SW Tips/Tricks

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Real World Assembly Mating

Assembly mating can be described as “taking away degrees of freedom”. When a component is floating around inside an assembly, that is, the component is moved or rotated relative to the assembly coordinate system, it has 6 degrees of freedom. Visualizing the coordinate system, the 6 degrees of freedom would be translation in the X, Y, Z directions, and rotation about the X, Y, Z axes. Adding a mate removes one or more of these degrees of freedom. For example, an assembly has a block with a hole through it. A pin is brought in to the assembly, and initially has the 6 degrees of freedom. A concentric mate applied between the inside cylindrical face of the hole and the outside cylindrical face of the pin will remove 4 of those degrees of freedom (see *Figure 1*). The two that remain include the pin translating in and out of the hole, and the pin rotating about its axis. By selecting the pin, it can still be moved in the 2 remaining degrees of freedom. Continuing to add mates would further reduce the

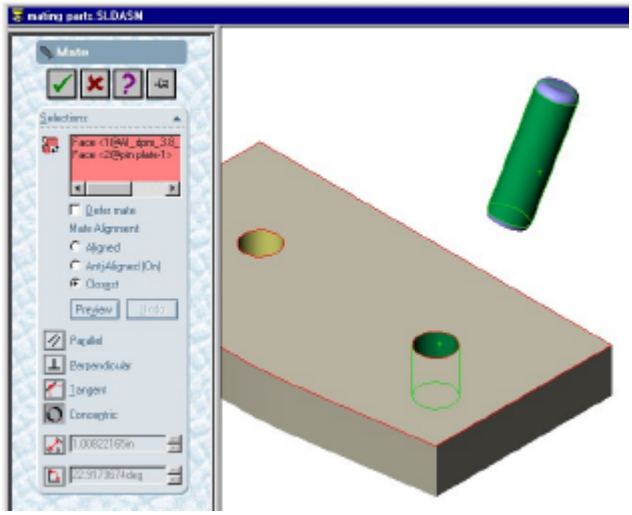

Figure 1 - Concentric mate will remove four degrees of freedom from pin

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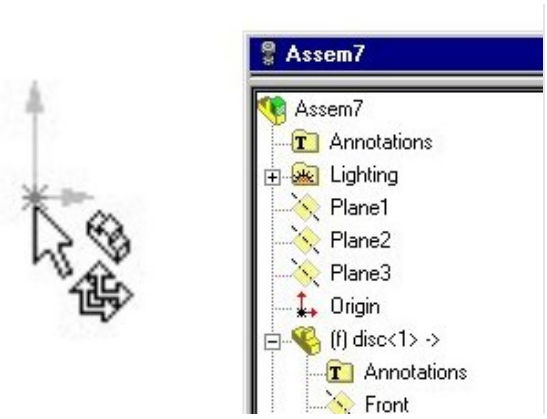

Figure 2 - Icon indicating default planes of component being inserted will align with assembly default planes

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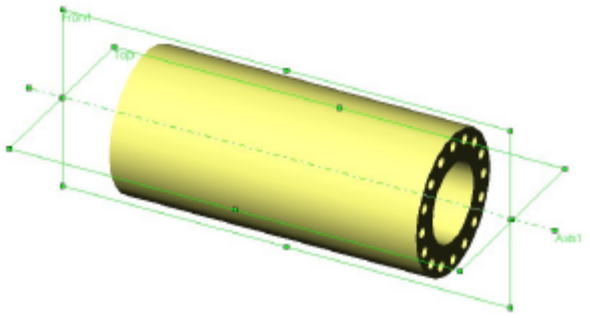

Figure 3 – A part created symmetric about origin and default planes

degrees of freedom. A coincident mate between the flat face of the pin and the outside face of the block would keep the pin from sliding in and out of the hole, but the pin could still rotate. A parallel mate between a flat face on the block and a plane in the pin component will take away the pin's last degree of freedom, rendering the pin "fully defined".

Fix (f) or Float

After creating a new assembly file, the first component inserted will always be "fixed". This "fixed" state is noted by a (f) prefix on the component name in the FeatureManager design tree of the assembly, and prevents components from moving unpredictably as more mates are added. This fixed state can be removed and replaced at any time. Simply right select and pick **Float**. The (f) component prefix is changed into a (-) indicating the component has degrees of freedom. Every assembly should have at least one component that is fixed or mated to the assembly planes in some way. For example, if two flat faces from two components floating in assembly space were mated, the new positions of these components would be unpredictable. Would component A move to component B or the other way around? Another possibility would be both components move to a third location. By fixing the first component, the subsequent assembly mates act as expected. To insert and position the component's origin and planes exactly on top of the assembly origin and planes, pick either the origin of the assembly, or the assembly feature manager as the location of the component. *Figure 2* shows the icon that appears, as the cursor is hovered at the assembly origin. This is also accomplished by dragging the component into the assembly and dropping it on the assembly origin or feature manager.

