0	TOP	10.0	10.0			X		LIB: DRILL, 4.0 dia, 50.0 l...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0...

- 4 Position the cursor in the **Finish tool** column of one of the selected holes.
 - ◆ Right-click and choose **Finish tool**.

Display all normals 14 features, 3 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 l...
	Drill	4.0	TOP	0.0	5.0					LIB: DRILL, 4.0 dia, 50.0 l...
	Drill	4.0	TOP	10.0	10.0			X		LIB: DRILL, 4.0 dia, 50.0 l...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0...

LIB: DRILL, 4.0 dia, 50.0 length, 118.0 tip angle

LIB: CBORE, 4.0 dia, 50.0 length, 0.0 tip angle, Pilot 3.6

LIB: CBORE, 4.6 dia, 50.0 length, 0.0 tip angle, Pilot 4.0

LIB: ENDMILL1 FLAT, 4.0 dia, 50.0 length, 0.0 tip angle

LIB: REAMER, 4.0 dia, 50.0 length, 0.0 tip angle, Pilot 3.5

LIB: REAMER, 4.5 dia, 50.0 length, 0.0 tip angle, Pilot 4.0

LIB: TAP LH, 4.0-0.7, 50.0 length, 0.0 tip angle, Pilot 3.3

LIB: TAP RH, M4x0.7, 50.0 length, 0.0 tip angle, 4.0 OD, Pilot 3.3

TAP RH, M6x1, 50.0...

TAP RH, M6x1, 50.0...

TAP RH, M6x1, 50.0...

The drop-down list does not contain a Ø4.0 reamer with a Ø3.6 pilot hole. Although it is a standard tool size, the tool is not available in the selected library. You change the FBM Drill Tools parameters to create the tool you need.

► Create Standard Tools

- 1 Choose **Tools** in the Tree View pane.

The Tools page displays.

- 2 In the Tools page, select **Create as needed** and verify that **Create only standard sizes** is selected (default).

*Note: When you activate the **Create as needed** and **Create only standard sizes** setting, FBM Drill uses the standard tool table file to create standard tools for the FBM Drill operation.*

- 3 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

FBM Drill re-analyzes the solid model based on your changes.

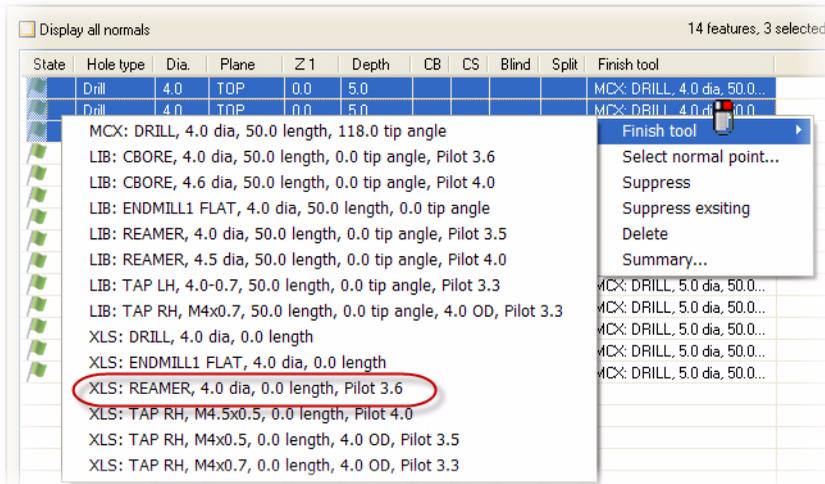
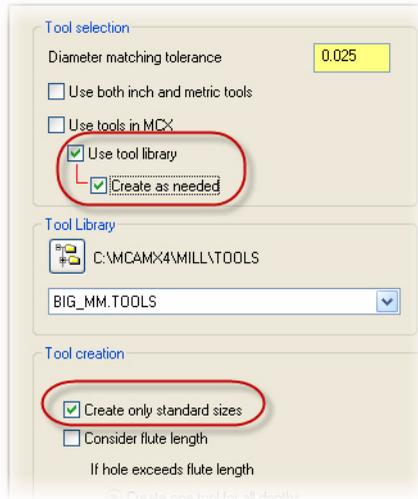
When finished, the Features page displays.

- 4 In the Features page list, select one of the **Ø4.0mm** holes.

FBM Drill selects all three Ø4.0mm holes in the list because the Select common features option is still active.

- 5 Position the cursor in the **Finish tool** column of one of the selected holes.

- a Right-click and choose **Finish tool**.



*Note: FBM Drill uses the standard tool table file to create the tools listed with an **XLS:** prefix.*

- b Select **XLS: REAMER. 4.0 dia, 0.0 length, Pilot 3.6** from the Finish tool drop-down list.

FBM Drill assigns the selected tool to all Ø4.0mm holes, and changes the Hole type to Ream.

Display all normals 14 features, 3 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Ream	4.0	TOP	0.0	5.0					MCX: REAMER, 4.0 dia, 16.0 len...
	Ream	4.0	TOP	0.0	5.0					MCX: REAMER, 4.0 dia, 16.0 len...
	Ream	4.0	TOP	10.0	10.0			X		MCX: REAMER, 4.0 dia, 16.0 len...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0 length...
	Drill	5.0	TOP	0.0	5.0					MCX: DRILL, 5.0 dia, 50.0 length...

▶ Reassign a Tap to All Ø5.0mm Holes



IMPORTANT: Redetecting features overrides any manual adjustment made in the Features page prior to the redetect! When you redetected features in Step 3 on page 92, the tap tool assignment to all Ø5.0mm holes was reset back to the original Ø5.0mm drill assignment.

- 1 Repeat the steps listed for “Assign a Tap to All Ø5.0mm Holes” on page 89 to reassign the **LIB: TAP RH, M6x1, 50.0 length, 0.0 tip angle, 6.0 OD, Pilot 5.0** to all Ø5.0mm holes.

▶ Generate FBM Drill Toolpaths

- 1 Your features list should match the following picture.

Display all normals 14 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Ream	4.0	TOP	0.0	5.0					MCX: REAMER, 4.0 dia, 16.0 len...
	Ream	4.0	TOP	0.0	5.0					MCX: REAMER, 4.0 dia, 16.0 len...
	Ream	4.0	TOP	10.0	10.0			X		MCX: REAMER, 4.0 dia, 16.0 len...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	0.0	5.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	10.0	15.0					MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	10.0	10.0			X		MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	10.0	10.0			X		MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	10.0	10.0			X		MCX: TAP RH, M6x1, 50.0 length...
	Tap RH	5.0	TOP	10.0	10.0			X		MCX: TAP RH, M6x1, 50.0 length...

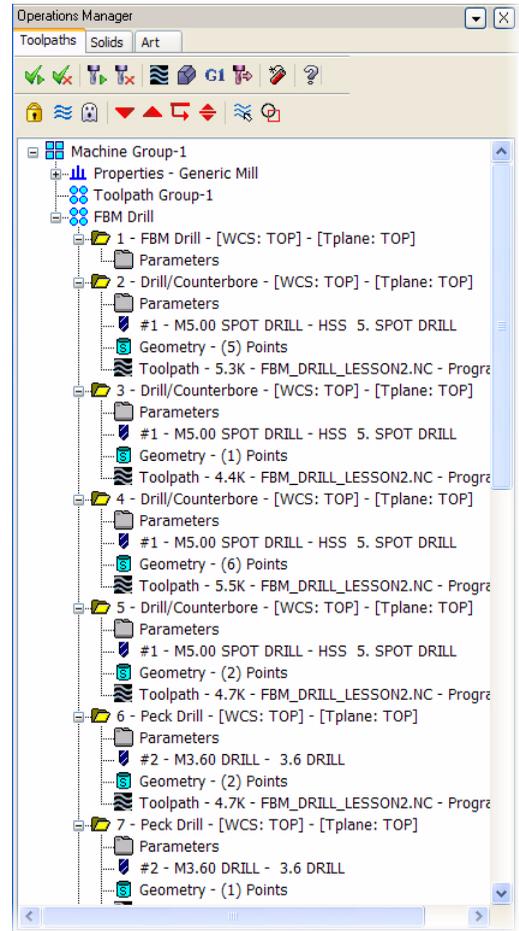
Select common features...
 Select coaxial features

Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four Ø5.0mm spot drill operations (#2-5)
- ◆ Two Ø3.6 pre-drill operations (#6-7)
- ◆ Three Ø5.0mm pre-drill operations (#8-10)
- ◆ Two Ø4.0mm reamer operations (#11-12)
- ◆ Three Ø6.0mm tap operations (#13-15)



► Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Change **LESSON2** to **LESSON4** and add your initials to the tutorial part **File name**—for example: `FBM_DRILL_LESSON4_[your initials].MCX`
 - b Click **OK** to save the file. This completes the exercise.

Exercise 3: Mapping Hole Sizes to Tools and Cycles

This exercise shows how to create a custom MAP file and assign it to an FBM Drill operation.

FBM Drill allows you to build a mapping table so that when a specific hole size is encountered during detection, it is automatically assigned to a specific hole type, drill cycle, and tool. Defining and activating a customized MAP file gives you full control over FBM Drill's tool assignment.

You can use the same MAP file to standardize tool assignment across FBM Drill operations, or create a unique MAP file as needed for a specific FBM Drill operation.

In this exercise, the MAP file you create automatically assigns a 6Mx1 tap to the Ø5.0mm holes FBM Drill detects in the part file, and assigns a Ø4.0mm reamer with a defined Ø3.6mm pilot hole to the Ø4.0mm holes.

► Create an FBM Drill Operation

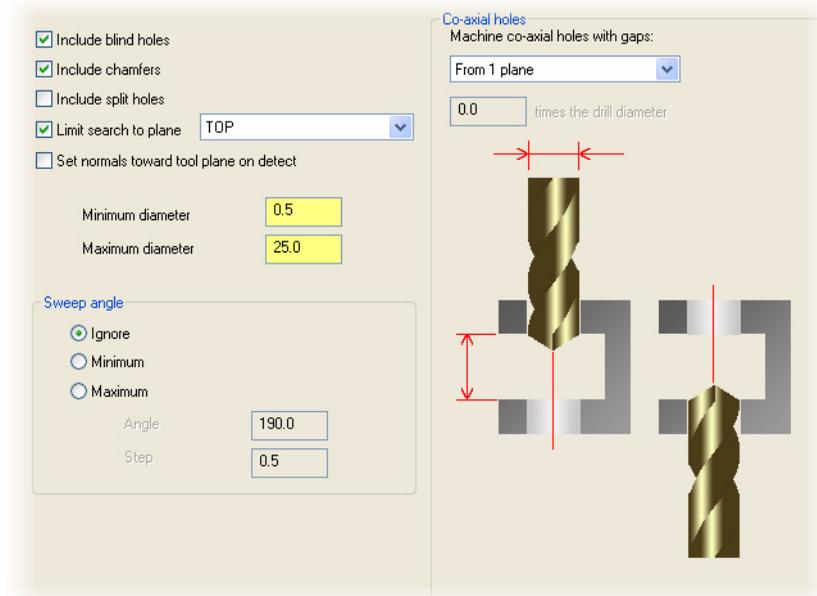
- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: FBM_DRILL_LESSON2.MCX.

Note: This is the same file used in Exercise 1 (page 84) It is not the file you saved in Exercise 2, “Reassigning Tools in the Features Page” on page 94.

- 3 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.
- 4 Choose **Toolpaths, FBM Drill**.
- 5 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.

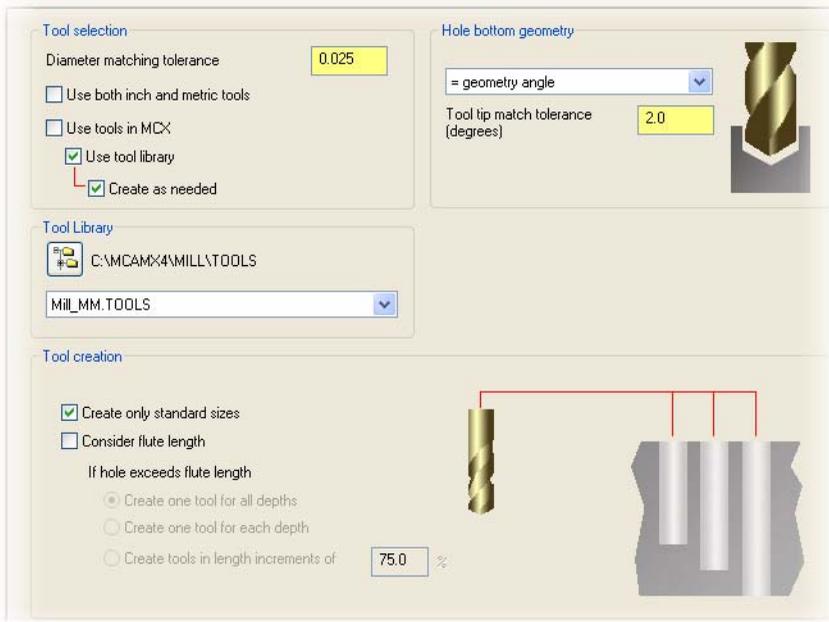
- 6 In the Hole Detection page, make sure that your parameters match the following picture:



- 7 Choose **Tools** in the Tree View pane.

The Tools page displays.

8 In the Tools page, make sure that your parameters match the following picture:

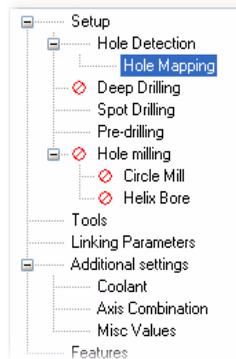


▶ Activate Hole Mapping and Create a Custom MAP File

1 Choose **Hole Mapping** in the Tree View pane.

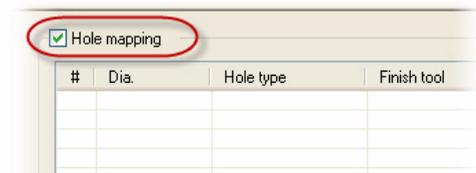
The Hole Mapping page displays.

By default, the feature and the page settings are inactive.



2 Select the **Hole mapping** check box.

This activates the feature for the FBM Drill operation and enables the parameters on the page.

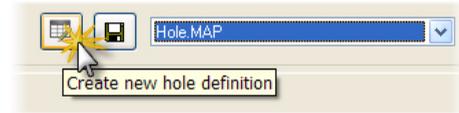


- If hole map entries are listed in the table, click the **Select all** button, and then press the **[Delete]** key to clear the table.

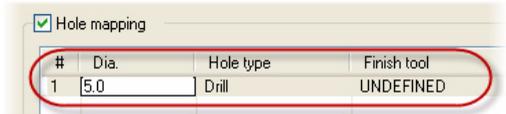


- Click the **Create new hole definition** button.

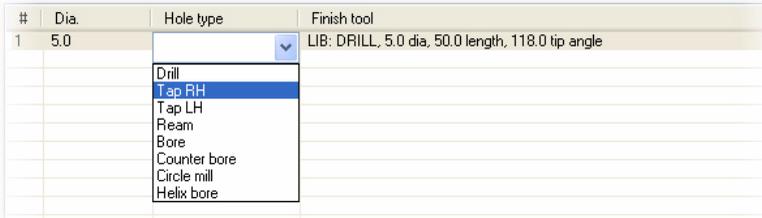
This adds a new row (**#1**) to your custom MAP file and positions the cursor in the **Dia.** column.



- Type **5.0** in the **Dia.** column, and then press the **[Tab]** key to advance to the **Hole type** column.

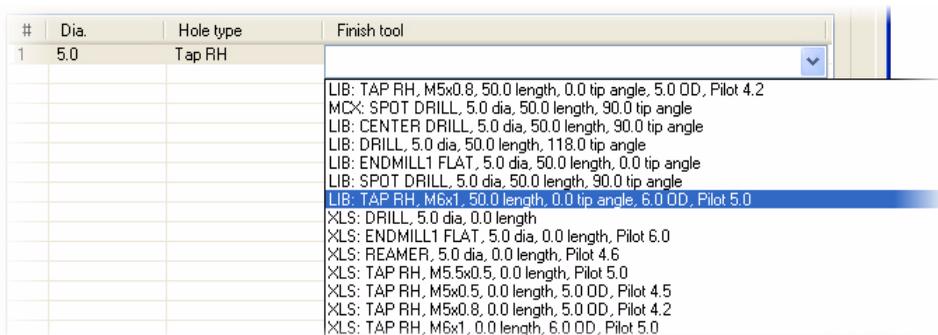


- In the **Hole type** column, choose **Tap RH** from the drop-down list.



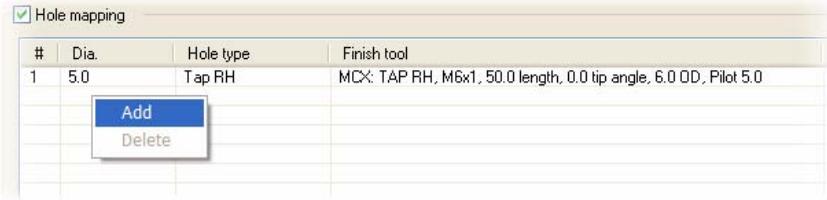
Then press the **[Tab]** key to advance to the **Finish tool** column.

- In the **Finish tool** column, choose **LIB: TAP RH. M6x1, 50.0 length, 0.0 tip angle, 6.0 OD, Pilot 5.0** from the drop-down list.

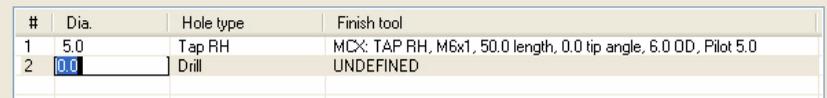


This completes the first table row entry for your custom MAP file. You use a different technique to create the second row.

8 Right-click in an empty area of the MAP table and then choose **Add**.

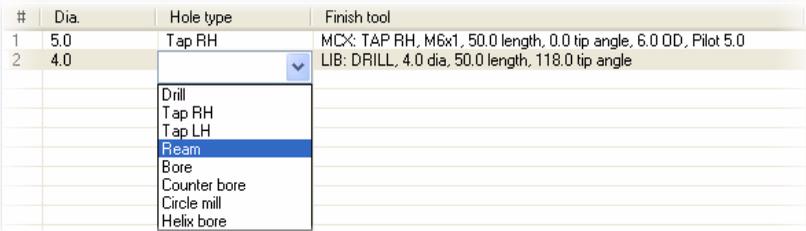


FBM Drill adds a new row (#2) to the table and positions the cursor in the **Dia.** column.



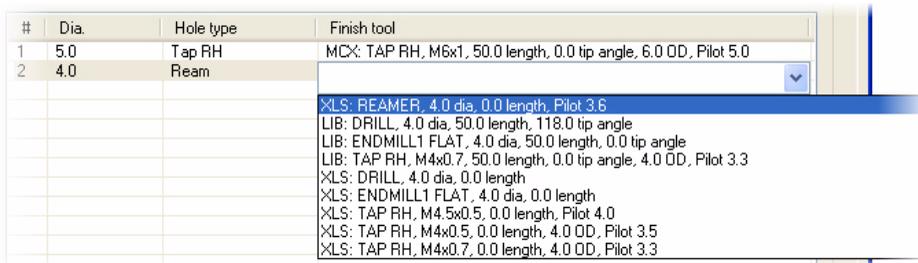
9 Type **4.0** in the Dia. column, and then press the [Tab] key to advance to the **Hole type** column.

10 In the Hole type column, choose **Ream** from the drop-down list.



Then press the [Tab] key to advance to the **Finish tool** column.

11 In the Finish tool column, choose **XLS: REAMER. 4.0 dia, 0.0 length, Pilot 3.6** from the drop-down list.

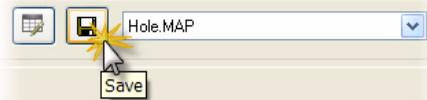


This completes the second table row entry for your custom MAP file.

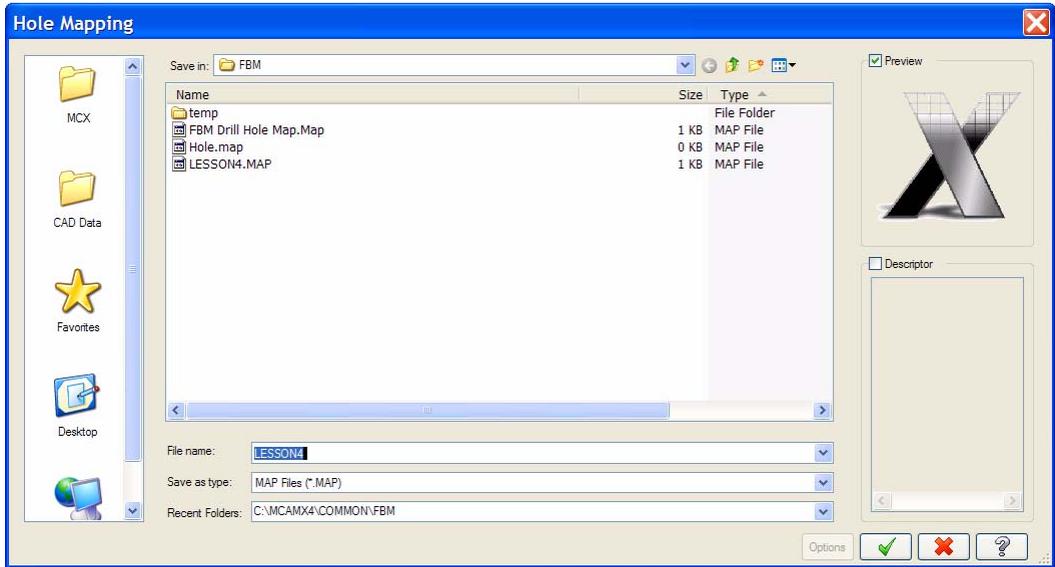
► Save a Custom MAP File

1 Select the **Save** button to save your custom MAP file.

The Hole Mapping dialog box opens.



2 In the File name field, type **LESSON4**.



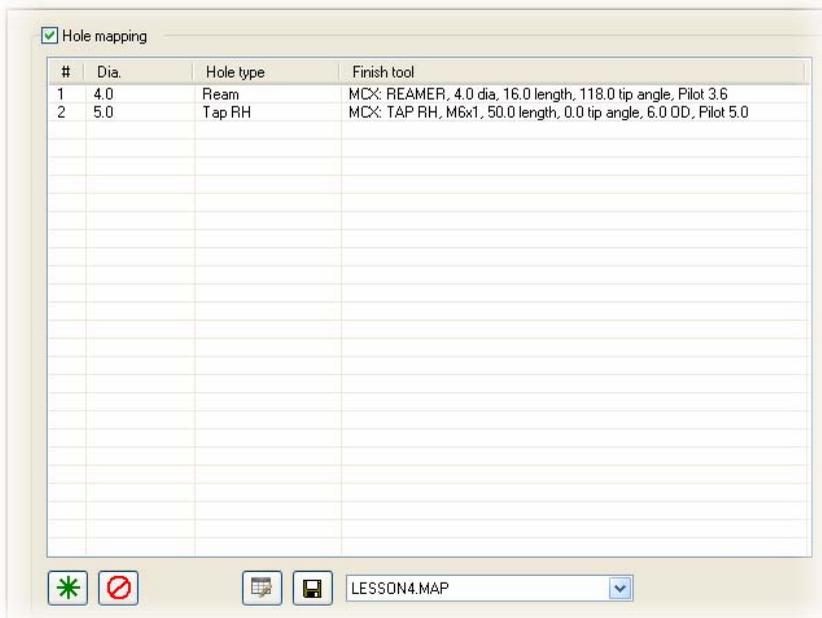
3 Click **OK**.

FBM Drill saves LESSON4 .MAP to your Mastercam installation's \common\FBM subfolder, and then closes the Hole Mapping dialog box.

Note: You can save MAP files to any location. However, MAP files you want to load in FBM Drill operations must reside in the Mastercam installation's \common\FBM subfolder. Otherwise, they do not appear in the Hole Mapping page drop-down list for selection.

