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Introduction

CATIA Version 5 Assembly Design

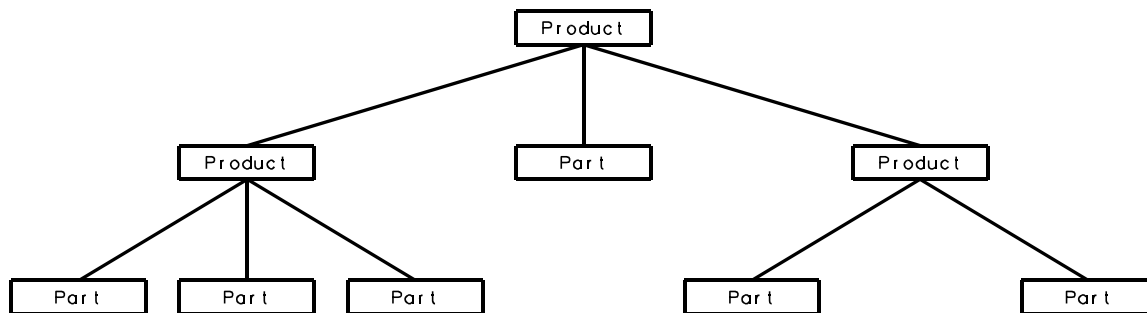
Upon completion of this course the student should have a full understanding of the following topics:

- Inserting models into an assembly
- Manipulating models in an assembly
- Constraining models in an assembly
- Using advanced methods to insert and constrain assemblies
- Analyzing assemblies for clashes and gaps
- Modifying assembly components and updating assemblies

Assembly Design

Very few finished designs are a single part. Usually a finished design consists of several to millions of individual parts to define them. This is where CATIA V5 assembly design is utilized. Assembly design allows parts and small assemblies of parts to be inserted to make larger, more complete products. In CATIA V5 Part Design and Sketcher, you learned how to generate parts. The primary objective of this class is to utilize those parts to create a complex assembly of those parts that can be later used in stress analysis, kinematics, fitting simulations, and other areas.

It is important to understand some of the terminology that CATIA uses when working with assemblies. There are basically three types of documents that are used in assembly design. They are the overall assembly, sub-assemblies and individual models. CATIA uses the word products to refer to assemblies and parts to refer to individual models. You can use parts to create products and then in turn use those products to produce other products. The diagram shown below represents the concept of the overall structure.

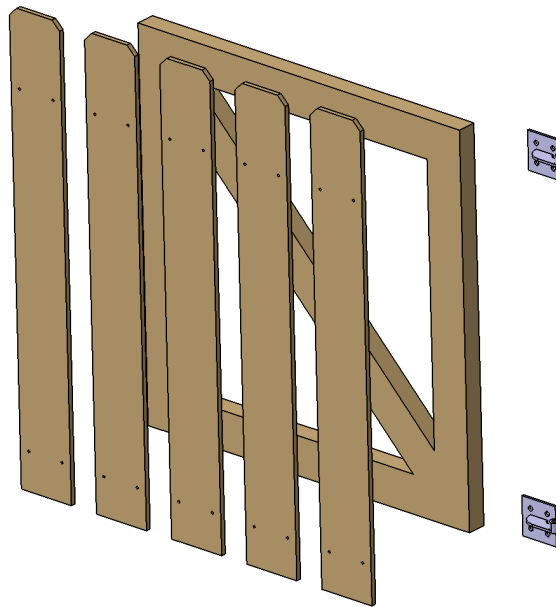


The first product at the top is generally regarded as the assembly, whereas the two products that are underneath are generally regarded as sub-assemblies of this assembly. This assembly could in turn be used to create an even bigger assembly at some other time, or the sub-assemblies could be used as sub-assemblies of a different assembly. With this concept in mind be aware that an assembly could be a very complex document due to its ability to have multiple levels of sub-assemblies and parts. Because of this complexity it is important that you have a plan of attack when building assemblies. There are basically two approaches that a user or company can take when building assemblies. One is to pre-determine what sub-assemblies a particular assembly is going to need. The other is to produce all of the parts and then determine what sub-assemblies are going to be created.

Constraint Creation

There are three modes you can be in when creating constraints. You have the default mode, chain mode and stack mode. Through the previous exercises you have been in the default mode. The chain mode is useful when constraining multiple objects to each other. This allows you to create a constraint from the first object to the second object and create one from the second object to the third object without having to select the second object again. The stack mode is useful when constraining multiple objects all to the same item. This keeps you from having to select the one item over and over again.

Open the Constraint Creation document located in the *Constraint Creation* directory. This has a frame that needs hinges and pickets attached to it.



