Assembly Modeling with SolidWorks 2004/2005

For the Intermediate SolidWorks User

David C. Planchard & Marie P. Planchard

Schroff Development Corporation
www.schroff.com
www.schroff-europe.com
Project 3
Top Down Design – In-context

Below are the desired outcomes and usage competencies based on the completion of this Project.

<table>
<thead>
<tr>
<th>Project Desired Outcomes:</th>
<th>Usage Competencies:</th>
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<tbody>
<tr>
<td>• 2AXIS-TRANSFER assembly.</td>
<td>• Ability to create assemblies with multiple configurations.</td>
</tr>
<tr>
<td>• PLATE-B part.</td>
<td>• An understanding of In-context methods as a Top Down assembly modeling approach.</td>
</tr>
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<td></td>
<td>• Ability to create, Lock and Redefine External references.</td>
</tr>
<tr>
<td>• Configurations for the GUIDE-CYLINDER, SLIDE-TABLE and 2AXIS-TRANSFER assemblies.</td>
<td>• Knowledge to develop and incorporate assembly configurations at various levels with the ConfigurationManager and Design Table.</td>
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<tr>
<td></td>
<td>• Ability to create and modify Mates related to configurations.</td>
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</table>
Project 3 – Top Down Design – In-Context

Project Objective

Create the 2AXIS-TRANSFER assembly. Design the PLATE-B part in the context of the GUIDE-CYLINDER and SLIDE-TABLE assemblies. A new part is developed in the context of an assembly. The new part develops in-context features.

Utilize the ConfigurationManager to create configurations for the GUIDE-CYLINDER and SLIDE-TABLE.

Utilize a Design Table to create configurations for the new 2AXIS-TRANSFER assembly. The 2AXIS-TRANSFER assembly is the second component in the 3AXIS-TRANSFER assembly.

On the completion of this project, you will be able to:

- Apply a Top-Down Design assembly modeling approach to develop components in the context of the assembly.
- Review External reference and InPlace Mate syntax to create the PLATE-B part.
- Apply a Bottom-Up Design assembly modeling approach to assemble additional components.
- Select the appropriate hole types and fasteners required in an assembly.
- Obtain the required dimensions, measure and insert features.
- Calculate the interference between components.
- Edit Mates and redefine External references.
- Add configurations to assembly components with the ConfigurationManager.
- Develop a Design Table and utilize parameters to control configurations and state.
**SolidWorks Tools and Commands**

In Project 3, utilize the following SolidWorks tools and commands.

<table>
<thead>
<tr>
<th>SolidWorks Tools and Commands:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$Configuration</td>
<td>Edit Part, Edit Sub-assembly, Rename</td>
</tr>
<tr>
<td>$STATE</td>
<td>Extrude Boss/Base, Replace Components</td>
</tr>
<tr>
<td>Add Configuration</td>
<td>Feature Palette, Replace Mate Entities</td>
</tr>
<tr>
<td>Autodimension</td>
<td>Fixed/Float, Rotate Component</td>
</tr>
<tr>
<td>Coincident Mate</td>
<td>Hide, Section view</td>
</tr>
<tr>
<td>Component Pattern</td>
<td>Hole Wizard, Selection Filters toolbar</td>
</tr>
<tr>
<td>Component Properties</td>
<td>InPlace Mate, Select Other</td>
</tr>
<tr>
<td>Concentric Mate</td>
<td>Interference Detection, Shortcut keys</td>
</tr>
<tr>
<td>Configurations</td>
<td>Insert Component, New Part, Show</td>
</tr>
<tr>
<td>Customize keyboard</td>
<td>List External References, Show Update Holders</td>
</tr>
<tr>
<td>Design Library</td>
<td>Lock All, Sketch relations: On Entity, Midpoint, Coincident, Horizontal, Vertical</td>
</tr>
<tr>
<td>Design Table</td>
<td>Mate Types, Sketch tools: Centerline, Dimension</td>
</tr>
<tr>
<td>Dimensions/Relations toolbar</td>
<td>Measure, SmartMate</td>
</tr>
<tr>
<td>Display/Delete Relations</td>
<td>Move Component, Suppress/Set to Resolved</td>
</tr>
<tr>
<td>Distance Mate</td>
<td>Move with Triad, Suppress/Unsuppress</td>
</tr>
<tr>
<td>Do not create External References</td>
<td>New view, Suspend Automatic Rebuild</td>
</tr>
<tr>
<td>Edit Component</td>
<td>Open part, Open assembly, View Planes, Origins, Temporary Axis</td>
</tr>
</tbody>
</table>

Build modeling skill and speed. Project 3 primarily utilizes Pop-up menus and Shortcut keys to execute the tools in the Assembly toolbar.