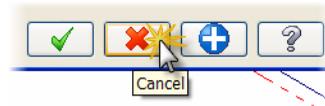
▶ Cancel the FBM Drill Operation

- 1 Your Hole Mapping page settings should match the following picture:



Note: FBM Drill automatically resorts and renumbers your MAP file tool list, from smallest diameter to largest. The Ø4.0mm entry is now #1 in the list, followed by the Ø5.0mm entry as #2.

- 2 Click **Cancel** to close the FBM Drill dialog box *without creating an FBM Drill operation*.



The purpose of this step is to demonstrate that you can create a custom MAP file and save it for use with other FBM Drill operations, when appropriate.

▶ Load a Custom MAP File in a New FBM Drill Operation

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: FBM_DRILL_LESSON2.MCX.

- 3 Choose **No** if prompted to save the Mastercam file.

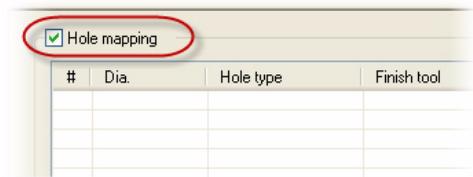


- 4 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.
- 5 Choose **Toolpaths, FBM Drill**.
- 6 Choose **Hole Mapping** in the Tree View pane.

The Hole Mapping page displays.

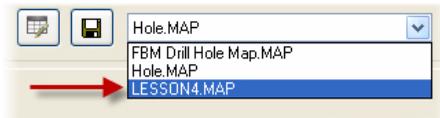
- 7 Select the **Hole mapping** check box.

This activates the feature for the FBM Drill operation and enables the parameters on the page.



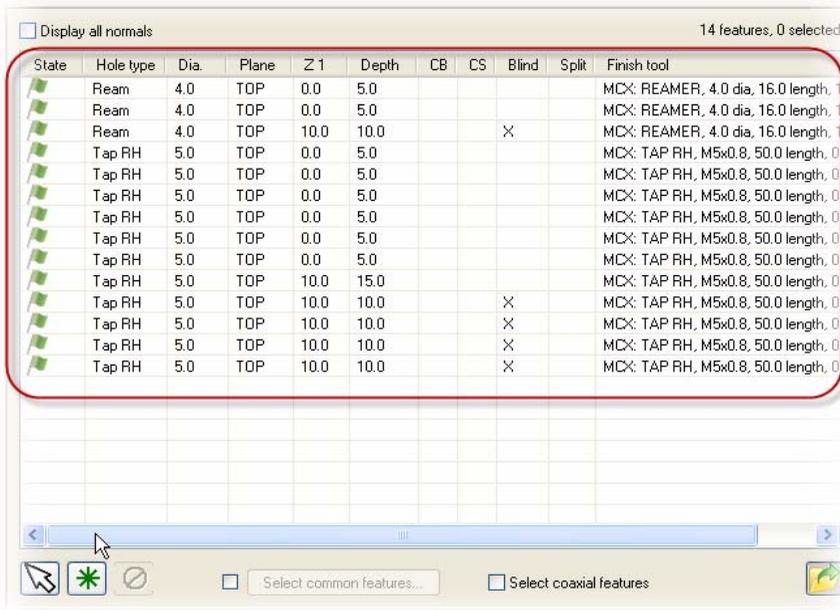
- 8 Choose **LESSON4.MAP** from the drop-down list.

FBM Drill loads the custom MAP file you created earlier in this exercise.



- 9 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

When finished analyzing features, FBM Drill displays the Features page.



FBM Drill automatically assigns tools from the selected MAP file to detected holes.

- 10 Click **OK**  in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Four Ø5.0mm spot drill operations (#2-5)
- ◆ Two Ø3.6mm pre-drill operations (#6-7)
- ◆ Three Ø5.0mm pre-drill operations (#8-10)
- ◆ Two Ø4.0mm reamer operations (#11-12)
- ◆ Three Ø6.0mm tap operations (#13-15)

Note: FBM Drill generates the same toolpaths for Exercise 3 as for Exercise 2 (page 88).

► Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Change **LESSON2** to **LESSON4**.

- b** Add **EX3** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON4_EX3_[your initials].MCX
- c** Click **OK** to save the file. This completes the exercise.

Exercise 4: Customizing FBM Drill's Standard Tool Table

In this exercise, you edit FBM Drill's standard tool table file (`FbmToolTable.XLS` or `FbmToolTable.CSV`) and add a custom-sized reamer.

After editing the file and saving your changes, you create an FBM Drill operation and assign the new tool to all detected holes.

The CAD model used in this exercise contains 14 Ø4.015mm holes. According to the job specifications, these are Ø4.0mm reamed holes. The finished part will be nickel plated. Nickel plating adds .015mm to the reamed hole diameter.

You need a Ø4.015mm reamer to machine the holes slightly larger to achieve a Ø4.0mm finish hole size after plating. For this exercise, you define this reamer with a 3.6 pilot hole.

Notes: There are many ways to create custom tools in Mastercam and in FBM Drill. This exercise shows one method; adding the tool to a standard tool list used by FBM Drill. Other methods include:

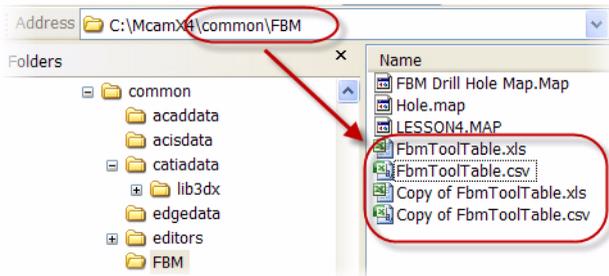
- *Using the Mastercam Tool Manager to create a tool and save it to the part file (MCX), or to a tool library (TOOLS).*
 - *Adding the tool to an FBM Drill mapping file (MAP).*
-

► Make Backup Copies of the FBM Drill Tool Table Files

Before changing any installed Mastercam files, make copies of the files to modify. This best practice allows you to easily restore any customized files to their original state. To restore the files, just delete the modified file and rename the copy to its original file name.

- 1** Open Windows® Explorer®. Then navigate to your Mastercam installation's `\common\FBM` folder.
- 2** Select **FbmToolTable.XLS** and press **[Ctrl + C]** to copy the file to the Windows clipboard.
- 3** Press **[Ctrl+V]** to paste the file from the Windows clipboard.
Windows creates a file named **Copy of FbmToolTable.XLS** in the folder.
- 4** Select **FbmToolTable.CSV** and press **[Ctrl + C]** to copy the file.
- 5** Press **[Ctrl+V]** to paste the file.
Windows creates a file named **Copy of FbmToolTable.CSV** in the folder.

Your folder contents should look similar to the following picture:



▶ Edit the FBM Drill Tool Table File (XLS)



IMPORTANT: To complete this part of the exercise, your workstation must include an installation of Microsoft Office® Excel that allows you to open a Microsoft Office Excel 97-2003 compatible XLS worksheet. If it does not, skip this section and begin with **Edit the FBM Drill Tool Table File (CSV)** on page 106.

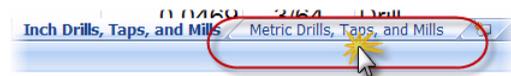
- 1 If the Mastercam application is open, close it.

Although having Mastercam open during the FbmToolTable.XLS file editing process does not cause a problem, you will not see any changes made to the FBM Drill tool table file in the current Mastercam session. Mastercam reads the FBM Drill tool table file *once*, the first time you create an FBM Drill operation, and holds that information in memory for the duration of the current Mastercam session.

- 2 Open the Excel application.
- 3 Based on your Excel version, choose **File, Open** or choose **Open** from the **Windows Office Button**. In the Open dialog box, complete the following steps:
 - a Navigate to the Mastercam installation's \common\FBM subfolder and choose **FbmToolTable.XLS**.
 - b Click **Open**.

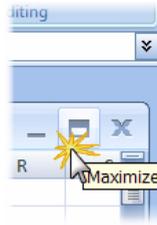
The worksheet opens in the Excel window. By default, the **Inch Drills, Taps, and Mills** worksheet displays.

- 4 At the bottom of the Excel window, click the tab labeled **Metric Drills, Taps, and Mills**.





TIP: If the tabs are not visible, maximize the worksheet window. You may need to first maximize the Excel window.



The metric worksheet displays.

	A	B	C	D	E	F	G	H
1	M		Metric Drills, Taps, and Mills					
2						Tap Drill		
3	Type	Size	Suffix	Designation	Pitch		CCW	Units
4	D	0.1		Drill				M
5	D	0.175		Drill				M
6	D	0.2		Drill				M
7	D	0.21		Drill				M
8	D	0.245		Drill				M
9	T	0.25		M0.25x0.075	0.075	0.175		M
10	D	0.28		Drill				M
11	D	0.3		Drill				M
12	T	0.3		M0.3x0.08	0.08	0.210		M
13	D	0.315		Drill				M
14	D	0.35		Drill				M
15	T	0.35		M0.35x0.09	0.09	0.245		M
16	D	0.38		Drill				M
17	D	0.4		Drill				M

This is where you add the Ø4.015mm reamer tool definition. Adding it to the standard tool table file makes the tool available for selection in FBM Drill Features page (when **Create as needed** and **Create only standard sizes** are selected in the Tools page).

- 5 Scroll down the worksheet until you locate the Ø4.0 reamer with a defined 3.6 pilot hole.

	A	B	C	D	E	F	G	H
1	M		Metric Drills, Taps, and Mills					
2						Tap Drill		
3	Type	Size	Suffix	Designation	Pitch		CCW	Units
28	D	3.9		Drill				M
29	D	4		Drill				M
30	M	4		Mill				M
31	R	4		Reamer		3.600		M
32	CS	4		Countersink				M
33	T	4		M4x0.7	0.7	3.300		M
34	T	4		M4x0.5	0.5	3.500		M
35	D	4.1		Drill				M

- Use the Excel **Insert** command and choose to insert a blank row, either above or below the Ø4.0 reamer row.

Note: You could position the new tool definition anywhere in the file.

- Select and then copy the Ø4.0 reamer row. Press [**Ctrl+C**], or right-click and choose **Copy**.

131	R	4	Reamer	3.600
132	CS	4	Countersink	
133	T	4	M4x0.7	0.7 3.300
134	T	4	M4x0.5	0.5 3.500

- Position the cursor in the **Type** cell of the new blank row you created in Step 6. Press [**Ctrl+V**], or right-click and choose **Paste**.

This creates a second row containing the Ø4.0 reamer tool definition.

- Position the cursor in the **Size** column of the new row. Change the value from 4.0 to **4.015**. Your worksheet should look similar to the following picture:

	A	B	C	D	E	F	G	H
1	M		Metric Drills, Taps, and Mills					
2						Tap Drill		
3	Type	Size	Suffix	Designation	Pitch		CCW	Units
128	D	3.9		Drill				M
129	D	4		Drill				M
130	M	4		Mill				M
131	R	4.015		Reamer		3.600		M
132	R	4		Reamer		3.600		M
133	CS	4		Countersink				M

- Save the file and exit Excel.
- Continue with **Create the FBM Drill Operation** on page 109.

▶ Edit the FBM Drill Tool Table File (CSV)



IMPORTANT: Use this part of the exercise only if your workstation does NOT include an installation of Microsoft Office Excel that allows you to open a Microsoft Office Excel 97-2003 compatible **XLS** worksheet.

- If it does, go back and begin with **Edit the FBM Drill Tool Table File (XLS)** on page 104.
- Then continue with **Create the FBM Drill Operation** on page 109.

- If the Mastercam application is open, close it.

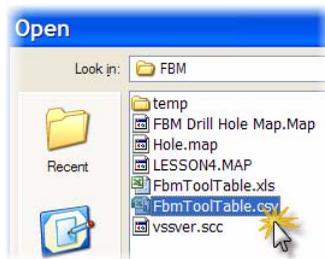
Although having Mastercam open during the `FbmToolTable.CSV` file editing process does not cause a problem, you will not see any changes made to the FBM Drill tool table file in

the current Mastercam session. Mastercam reads the FBM Drill tool table file *once*, the first time you create an FBM Drill operation, and holds that information in memory for the duration of the current Mastercam session.

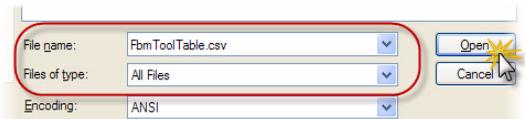
- 2 Open the Microsoft Notepad application. Typically, you do this by choosing **Start, All Programs, Accessories, Notepad**.
- 3 From the Notepad menu, choose **File, Open**.
- 4 In the Open dialog box, complete the following steps:
 - a Change the Files of type to **All files**.



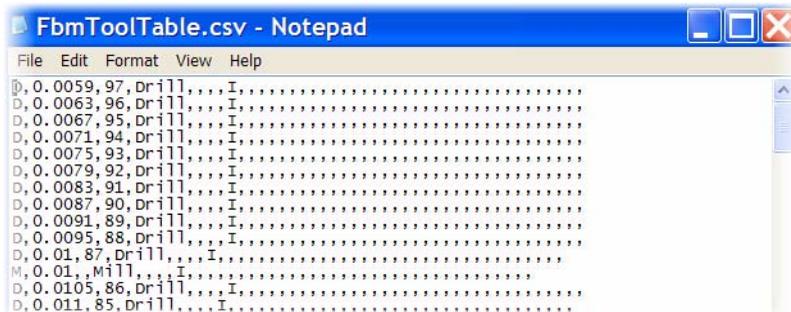
- b Navigate to the Mastercam installation's \common\FBM subfolder and choose **FbmToolTable.CSV**.



- c Click **Open**.



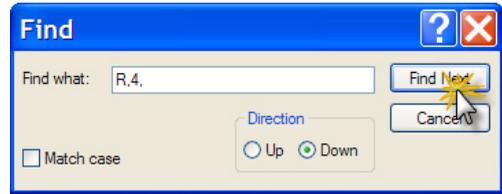
The file opens in the Notepad window.



- 5 Choose **Edit, Find**.

The Find dialog box displays.

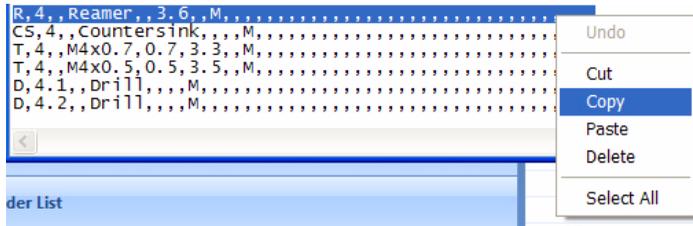
- 6 In the Find dialog box:
 - a Type **R,4**,
 - b Click **Find Next**.



Notepad finds the reamer tool to copy and modify.

```
D,4,,Drill,,,M,,,,,
M,4,,Mill,,,M,,,,,
R,4,,Reamer,,3.6,,M,,,,,
CS,4,,Countersink,,,M,,,,,
T,4,,M4x0.7,0.7,3.3,,M,,,,,
T,4,,M4x0.5,0.5,3.5,,M,,,,,
```

- 7 Select and then copy the Ø4.0 reamer row. Press **[Ctrl+C]**, or right-click and choose **Copy**.



- 8 Position the cursor at the start of the reamer line and press **[Enter]** to create a new blank line in the file.

```
D,4,,Drill,,,M,,,,,
M,4,,Mill,,,M,,,,,

R,4,,Reamer,,3.6,,M,,,,,
CS,4,,Countersink,,,M,,,,,
T,4,,M4x0.7,0.7,3.3,,M,,,,,
```

- 9 Position the cursor at the start of the new blank line you created in Step 8. Press **[Ctrl+V]**, or right-click and choose **Paste**.

This creates a second row containing the Ø4.0 reamer tool definition.

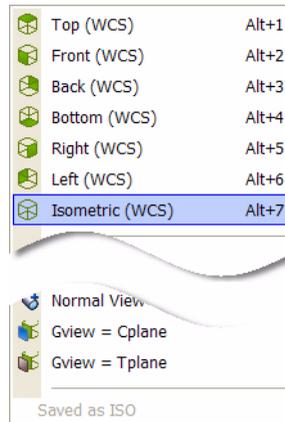
- 10 In the new row, change the value from 4 to **4.015**. Your entry should look similar to the following picture:

```
D,3.9,,Drill,,,M,,,,,
D,4,,Drill,,,M,,,,,
M,4,,Mill,,,M,,,,,
R,4.015,,Reamer,,3.6,,M,,,,,
R,4,,Reamer,,3.6,,M,,,,,
CS,4,,Countersink,,,M,,,,,
```

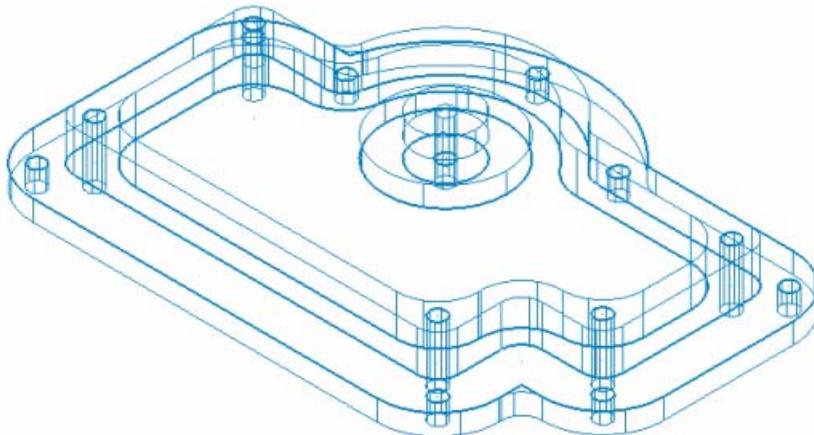
- 11 In the Find dialog box, click **Cancel**.
- 12 From the Notepad menu, choose **File, Save**.
This saves the changes you made to the file.
- 13 Choose **File, Exit**.

► Create the FBM Drill Operation

- 1 Start the Mastercam application.
- 2 From the Mastercam menu, choose **File, Open**.
- 3 Open the tutorial part file: FBM_DRILL_LESSON4_EX4 .MCX.
- 4 From the Status bar **Gview** menu, choose **Isometric (WCS)**.



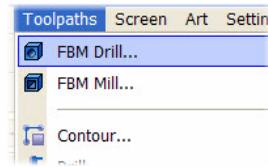
- 5 Fit the part to the screen,  and then change your shade settings to **Wireframe**.  Your part should look similar to the following picture:



- 6 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

This creates a Machine Group in the Toolpath Manager.

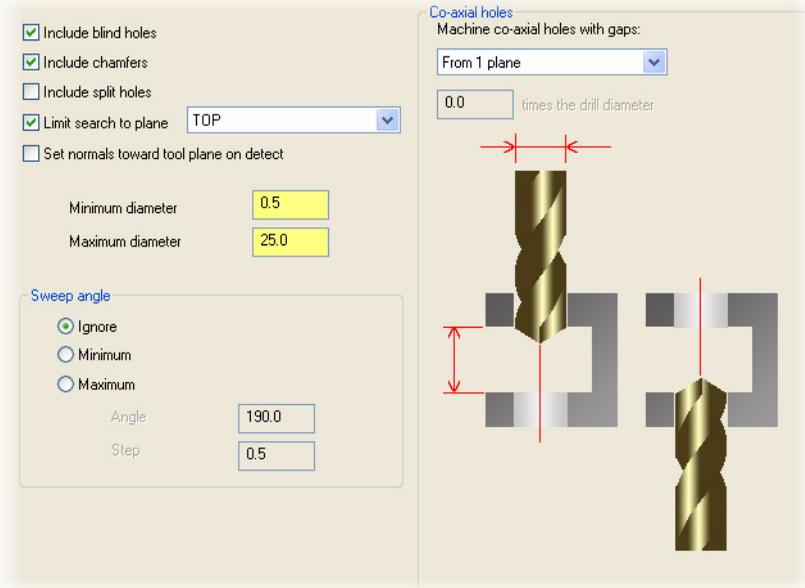
7 Choose **Toolpaths, FBM Drill**.



8 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.

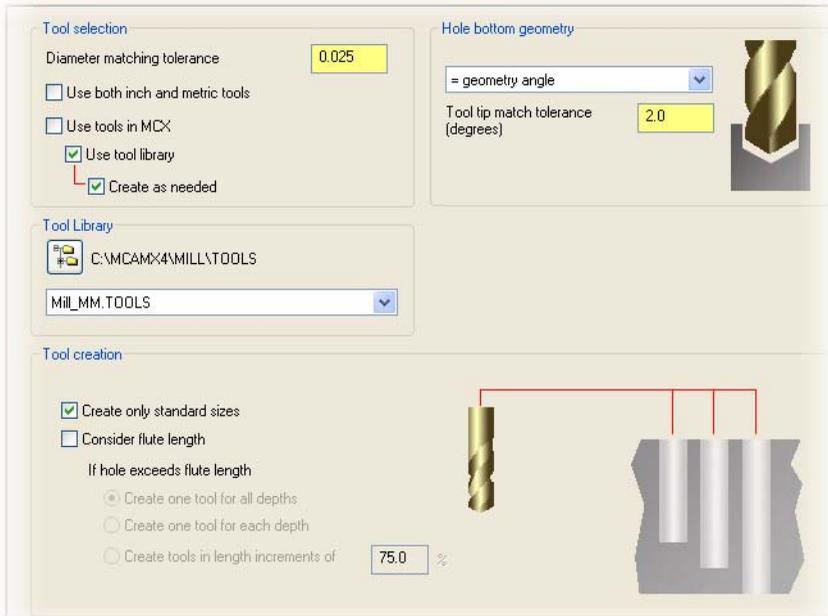
9 In the Hole Detection page, make sure that your parameters match the following picture:



10 Choose **Tools** in the Tree View pane.

The Tools page displays.

11 In the Tools page, make sure that your parameters match the following picture:



12 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

When finished analyzing features, FBM Drill displays the Features page.

Your features list should match the following picture.

Display all normals 14 features, 1 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...
	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length,...

Select common features... Select coaxial features

FBM Drill detects 14 Ø4.015mm holes in the model.

► Assign the Ø4.015 Reamer to All Detected Features

- 1 In the Features page, click the **Select all** button.



FBM Drill selects all features in the list.

Display all normals 14 features, 14 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...

- 2 Position the cursor in the **Finish tool** column of one of the selected holes.
 - a Right-click and choose **Finish tool**.
 - b Select **XLS: REAMER. 4.015 dia, 0.0 length, Pilot 3.6** from the drop-down list.

Display all normals 14 features, 14 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	0.0	5.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...
✓	Drill	4.015	TOP	10.0	15.0					MCX: DRILL, 4.0 dia, 50.0 length...

MCX: DRILL, 4.0 dia, 50.0 length, 118.0 tip angle

LIB: ENDMILL1 FLAT, 4.0 dia, 50.0 length, 0.0 tip angle

LIB: TAP RH, M4x0.7, 50.0 length, 0.0 tip angle, 4.0 OD, Pilot 3.3

XLS: DRILL, 4.0 dia, 0.0 length

XLS: ENDMILL1 FLAT, 4.0 dia, 0.0 length

XLS: REAMER, 4.0 dia, 0.0 length, Pilot 3.6

XLS: REAMER, 4.015 dia, 0.0 length, Pilot 3.6

XLS: TAP RH, M4x0.5, 0.0 length, 4.0 OD, Pilot 3.5

XLS: TAP RH, M4x0.7, 0.0 length, 4.0 OD, Pilot 3.3

(ID) XLS: TAP RH, M4.5x0.5, 0.0 length, Pilot 4.0

Finish tool

Select normal point...

Suppress

Suppress exiting

Delete

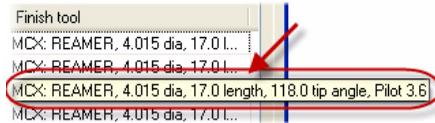
Summary...

FBM Drill assigns the selected tool to all selected features.

Display all normals 14 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	0.0	5.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...
	Ream	4.015	TOP	10.0	15.0					MCX: REAMER, 4.015 dia, 17.0 L...

3 In the **Finish tool** column, hover the mouse over any feature in the list to display information about the assigned tool.



- ◆ FBM Drill creates a 17.0mm tool length for the Ø4.015 reamer to accommodate the longest hole to ream (15.0mm).
- ◆ Mastercam saves the custom tool definition in the part file (MCX).