In the bottom toolbar you should find the Constraint Creation toolbar which contains icons for the three modes. One of these modes will be on at any point of time. Currently the default mode should be highlighted. These will only affect your constraining when you are creating multiple constraints of the same type.



Default mode



Chain mode




Stack mode

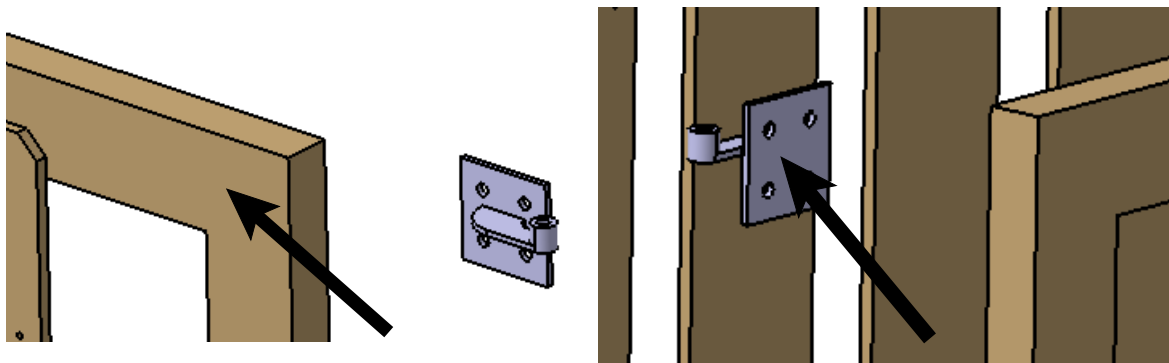
Default Mode

Default mode is the mode you have been using all along and it requires that you define both objects for every constraint.


Make sure the Default Mode icon is selected. 

Double select the Contact Constraint icon.  This will keep the icon active until you turn it off.

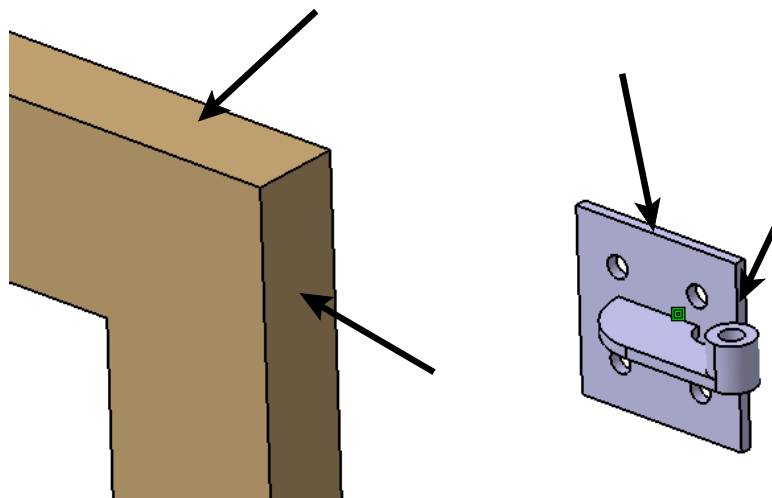
Select the back face of one of the hinges and the front face of the frame as shown below. This should produce a surface contact constraint and the contact constraint icon should still be active.



Select the back face of the other hinge and the front face of the frame. The surface contact constraint is created.

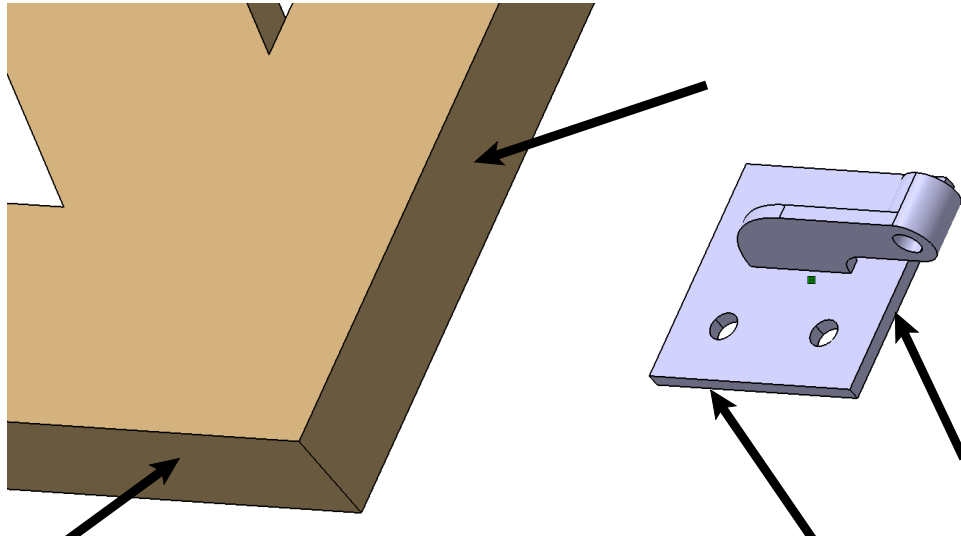
Double select on the Coincidence Constraint icon.  You are going to create some coincident constraints to position the hinges.