**Assembly Toolbar:**

<table>
<thead>
<tr>
<th>Assembly Toolbar:</th>
<th></th>
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<tbody>
<tr>
<td>Insert Component (3)</td>
<td></td>
</tr>
<tr>
<td>Hide/Show (3)</td>
<td></td>
</tr>
<tr>
<td>Suppress (3)</td>
<td></td>
</tr>
<tr>
<td>Edit Component (3)</td>
<td></td>
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<tr>
<td>Mate (3)</td>
<td></td>
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<tr>
<td>Move Component (3)</td>
<td></td>
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<tr>
<td>Rotate Component (3)</td>
<td></td>
</tr>
<tr>
<td>Smart Fasteners (Add-in)</td>
<td></td>
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<tr>
<td>Exploded View (Exercise 3.3)</td>
<td></td>
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<tr>
<td>Exploded Line Sketch</td>
<td></td>
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<tr>
<td>Interference Detection (3)</td>
<td></td>
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<tr>
<td>Features (3)</td>
<td></td>
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<tr>
<td>Simulation</td>
<td></td>
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</tbody>
</table>

(3) Assembly tools utilized in Project 3.
**Project Overview**

The 2AXIS-TRANSFER assembly is the second sub-assembly for the 3AXIS-TRANSFER assembly. The 2AXIS-TRANSFER assembly combines the GUIDE-CYLINDER assembly and the SLIDE-TABLE assembly. The SLIDE-TABLE assembly vertically lifts the GRIPPER 100mm. The GUIDE-CYLINDER assembly moves 100mm horizontally.

The SLIDE-TABLE assembly cannot be fastened directly to the GUIDE-CYLINDER assembly. Design the PLATE-B part as an interim part to address this issue. Create PLATE-B in the context of the GUIDE-CYLINDER assembly.

The 2AXIS-TRANSFER assembly consists of the following models:

- GUIDE-CYLINDER assembly.
- PLATE-B part.
- SLIDE-TABLE assembly.
- SHCS.

Add the configurations for the GUIDE-CYLINDER, SLIDE-TABLE and 2AXIS-TRANSFER assemblies to represent physical positions.

Utilize the ConfigurationManager to create the GUIDE-CYLINDER configurations named, Normal and Extended.
Utilize the ConfigurationManager to create the SLIDE-TABLE configurations, named Normal and Extended.

Combine the GUIDE-CYLINDER Normal configuration and Extended configuration with the SLIDE-TABLE Normal configuration and Extended configuration to create the following four 2AXIS-TRANSFER configurations:

1. Normal-Normal.
2. Normal-Extended.
3. Extended-Normal.
4. Extended-Extended.

The GUIDE-CYLINDER configuration is listed first, followed by the SLIDE-TABLE configuration.

Create the fifth 2AXIS-TRANSFER configuration named Fastener. Unsuppress the SHCSs in the Fastener configuration. Suppress the SHCSs in the other four configurations.
Top Down Design Assembly Modeling Approach

In the Top Down design assembly modeling approach, the major design requirements are translated into assemblies, sub-assemblies and components. You do not need all of the required component design details. The model requires individual relationships between components. There are two methods to begin a Top Down design assembly approach:

- Method 1: Start with a Layout Sketch in the assembly.
- Method 2: Start with a component in the assembly.

In Method 1, all major components are positioned based on a 2D sketch. Relationships between sub-assemblies must be maintained for proper fit. Utilize Method 1 in Project 6.

In Method 2, relationships are derived from an existing component in the assembly. Utilize Method 2 for the PLATE-B part.

Develop the PLATE-B part in the context of the existing GUIDE-CYLINDER assembly. The PLATE-B part contains In-context relations.

An In-context relation is a reference between a sketch entity in a part and an entity in another component. Relations that are defined In-context are listed as External references.

In-context relations and External references are powerful tools in the design phase. Begin with an empty part and utilize existing components in the assembly. Determine the geometric and functional requirements of the part.
Mastering assembly modeling techniques with in-context relations requires practice and time. Planning and selecting the correct reference and understanding how to incorporate changes are important. Explore various techniques using InPlace Mates and External references developed in the context of an assembly.

<table>
<thead>
<tr>
<th>Assembly Modeling Techniques with InPlace Mates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plan the Top Down design method. Start from a Layout sketch or with a component in the assembly.</td>
</tr>
<tr>
<td>2. Prepare the references. Utilize descriptive feature names for referenced features and sketches.</td>
</tr>
<tr>
<td>3. Utilize InPlace Mates sparingly. Load all related components into memory to propagate changes. Do not use InPlace Mates for purchased parts or hardware.</td>
</tr>
<tr>
<td>4. Group references. Select references from one component at a time.</td>
</tr>
<tr>
<td>5. Ask questions! Will the part be used again in a different assembly? If the answer is yes, do not use InPlace Mates. If the answer is no, use InPlace Mates.</td>
</tr>
<tr>
<td>6. Will the part be used in physical dynamics or multiple configurations? If the answer is yes, do not use InPlace Mates.</td>
</tr>
<tr>
<td>7. Examine how to redefine External references. Use List References and Lock References to locate and protect geometry. Existing references do not update in a locked state. Locate the locked references. Create new references for the sketch and the feature.</td>
</tr>
<tr>
<td>8. Reduce the size of the FeatureManager. Hide Update Holders for In-context features.</td>
</tr>
<tr>
<td>9. Work in the Edit Part mode to obtain the required external references in the assembly. Create all non-referenced features in the Part, not in the assembly.</td>
</tr>
<tr>
<td>10. Obtain knowledge of your company’s policy on InPlace Mates or develop one as part of an engineering standard.</td>
</tr>
<tr>
<td>Note: Using the Break All command keeps External references from updating.</td>
</tr>
</tbody>
</table>

Note: The Break All command is not utilized in this project. The authors prefer other techniques based on experience.
**2AXIS-TRANSFER assembly**

Create an assembly called 2AXIS-TRANSFER assembly. Determine the specific features required to create the PLATE-B part using the Top Down design assembly approach. Utilize Insert, Component, New Part to create PLATE-B in the context of the GUIDE-CYLINDER assembly.