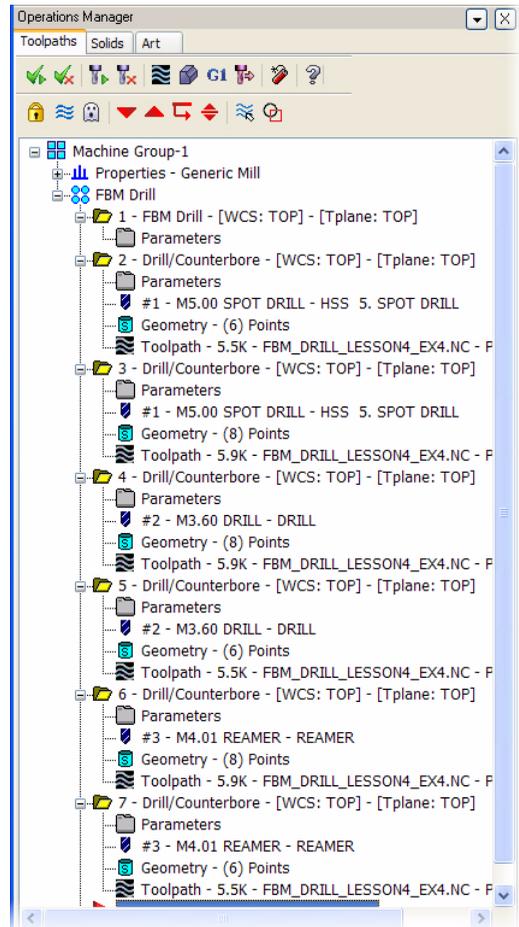
► Generate FBM Drill Toolpaths

1 Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Two Ø5.0mm spot drill operations (#2-3)
- ◆ Two Ø3.6 pre-drill operations (#4-5)
- ◆ Two Ø4.015mm reamer operations (#6-7)



► Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Add your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON4_EX4_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise and the lesson.

Skills Challenge

Congratulations! You have completed Lesson 4, “Assigning Tools”.

As a challenge to the skills you learned in this lesson, try one or more of the following exercise suggestions.

Using the tutorial part file: `FBM_DRILL_LESSON2.MCX`:

- Repeat all of the exercises and experiment with assigning different tools.

Using the tutorial part file: `FBM_DRILL_LESSON4_EX4.MCX`:

- Create a custom `MAP` file that assigns a 4.015 reamer (refer to Lesson 3 on page 94 for guidance).
- Using the techniques you learned in Lesson 4 (page 103), update the FBM standard tools table file—`XLS` or `CSV` based on your workstation's configuration—by adding an M6x1 tap tool that taps oversize for nickel plating. Use Features page options to assign the tool to selected holes and then generate the toolpaths.

LESSON 5

Adjusting the Tool Tip

This lesson demonstrates adding tip compensation with additional break-through distances to FBM Drill-generated cycles for blind and through holes. It also shows how to adjust the tool tip in pre-drill and tap/ream cycles for threaded and reamed holes.

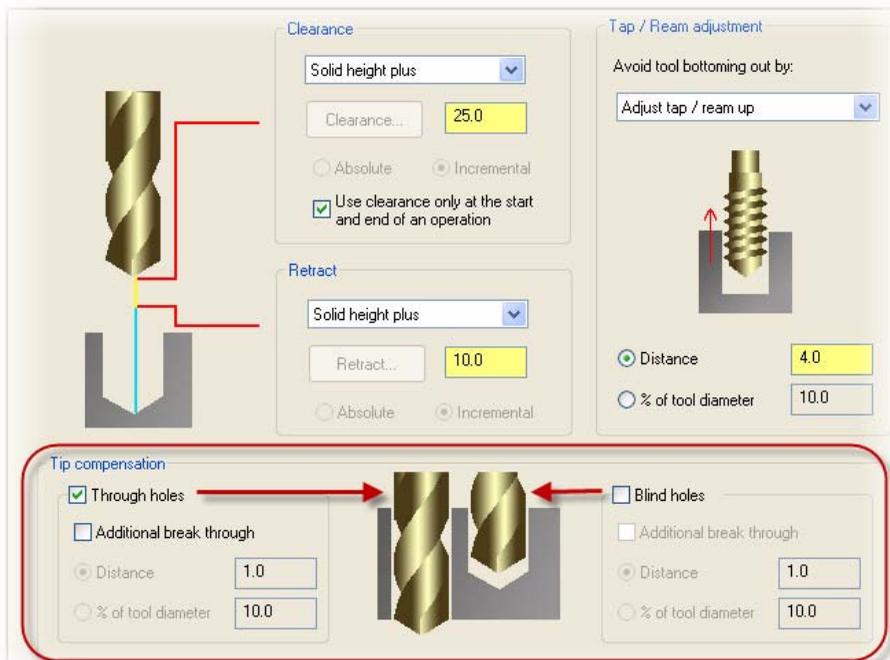
Most importantly, you learn about the interaction of tip compensation/additional break-through settings and tap/ream adjustment settings.

Lesson Goals

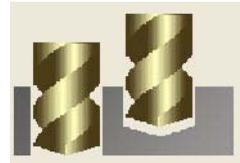
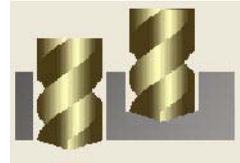
- Create an FBM Drill operation that applies tip compensation and additional break-through settings to only through hole cycles.
- Update an FBM Drill operation to add tip compensation for blind hole cycles.
- Adjust the tool tip for tapped holes in an FBM Drill operation in which tip compensation and additional break-through settings are also activated for blind and through holes. Analyze the effect on all holes in the model.

Linking Parameters

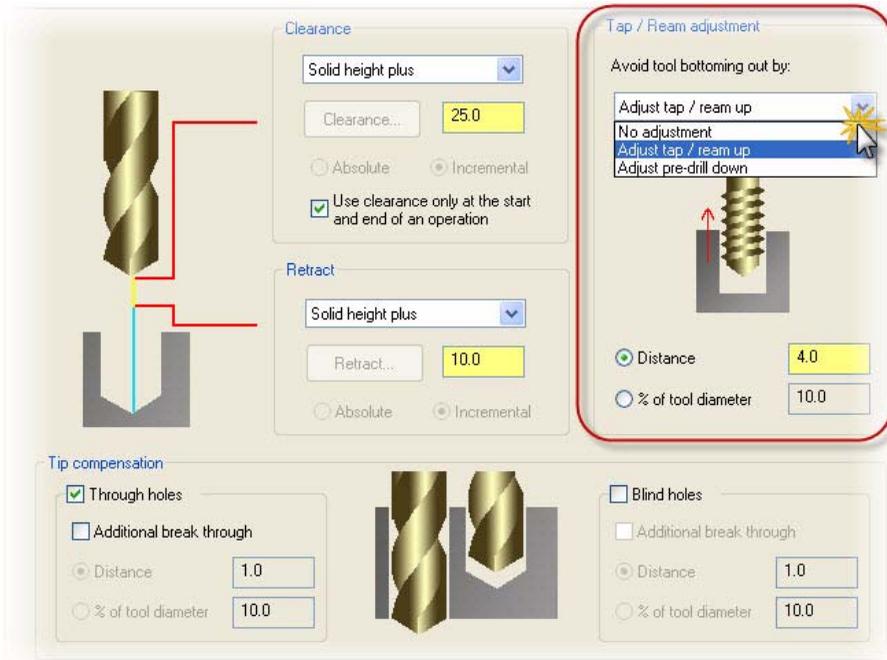
You set tip compensation parameters for blind and through hole types in FBM Drill's Linking Parameters page.



- Activating tip compensation adds the tool tip to the final plunge depth in the cycles FBM Drill generates for the selected hole type (through/blind). Selecting tip compensation for through or blind holes also activates the **Additional break through amount** fields, allowing you to adjust the tip-compensated plunge depth by a fixed distance, or by a percentage of the tool diameter.
- Deactivating tip compensation sets the final plunge depth to the apex of the tool tip. It also deactivates the **Additional break through** fields.



The Linking Parameters page also lets you adjust the plunge depth in FBM Drill-generated cycles for tapped and reamed holes.

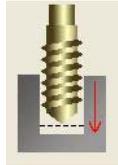
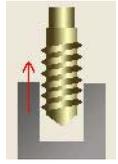


These settings determine whether FBM Drill fully finishes the tapped and reamed holes. Use the following guidelines when choosing a tap/reamer adjustment strategy:

- Select **No adjustment** to plunge the tool to the defined hole depth. This setting deactivates the **Distance** and **% of tool diameter** fields.



- Choose **Adjust tap/ream up** when you want FBM Drill to machine the hole at the specified depth, but you do not want to finish the hole all the way to the bottom. This setting modifies only the *tap/ream drill cycle*. Instead of plunging the tap/ream tool to the bottom of the hole, it lifts the tool up from the hole bottom by the specified **Distance** or **% of tool diameter**.
- Use **Adjust pre-drill down** when the effective cut depth is equal to the designed hole depth. This setting modifies only the *pre-drill cycle* for tapped/reamed holes. The hole is pre-drilled deeper than its designed depth by the specified **Distance** or **% of tool diameter**. This allows the subsequent tap/ream drill cycle to fully finish the hole, achieving full cutter depth without bottoming out the tap/reamer tool.



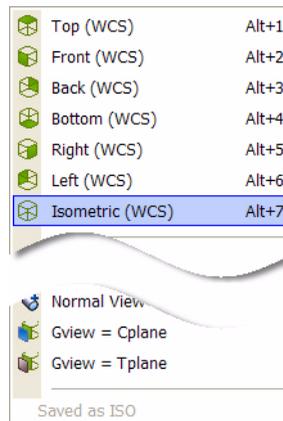
Exercise 1: Applying Tip Compensation for Through Holes

In this exercise, you:

- Create an FBM Drill operation and apply tip compensation to only the through holes FBM Drill detects in the model.
- Backplot the finish drill cycles for blind and through holes to view the difference in final plunge depths.
- Modify the FBM Drill operation to add an additional break-through amount for through holes.

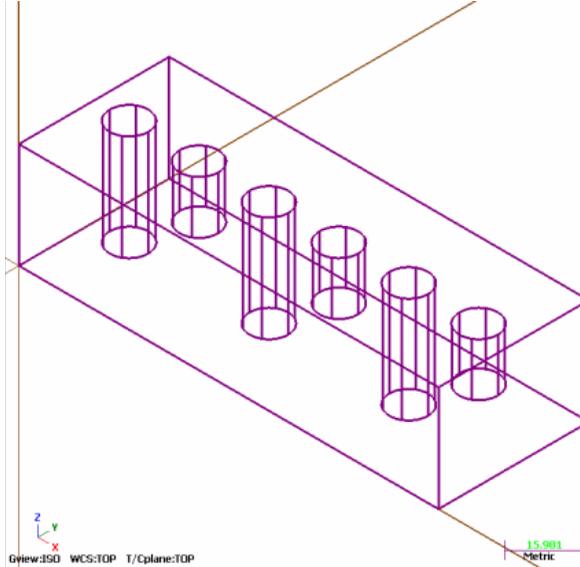
► Examine the Part Features

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part: `FBM_DRILL_LESSON5.MCX`
- 3 From the Status bar **Gview** menu, choose **Isometric (WCS)**.



- 4 Fit the part to the screen  and change your shade settings to **Wireframe**. 

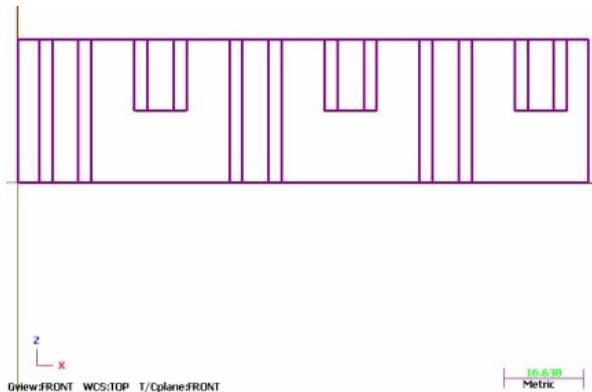
- 5 Press **F9** to display the coordinate axes in the graphics window. Your graphics window part display should look similar to the following picture.



The part contains six $\text{Ø}11.0\text{mm}$ holes evenly spaced along the centerline of the block. The hole type alternates between through holes and blind holes.

Note: The simple part design facilitates learning the tip compensation and plunge depth concepts presented in this lesson.

- 6 From the Status bar **Gview** menu, choose **Front (WCS)**. Then fit the part to the screen to get a better view of the hole depths.



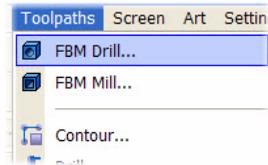
► Create the FBM Drill Operation

- 1 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu.

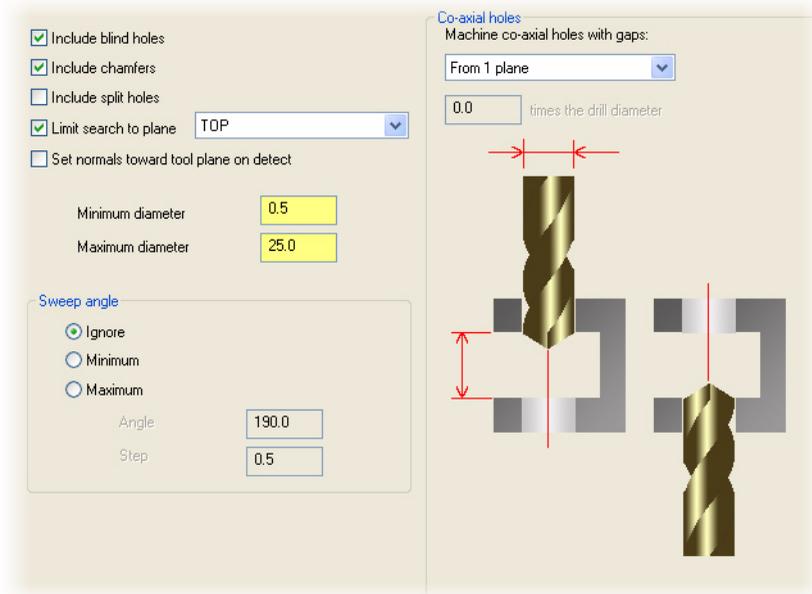
This creates a Machine Group in the Toolpath Manager.

- 2 Choose **Toolpaths, FBM Drill**.
- 3 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.



- 4 In the Hole Detection page, make sure that your parameters match the following picture:



- 5 Choose **Pre-drilling** in the Tree View pane.

The Pre-drilling parameters display.

6 Make the following changes in the Pre-drilling page:

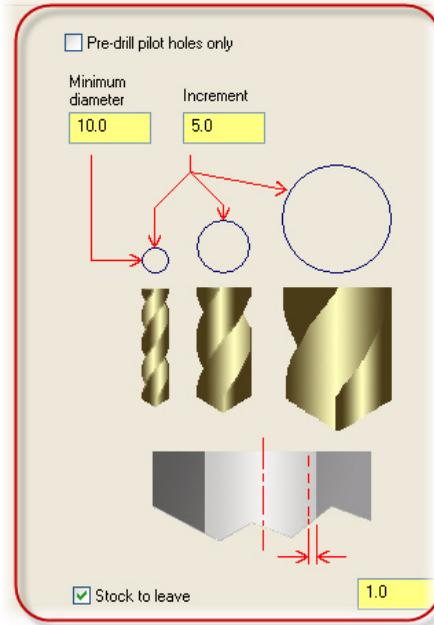
a Deselect **Pre-drill Pilot holes only**.

b Select **Stock to leave**.

Accept the default value of **1.0**.

FBM Drill generates pre-drill cycles that leave 1.0mm of stock on the walls of the detected holes.

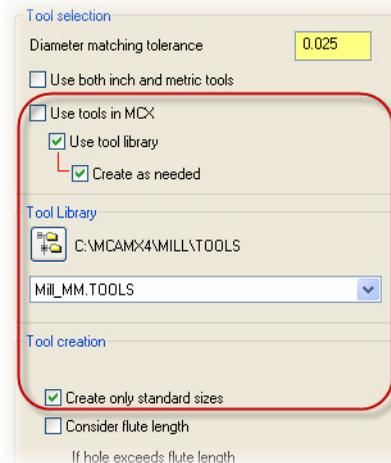
The finish drill cycles remove the remaining stock.



7 Choose **Tools** in the Tree View pane.

The Tools page displays.

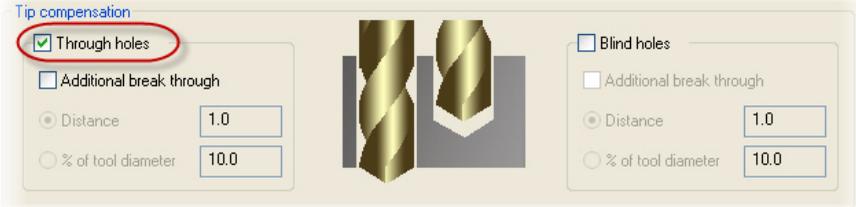
8 In the Tools page, make sure your settings are as shown:



9 Choose **Linking Parameters** in the Tree View pane.

The Linking Parameters page displays.

10 In the Linking Parameters page, make sure your **Tip compensation** settings are as shown:



11 In the top left corner of FBM Drill dialog box, click the **Detect** button. 

FBM Drill analyzes the solid model based on your selections.

When finished analyzing features, FBM Drill displays the Features page.

► Generate FBM Toolpaths

1 Your features list should match the following picture.

The image shows a screenshot of the 'Features' page in a software application. At the top left, there is a checkbox labeled 'Display all normals' which is unchecked. At the top right, it says '6 features, 0 selected'. Below this is a table with the following columns: State, Hole type, Dia., Plane, Z1, Depth, CB, CS, Blind, Split, and Finish tool. There are six rows of data, each starting with a green flag icon in the 'State' column. The 'Finish tool' column contains the text 'MCX: DRILL, 11.0 dia, 50.0 lengt...'. The 'Blind' column has 'X' marks for the last three rows.

State	Hole type	Dia.	Plane	Z1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	11.0	TOP	30.0	30.0					MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	30.0					MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	30.0					MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...

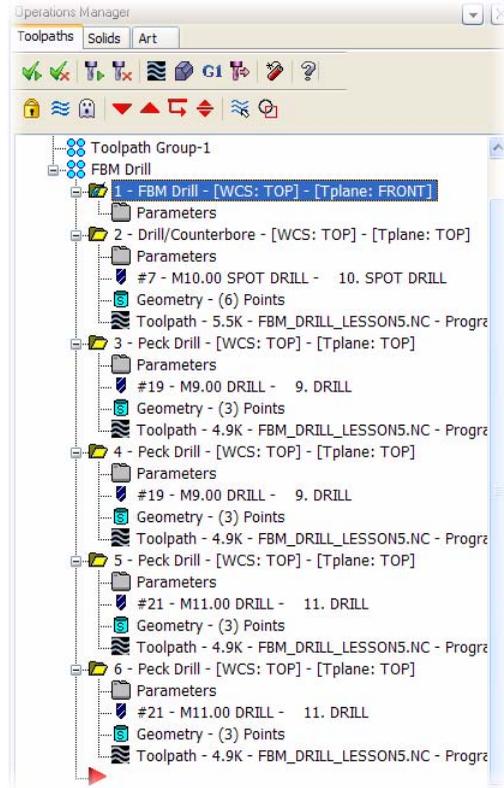
The icon  in the Features page indicates that the features can be machined with the assigned tool.

Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One spot drill operation (#2)
- ◆ Two pre-drill operations (#3-4)
- ◆ Two finish drill operations (#5-6)



► Backplot Blind and Through Hole Finish Operations

- 1 In the Toolpath Manager list, use the **[Shift+Click]** method to select the toolpaths numbered **5** (through hole finish) and **6** (blind hole finish).

- 2 In the Toolpath Manager, click the **Backplot selected operations** button. 

The Backplot dialog box and Backplot VCR bar open.

- 3 In the Backplot dialog box, select the **Display tool** and **Quick verify** buttons.

(Do not display the tool holder.)

These options display a simulation of a tool during backplot, and shade the toolpath.

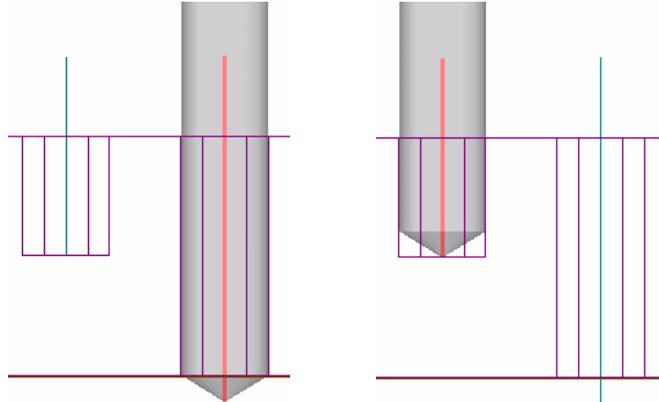


- 4 Use the buttons and sliders on the Backplot VCR bar to backplot the operations.



Click **Play**  to begin the backplotting action.

The plunge depth of the tool for through holes is tip-compensated; for blind holes, it is not.

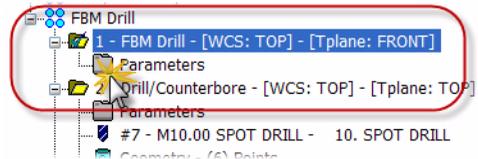


- 5 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.

► Add Additional Break Through for Through Holes

- 1 In the Toolpath Manager, click the FBM Drill **Parameters**.

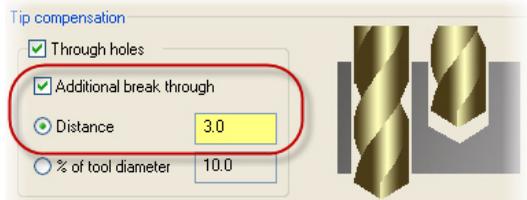
The FBM Drill dialog box opens.



- 2 Choose **Linking Parameters** in the Tree View pane.
- 3 In the Linking Parameters page, enter the following changes:

- a Select **Additional break through**.
- b Make sure **Distance** is selected and type **3.0** in the field provided.

This setting adds 3.0mm to the through hole's tip-compensated plunge depth.



- 4 Click **OK**  in the FBM Drill dialog box to accept the changed parameters.

The FBM Drill dialog box closes.

- 5 In the Toolpath Manager, click the **Regenerate all dirty operations** button.



Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

6 In the Toolpath Manager list, select the toolpath numbered **5** (through hole finish).

7 In the Toolpath Manager, click the **Backplot selected operations** button. 

8 In the Backplot VCR bar, click **Play**  to backplot the through hole finish drill cycle.

The plunge depth of the tool for through holes is tip-compensated and plunges an additional 3.0mm.

9 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.

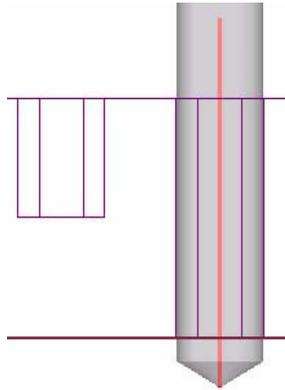
10 Choose **File, Save As**.

11 In the Save As dialog box, do the following:

a Add **EX1** and your initials to the tutorial part **File name**—for example:

FBM_DRILL_LESSON5_EX1_[your initials].MCX

12 Click **OK** to save the file. This completes the exercise.



Exercise 2: Applying Tip Compensation for Blind Holes

In this exercise, you edit an FBM Drill operation to apply tip compensation to the blind holes FBM Drill detects in the model. After regenerating the FBM Drill operation, you backplot the blind hole finish toolpaths to see the results.

1 If necessary, open the MCX part file you saved on page 126 in Exercise 1—for example:

FBM_DRILL_LESSON5_EX1_[your initials].MCX.

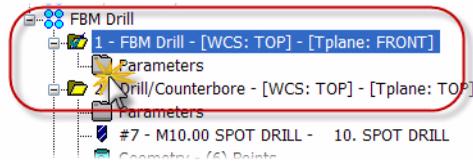
2 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.