Mating to Reference Geometry

Bringing virtual components into a virtual assembly is similar in many ways to putting together the same assembly in the real world. A couple of plates can be fastened together with a bolt, nut, washer, and lockwasher. However there are tools in the virtual world, that allow even greater control over how assemblies go together and behave. A good example of this is the practice of mating the planes of the components with either the planes of the assembly or the other components in the assembly. This is useful when the assembly is arranged around a central axis, as in a cylindrical pressure vessel. The first component of the pressure vessel, the housing, is inserted into the new assembly and floated. The housing was created so the front and top planes intersect along the main axis of the pressure vessel (see *Figure 3*). The front and top planes of the housing are mated to the corresponding planes of the assembly (see *Figure 4*). The front plane of the housing mated coincident to the front plane of the

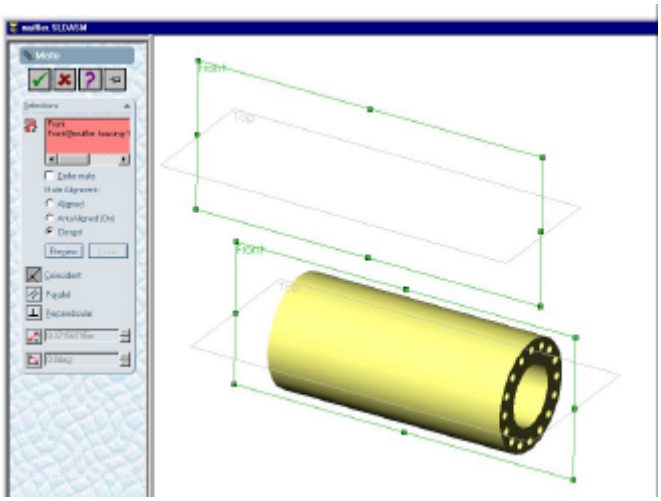

Figure 4 – Mating a plane of a the first component to a default assembly plane

assembly, top plane coincident to the top plane, and finally right plane coincident to the right plane. The next component brought in is an endcap. The endcap was also created with the front and top planes intersecting along the main axis of the pressure vessel. Now simply mate the front plane of the endcap with the front plane of the assembly and the top plane to the top plane (see *Figure 5*). A coincidence mate between the two flat faces of the housing and the endcap is then added to locate the component along the axis. This is repeated for all the axial components of the pressure vessel assembly. This practice prevents the components from rotating, assures all the bolt patterns line up, and keeps the mates simple to understand six months from now when trying to figure out how the components were mated.

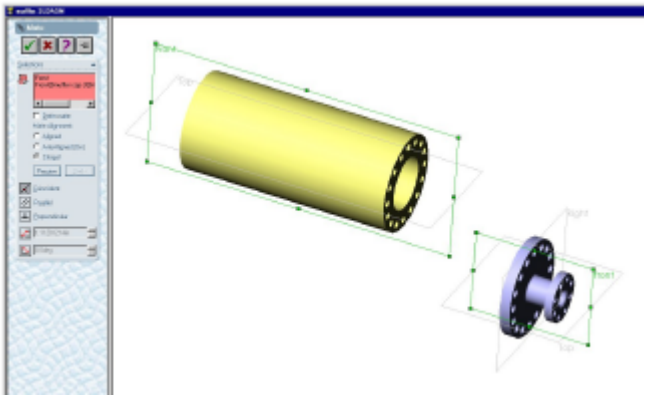

Figure 5 - Mating a plane of a the second component to a default assembly plane

Dragging and Dropping into Assemblies

When inserting components into the assembly, the parts can be dragged from the part file window or the Feature Palette into the assembly window. Dragging the cursor will turn the washer image a translucent green color (see *Figure 6*).

Depending on where the cursor is placed prior to dragging, one or more mates can be added automatically between the component being dragged and the location in the assembly where the component is dropped. Dragging the component from a flat face to a flat face in the assembly will add a coincident mate between those faces. Likewise dragging a cylindrical/conical face to a cylindrical/conical face in the assembly will add a concentric mate. Look for the cursor feedback while dragging the components. The component being inserted should snap into place as the cursor is dragged across corresponding faces. Before dropping the component in the assembly, use the Tab key to change the alignment of the component as it related to the assembly. Then alignment will toggle between the two solutions to the mate.

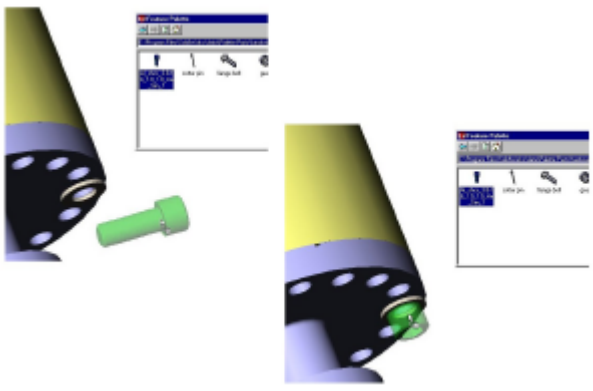

Figure 6 - Dragging and dropping a component from Feature Palette into the assembly

There are many types of components that are best mated concentric and coincident with a common circular edge between the cylindrical face and a flat face. This includes a washer mated to a hole on a plate, and the subsequent mating of a bolt to the same washer. There are a couple of ways to take advantage of this circular edge and add both the concentric and coincident simultaneously.

With both the washer part window and the assembly window visible, place the cursor on the common circular edge of the washer. Drag the cursor across into the assembly window locating it on the corresponding circular edge of the hole. As the cursor is placed on the circular edge of the hole, the washer image will snap into place. Before dropping the washer in place, change the alignment of the washer with the Tab key. Dropping the washer into the assembly will add both the mates between the two parts. -(O||||O)-

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2nd Wednesday of the Month at 7:00pm

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