Redefine the orientation of the GUIDE-CYLINDER assembly. The Float option removes the Fixed constraint in the FeatureManager. Utilize the 2AXIS-TRANSFER default reference planes: Front Plane, Top Plane and Right Plane. The reference planes provide an accurate method to locate the first component in an assembly at the required orientation.

Note: To rotate a component by an exact value, select Rotate Component. Select the By Delta XYZ option. Enter an angular value.

Rotate Component is accessed through the Assembly toolbar.

To display the Move command in the Pop-up menu, right-click the Customize option in the Graphics window. Check Move.

With the Pop-up menu, the Rotate Component command requires two steps. Right-click Move. Right-click Rotate Component.

The Shortcut keys you created in Project 2 are utilized in this project.

P (Show/Hide Planes), T (Show/Hide Temporary Axis), and M (Mate) are utilized in this project.

Deactivate the Large Assembly Mode.
Activity: 2AXIS-TRANSFER assembly

Close all documents.

1) Click Window, Close All.

Deactivate the Large Assembly Mode.

2) Click Tools. Uncheck Large Assembly Mode.

Open the GUIDE-CYLINDER assembly.

3) Double-click the SMC folder. Double-click the MGPM50-100 folder. Drag the GUIDE-CYLINDER icon into the Graphic window.

Create a new assembly.

4) Click Make Assembly from Part/Assembly from the Standard toolbar.

5) Select the MY-TEMPLATES tab. Double-click the ASM-MM-ANSI icon. The Insert Component PropertyManager is displayed.

6) Click a position to the left of the new assembly Origin.

7) Click View. Uncheck Planes to hide all planes.
   Short cut key: P key.

Save the assembly.

8) Click Save.

9) Select DELIVERY-STATION for Save in: file folder.

10) Enter 2AXIS-TRANSFER for File name. Click Save.
Float the GUIDE-CYLINDER.

11) Right-click GUIDE-CYLINDER in the FeatureManager.

12) Click Float. The GUIDE-CYLINDER entry changes from fixed, (f) to under-defined, (-).

Rotate the GUIDE-CYLINDER.

13) Right-click the GUIDE-CYLINDER in the Graphics window. Click Move with Triad.

14) Hold the right mouse button down on the green vertical arrow.

15) Drag the mouse pointer to the right to rotate the component approximately 90 degrees.

16) Release the right mouse button.

Mate the GUIDE-CYLINDER.

17) Click Mate. Shortcut key: M.

18) Click GUIDE-CYLINDER|Plane3. Click 2AXIS-TRANSFER|Front Plane. Coincident is selected by default. Click OK.

19) Click GUIDE-CYLINDER|Plane2.

20) Click 2AXIS-TRANSFER|Top Plane. Coincident is selected by default. Click OK.

21) Click GUIDE-CYLINDER|Plane1.

22) Click 2AXIS-TRANSFER|Right Plane. Coincident is selected by default. Click OK.

23) Click OK to exit the Mate PropertyManager.

Expand the Mates.

24) Double-click the Mates in 2AXIS-TRANSFER folder to display the 3 Coincident Mates. The GUIDE-CYLINDER is fully defined in the 2AXIS-TRANSFER assembly.
The Fix option provides a fast technique in assembly modeling. As models become more complex, it is difficult to determine where the component Origin is in space. Mating the first component to three planes takes more time but provides orientation flexibility and greater accuracy.

Hide the MGPTube part.

25) Right-click the MGPTube part in the Graphics window.

26) Click Hide

Expand the MGPRod part.

27) Double-click MPGRod in the 2AXIS-TRANSFER FeatureManager.

28) Click MountHoles2 in the FeatureManager. The four holes are selected in the Graphics window and displayed in green.

The PLATE-B part references the MountHoles2 feature.

In-context, External References and InPlace Mates

An in-context relationship is a geometric relationship between a sketch entity in one part, and a feature on a component in the assembly.

An External reference is a relationship that exists between a sketch entity and geometry outside the sketch. Example: The GUIDE-CYLINDER utilizes reference planes to develop the Base Extrude feature for the MGPTube.

An External reference develops an in-context relationship when geometry is referenced outside the part. Example: Create the new PLATE-B part in the context of the 2AXIS-TRANSFER assembly that references the MGPRod component.

Components added in the context of an existing assembly automatically receive an InPlace Mate. The InPlace Mate is a Coincident Mate created between the Front Plane of
a new component and the selected planar geometry of the assembly. The component is fully defined; no additional Mates are required to position the component.

By default, SolidWorks uses the default templates for new parts and assemblies developed in the context of an existing assembly. To select a custom Template, define the System Options, Document Templates option before you insert a new component into the assembly.

To create the PLATE-B part developed in the context of the 2AXIS-TRANSFER assembly, select Insert, Component, New Part. Select the custom Part Template from the MY-TEMPLATES folder. Enter PLATE-B for the new part.

Select the custom Part Template from the MY-TEMPLATES folder. Enter PLATE-B for the new part.

Select the MGPRod right face to create an InPlace Mate reference with the PLATE-B Front Plane. SolidWorks automatically selects the Edit Component icon when inserting a new component. The PLATE-B blue text appears in the FeatureManager. The default blue color indicates that the part is actively being edited.
The right face of the MGPRod part is the current Sketch plane. The current sketch name is Sketch1. The current Graphics window title displays the sketch and name.