3 Choose **Linking Parameters** in the Tree View pane.

4 In the Linking Parameters page, select **Blind holes**.

This setting adds tip compensation to the plunge depth of blind hole finish operations.



- 5 Click **OK**  in the FBM Drill dialog box to accept the changed parameters.
The FBM Drill dialog box closes.

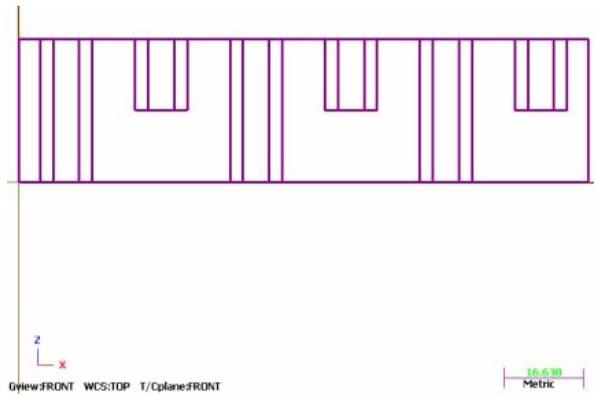
- 6 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

- 7 If necessary, set up the part in the graphic window as follows:

- a Choose **Front (WCS)** from the Status bar **Gview** menu.

- b Fit the part to the screen  and set shade settings to **Wireframe**. 



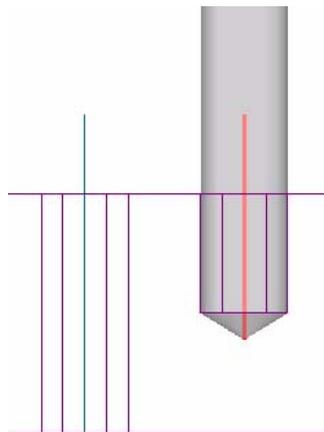
- 8 In the Toolpath Manager list, select the toolpath numbered **6** (blind hole finish).

- 9 In the Toolpath Manager, click the **Backplot selected operations** button. 

- 10 In the Backplot VCR bar, click **Play**  to backplot the blind hole finish drill cycle.

The plunge depth of the tool for blind holes is tip-compensated.

- 11 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.



- 12 From the Mastercam menu, choose **File, Save As**.

In the Save As dialog box, do the following:

- a Change EX1 to **EX2** in the tutorial part **File name**—for example:
FBM_DRILL_LESSON5_EX2_[your initials].MCX.
- b Click **OK** to save the file. This completes the exercise.

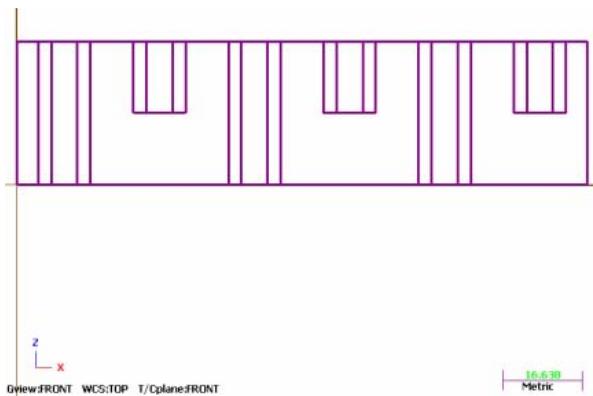
Exercise 3: Adjusting Tap/Ream Plunge Depths

In this exercise, you edit an FBM Drill operation by assigning a tap to selected holes. You adjust the plunge depth for tap/ream pre-drill cycles. After regenerating the FBM Drill operation, you backplot the tap pre-drill and finish toolpaths to see the results.

► Assign Tap Tool and Cycle

- 1 If necessary, open the MCX part file you saved on page 128 in Exercise 2—for example:
FBM_DRILL_LESSON5_EX2_[your initials].MCX.
- 2 If necessary, set up the part in the graphic window as follows:
 - a Choose **Front (WCS)** from the Status bar **Gview** menu.

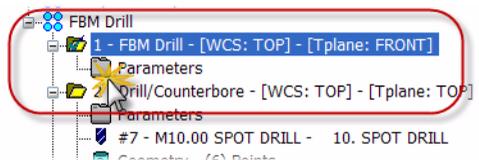
- b Fit the part to the screen  and set shade settings to **Wireframe**. 



- 3 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.

- 4 Choose **Features** in the Tree View pane.

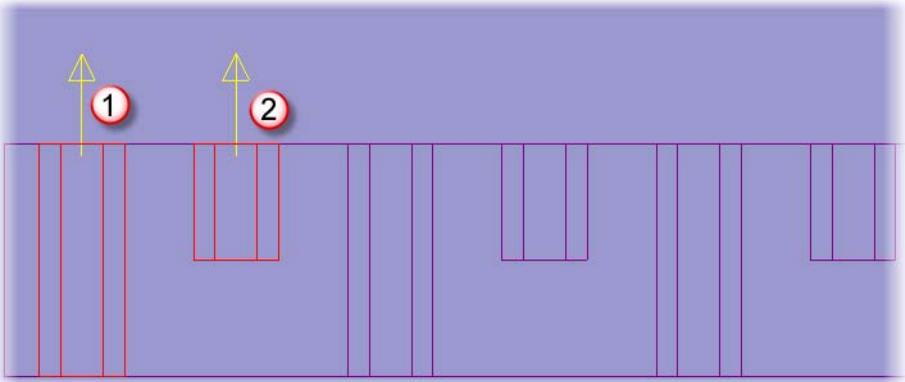


- 5 In the Features page, use the [Ctrl+Click] method to select the first and the fourth hole feature in the list:

Display all normals 6 features, 2 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
1	Drill	11.0	TOP	30.0	30.0					MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	30.0					MCX: DRILL, 11.0 dia, 50.0 lengt...
2	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...
	Drill	11.0	TOP	30.0	15.0			X		MCX: DRILL, 11.0 dia, 50.0 lengt...

Mastercam displays the normals of the selected holes in the graphics window.



Verify that you selected the proper holes for this step.

*Note: If you cannot view the graphics window clearly, click the **Hide dialog** button  in the FBM Drill dialog box. The dialog box minimizes in the lower left area of the Mastercam window. Press [Esc] to maximize the FBM Drill dialog box when you are ready to continue the exercise.*

- 6 Position the cursor in the **Finish tool** column of one of the selected holes.

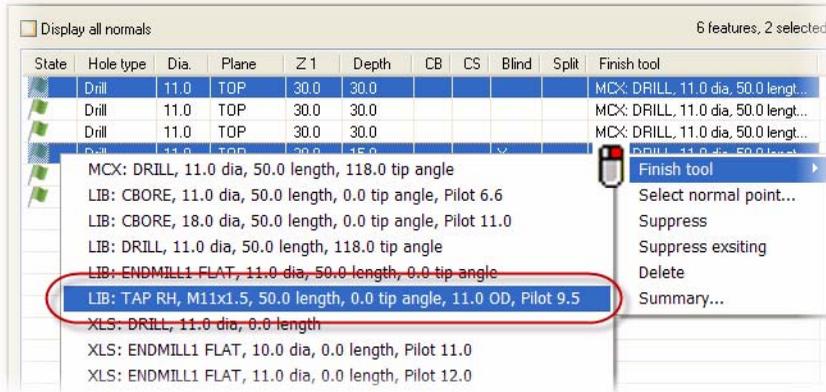


TIP: If necessary, move the slider at the bottom of the Features page to the right to view the Finish tool column.



- a Right-click in the Finish tool column and choose **Finish tool**.

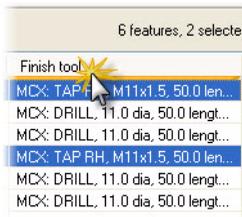
- b Select **LIB: TAP RH, M11X1.5, 50.0 length, 0.0 tip angle, 11.0 OD. Pilot 9.5** from the drop-down list.



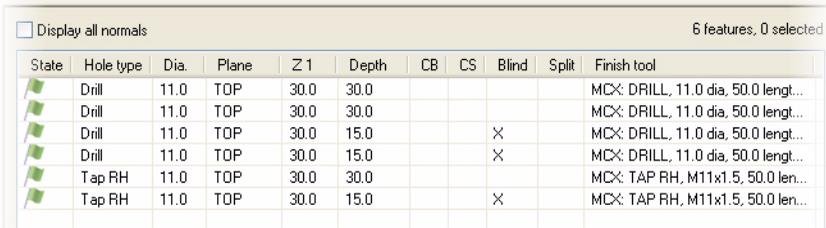
FBM Drill assigns the tap drill to both selected features and changes their Hole type to **Tap RH**.

- 7 Click on the **Finish tool** column heading.

FBM Drill sorts the Features page list by the finish tool description.



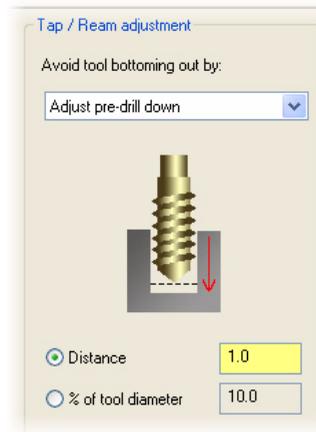
Your list should match the following picture:



► Adjust the Tap Pre-drill Plunge Depth

- 1 Choose **Linking Parameters** in the Tree View pane.

- 2** In the Linking Parameters page, make the following changes to the **Tap/Ream adjustment** settings:
- a** Choose **Adjust pre-drill down** from the drop-down list.
 - b** Make sure **Distance** is selected and type **1.0** in the field provided.
- This setting modifies the pre-drill cycles for tapped and reamed holes.
- The tool plunges 1.0mm deeper than the hole's defined bottom.



- 3** Click **OK**  in the FBM Drill dialog box to accept the changed parameters.
- The FBM Drill dialog box closes.

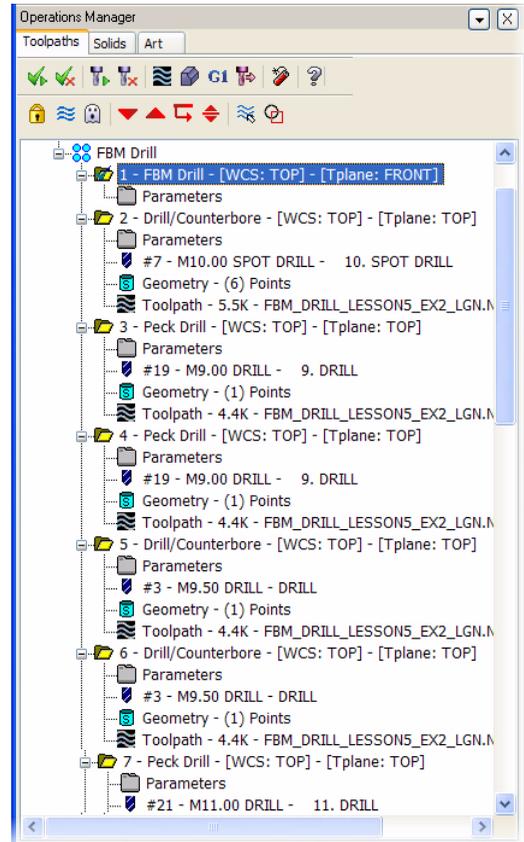
► Regenerate the FBM Drill Operation and its Toolpaths

- 1** In the Toolpath Manager, click the **Regenerate all dirty operations** button. 
- Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new drill toolpaths for the operation.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One spot drill operation (#2)
- ◆ Two pre-drill operations for the drilled holes (#3-4) using a Ø9.0mm drill
- ◆ Two pre-drill operations for the tapped holes (#5-6) using a Ø9.5mm drill to match the finish tool's defined pilot hole diameter
- ◆ Two finish drill operations (#7-8)
- ◆ Two finish tap operations (#9-10)



► Backplot Tapped Hole Operations

- 1 In the Toolpath Manager list, use the **[Shift+Click]** method to select the toolpaths numbered **5-6** (tap pre-drill).
- 2 In the Toolpath Manager, click the **Backplot selected operations** button. 
- 3 In the Backplot VCR bar, click **Play**  to backplot pre-drill cycles generated for the tapped holes (blind and through).

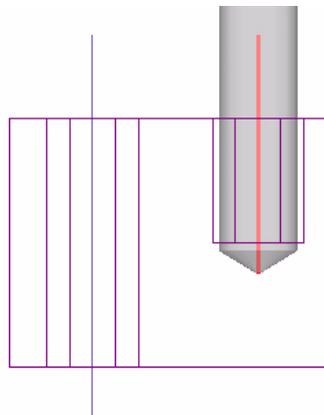
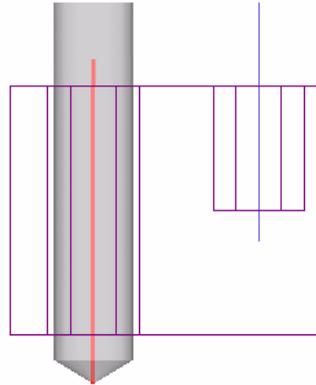
FBM Drill applies the tip compensation and additional break-through amount (3.0mm) to the tapped through hole's pre-drill cycle.



IMPORTANT: This example demonstrates that FBM Drill does *not* apply tap/ream adjustments to tapped through holes if the following conditions are true:

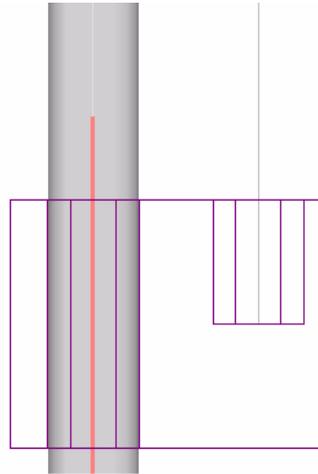
- tip-compensation is active for through holes
- an additional break-through value is assigned to through holes

FBM Drill adds 1.0mm to the tip-compensated plunge depth for the tapped blind hole's pre-drill cycle.

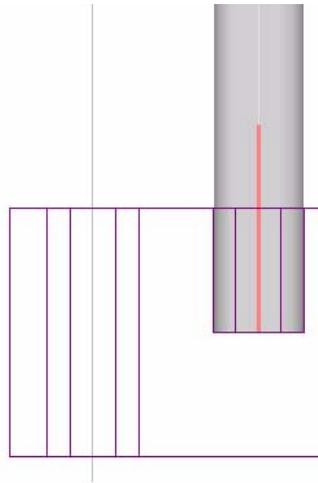


- 4 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.
- 5 In the Toolpath Manager list, use the [**Shift+Click**] method to select the toolpaths numbered **9-10** (finish tap).
- 6 In the Toolpath Manager, click the **Backplot selected operations** button. 
- 7 In the Backplot VCR bar, click **Play**  to backplot finish tap cycles for the blind and through holes.

FBM Drill applies the tip compensation and additional break-through amount (3.0mm) to the tapped through hole's finish cycle, fully finishing the threaded hole.



The tapped blind hole's finish cycle plunges the tool to the hole's defined bottom.



- 8** When finished, click **OK** in the Backplot dialog box to exit the Backplot function.
- 9** From the Mastercam menu, choose **File, Save As**.

In the Save As dialog box, do the following:

- a** Change EX2 to **EX3** in the tutorial part **File name**—for example:
`FBM_DRILL_LESSON5_EX3_[your initials].MCX`
- b** Click **OK** to save the file. This completes the exercise, and the lesson.

Skills Challenge

Congratulations! You have completed Lesson 5, “Adjusting the Tool Tip”.

As a challenge to the skills you learned in this lesson, try one or more of the following exercise suggestions.

Using any of the files you saved in this lesson:

- Backplot all of the toolpaths to see the plunge depths in different cycles. Can you explain what is happening and why?
- Experiment with the FBM Drill parameters by changing the finish tool type (Hint: **Features** page), and the tip compensation, break-through, and tap/ream adjustment settings. Then regenerate the toolpaths and backplot the results. How did the plunge depths change? Do you understand the change?

LESSON 6

Working in the Features Page

The Features page is your dashboard for managing hole detection results, hole type and tool assignments, the direction of hole normals, and the toolpath output you receive from the FBM Drill operation.

Only features that match your detection criteria appear in the Features page for review. Mastercam automatically creates toolpaths for detected features when you save the FBM Drill operation.

Lesson Goals

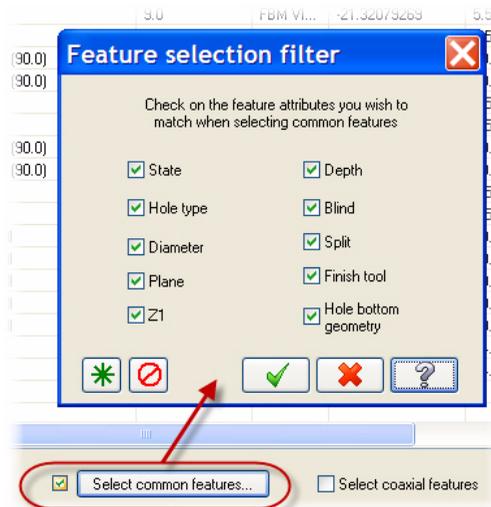
- Isolate and select specific features, and check the direction of normals in the graphics window.
- Suppress features from toolpath generation, and delete features before generating toolpaths.
- Adjust the FBM Drill parameters to change feature detection results, and resolve FBM warnings.

Selection Skills Review

You use [**Shift+Click**] and [**Ctrl+Click**] methods to select features in the Features page list in the same manner as selecting toolpaths in the Toolpath Manager. The Features page also provides **Select all/Unselect all** buttons that work the same as in other Mastercam dialog boxes.



In Lesson 4, “Assigning Tools” (page 81), you were introduced to the Features page **Select common features** function and used it to create and apply a Feature selection filter.



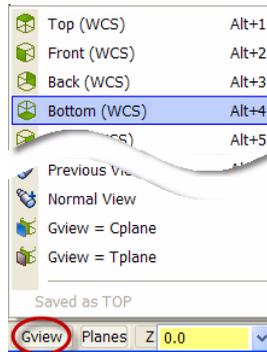
In that lesson, you used the filter to select all holes with the same diameter by selecting one hole in the Features page list. To modify the attributes to match, click the **Select common features** button and then choose any combination of attributes in the Feature selection filter dialog box.

Exercise 1: Selecting Features

In this exercise, you learn new techniques for locating and selecting specific features. You select holes in the Features page list to highlight their geometry in the graphics window, view the normals of all detected features, and select holes in the graphics window to automatically locate and select them in the Features page list.

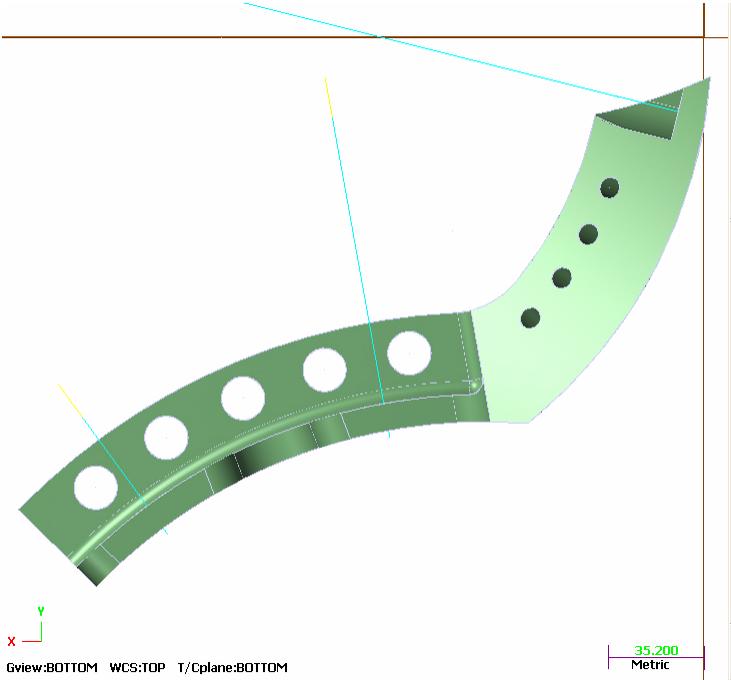
► Sort Features

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part: FBM_DRILL_LESSON6 .MCX
- 3 From the Status bar **Gview** menu, choose **Bottom (WCS)**.

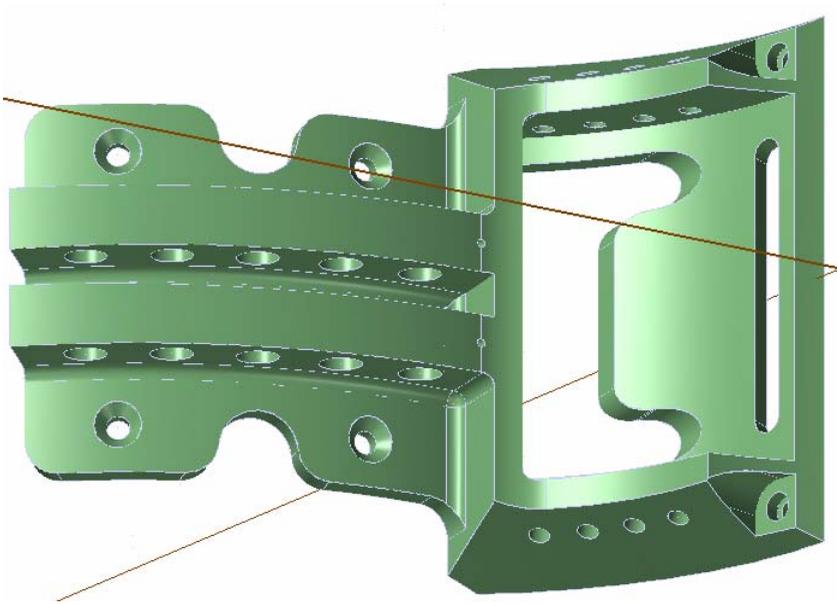


- 4 Fit the part to the screen  and shade it. 

- 5 Press **F9** to display the coordinate axes in the graphics window. Your graphics window part display should look similar to the following picture:



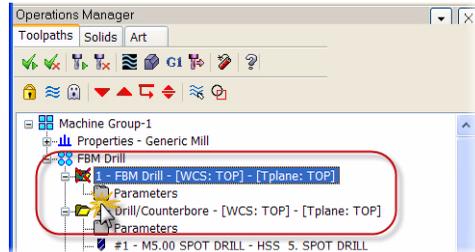
- 6 Dynamically rotate the part until it looks similar to the following picture:



This orientation helps you see all holes in the model.

- In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.



- Choose **Features** in the Tree View pane.

Your features list should match the following picture.

Display all normals 19 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Fi
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Chamfer (90.0)	17.91990231	FBM VI...	-15.82079269	10.0		X			MC
🚩	Chamfer (90.0)	17.91990448	FBM VI...	-15.82079269	10.0		X			MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Chamfer (90.0)	17.91980103	FBM VI...	-109.28493099	10.0		X			MC
🚩	Chamfer (90.0)	17.91980225	FBM VI...	-109.28493099	10.0		X			MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC

Select common features... Select coaxial features

The default sort order of detected features in the list is by *Plane*.

- Click on the **State** column heading.

FBM Drill sorts the Features page list by the State description. All holes that can be successfully machined appear first in the list, followed by holes with warning messages.

Display all normals

State	Hole type	Dia.
⚠	Drill	3.3
⚠	Drill	3.3
⚠	Drill	6.6
⚠	Drill	6.6
🚩	Counter bore	11.0
🚩	Counter bore	11.0



TIP: Sorting by column lets you quickly group features prior to selecting them. Click in any column heading to sort the Features page list in ascending/descending order by the column data. To reverse the sort order, click again.

Note: In Exercise 3 (page 155) you learn to fix problems reported by FBM Drill warnings.

► Select Coaxial Features

- 1 At the bottom of the Features page, activate the **Select coaxial features** check box.

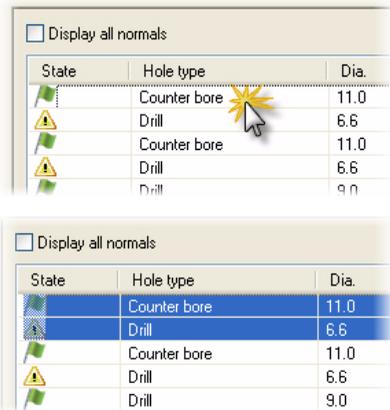


FBM Drill sorts the Features page list to group coaxial hole features (multiple holes that share a common axis).