Select the top face of the frame and the top face of the hinge as shown below and select **OK**. This positions the hinge to be aligned with the top of the frame. The coincidence constraint icon should still be active.



Select the **right face of the frame** and the **right face of the hinge** as shown above and select **OK**. That constrains the top hinge. You will now finish constraining the bottom hinge. The coincidence constraint should still be active.

Select the **bottom face of the frame** and the **bottom face of the hinge** as shown below and select **OK**. This positions the hinge to be aligned with the bottom of the frame. The coincidence constraint icon should still be active.



Select the **right face of the frame** and the **right face of the hinge** as shown above and select **OK**. That constrains the bottom hinge.


Turn off the Coincidence Constraint icon. 

When you are in default mode and you double select a constraint icon, you were able to create multiple constraints in a row but you had to select both elements for the constraint every time. The other two modes keep you from having to select both elements when defining multiple constraints.

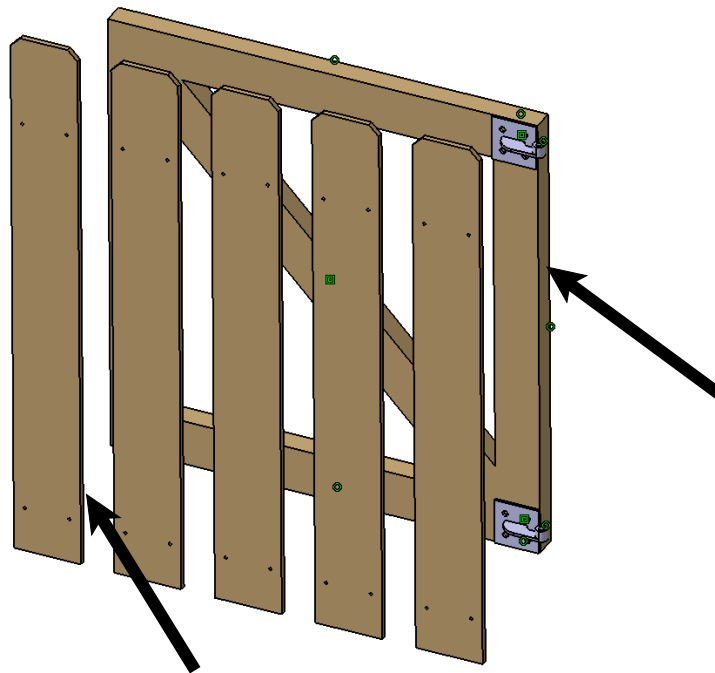
Chain Mode

Chain mode allows you to create a constraint by selecting a first object and then a second object and then on subsequent constraints you only have to select the second object. The second object of the previous constraint becomes the first object of the next constraint. This only works when creating multiple constraints of the same type.

Select the **Chain Mode icon**. 

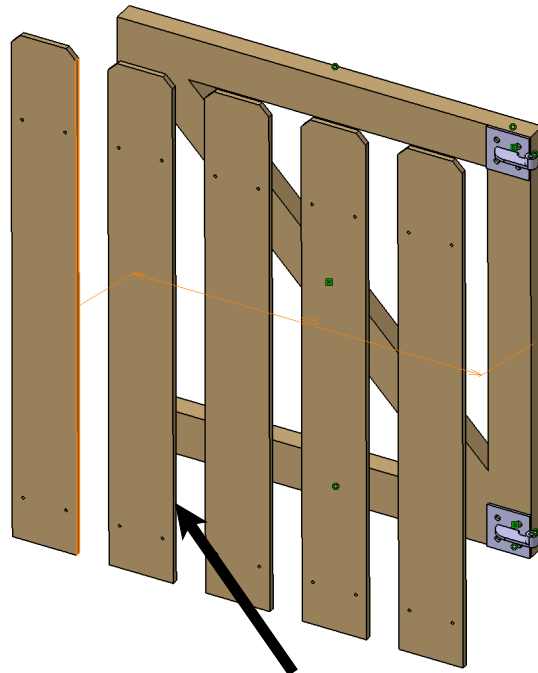
Double select on the Offset Constraint icon.  You are going to create a series of offset constraints to space the pickets along the frame.

Select the right face of the frame and the right face of the leftmost picket as shown below. Make sure you pick the face of the frame first. The *Constraint Properties* window appears.