Example:

“Sketch1 of PLATE-B -in- 2AXIS-TRANSFER.”

PLATE-B is the name of the component created in the context of the 2AXIS-TRANSFER assembly. SolidWorks automatically selects Sketch

The Mate, InPlace1 (GUIDE-CYLINDER<1>, PLATE-B<1>) fully defines PLATE-B in the 2AXIS-TRANSFER assembly.

The Assembly toolbar, FeatureManager and Pop-up Assembly menu display different options.

Review Edit Component, Edit Part and Edit Sub-assembly tools.

- For parts and assemblies, utilize the Edit Component from the Assembly toolbar.
- For parts only, utilize Edit Part and Open Part.
- For assemblies only, utilize Edit Sub-assembly and Open Assembly.
SolidWorks creates External references from the PLATE-B part to the GUIDE-CYLINDER assembly. Example: The Extrude1 feature develops an External reference from the sketch plane. Sketch1 develops External references from the Convert Entities Sketch tool.

In SolidWorks 2005, the Do not create External references option develops no InPlace Mate or External references. Select this option before you select Insert, Component, New Part. Customize the Assembly toolbar in the next activity to include this important option.

The procedure to create a component in the context of an assembly with no External references is the same as creating a new part with External references. Select a Sketch plane and create the sketch.

If you utilize Convert Entities and Offset Entities Sketch tools, no External references develop. The new part requires dimensions and relations to fully define the geometry and Mates to constrain its position in the assembly. The Do not create External references option toggles on and off. Insert this option into the Assembly toolbar.

### Activity: In-context, External References and InPlace Mates

Set the Default Template option.

29) Click Tools, Options, System Options

30) Click Default Templates.

31) Check Prompt user to select document template.

32) Click OK.
Insert the new PLATE-B part.

**33)** Click **Insert, Component, New Part.**

**34)** Select the **PART-MM-ANSI** Template.

**35)** Select **DELIVERY-STATION** for Save in: file folder.

**36)** Enter **PLATE-B** for the file name.

**37)** Click **Save.**
Locate the new part with an InPlace Mate.

38) The Component Pointer icon is displayed on the mouse pointer. The PLATE-B component is empty and requires a sketch plane. Click the right face of the MGPRod Part. SolidWorks creates the InPlace1 Mate.

Convert existing edges.

39) Click the right face.

40) Click Convert Entities from the Sketch toolbar.

41) Click the top left MountHoles2 circle. Hold the Ctrl key down. Select the three MountHoles2 circles.

42) Click Convert Entities. Release the Ctrl key.

Extrude Sketch1.

43) Click Extruded Boss/Base from the Features toolbar.

44) Enter 15 for Depth.

45) Click OK. The name of PLATE-B is displayed in blue. The PLATE-B part is edited in-context of the 2AXIS-TRANSFER assembly.

Return to the 2AXIS-TRANSFER assembly.

46) Right-click a position in the Graphics window. Click Edit Assembly 2AXIS-TRANSFER.

   Note: Select Component from the Assembly toolbar to exit Edit Part and return to the assembly.

47) Right-click PLATE-B in the Graphics window. Click View Mates. The InPlace1 Mate lists the component references; GUIDE-CYLINDER<1> and PLATE-B<1>.
Display the MGPTube part.

48) Right-click **MGPTube** from the FeatureManager. Click **Show**.

Save the 2AXIS-TRANSFER assembly.

49) Click **Save**.

Open PLATE-B.

50) Right-click **PLATE-B** in the Graphics window. Click **Open Part**.

Review External references in PLATE-B.

51) The "->" symbol indicates that there are External references for the PLATE-B part. Right-click **PLATE-B**. Click **List External Refs**. The External Reference list contains the Feature, Data, Status, Reference Identity and Feature Component. All External references are defined. Click **OK**.

Customize the Assembly toolbar.

52) Click **Tools**, **Customize**, **Commands**.

53) Select **Assembly** from the Categories list.

54) For 2004: Click the **New Part** icon.
55) For 2005: Click the Do not create External references icon.

56) Drag the icon into the Assembly toolbar.

57) Click OK.

Base-Extrude Sketch1 contains three types of External references.

Convert Face entry occurs when you select the sketch plane. Convert Edge and Arc entries occur when you select Convert Entities in Sketch1. The Data column lists External references.

- Convert Face.
- Convert Edge.
- Arc.

The Convert Entities of the MGPRod’s right face results in four Convert Edge references. The four Convert Edge references are:

- Bottom Horizontal Line.
- Right Vertical Line.
- Top Horizontal Line.
- Left Vertical Line.
There are four Arc references. The Convert Entities of the four MountHoles2 circles created the Arc references.

From the 2AXIS-TRANSFER assembly, utilize two additional methods to access External references.

Method 1: Right-click on a component in the FeatureManager or Graphics window. Click List External Refs.

Method 2: Right-click on the top level assembly icon. Click Show Update Holders. SolidWorks creates an Update Holder for each External sketch reference. The Update Holders are displayed at the bottom of the FeatureManager.

The Update Holder entry contains the option to List External Refs.

Reduce the size of the FeatureManager. Select the default Hide Update Holders.
Hole Selection

Hole selection becomes an important decision in machine design. You decide on the hole type, placement and feature selection. Four ∅10mm SHCSs fasten the PLATE-B part to the GUIDE-CYLINDER assembly. Should the holes utilize a counterbore? Answer: No. The holes are too close to the edge of the PLATE-B part. Do you enlarge PLATE-B to accommodate the counterbore? Answer: No. Increasing the part size adds additional weight and cost.