- 2 Select the first hole in the list.

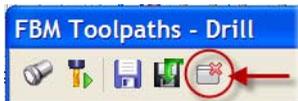
FBM Drill automatically selects the second hole in the list because it is coaxial with the counterbore hole you first selected.

The graphics window displays the normals of the selected holes and highlights their geometry.



TIP: The **Z1** column displays the depth where the hole feature starts. For coaxial features, the **Z1** value is also the bottom (end) of the feature that is positioned immediately above the next coaxial feature. The **Depth** column shows the distance between **Z1** and the designed bottom of the hole.

- 3 In the FBM Drill dialog box menu, click the **Hide dialog** button.

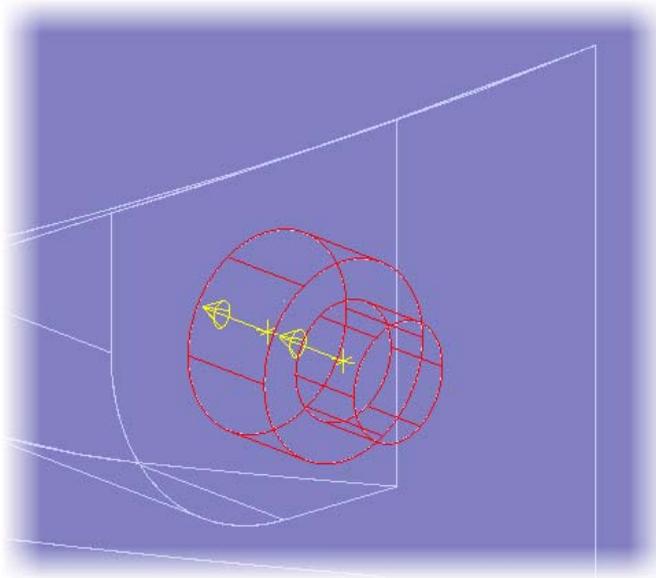


The dialog box minimizes in the lower left area of the Mastercam window.

- 4 Change your shade settings to **Wireframe**.



- 5 Use **Zoom** functions to get a better view of the hole geometry highlighted in the graphics window and the normals display.



Both holes share the same axis, as indicated by their normals.

- 6 Fit the part to the screen.



- 7 Press **[Esc]** to maximize the FBM Drill dialog box in the Mastercam window.

- 8 Select the **Display all normals** check box.

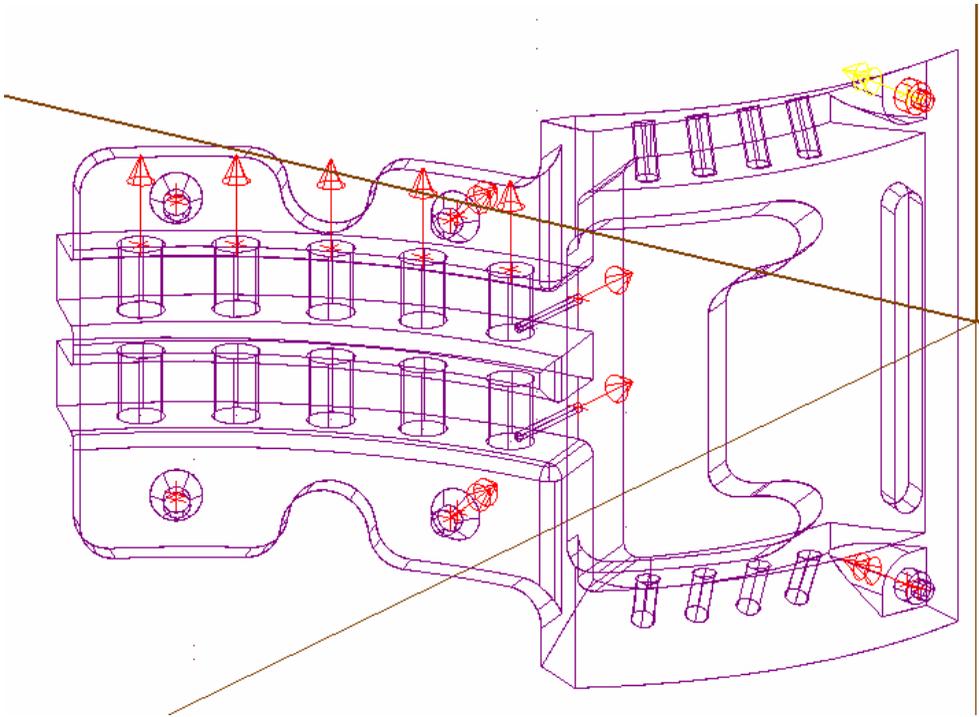


The graphics window displays the normals for *all holes in the FBM Drill features list* and highlights their geometry.



TIP: If you cannot view the graphics window clearly to verify that all normals display, hide the FBM Drill dialog box. Then maximize it when you are ready to continue the exercise.

Your graphics window should look similar to the following picture:



► Locate Hole Features

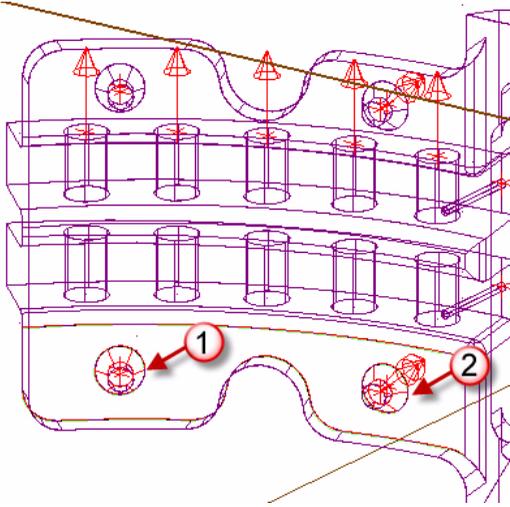
- 1 Choose the **Select** button.

The FBM Drill dialog box minimizes.

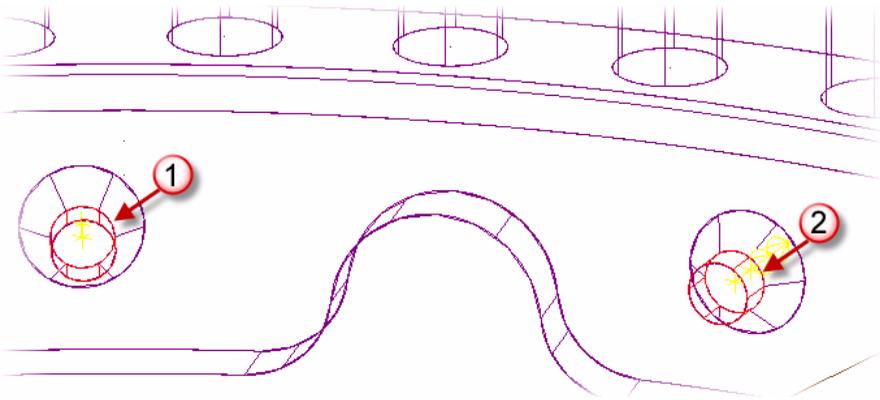


You are prompted in the graphics window to select hole features in the solid model.

2 Select the two chamfered holes as indicated (select only the hole features, *not* the chamfers):



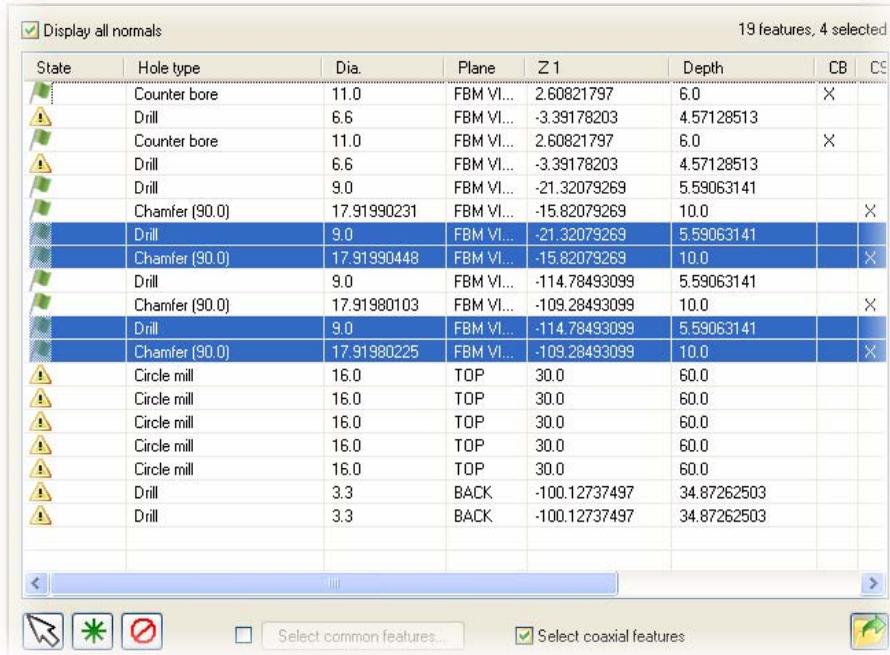
TIP: Use **Zoom** functions if you have difficulty selecting the holes.



3 In the General Selection ribbon bar, choose the **End selection** button.



The FBM Drill dialog box maximizes. All of the holes that you selected in the graphics window are selected in the Features page list.



The chamfers are also selected because **Select coaxial features** is active.

This selection technique helps you relate model features displayed in the graphics window to detected features in the Features page list.

- 4 Click **OK** to accept the parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

Note: The FBM Drill operation is marked dirty in the Toolpath Manager. Do not regenerate the operation.

► Save the Part File

- 1 Choose **File, Save As**.

- 2 In the Save As dialog box, do the following:
 - a Add **EX1** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON6_EX1_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise.

Note: Although you have not modified FBM_DRILL_LESSON6.MCX in this lesson, it is a best practice to save the lesson file to a different file name. This allows you to experiment with the file and FBM Drill parameters without risk of overwriting the original tutorial file.

Exercise 2: Suppressing and Deleting Features

In this exercise, you learn to suppress features from toolpath generation, and to delete them from the Feature page list.



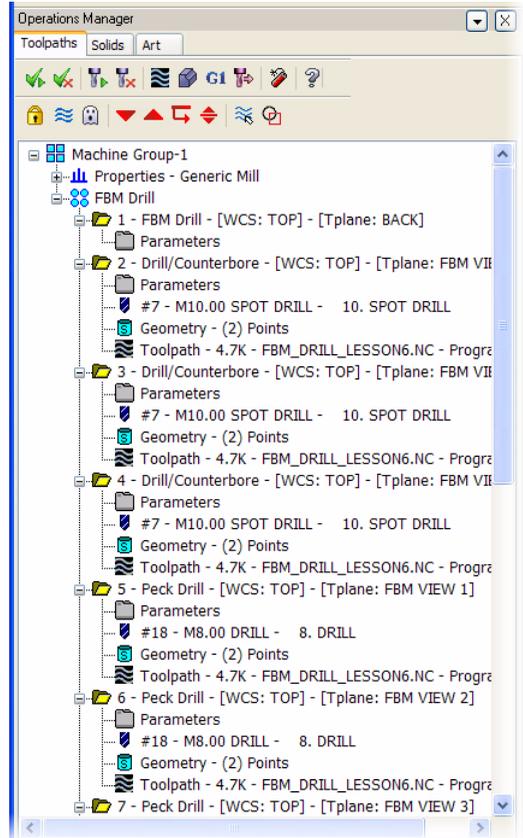
IMPORTANT: As a best practice, make modifications to features only at the final stage of creating the FBM Drill operation. Detecting holes features in the FBM Drill operations rebuilds the Features page list, overwriting any manual hole type, plane, and finish tool modifications.

▶ Suppress Features

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part: FBM_DRILL_LESSON6.MCX

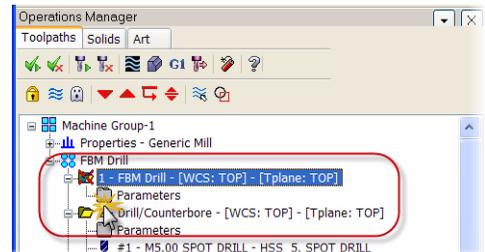
The Toolpath Manager lists the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Three Ø10.0mm spot drill operations (#2-4)
- ◆ Three Ø8.0mm pre-drill operations (#5-7)
- ◆ One Ø10.0mm counterbore operation (#8)
- ◆ Two Ø9.0mm drill operations (#9-10)
- ◆ One Ø11.0mm drill operation (#11)
- ◆ Two Ø20.0mm chamfer operations (#12-13)



- 3** In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.



- 4** Choose **Features** in the Tree View pane.

Your features list should match the following picture.

Display all normals 19 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Fill
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Chamfer (90.0)	17.91990231	FBM VI...	-15.82079269	10.0		X			MC
🚩	Chamfer (90.0)	17.91990448	FBM VI...	-15.82079269	10.0		X			MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Chamfer (90.0)	17.91980103	FBM VI...	-109.28493099	10.0		X			MC
🚩	Chamfer (90.0)	17.91980225	FBM VI...	-109.28493099	10.0		X			MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC

Select common features... Select coaxial features



TIP: Change the size of any column in the page to improve your view of the data. To do this:

- a In a column header row, hover the mouse over the column border until the cursor changes to a resize icon.
- b Click and drag the column border to the left or right.
- c Release the mouse button when the column is the size you want.

- 5 At the bottom of the Features page, activate the **Select coaxial features** check box.



FBM Drill sorts the Features page list to group coaxial hole features (multiple holes that share a common axis).

- 6 Click the **Dia.** column heading.
FBM Drill sorts the list by hole diameter.
- 7 Use the [**Shift+Click**] method to select both Ø6.6mm holes in the list.

Display all normals

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Fill
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC

Select common features... Select coaxial features

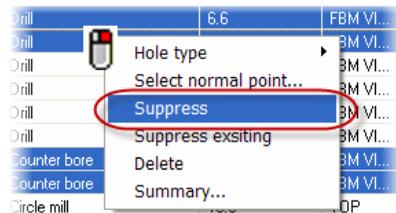
FBM Drill also selects the Ø6.6mm holes' coaxial counterbore features.

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	3.3	BACK	-100.12737497	34.87262503		
	Drill	6.6	FBM VI...	-3.39178203	4.57128513		
	Drill	6.6	FBM VI...	-3.39178203	4.57128513		
	Drill	9.0	FBM VI...	-21.32079269	5.59063141		
	Drill	9.0	FBM VI...	-21.32079269	5.59063141		
	Drill	9.0	FBM VI...	-114.78493099	5.59063141		
	Drill	9.0	FBM VI...	-114.78493099	5.59063141		
	Counter bore	11.0	FBM VI...	2.60821797	6.0	X	
	Counter bore	11.0	FBM VI...	2.60821797	6.0	X	
	Circle mill	16.0	TOP	30.0	60.0		
	Circle mill	16.0	TOP	30.0	60.0		

8 Right-click and choose **Suppress**.

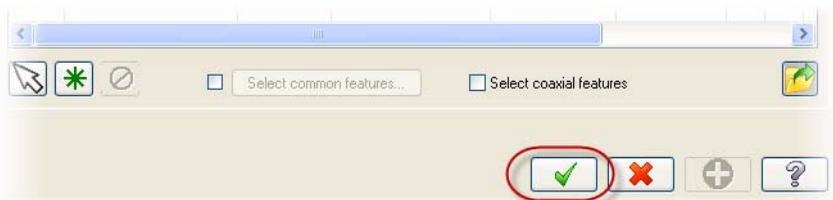
The icons next to the selected features changes from green to gray to indicate that they are suppressed.

FBM Drill does not create toolpaths for suppressed features.



However, when FBM Drill generates toolpaths for unsuppressed features, it considers suppressed feature data when calculating incremental clearance and retract moves.

9 Click **OK** to accept the changed parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button.

- 2 The FBM Warnings dialog box displays information about detected hole features with a warning state.

Click **OK** to close the dialog box.

Note: In Exercise 3 (page 155) you learn to fix problems reported by FBM Drill warnings.

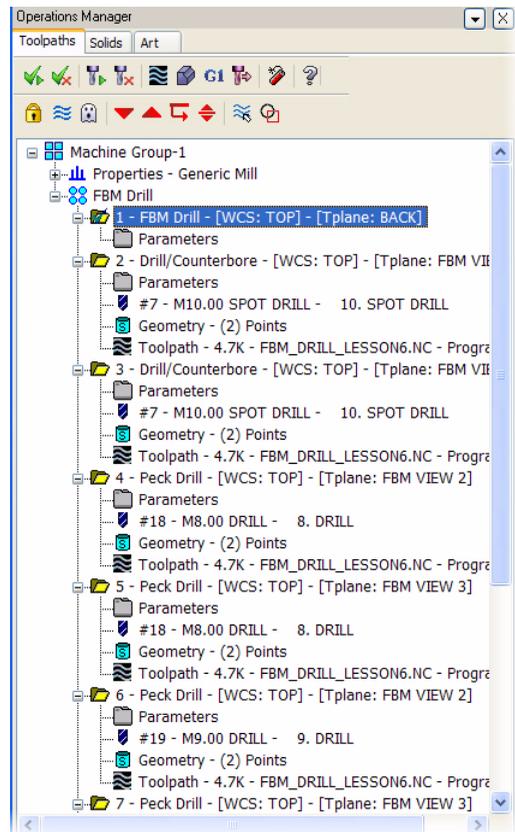
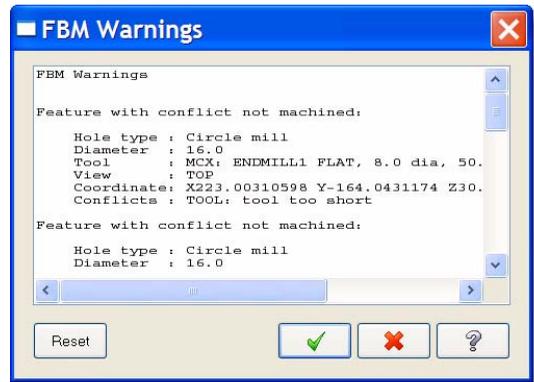
Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

- 3 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Two Ø10.0mm spot drill operations (#2-3)
- ◆ Two Ø8.0mm pre-drill operations (#4-5)
- ◆ Two Ø9.0mm drill operations (#6-7)
- ◆ Two Ø20.0mm countersink operations (#8-9)

FBM Drill does not generate spot drill, pre-drill, and finish drill operations for the two Ø6.6mm holes and their Ø11.0mm counterbores because you suppressed them.

Use Backplot to verify this.



► Backplot the FBM Drill-Generated Toolpaths

- 1 In the Toolpath Manager, click the **Select all operations** button. 

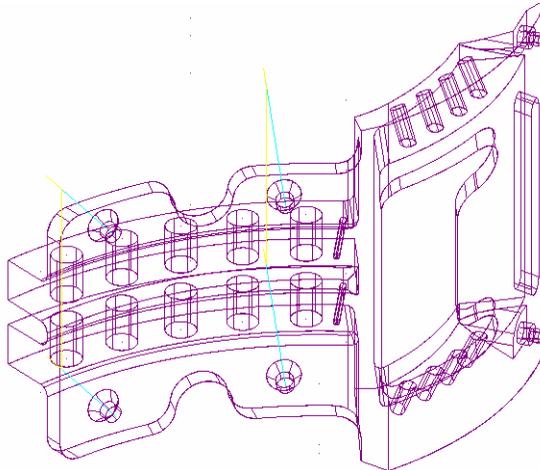


- 2 Set up the part display in the graphics window.

- a Change the Gview to **Back (WCS)**.

- b Set shade settings to **Wireframe**. 

- c Slightly rotate the part to get a better view of the chamfered holes and their toolpaths.



- d Fit the part to screen.  Then zoom out to about 40% and position the part lower in the graphics window.

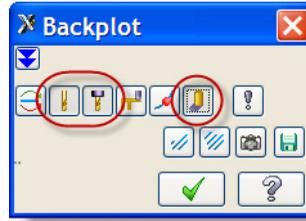
- 3 In the Toolpath Manager, click the **Backplot selected operations** button. 

The Backplot dialog box and Backplot VCR bar open.

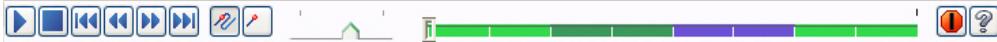


- In the Backplot dialog box, select the **Display tool**, **Display holder**, and **Quick verify** buttons.

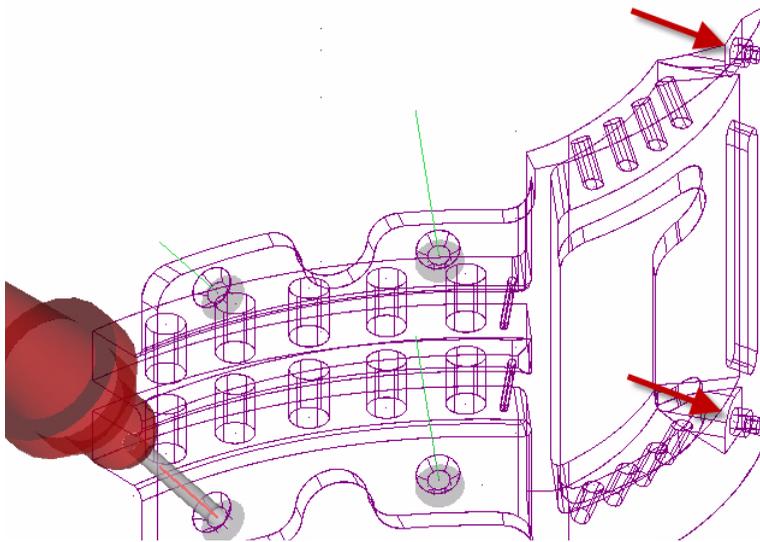
These options display a simulation of a tool and holder during backplot, and shade the toolpath.



- Use the buttons and sliders on the Backplot VCR bar to backplot the operations.



Click **Play**  to begin the backplotting action. Confirm that no toolpaths exist for the two counterbore holes in the part.



- When finished, click **OK** in the Backplot dialog box to exit the Backplot function.

▶ Delete Features

- In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.

- If necessary, choose **Features** in the Tree View pane.

- In the Features page list, deactivate the **Select coaxial features** check box.



4 Click the **Hole type** column.

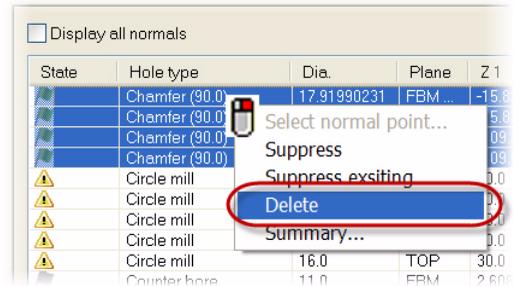
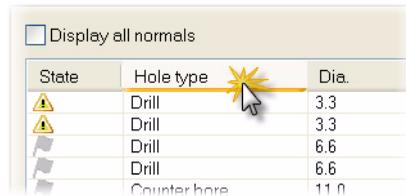
FBM Drill sorts the list by hole type.

5 Use the **[Shift+Click]** method to select all four chamfers in the list.

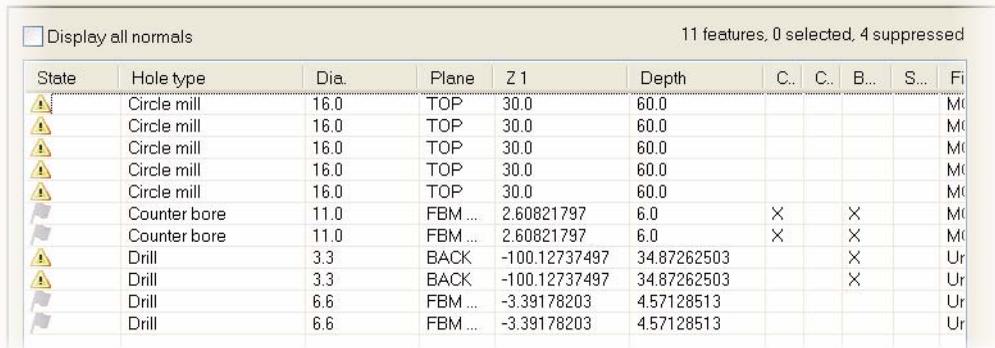
6 Right-click and choose **Delete**.



TIP: You can also delete selected features by pressing the **[Delete]** key.



FBM Drill deletes the selected chamfer features *and also deletes their associated Ø9.0mm coaxial holes* from the Features page list. The features are deleted only from the list. They are not deleted from the model.



7 Click **OK** to accept the changed parameters for the FBM Drill operation.



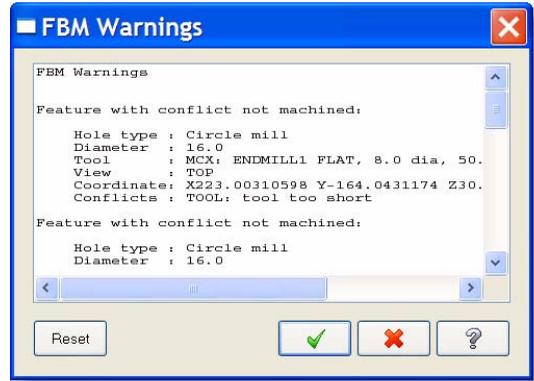
The FBM Drill dialog box closes.

▶ Regenerate the FBM Drill Operation and its Toolpaths

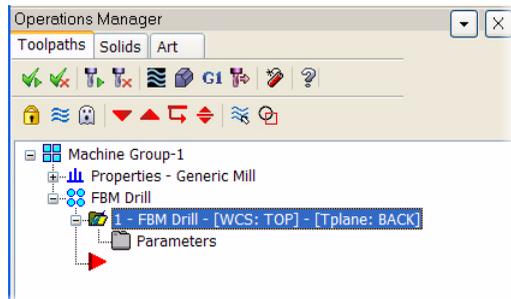
- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

- 2 The FBM Warnings dialog box displays information about detected hole features with a warning state.

Click **OK** to close the dialog box.



- 3 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results. You should see only the FBM Drill operation.



▶ Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Add **EX2** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON6_EX2_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise.



TIPS:

- To *unsuppress* features and restore them to their original state, select them in the Features page list, right-click and choose **Suppress** again. The Suppress right-click menu function works as a toggle to suppress/unsuppress selected features.
- To restore deleted hole features, click the **Detect** button  in the FBM Drill dialog box. The model is analyzed and holes are redetected based on the current FBM Drill parameters.

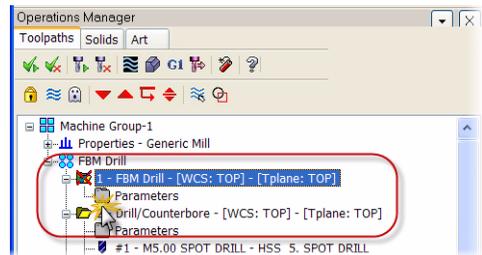
Exercise 3: Resolving FBM Warnings

In this exercise, you resolve a short tool problem and an unassigned tool problem by changing FBM Drill settings. FBM Drill reports problems with detected hole features in the Features page State column and in the FBM Warnings dialog box.

FBM Drill does not generate toolpaths for detected features with a warning state.

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part: FBM_DRILL_LESSON6.MCX
- 3 In the Toolpath Manager, click the FBM Drill **Parameters**.

The FBM Drill dialog box opens.



- 4 Choose **Features** in the Tree View pane.

Your features list should match the following picture.

Display all normals 19 features, 0 selected

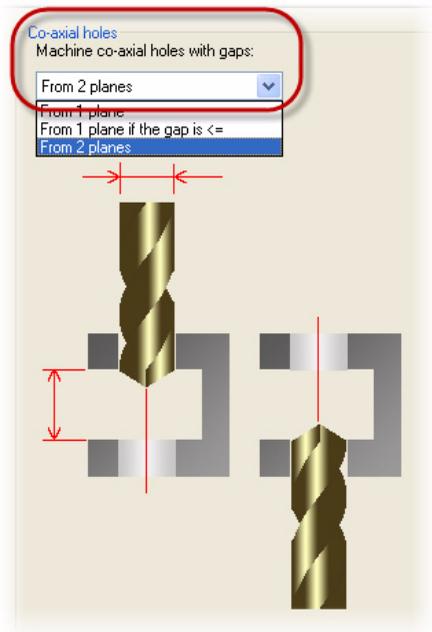
State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Fi
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	3.3	BACK	-100.12737497	34.87262503			X		Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
⚠	Drill	6.6	FBM VI...	-3.39178203	4.57128513					Ur
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Counter bore	11.0	FBM VI...	2.60821797	6.0	X		X		MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-21.32079269	5.59063141					MC
🚩	Chamfer (90.0)	17.91990231	FBM VI...	-15.82079269	10.0		X			MC
🚩	Chamfer (90.0)	17.91990448	FBM VI...	-15.82079269	10.0		X			MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Drill	9.0	FBM VI...	-114.78493099	5.59063141					MC
🚩	Chamfer (90.0)	17.91980103	FBM VI...	-109.28493099	10.0		X			MC
🚩	Chamfer (90.0)	17.91980225	FBM VI...	-109.28493099	10.0		X			MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC
⚠	Circle mill	16.0	TOP	30.0	60.0					MC

Select common features... Select coaxial features

- 4 In the Hole Detection page, choose **From 2 planes** in the drop-down list.

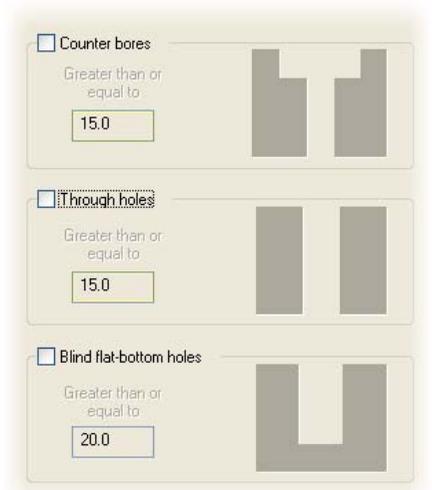
FBM Drill generates toolpaths that machine each of the coaxial holes from their respective planes.

This includes generating separate spot drill, pre-drill, and drill cycles for each hole.



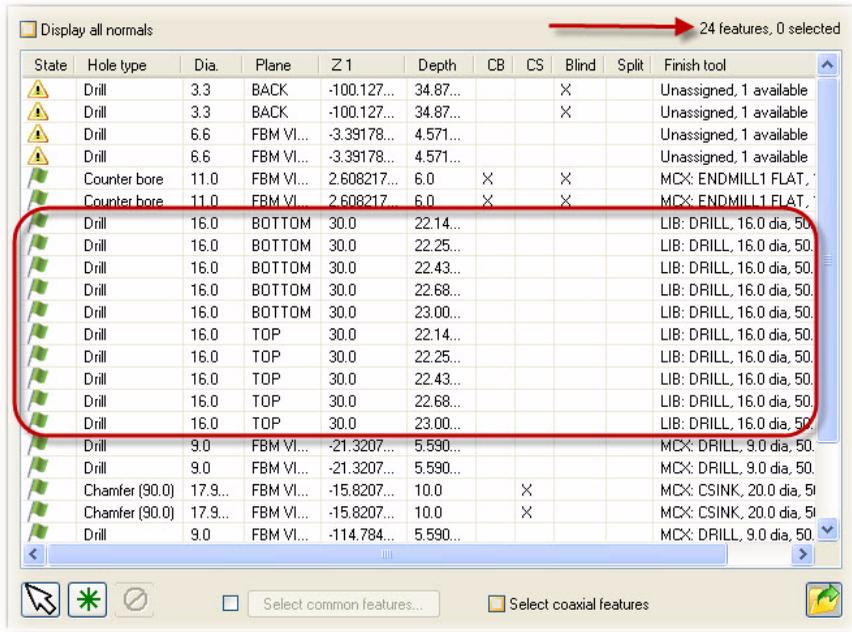
- 5 Choose **Hole milling** in the Tree View pane.
- 6 In the Hole milling page, deselect the **Counter bores** and **Through holes** check boxes.

Note: Deselecting all of the check boxes in the page deactivates hole milling for the FBM Drill operation.



- 7 Click the **Detect** button  to analyze the solid model based on your changes.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

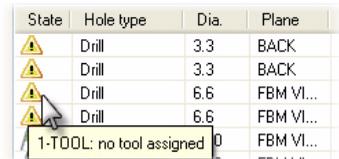


- ◆ FBM Drill replaces the five Ø16.0mm coaxial Circle mill hole features detected previously with ten separate Ø16.0mm Drill features.
- ◆ The total number of detected features changes from 19 to 24.
- ◆ The Plane column shows that five of the Ø16.0mm coaxial features are detected in the BOTTOM plane, and five in the TOP plane.
- ◆ The icon  in the State column indicates that the Ø16.0mm coaxial features can be machined with the assigned tool.

► Resolve an Unassigned Tool Problem

- 1 In the Features page, hover your mouse in the **State** column of one of the Ø6.6mm drill features until the error message displays.

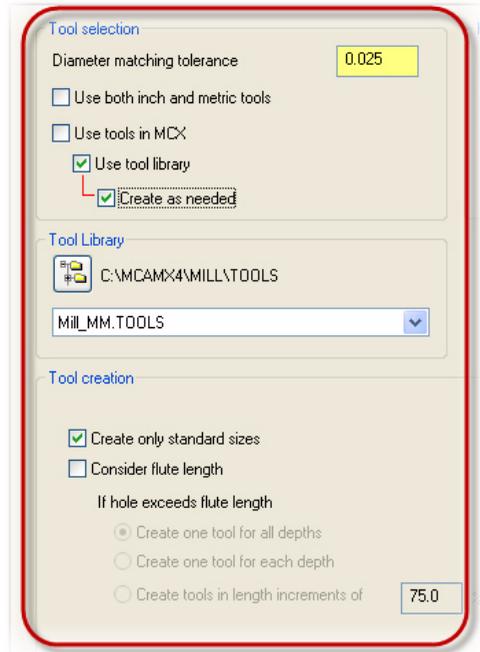
FBM Drill cannot assign a tool. To resolve this issue, change settings in the Tools page.



- 2 Choose **Tools** in the Tree View pane.

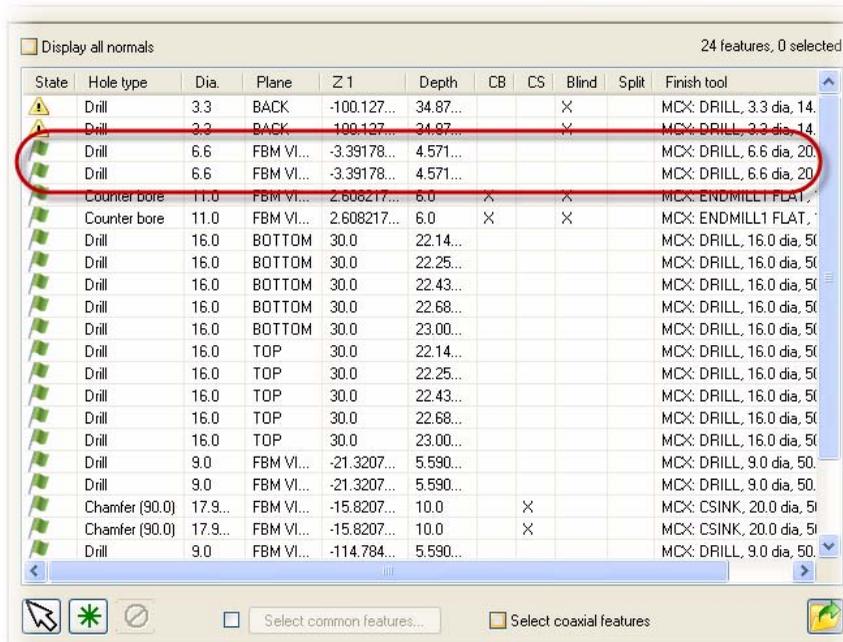
3 In the Tools page, select **Create as needed**.

Verify that your other parameters are as shown.



4 Click the **Detect** button  to analyze the solid model based on your changes.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.



- ◆ FBM Drill creates and assigns a standard Ø6.6mm drill to the two Ø6.6mm features in the list.
- ◆ The icon  in the State column indicates that the Ø16.0mm coaxial features can be machined with the assigned tool.

Note: The remaining warnings in the Features page list for the two Ø3.3mm features are related to settings in the Deep Drilling page; they will not be resolved in this exercise. You learned about these settings in Lesson 2, “Adding Drill Cycle Operations”, Exercise 3 (page 58).

- 5 Click **OK** to accept the changed parameters for the FBM Drill operation.



The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

- 1 In the Toolpath Manager, click the **Regenerate all dirty operations** button. 

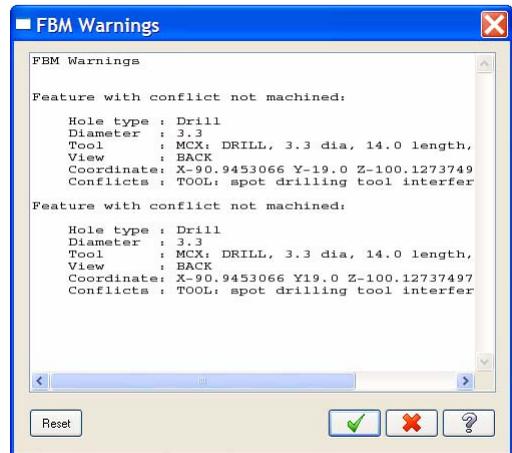
Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

- 2 The FBM Warnings dialog box displays information about the two Ø3.3mm hole features that remain in a warning state.

Click **OK** to close the dialog box.

- 3 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see operations #1-67 in the FBM Drill toolpath group, including their parent FBM Drill operation.



► Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Add **EX3** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON6_EX3_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise and the lesson.

Skills Challenge

Congratulations! You have completed Lesson 6, “Working in the Features Page”.

As a challenge to the skills you learned in this lesson, try one or more of the following exercise suggestions.

Using any of the files you saved in this lesson:

- 1** Suppress or delete detected features in the FBM Drill Features page.
- 2** Regenerate the FBM Drill operation and its toolpaths to see the effect.
- 3** From the Toolpath Manager, open the FBM Drill operation dialog box and redetect features. What happens in the Features page?
(Hint: Make modifications to features only at the *final stage* of creating the FBM Drill operation.)

Using the file you saved in Exercise 2 (page 146):

- Unsuppress the features you suppressed in the Features page list, and restore them to their original state.
- Undelete the features you deleted from Features page list.

Using the file you saved in Exercise 3 (page 155):

- 1** Add the deep drilling parameters defined in Lesson 2, “Adding Drill Cycle Operations”, Exercise 3 (page 58) to the FBM Drill operation.
- 2** Redetect features. Did your changes resolve the final two warnings reported for the Ø3.3mm drill features detected the model? Do you understand why/why not?

LESSON 7

Creating Point and Vector Geometry

In this lesson, you configure FBM Drill's Setup page to create two different types of geometry:

- Points associative to independent FBM Drill-generated toolpaths, but not associative to the solid model.
- Points and vectors that are not associative to the solid model nor to any toolpath.

Independent Points and FBM Drill-Generated Operations

The Setup page offers an option to create drilling operations that are independent of both the solid model and of the FBM Drill parent operation.

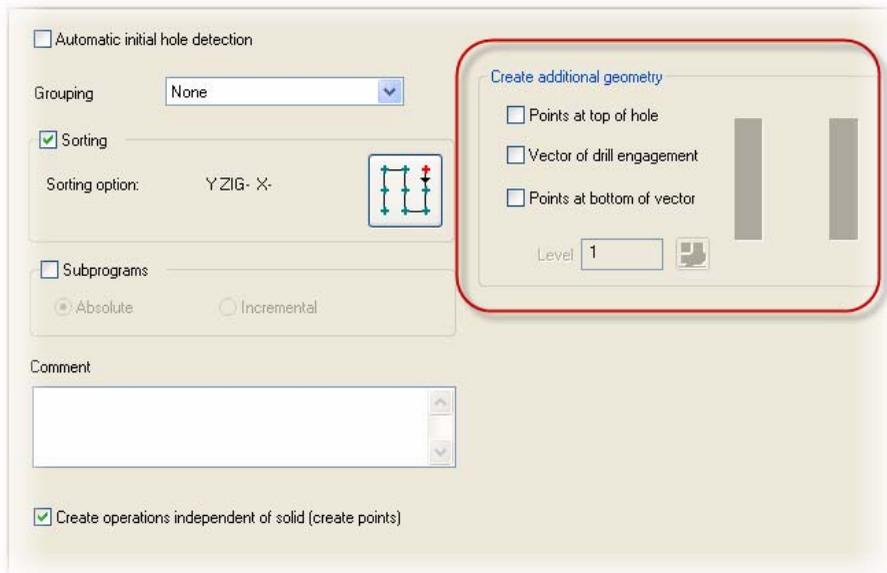
Create operations independent of solid (create points)

To accomplish this, FBM Drill creates a point at the top of each detected hole, and makes the point associative to the independent drill operation it generates.

The point geometry is not associative to the hole feature in the solid model. The drill operations are not associative to the FBM Drill operation.

Non-associative Points and Vectors

You also can use FBM Drill's Setup page parameters to create geometry (points at the top and bottom of each hole, and vectors for each hole) on a specified Mastercam level.



The additional geometry is completely non-associative; it is independent of any toolpath or solid model feature, and can be used in any Mastercam toolpath.

FBM Drill uses the detected hole feature data to create points at the top of the hole. FBM Drill calculates drill cycle toolpath data to create the vectors and the bottom points. The vector length is defined by a theoretical drill path while it is engaged in the cut. The vector starts at the top of the hole and extends to where the drill tip of the finish tool would stop. The end point of the vector includes any **Tip Comp** and **Additional Break Through** defined for the toolpath in the FBM Drill Linking Parameters page.



TIP: If you choose to **Create operation independent of solid (create points)** and also select **Points at top of hole**, a best practice is to place the additional geometry on a different level than the toolpath geometry. Otherwise, you will create duplicate points.

Lesson Goals

- Use FBM Drill to create points that are associative with the independent drilling toolpaths FBM generates. Use FBM Drill settings to group the generated toolpaths by plane in the Toolpath Manager.
- Create point and vector geometry on level 200 for use by other toolpaths, for example, a 5-axis drill operation. The FBM Drill-created geometry is independent, both of the solid model and of the FBM Drill operation.

Exercise 1: Creating Independent Points and Drill Cycles

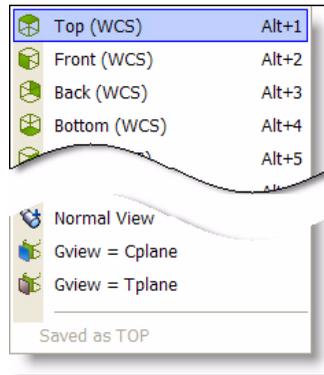
In this exercise, you perform the following tasks:

- Isolate five pairs of Ø16.0mm coaxial holes in the Top and Bottom planes.
- Configure the FBM Drill operation to create drill points and generate a series of independent spot drill and finish drill operations for machining the holes in a single plane (Top).
- Reconfigure the FBM Drill operation and generate spot drill, pre-drill, and finish toolpaths to machine each of the coaxial holes from their respective planes (Top and Bottom).
- Use FBM Drill settings to group the generated toolpaths by plane in the Toolpath Manager.

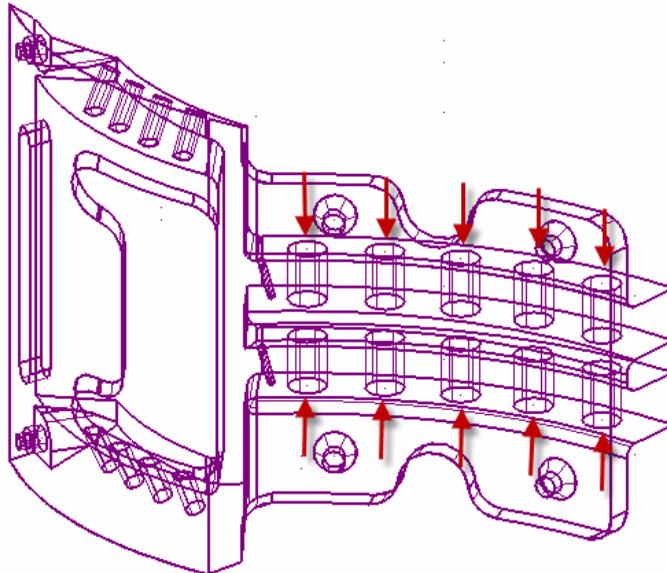
► Create the FBM Drill Operation

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: `FBM_DRILL_LESSON7.MCX`.

- 3 From the Status bar **Gview** menu, choose **Top (WCS)**.

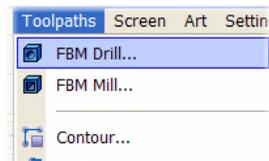


- 4 Fit the part to the screen  and set shade settings to **Wireframe**. 
- 5 Dynamically rotate the part until you see the ten $\text{\O}16.0\text{mm}$ holes indicated in the following picture. Five pairs of holes share the same axis, making each pair coaxial holes.



- 6 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu to create one.
- 7 Choose **Toolpaths, FBM Drill**.

The FBM Drill dialog box opens to the Setup page parameters.

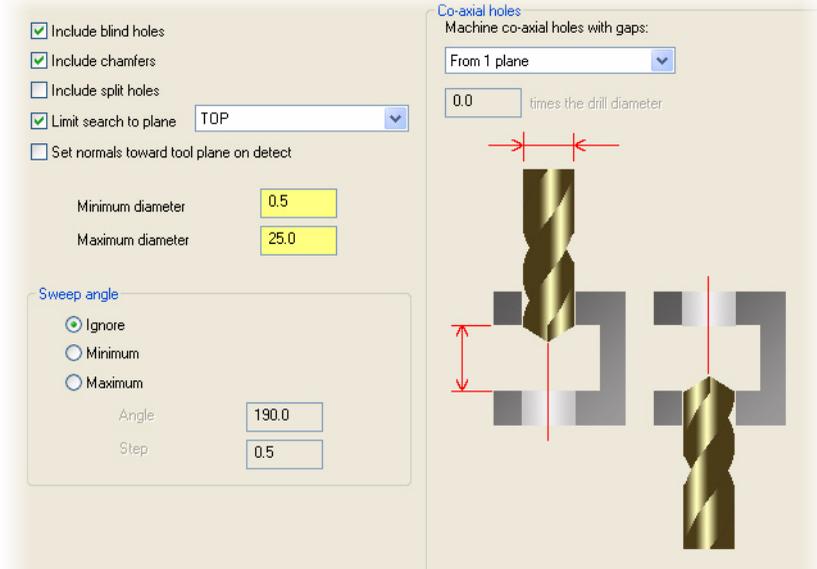


8 In the Setup page, select **Create operations independent of solid (create points)**.

Create operations independent of solid (create points)

9 Choose **Hole Detection** in the Tree View pane.

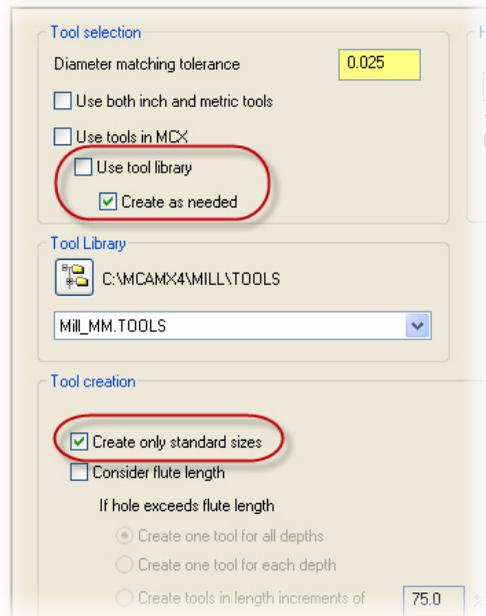
10 In the Hole Detection page, make sure that your parameters match the following picture:



11 Choose **Tools** in the Tree View pane.

12 In the Tools page, deselect **Use tool library**.

Make sure **Create as needed** and **Create only standard sizes** are selected.