You must decide whether to create the PLATE-B holes in a Top Down design approach with External references, or a Bottom-Up Design approach with no External references. Examine the SLIDE-TABLE assembly to determine the fastener type. Are additional holes required to mount the SLIDE-TABLE assembly to PLATE-B? Answer: Yes. Add two additional holes.

There are two major components in the SLIDE-TABLE assembly:

1.) MXSL-Body.
2.) MXSL-Table.

The MXSL-Body back face mates to the PLATE-B front face. Simplify the mate process. Hide the MXSL-Table.

Utilize BodyThruHole4 and BodyThruHole5, closest to the bottom face. Create two M6 Cbores in the PLATE-B part that correspond to the ThruHoles in the MXSLTable. No External references are created in this Bottom Up approach.
Minimize the use of External references from multiple parts. Multiple part references lead to problems in higher levels of the assembly. External references require additional modification when dissolving components and forming sub-assemblies used in other projects.

Avoid unnecessary references. Do not work continuously in Edit Component mode for the individual part. Open the part. Insert additional features at the part level. The individual part is less complex than an assembly. Rebuild time is quicker.

Activity: Hole Selection

Hide the GUIDE-CYLINDER assembly.

58) Press Ctrl-Tab to return to the 2AXIS-TRANSFER assembly.

59) Right-click GUIDE-CYLINDER in the Graphics window. Right-click Hide. PLATE-B is displayed.

Note: Do not suppress the GUIDE-CYLINDER assembly. The Mates will be suppressed and the 2AXIS-TRANSFER assembly will no longer be constrained.

Note: The 2AXIS-TRANSFER assembly determines the location of the PLATE-B Origin.

Open the SLIDE-TABLE assembly.

60) Double-click the SMC\MXS25L-100B folder.

61) Right-click the SLIDE-TABLE icon.

62) Click Open.

For 2004: Select File, Open or right-click on the SLIDE-TABLE icon. Click Open.
Determine the SLIDE-TABLE/MXSLBody Thru Hole locations.

63) Right-click SLIDE-TABLE/MXSL-Table in the FeatureManager. Right-click Hide.

64) Right-click the SLIDE-TABLE/MXSLBody part in the FeatureManager. Click Set to Resolved.

65) Double-click the MXSLBody to view the ThruHole sketch.

66) Double-click the ThruHoles Sketch from the FeatureManager. The Ø6.6mm holes are spaced 35mm apart and 32mm from the MXSLBody Top face.

67) Click BodyThruHole4 and BodyThruHole5 to display the Thru Hole feature.

68) Right-click the SLIDE-TABLE/MXSL-Table in the FeatureManager.

69) Right-click Show.

Display the SLIDE-TABLE/MXSL-Table part.

70) Press Ctrl+7.

Open the PLATE-B part.

71) Press Ctrl-Tab.
Add Cbore Holes to the back face of the PLATE-B part.

72) Press Ctrl+2 to display the Back view.

73) Click the back face above the Origin.

74) Click the HoleWizard.

Create Cbore Hole1.

75) Click the Counterbore tab.

76) Select ANSI Metric for Standard.

77) Select Socket Head Cap Screw for Screw Type.

78) Select M6 SHCS.

79) Select Through All for Depth.

80) Click Next. Cbore Hole1 is displayed in orange. Orange is the preview color.

Create a Cbore Hole2.

81) Click a position below the Top plane, aligned with the Origin. The center point of Cbore Hole2 is displayed in blue. Note: Blue indicates that dimensions and relations are required.

Add a Vertical relation.

82) Right-click Select. Click the Origin.

83) Hold the Ctrl key down.

84) Click the Hole1 center point and Hole2 center point.

85) Click Vertical. Release the Ctrl key.
Add a Symmetric relation.

86) Click **Centerline**.

87) Sketch a **horizontal centerline** from the Origin to the midpoint of the right vertical line.

88) Right-click **Select**.

89) Click the **centerline**.

90) Hold the **Ctrl** key down. Click the **Hole1 center point** and the **Hole2 center point**. Click **Symmetric**. Release the **Ctrl** key.

Add a vertical dimension.

91) Click **Smart Dimension**.

92) Click the **Hole1 center point** and the **Hole2 center point**. Enter **35**. The hole center points are fully defined.

93) Click **Finish**.

Display an Isometric view.

94) Press **Ctrl+7**.

Save the PLATE-B part.

95) Press **Ctrl+S**.

Return to the 2AXIS-TRANSFER assembly.

96) Press **Ctrl+Tab**.

97) Click **Window, 2AXIS-TRANSFER**. The message, “Models contained within the assembly have changed. Would you like to rebuild the assembly now?” Click **Yes**.

PLATE-B changed by adding two Cbore Holes. The 2AXIS-TRANSFER assembly contains the PLATE-B part. Utilize a Section view to display the new Cbores.
Update the 2AXIS-TRANSFER assembly.
98) Right-click the GUIDE-CYLINDER assembly.

99) Click Show.

View the Cbore Hole in the 2AXIS-TRANSFER assembly.
100) Click the Front Plane in the 2AXIS-TRANSFER assembly.

101) Click Section View from the View toolbar. The Cbores are on the back face of the PLATE-B part.

102) Click Cancel from the Section View PropertyManager to display the Full view.