- 13 Click the **Detect** button  to analyze the solid model based on your current FBM Drill parameters.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	16.0	TOP	30.0	60.0					MCX: DRILL, 16.0 dia, 160.0 len
	Drill	16.0	TOP	30.0	60.0					MCX: DRILL, 16.0 dia, 160.0 len
	Drill	16.0	TOP	30.0	60.0					MCX: DRILL, 16.0 dia, 160.0 len
	Drill	16.0	TOP	30.0	60.0					MCX: DRILL, 16.0 dia, 160.0 len
	Drill	16.0	TOP	30.0	60.0					MCX: DRILL, 16.0 dia, 160.0 len

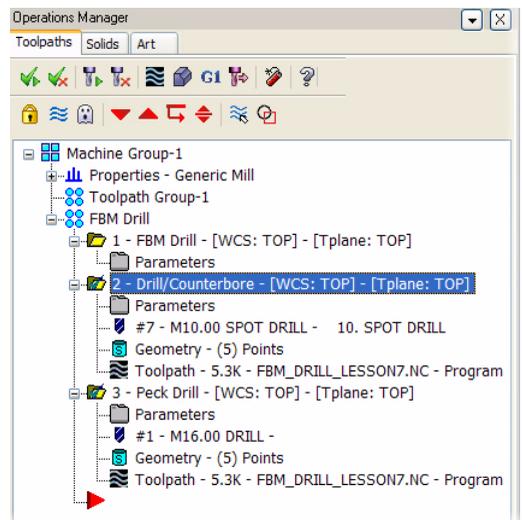
- ◆ FBM Drill detects five Ø16.0mm holes in the model that match your settings.
- ◆ Each pair of coaxial holes is considered a single combined hole to be machined from the TOP plane.
- ◆ FBM Drill creates a Ø16.0mm drill 160.0mm long and assigns it to the coaxial holes.
- ◆ The icon  in the State column indicates that the detected features can be machined with the assigned tool.

► Generate FBM Toolpaths

- 1 Click **OK**  in the FBM Drill dialog box to create points and generate independent toolpaths to machine the detected features.
- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

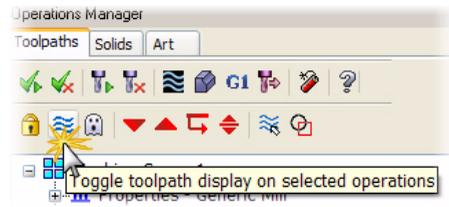
You should see the following:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One Ø10.0mm spot drill cycle for each set of five holes (#2)
- ◆ One Ø16.0mm drill cycle for each set of five holes (#3)



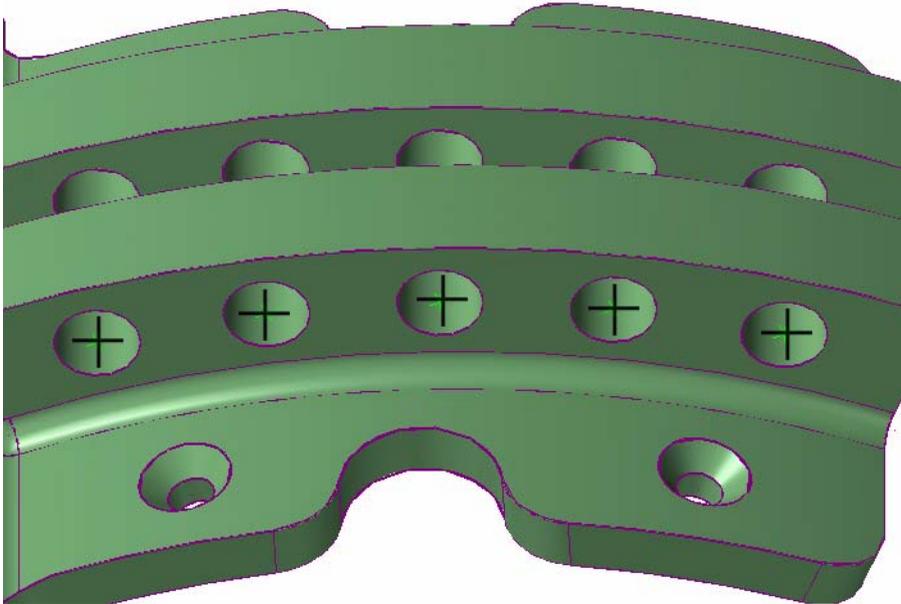
► View Toolpath Point Geometry

- 1 In the Toolpath Manager, click the **Toggle toolpath display** button  until you toggle off the toolpath display of selected toolpaths in the graphics window.



TIP: You can also press [Alt+T] to toggle on and off the display of toolpaths in the graphics window.

- 2 Change your shade settings from wireframe to **Shaded**. 
- 3 Use Mastercam's view manipulation functions to get a better view of the new five points FBM Drill created for the generated toolpaths.

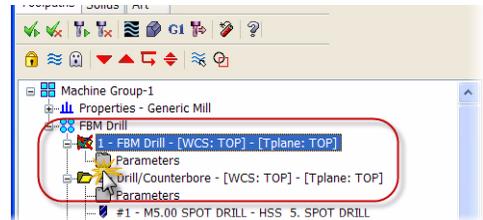


► Create Points and Toolpaths Grouped by Plane

- 1 In the Toolpath Manager, click the FBM Drill Parameters.

The FBM Drill dialog box opens.

- 2 Choose **Setup** in the Tree View pane.



- 3 In the Setup page, choose **Plane** from the **Grouping** drop-down list.

This selection groups all operations by plane in the Toolpath Manager.

Mastercam orders operations within groups into subgroups by operation type.

- ◆ The first subgroup includes all spot and pre-drilling operations.
- ◆ The next subgroup includes all finish tool and chamfering operations.

- 4 Choose **Hole Detection** in the Tree View pane.

- 5 In the Hole Detection page, verify that **Limit search to plane** is selected and the plane is set to **TOP**.

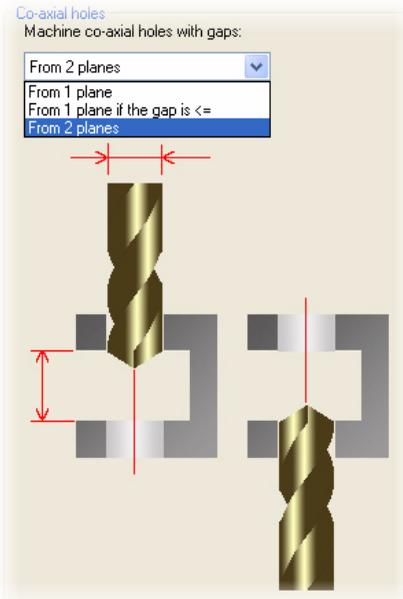
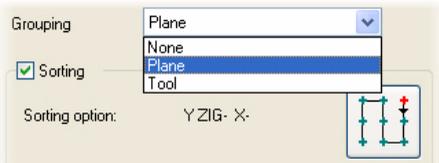
- 6 Choose **From 2 planes** from the Co-axial holes drop-down list.

FBM Drill generates toolpaths that machine each of the coaxial holes from their respective planes.

This includes generating separate spot drill, pre-drill and drill cycles.

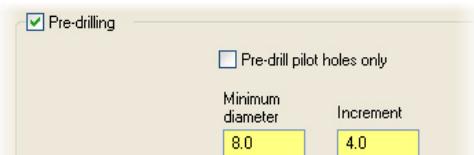
- 7 Choose **Pre-drilling** in the Tree View pane.

The Pre-drilling page is activated by default (**Pre-drilling** is selected). The option to **Pre-drill Pilot holes only** is also selected.



- 8 In the Pre-drilling page:

- a Deselect **Pre-drill Pilot holes only**.
- b Type **8.0** in the Minimum diameter field.

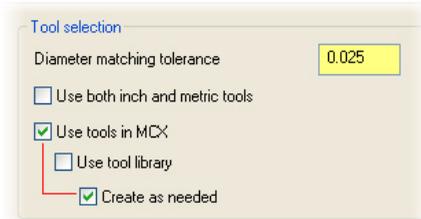


c Type **4.0** in the Increment field.

9 Choose **Tools** in the Tree View pane.

10 In the Tools page, select **Use tools in MCX**.

FBM Drill looks first for tools in the Mastercam part. Then it creates any tools needed using FBM Drill's standard tools table file.



11 Click the **Detect** button  to analyze the solid model based on your changes.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

Display all normals → 10 features, 0 selected

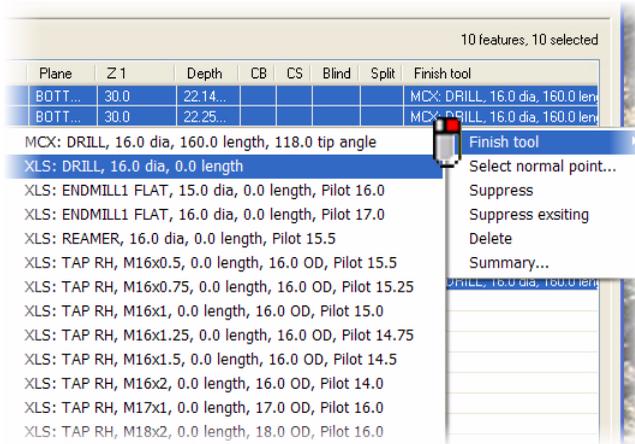
State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	16.0	BOTTOM	30.0	22.14...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	BOTTOM	30.0	22.25...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	BOTTOM	30.0	22.43...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	BOTTOM	30.0	22.68...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	BOTTOM	30.0	23.00...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	TOP	30.0	22.14...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	TOP	30.0	22.25...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	TOP	30.0	22.43...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	TOP	30.0	22.68...					MCX: DRILL, 16.0 dia, 160.0 lei
	Drill	16.0	TOP	30.0	23.00...					MCX: DRILL, 16.0 dia, 160.0 lei

- ◆ FBM Drill replaces the five Ø16.0mm coaxial drill features detected previously with ten Ø16.0mm drill features.
- ◆ The total number of detected features changes from 5 to 10.
- ◆ The Plane column shows that five of the Ø16.0mm coaxial features are detected in the BOTTOM plane, and five in the TOP plane.

12 In the Features page, click **Select all**.

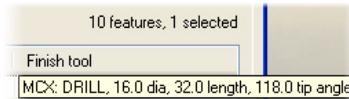


- 13 Right-click in the **Finish tool** column. Choose **Finish tool**, and then select **XLS: Drill, 16.0 dia., 0.0 length** from the drop-down list.



This replaces the 160.0mm long tool FBM Drill assigned to the coaxial hole pairs with a standard size Ø16.0mm tool. Each hole has a 30.0mm depth.

- 14 Hover the mouse over the assigned tool in the Finish tool column.



FBM Drill assigned a Ø16.0mm drill 32.0mm long to each coaxial hole.

The icon  in the State column indicates that the Ø16.0mm coaxial features can be machined with the assigned tool.

- 15 Click **OK**  in the FBM Drill dialog box to accept the changed parameters.

The FBM Drill dialog box closes.

► Regenerate the FBM Drill Operation and its Toolpaths

- 1 In the Toolpath Manager, the FBM Drill operation is marked “dirty” because you modified its parameters. Click the **Regenerate all dirty operations** button. 

Mastercam regenerates the FBM Drill operation using the current settings, and recreates all new toolpaths for the operation.

2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

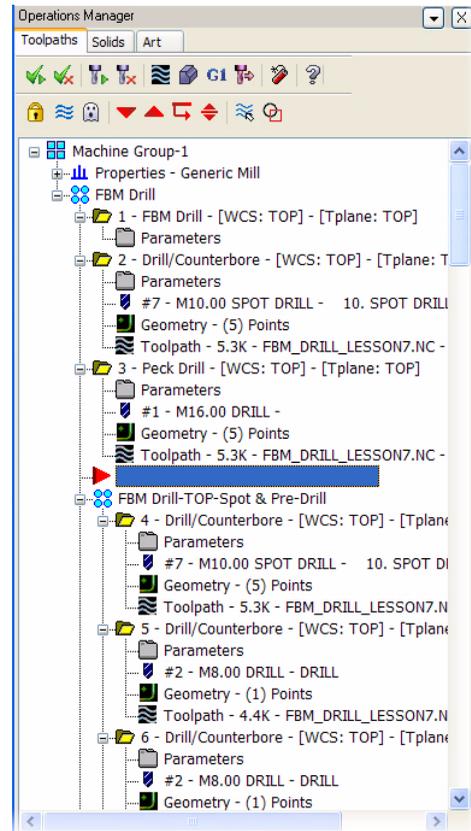
You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ One Ø10.0mm spot drill cycle for each set of five coaxial holes (#2)
- ◆ One Ø16.0mm drill cycle for each set of five coaxial holes (#3)



IMPORTANT: FBM Drill does not remove or regenerate toolpaths #2-3. They were created from the initial set of FBM Drill parameters as independent toolpaths. Your regeneration of the FBM Drill operation in Step 1 creates a separate set of toolpaths, beginning with #4. The new toolpaths are also independent of the FBM Drill operation.

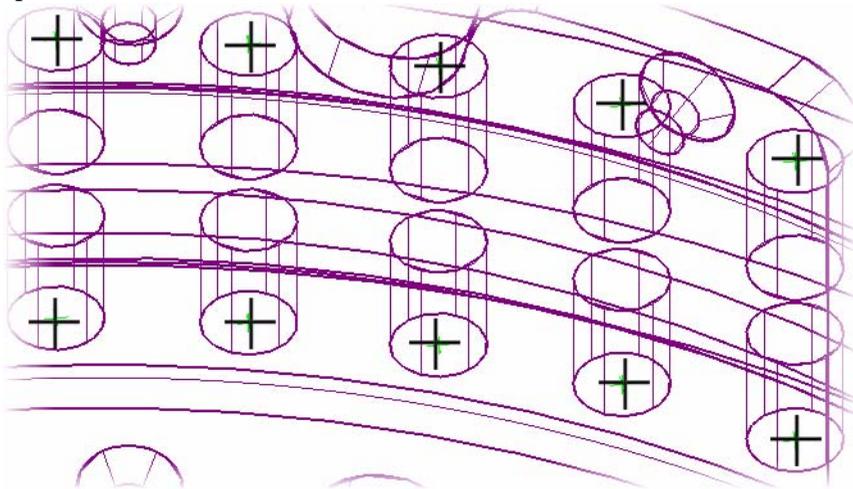
- ◆ One Toolpath group named **FBM Drill-TOP-Spot & Pre-Drill**. This group includes all of the spot and pre-drill cycles generated for the five coaxial holes that are defined in the TOP plane.
 - ◆ One Ø10.0mm spot drill operation (#4)
 - ◆ One Ø8.0mm pre-drill operation for each hole (#5-9)
 - ◆ One Ø12.0mm pre-drill cycle for each hole (#10-14)
- ◆ One Toolpath group named **FBM Drill-BOTTOM-Spot & Pre-Drill**. This group includes all of the spot and pre-drill cycles generated for the five coaxial holes that are defined in the Bottom plane.
 - ◆ One Ø10.0mm spot drill operation (#15)
 - ◆ One Ø8.0mm pre-drill operation for each hole (#16-20)
 - ◆ One Ø12.0mm pre-drill cycle for each hole (#21-25)
- ◆ One Toolpath group named **FBM Drill-BOTTOM-Finish Tool**. This group includes all of the Ø16.0mm finish drill cycles generated for all of the coaxial holes defined in the Bottom plane (#26-30).
- ◆ One Toolpath group named **FBM Drill-TOP-Finish Tool**. This group includes all of the Ø16.0mm finish drill cycles generated for all of the coaxial holes defined in the Top plane (#31-35).



Note: When you activate the option to create independent operations, every time the FBM Drill operation regenerates, it creates new toolpaths and adds them to the Toolpath Manager. The previously generated toolpaths are not deleted or overwritten.

► View Toolpath Point Geometry

- 1 In the Toolpath Manager, select all of the toolpaths in the list.
- 2 Click the **Toggle toolpath display** button  until you toggle off the toolpath display in the graphics window.
- 3 Change your shade settings to **Wireframe**. 
- 4 Use **Zoom** functions to see the 10 new points FBM Drill created for the generated toolpaths.



► Save the Part File

- 1 Choose **File, Save As**.
- 2 In the Save As dialog box, do the following:
 - a Add **EX1** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON7_EX1_[your initials].MCX
 - b Click **OK** to save the file. This completes the exercise.

Exercise 2: Creating Points and Vectors From Solid Holes

In this exercise, you use FBM Drill to create geometry (holes and vectors) for eight Ø8.0mm through holes in the model, each defined in its own non-standard plane.

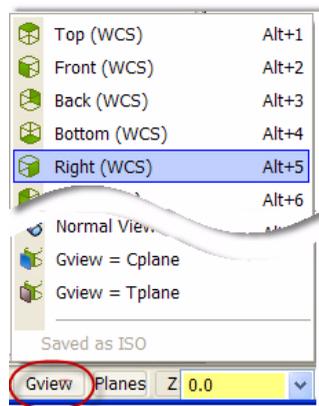
The purpose of this exercise is to create the geometry needed to machine the Ø8.0mm through holes using Mastercam's Multiaxis toolpaths. The solid model does not provide the geometry needed; you use FBM Drill to create it.

You delete the FBM Drill operation and its generated toolpaths. You also delete all of the toolpath groups before saving the part file.

Note: During feature detection, FBM Drill automatically creates the non-standard tool planes needed to machine the part using Mill Level 1 3-axis drill toolpaths. Without FBM Drill, you must manually create the non-standard tool planes.

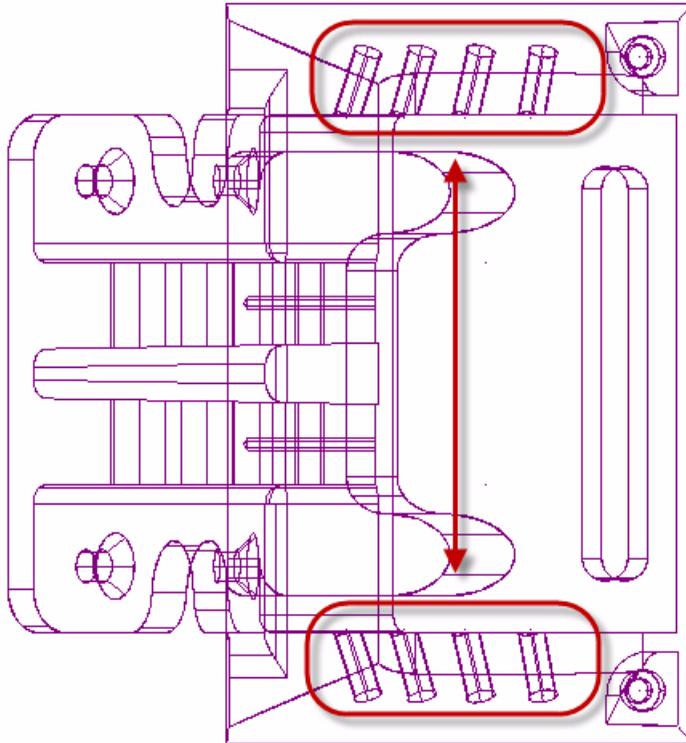
► Create the FBM Drill Operation

- 1 From the Mastercam menu, choose **File, Open**.
- 2 Open the tutorial part file: FBM_DRILL_LESSON7.MCX.
- 3 From the Status bar **Gview** menu, choose **Right (WCS)**.



- 4 Fit the part to the screen  and, if necessary, set shade settings to **Wireframe**. 

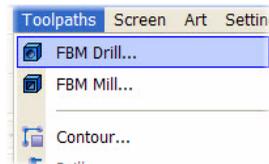
Your graphics window part display should look similar to the following picture. The markups in the picture indicate the Ø8.0mm holes used in this exercise.



5 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu to create one.

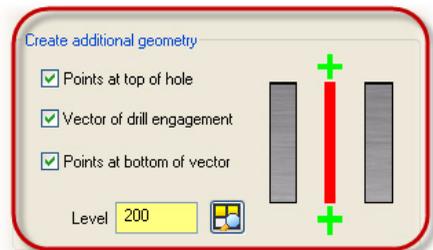
6 Choose **Toolpaths, FBM Drill**.

The FBM Drill dialog box opens to the Setup page parameters.



7 In the Setup page, make the following changes under **Create additional geometry**:

- a Select **Points at top of hole**.
- b Select **Vector of drill engagement**.
- c Select **Points at bottom of vector**.
- d Type **200** in the Level field.



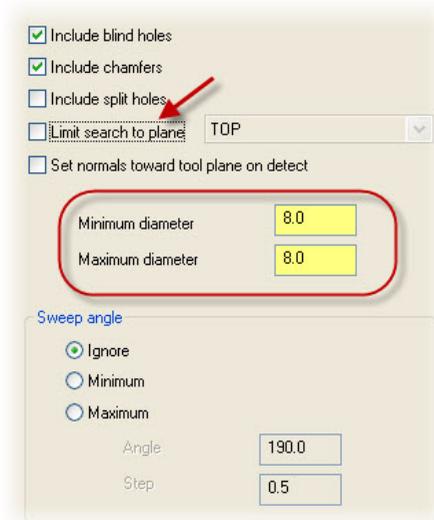
Note: Mastercam's Multiaxis Drill toolpaths do not require points at the top of the hole. However, the exercise shows how to create them if needed by other toolpath types.

8 Choose **Hole Detection** in the Tree View pane.

9 In the Hole Detection page, enter the following settings:

- a** Deselect **Limit search to plane**.
- b** Type **8.0** in the Minimum diameter field.
- c** Type **8.0** in the Maximum diameter field.

These settings allow FBM Drill to detect only $\text{Ø}8.0\text{mm}$ hole features in the solid model. Detection is not limited to a specific plane. FBM Drill analyzes all planes and creates custom views as needed for features detected in non-standard planes.



10 Click the **Detect** button  to analyze the solid model based on your current FBM Drill parameters.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

Display all normals 8 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	CB	CS	Blind	Split	Finish tool
	Drill	8.0	FBM VIEW 1	83.36738...	20.01...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 2	79.48215...	20.19...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 3	74.44513...	20.19...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 4	68.33030...	20.01...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 5	83.36732...	20.01...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 6	79.48215...	20.19...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 7	74.44513...	20.19...			X		MCX: DRILL, 8.0 dia, 50
	Drill	8.0	FBM VIEW 8	68.33022...	20.01...			X		MCX: DRILL, 8.0 dia, 50

- ◆ FBM Drill detects all of the $\text{Ø}8.0\text{mm}$ holes in the model.
- ◆ The Plane column shows that FBM Drill created a custom view for each of the holes because they were detected in non-standard planes.
- ◆ The icon  in the State column indicates that the holes can be machined with the assigned tool.