Conserve design time. There are numerous Front Plane, Top Plane and Right Plane entries in an assembly FeatureManager. Each component contains these reference planes. How do you select the correct Plane? Answer: Locate the component in the FeatureManager. Expand the component entry. Select the reference plane directly below the component name.
Mating the SLIDE-TABLE assembly

The SLIDE-TABLE assembly fastens to the PLATE-B Cbores. Open the SLIDE-TABLE and 2AXIS-TRANSFER assemblies if required. Utilize Tile Horizontally and drag the SLIDE-TABLE assembly icon into the 2AXIS-TRANSFER assembly. Position the SLIDE-TABLE in its approximate orientation before creating a Mate.

Hide components when not required. Do not suppress the GUIDE-CYLINDER assembly. Suppressing components suppresses Mates, resulting in parts being free to move and rotate.

There are many holes on the MXSL-Body part. What holes do you assemble to PLATE-B? Answer: The two bottom holes on the MXSL-Body part.

Investigate the physical behavior of the SLIDE-TABLE assembly. What part moves? What part remains static? Answer: The MXSL-Table part linearly translates and the MXSL-Body part is fixed.

For 2005, the Suspend Automatic Rebuild defers the updating of Mates in the top level 2AXIS-TRANSFER assembly. Utilize this option to create and change multiple Mates. The Rebuild command from the Standard toolbar controls the update of the deferred Mates.

Utilize a Section view to see the PLATE-B Cbores and the BodyThruHole4 and BodyThruHole5.

Utilize the Use for positioning only option to move and rotate components based on the Mate type. The Mate is not created or added to the FeatureManager.
Activity: Mating the SLIDE-TABLE assembly.

Insert the SLIDE-TABLE assembly.

103) Click Window, Tile Horizontally.

104) Drag the SLIDE-TABLE assembly icon into the 2AXIS-TRANSFER assembly.

105) Click a position in front of the PLATE-B part.

106) Maximize the 2AXIS-TRANSFER assembly.

Move and Rotate the SLIDE-TABLE assembly.

107) Right-click the SLIDE-TABLE assembly in the Graphics window.

108) Click Move.

109) Right-click Rotate Component.

110) Drag the SLIDE-TABLE assembly in front of the PLATE-B part.

111) Click OK.
Hide the Components not required.

112) Double-click the **SLIDE-TABLE** entry in the FeatureManager.

113) Hold the **Shift** key down. Click **MXSL-Table<1>**. Click the **MXSL-BS+BT<2>**. Release the **Shift** key. The **MXS-A+B** is selected automatically with Shift-Select.

114) Hold the **Ctrl** key down.

115) Click the **GUIDE-CYLINDER assembly** in the FeatureManager.

116) Right-click **Hide**. Release the **Ctrl** key.

Create a new view.

117) Press the **Space bar**.

118) Pin the View Orientation dialog box.

119) Click **Isometric**.

120) Hold the **Shift** key down. Press the **Right Arrow** key. Release the **Shift** key.

121) Click **New View**. Enter **Back Iso** for view name.

122) Click **OK**.

123) Click **Isometric**.

Position the **MXSL-Body**.

124) Select the assembly **Front Plane**. Hold the **Ctrl** key down. Select **Plane3** from the **SLIDE-TABLE**. Release the **Ctrl** key.

125) Press the **M** Shortcut key to display the Mate PropertyManager.

126) Click the **Use for positioning only** option. Coincident is selected by Default.

127) Click **OK**. Do not move or rotate the **MXSL-Body**.
Defer the Mates.

128) Right-click the 2AXIS-TRANSFER icon.

129) Click Suspend Automatic Rebuild.

Display the Section view.

130) Click the assembly Front Plane. Click Section view.

Insert the first Concentric Mate.

131) Click the BodyThruHole4 cylindrical face. Click the top PLATE-B Cbore cylindrical face. Concentric is selected by default.

132) Click OK.

Insert the second Concentric Mate.

133) Click the BodyThruHole5 cylindrical face.

134) Click the bottom PLATE-B Cbore cylindrical face. Concentric is selected by default. Click OK.
Insert the first Coincident Mate.

135) Click the PLATE-B front face.

136) Click the Back Iso view.

137) Click the MXSL-Body back face.

138) Click OK. The SLIDE-TABLE is fully defined.

Save the 2AXIS-TRANSFER assembly.

139) Click Save.

Fasteners

The 2AXIS-TRANSFER assembly requires two different length fasteners.

- Insert two M6x1.0 SHCSs between the PLATE-B part and the SLIDE-TABLE assembly.
- Insert two M6x1.0 SHCSs between the PLATE-B part and the GUIDE-CYLINDER assembly.
- Create an assembly-sketched pattern for the fasteners.

Inserting fastener components simulates the assembly process in manufacturing. Assemble the PLATE-B part to the SLIDE-TABLE assembly. The individual SHCSs were created from SolidWorks Toolbox and stored in the MY-TEMPLATE\SHCS folder.

The Mate References in the SHCS create the Concentric\Coincident SmartMate when dragged to the PLATE-B hole. Utilize the components located in the SHCS folder instead of SolidWorks\Toolbox to practice Replace and Redefine options.
Activity: Fasteners

Measure the thread length distance.

140) Press Ctrl+5 to display the Top view.

141) Click Tools, Measure.

142) For 2005: Click Show XYZ Measurements.

143) Click the inside edge of the PLATE-B Cbore Hole.