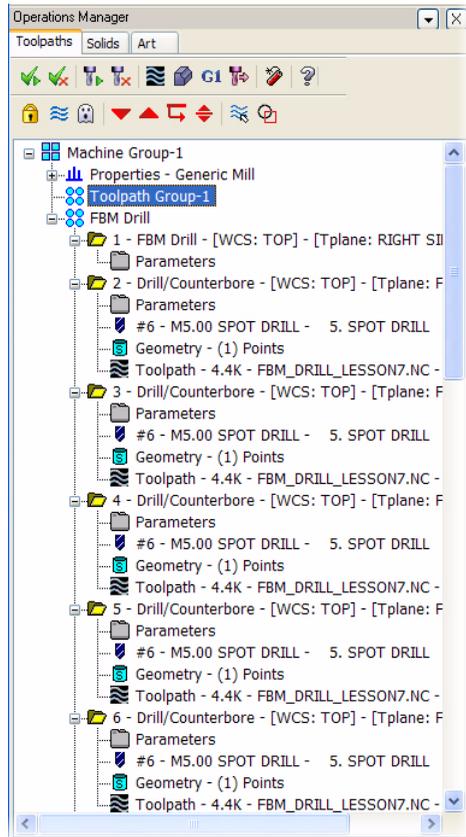
► Generate FBM Toolpaths and View New Geometry

- 1 Click **OK** in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

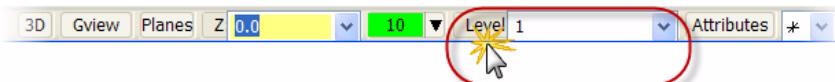
When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ♦ One FBM Drill operation in the machine group (#1)
- ♦ Eight Ø5.0mm spot drill toolpaths (#2-9)
- ♦ Eight Ø8.0mm drill toolpaths (#10-17)

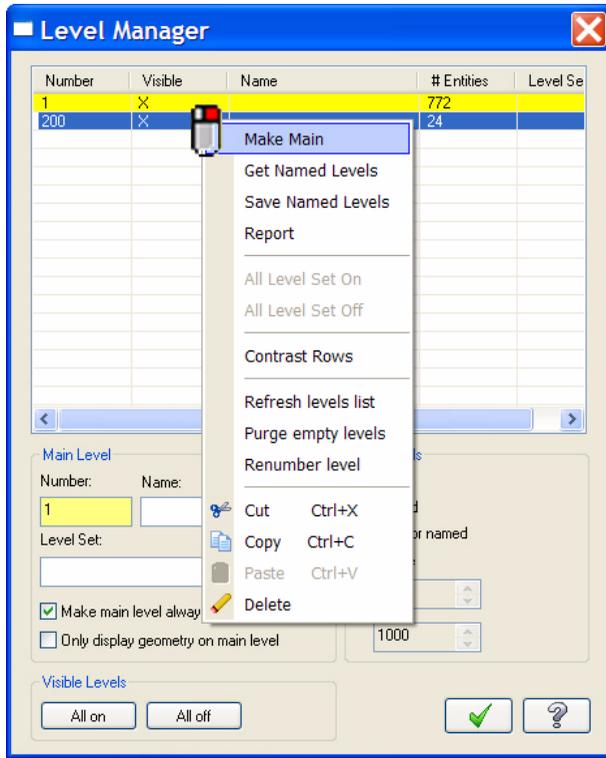


- 2 In the Status bar, click **Level**.



The Level Manager dialog box opens.

- 3 In the Level Manager dialog box, select level **200**, right-click, and then select **Make Main**.



Mastercam makes level 200 the main level.

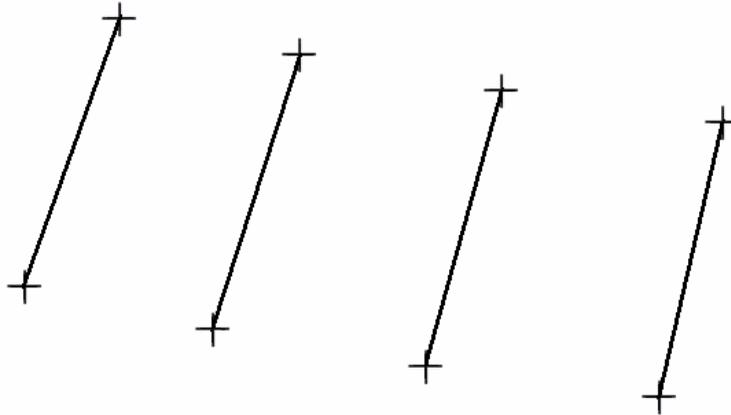
The # **Entities** column lists **24** entities on level 200; two points and one vector for each the eight Ø8.0mm holes.

- 4 Click in the **Visible** column of level 1.

Mastercam removes level 1 from view in the graphics window.

Number	Visible	Name	# Entities
1	X		772
200	X		24

Here is a sample picture showing half of the new point and vector geometry in the graphics window (without toolpath display).

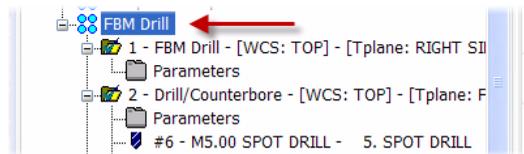


5 Click **OK** to close the Level Manager dialog box.

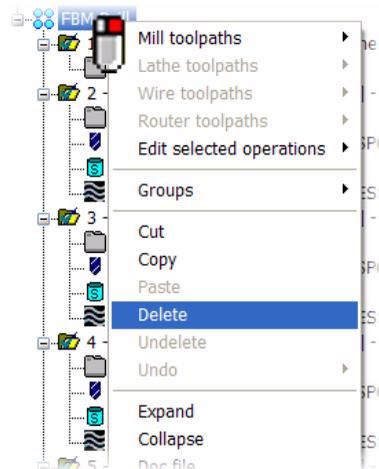
► Delete FBM Toolpaths and Save the Part File

1 In the Toolpath Manager, select the toolpath group named **FBM Drill**.

Mastercam selects all toolpaths in the toolpath group.



2 Right-click and choose **Delete**.

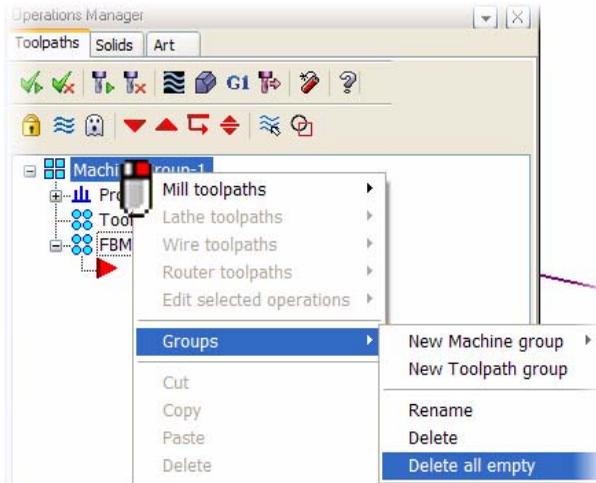


- 3 If a dialog box displays information about undeleting this action, click **Yes** when asked to proceed.

Mastercam deletes all toolpaths in the selected toolpath group.



- 4 In the Toolpath Manager, right-click and then choose **Groups, Delete all empty**.



Mastercam deletes all empty toolpath groups.

- 5 Choose **File, Save As**.
- 6 In the Save As dialog box, do the following:
- Add **EX2** and your initials to the tutorial part **File name**—for example:
FBM_DRILL_LESSON7_EX2_[your initials].MCX
 - Click **OK** to save the file. This completes the exercise and the lesson.

Skills Challenge

Congratulations! You have completed Lesson 7, “Creating Point and Vector Geometry”.

As a challenge to the skills you learned in this lesson, try one or more of the following exercise suggestions.

Using the file you saved in Exercise 1 (page 164):

- Use drag and drop methods in the Toolpath Manager to arrange the FBM Drill-generated toolpath groups in sequence by plane (first list all spot, pre-drill, and finish operations for the Top plane, followed by those in the Bottom plane). Could you use this toolpath grouping to make job setup easier?
- Modify the FBM Drill operation to group toolpaths by tool. Regenerate the FBM Drill operation and view the results. Think about the types of jobs where setup would be easier if grouped by tool.

Using the file you saved in Exercise 2 (page 174):

- 1** Create an FBM Drill operation that creates points only at the bottom of detected holes, and also creates vectors. Place this new geometry on a new level. In the Level Manager dialog box, assign a descriptive name to the level you created for new geometry.
- 2** If your Mastercam installation includes Multiaxis toolpaths, use the new geometry you created in Step 1 above (vectors and bottom points) to create a Drill 5-axis toolpath.

LESSON 8

Using SolidWorks Hole Wizard Data

If your workstation includes an installation of SolidWorks 2008 or higher, and you also have access to the SolidWorks part file (.SLDPRT) used to create the solid model, FBM Drill can update the Features page list with imported SolidWorks Hole Wizard data. This is particularly helpful if the threaded holes in the model are not drawn with thread geometry. Importing the data from the SolidWorks Hole Wizard provides FBM Drill with this information, allowing the correct assignment of hole types and tools.



TIP: If you have SolidWorks installed and a copy of the model's .SLDPRT file, a best practice is to *always* choose the **Select SolidWorks file** button in the FBM Drill Features page before generating toolpaths. This ensures that you provide FBM Drill with the most complete information on detected hole features.

Lesson Goals

- Create an FBM Drill operation. Detect holes. Then import SolidWorks Hole Wizard information to update two Ø8.0mm tapped holes in the Features page list.
- Backplot the FBM Drill-generated toolpaths.

Exercise 1: Importing SolidWorks Hole Wizard Data



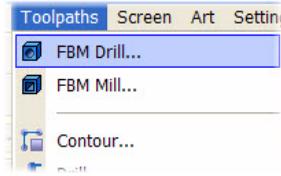
IMPORTANT: To complete this exercise, in addition to Mastercam, your workstation must have a licensed installation of SolidWorks 2008 or higher.

► Create the FBM Drill Operation

- 1 From the Mastercam menu, choose **File, Open**.
- 2 In the Open dialog box:
 - a Select the tutorial part file: FBM_DRILL_HOLE_WIZARD_MM.MCX
 - b Click **OK**.
- 3 If a Machine group does not display in the Toolpath Manager, choose **Machine Type, Mill, Default** from the Mastercam menu to create one.

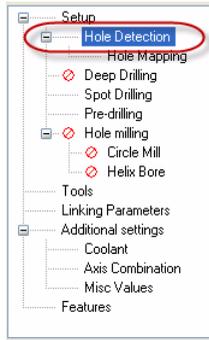
- 4 Choose **Toolpaths, FBM Drill** from the Mastercam menu.

Mastercam displays the FBM Drill dialog box.

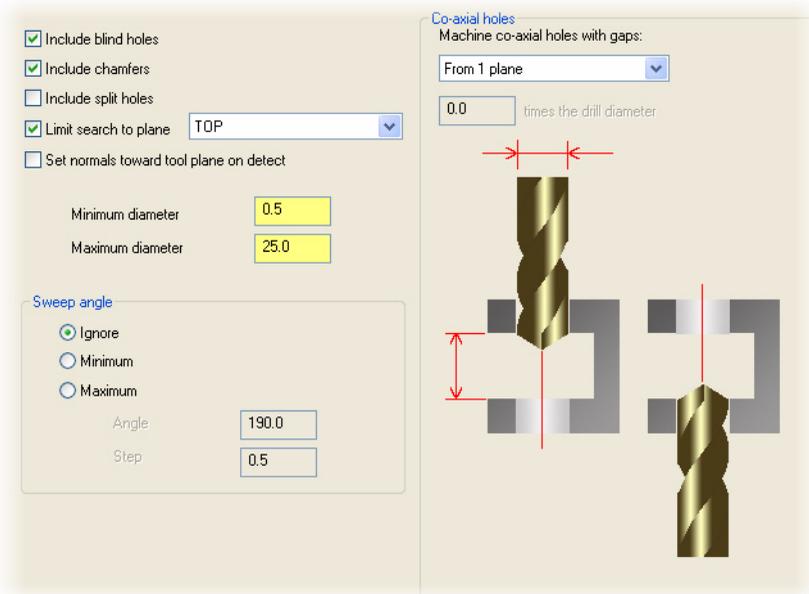


- 5 Choose **Hole Detection** in the Tree View pane.

The Hole Detection page displays.

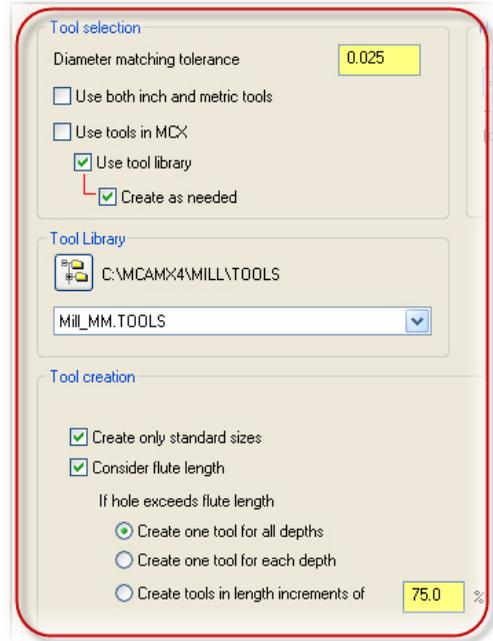


- 6 In the Hole Detection page, make sure that your parameters match the following picture:



- 7 Choose **Tools** in the Tree View pane.
- 8 In the Tools page, select **Consider flute length**.

Make sure the other settings are as shown.



- 9 Click the **Detect** button  to analyze the solid model based on your current FBM Drill parameters.

When finished, FBM Drill displays the Features page. Your features list should match the following picture.

Display all normals 10 features, 0 selected

St...	Hole type	Dia.	Plane	Z 1	Depth	C..	C..	B...	S...	Finish tool
	Drill	6.8	TOP	0.0	50.8					MCX: DRILL, 6.8 dia, 54.2 le...
	Drill	6.8	TOP	0.0	50.8					MCX: DRILL, 6.8 dia, 54.2 le...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 l...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 l...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 l...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 l...
	Counter b...	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18....
	Counter b...	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18....
	Counter b...	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18....
	Counter b...	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18....

- ♦ FBM Drill detects four pairs of coaxial Ø11.0mm drill and Ø18.0mm counterbore features. These coaxial holes are defined as M10 socket head cap screws in the SolidWorks Hole Wizard. FBM Drill assigns the correct hole type and tools to machine the holes.
- ♦ The SolidWorks Hole Wizard defines the two Ø6.8mm holes marked in the picture as M8x1.25 bottom tapped holes with threaded callouts. However, the model in the Mastercam part file does not provide this information to FBM Drill. FBM Drill assigns

both a Drill Hole type and Ø6.8mm Drill Finish tool to these holes. You import SolidWorks Hole Wizard data to automatically change these assignments.

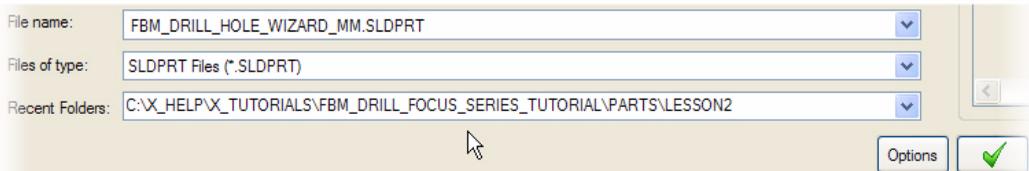
► Import SolidWorks Hole Wizard Data

- 1 Choose the **Select SolidWorks file** button  located in the lower right corner of the Features page.

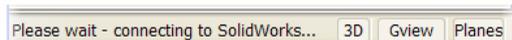


IMPORTANT: SolidWorks must be installed on the same system as Mastercam for the Hole Wizard data to successfully import.

- 2 In the Open dialog box:
 - a Navigate to where you saved the FBM Drill part files provided with this tutorial.
 - b In the Files of Type drop-down list, select: **SLDPRT Files (*.SLDPRT)** if necessary.
 - c Select `FBM_DRILL_HOLE_WIZARD_MM.SLDPRT`.
 - d Click **OK**.

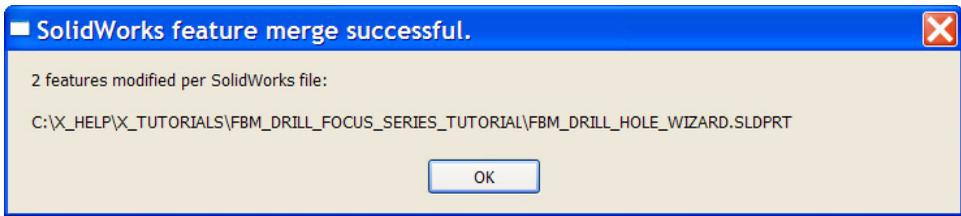


A message displays in the Mastercam Status bar while Mastercam connects to SolidWorks on your computer. This may take a minute or two.



Mastercam imports the SolidWorks Hole Wizard data from the selected part file.

- 3 When the import is complete, a message informs you that two features were modified. The SolidWorks information was successfully merged into the features list. Click **OK**.



Your features list should match the following picture:

Display all normals 10 features, 0 selected

State	Hole type	Dia.	Plane	Z 1	Depth	C.	C.	B...	S...	Finish tool
	Tap RH	8.0	TOP	0.0	50.8					MCX: TAP RH, M8x1.25, 54.8 length...
	Tap RH	8.0	TOP	0.0	50.8					MCX: TAP RH, M8x1.25, 54.8 length...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 length, 11...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 length, 11...
	Drill	11.0	TOP	-10.0	40.8					MCX: DRILL, 11.0 dia, 56.3 length, 11...
	Counter bore	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18.0 dia, 19.0...
	Counter bore	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18.0 dia, 19.0...
	Counter bore	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18.0 dia, 19.0...
	Counter bore	18.0	TOP	0.0	10.0	X		X		MCX: ENDMILL1 FLAT, 18.0 dia, 19.0...

- ♦ The Features page list updates with the SolidWorks Hole Wizard data.
- ♦ The SolidWorks icon  displays in the **State** column of the two holes modified by the SolidWorks Hole Wizard import.
- ♦ The SolidWorks Hole Wizard data does *not* update the four pairs of coaxial holes in the Features page list. The information FBM Drill displays for these holes matches the M10 socket head caps screw definition in the SolidWorks Hole Wizard; no update is needed.



IMPORTANT: You cannot edit the imported SolidWorks Hole Wizard information in the Features page list.

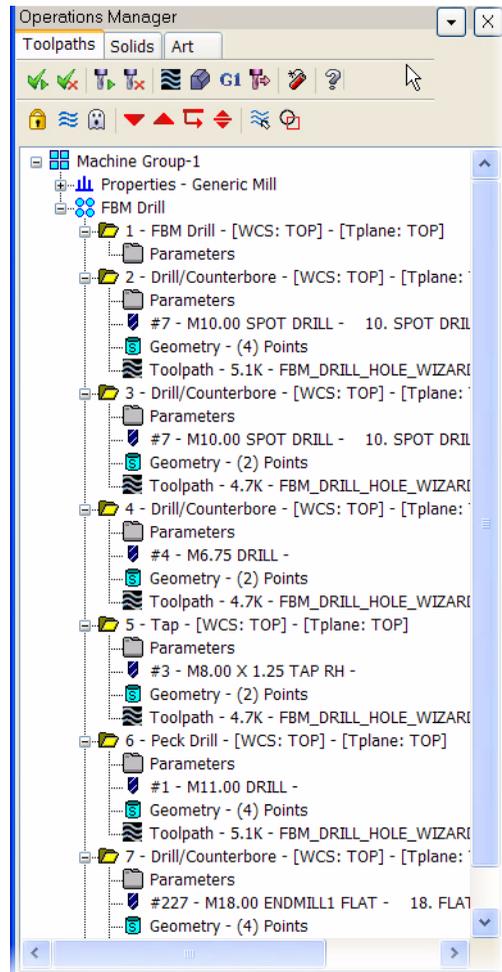
► Generate the FBM Drill Toolpaths

- 1 Click **OK**  in the FBM Drill dialog box to generate the toolpaths needed to machine the detected features.

- 2 When FBM Drill completes the toolpath generation, the Toolpath Manager lists the results.

You should see the following FBM Drill-generated toolpaths:

- ◆ One FBM Drill operation in the machine group (#1)
- ◆ Two Ø10.0mm spot drill operations (#2-3)
- ◆ One Ø6.75mm pre-drill operation for the M8x1.25 tapped holes (#4)
- ◆ One Ø8.0mm tap finish operation (#5)
- ◆ One Ø11.0 drill operation for the counterbore's coaxial through holes (#6)
- ◆ One Ø18.0mm drill operation for the counterbore holes. (#7)



► Backplot the FBM Drill-Generated Toolpaths

- 1 In the Toolpath Manager, click the **Select all operations** button. 

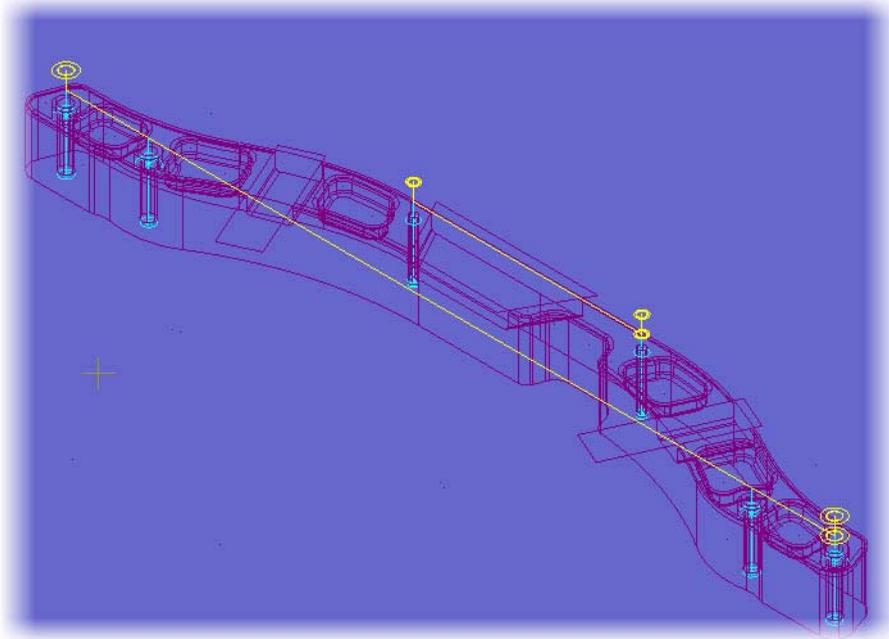


- 2 Set up the part display in the graphics window.

a Change the Gview to **Isometric (WCS)**.

b Set shade settings to **Wireframe**. 

- c Fit the part to screen.  This allows you to view the entire part and all of the toolpaths in the graphics window during Backplot.



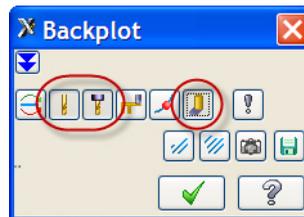
TIP: At any time during Backplot, you can pause and then use view manipulation functions to change your view of the part in the graphics window before resuming play.

- 3 In the Toolpath Manager, click the **Backplot selected operations** button. 

The Backplot dialog box and Backplot VCR bar open.

- 4 In the Backplot dialog box, select the **Display tool**, **Display holder**, and **Quick verify** buttons.

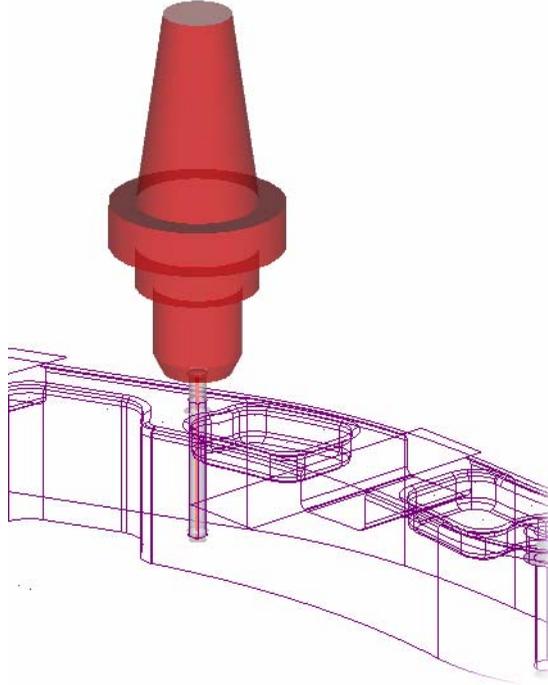
These options display a simulation of a tool and holder during backplot, and shade the toolpath.



- 5 Use the buttons and sliders on the Backplot VCR bar to backplot the operations.



Click **Play**  to begin the backplotting action. Here is a sample picture taken during the backplot.



- 6 When finished, click **OK** in the Backplot dialog box to exit the Backplot function.
- 7 This completes the exercise and the lesson.



TIP: To remove imported SolidWorks Hole Wizard data from the FBM Drill Features page, click **Detect**.  FBM Drill analyzes the solid model, replacing the imported SolidWorks Hole Wizard data with information available from the model in the Mastercam part file.

Conclusion

Congratulations! You have completed the *FBM Drill* tutorial. Now that you have mastered the skills in this tutorial, we encourage you to explore Mastercam's other features and functions. Additional tutorials may be available in this or other series. Please contact your authorized Mastercam Reseller for further training.



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