144) Click the bottom edge of the hole. The Delta X distance is 57mm. Utilize a 50mm thread length for the SHCS.

For 2004, SolidWorks displays the measured values in the dialog box.

Position the model.

145) Rotate PLATE-B. Click the top Cbore. Right-click Zoom to Select.

Insert the M6 SHCSs.

146) Double-click MY-TOOLBOX\SHCS. Drag the B18.3.1M-6x1.0x50 Hex SHCS to the top Cbore. The Coincident\Concentric icon is displayed. Release the mouse pointer on the inside circular edge.

147) Drag the B18.3.1M-6x1.0x50 Hex SHCS to the bottom Cbore. Release the mouse pointer on the inside circular edge.
148) Double-click the **Mates** entry in the FeatureManager.

Two instances of the M6x1.0x50 SHCS have been added to the FeatureManager. The B18.3.1M-6x1.0x50Hex SHCS<1> is the first instance. The B18.3.1M-6x1.0x50Hex SHCS<2> is the second instance. Each time you insert a SHCS, in the same session of SolidWorks, the instance number is incremented. Your instance numbers <1>, <2>, may be different if a SHCS was deleted.

Dragging the SHCS into the assembly and referencing the Cbore circular edge created four SmartMates named 1, 2, 3 and 4. Each time you insert a SmartMate, the instance number is incremented. Your numbers may be different if a Mate was deleted.

149) Click **SLIDE-TABLE, B18.3.1M-6x1.0x50Hex SHCS <1>**. Hold the Ctrl key down.

150) Click **B18.3.1M-6x1.0x50Hex SHCS<2>** from the FeatureManager.

151) Right-click **Hide**. Release the Ctrl key.

152) Right-click **GUIDE-CYLINDER** in the FeatureManager.

153) Click **Show**. Right-click **MGPTube** in the Graphics window.

154) Click **Hide**. PLATE-B and the MGPRod parts are displayed.

Add one M10x1.5 SHCS to PLATE-B.

155) Press the **Space** bar. Click the **Back Iso** view.

156) Drag the **B18.3.1M-10x1.5x25 Hex SHCS** to the back top hole.

157) Release the mouse pointer on the **outside circular edge**.
The FeatureManager Mates entry displays the Concentric\Coincident SmartMates named 5 and 6.

![SmartMates](image)

### Editing Mates and Redefining Components

Assemblies require the ability to modify Mates and redefined components. The 2AXIS-TRANSFER assembly requires four M10 SHCSs to fasten the PLATE-B part to the GUIDE-CYLINDER assembly. Errors occur in the modify process. The goal is to learn how to recognize and correct errors.

A Concentric Mate and Coincident Mate define the SHCS placement. Suppress the Coincident Mate in order to flip the alignment. Modify the Concentric Mate selections from the GUIDE-CYLINDER top back hole to the PLATE-B bottom front hole with the Replace Mate Entities option. Unsuppress the Coincident Mate. Utilize the Replace Mate Entities option to redefine the Coincident Mate selections.

What is the required thread length? Answer: 25mm or 30mm. Try a 25mm SHCS. The 25mm SHCS thread does not provide the minimum engagement of 75% for the MGPRod Plate hole.

Utilize the Replace Component option to modify the 25mm SHCS to a 30mm.
The SHCS fastens PLATE-B to the GUIDE-CYLINDER assembly. Create a Local Assembly Pattern that corresponds to the MountHoles2 position. Record the dimensions between the holes.

The Local Assembly Pattern of the M10 SHCS requires the 130mm and 40mm dimensions. Identify the location of the pattern. Locate the pattern at the top level of the 2AXIS-TRANSFER assembly.

There is a visual interference between the lower right fastener and the SLIDE-TABLE assembly. What is the solution? Answer: Utilize the second set of MGPRod M6 holes, named MountHoles.

### Activity: Editing Mates and Redefining Components

1. **Suppress the Coincident Mate, 6.** Right-click Mate 6 in the FeatureManager. Click Suppress.

2. **Redefine Concentric Mate 5.** Right-click Mate 5 in the FeatureManager.
160) Click Replace Mate Entities.

161) Select the Face of GUIDE-CYLINDER from the Mate Entities box.

162) Select the PLATE-B front bottom hole.

163) Click OK.

The SHCS head points towards PLATE-B. Press the Flip Mate Alignment button if required.

Move the SHCS into position.
164) Drag the SHCS in front of PLATE-B.

Modify Coincident Mate 6.
165) Right-click Mate 6.

166) Click Unsuppress.
The What’s Wrong box displays two errors. The first error is a general error statement about the 2AXIS-TRANSFER Mate group. The 2AXIS-TRANSFER entry displays an error flag in red. The Mates entry displays an error flag in red.

The second error lists the Feature, Mate 6 and provides a description about the error condition. The separation distance value is based on the SHCS position in the Graphics window. To maintain coincident faces, utilize Replace Mate Entities and select the front PLATE-B face.

Redefine the Mate Entities.

167) Right-click Mate 6.

168) Click Replace Mate Entities. Red error flags are displayed on the Mate Entities.

169) Select the Face of GUIDE-CYLINDER entry from the Mate Entities box.

170) Select the GUIDE-CYLINDER front face. Green check marks are displayed on the Mate Entities.

171) Click OK.
The Mates rebuild successfully. Mate 5 and Mate 6 reference the SHCS and PLATE-B.

Create a Section view.
172) Click the Front face of PLATE-B.
173) Click Section View.
174) Enter -8 to display the Section view with the hole and fastener.
175) Click OK.

Replace the SHCS.
176) Right-click B18.3.1M-10x1.5x25 Hex SHCS in the FeatureManager.
177) Click the More Arrow at the button of the Pop-up.
178) Click Replace Components.
179) Click the Browse button from the Replace PropertyManager.
180) Select B18.3.1M-10x1.5x30 Hex SHCS from the MY-TOOLBOX\SHCS folder.
181) Click Open.
182) Click OK.
Display the full view.

183) Click Section View.

Show the MGPTube.

184) Right-click MGPTube in the FeatureManager.

185) Click Show.

The Mated Entities PropertyManager displays the Concentric and Coincident references for Mate 5 and Mate 6. The SHCS updates in the Graphics window. The FeatureManager displays the new entries with the part icon and Mates entries.

The Mate Entities PropertyManager provides the ability to change Mate selection. Explore additional Mate errors and their recovery in Project 4.
View the dimensions required for a Local Pattern.

186) Double-click GUIDE-ROD in the FeatureManager.


Create a Local Assembly Pattern.

188) Select the B18.3.1M-10x1.5x30Hex SHCS from the 2AXIS-TRANSFER FeatureManager for the seed component.

189) Click Insert, Component Pattern, Linear Pattern.

190) Click the horizontal edge for Direction 1.

191) Enter 130 for Spacing. Enter 2 for Instances.

192) Click the vertical edge for Direction 2.

193) Enter 40 for Spacing. Enter 2 for Instances.

194) Click OK.
Show the SLIDE-TABLE components.
195) Right-click the SLIDE-TABLE. Click Show.


197) Hold the Ctrl key down.

198) Select MXSL-BS+BT<2>.

199) Right-click Show. Release the Ctrl key.

200) Click Interference Detection from the Assembly toolbar.

201) Right-click a position in the Selected components box. Click Clear Selections.

202) Select MXSL-BS+BT.

203) Select B18.3.1M-10x1.5x30 Hex SHCS.

204) Click the Calculate button. The results display the Interference volume.

The Interference results in a design decision. Review the four options:

- Modify the positions of the PLATE-B four holes.
- Mount the SLIDE-TABLE to PLATE-B utilizing BodyHole3 and BodyHole4.
- Increase the overall size of PLATE-B and modify the four through holes to countersink or counterbore.
- Locate additional holes on the MGPRod component.
The first option results in modification of a purchased part. The second and third options cause interference with other components. Proceed with the fourth option. Locate two MountHoles on the MGPRod. Insert two M6 Cbores in PLATE-B with the Holes Wizard.

Delete the M10 SHCS and Local Pattern.

205) Click M10 SHCS in the 2AXIS-TRANSFER FeatureManager. Hold the Ctrl key down.

206) Click the LocalPattern1. Press the Delete key. Release the Ctrl key.

207) Click Yes to All to delete the dependent Mates.

Hide the SLIDE-TABLE and the GUIDE-CYLINDER/MGPTube.

208) Click the SLIDE-TABLE in the FeatureManager. Hold the Ctrl key down.

209) Click the GUIDE-CYLINDER/MGPTube. Right-click Hide. Release the Ctrl key.

Edit PLATE-B In-context of the 2AXIS-TRANSFER assembly.

210) Right-click PLATE-B in the FeatureManager. Click Edit Part. The PLATE-B part name is displayed in blue.

Display the hidden lines.

211) Click Hidden Lines Visible.

212) Press the T Shortcut key to display the Temporary Axes.

Insert an M6 Cbore.

213) Click the PLATE-B face to the left of the Origin.


215) Select Socket Head Cap Screw for Screw Type.

216) Select M6 for Diameter. Select Through All for Depth. Click Next.

Position the second M6 hole center point.

217) Click a position to the right of the Origin.
There are two methods to reference the center point of a Hole Wizard hole or Circle Sketch tool. The first method is to “wake up” the center point of an existing hole by dragging the mouse pointer over circular geometry. A Coincident relationship is inferred. This method requires that the referenced circular geometry and the new center point are on the same plane or face.

The second method utilizes the Temporary axis of an existing hole and the new center point. Work in an Isometric view to display the Temporary axis and the center point. Utilize this method in the next step.

Select the Axis filter.

218) Right-click a position in the gray area of the Main menu.

219) Check Selection Filter.

220) Click Filter Axes.

Add Relations.

221) Click the left MGPRod/MountHole Temporary Axis.

222) Click Clear All Filters.

223) Hold the Ctrl key down.

224) Select the left Cbore center point.

225) Click Coincident. The hole is fully defined.

226) Repeat for Coincident relation for the right Cbore.
Return to the 2AXIS-TRANSFER assembly.


Save the 2AXIS-TRANSFER assembly.

228) Click Save.

Two M6 SHCSs are sized and inserted. This action is an exercise at the end of the project. Utilize the four outside mounting holes in a different assembly.

Suppress the SHCSs.

229) Select B18.3.1M-6x1.0x50 Hex SHCS <1>.

230) Hold the Ctrl key down.

231) Select B18.3.1M-6x1.0x50 Hex SHCS <2>.

232) Right-click Suppress.

233) Release the Ctrl key.

Display the Hidden components.

234) Right-click the GUIDE-CYLINDER/MGPTube part in the FeatureManager.

235) Click Show.