Make sure the *Orientation* is *Same* and change the *Offset* to *-32.5* and select *OK*. The picket is positioned and the right face of that picket becomes the first selection for the next offset constraint.

Select the **right face of the next picket** as shown below. Notice that the offset is from the previous face selected and the new face selected. Chain mode causes the second object selected to become the first object for the next constraint. The *Constraint Properties* window appears.



Make sure the *Orientation* is *Same* and change the *Offset* to 7.125 and select *OK*. The picket is positioned.

Select the right face of the next picket, make sure the *Orientation* is *Same* and change the *Offset* to 7.125 and select *OK*. The picket is positioned.

Select the right face of the next picket, make sure the *Orientation* is *Same* and change the *Offset* to 7.125 and select *OK*. The picket is positioned.

Select the right face of the next picket, make sure the *Orientation* is *Same* and change the *Offset* to 7.125 and select *OK*. The last picket is positioned.


Turn off the **Offset Constraint icon**.  Notice how all of the offsets are “chained” together, with each one being based off the last selected object.



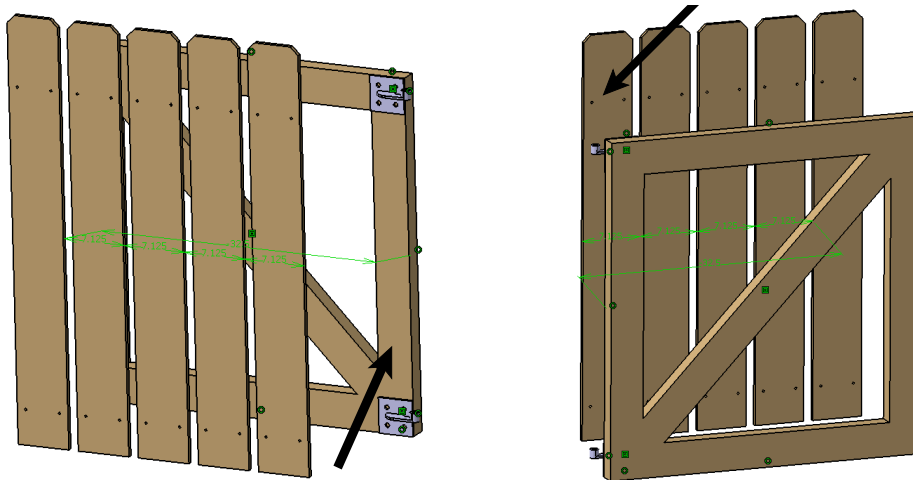
Stack Mode

Stack mode allows you to create a constraint by selecting an object and then every constraint will use that object as its first selection. Then, all you have to do is keep selecting the objects you want constrained to that object. This is very useful when you have several items that need to be constrained to the same object.

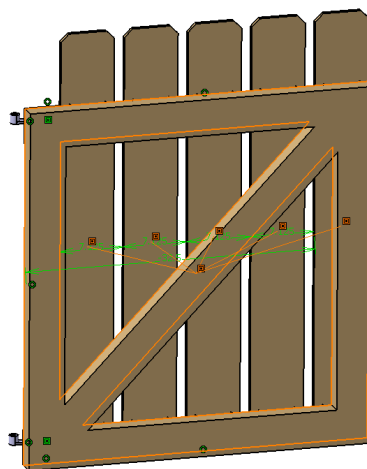
Select the Stack Mode icon. 

Double select on the Contact Constraint icon.  You are going to create surface contact constraints a series of offset constraints to space the pickets along the frame.

Select the front face of the frame and the back face of a picket as shown below. Make sure you pick the face of the frame first. The picket moves to the frame.



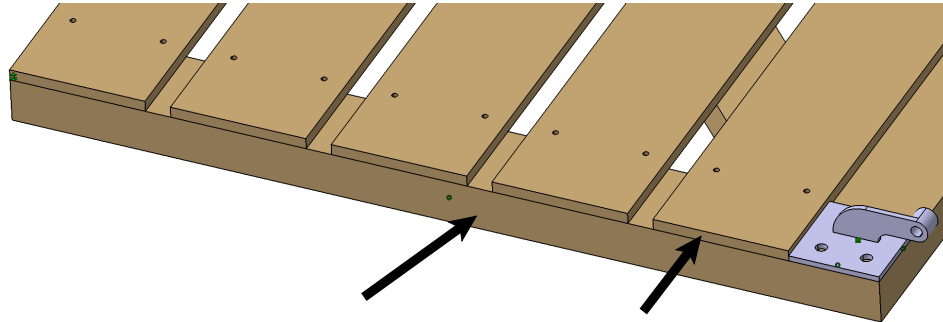
Select the back surface of the other four pickets. The pickets all move to the frame. Since you are using the stack mode all you had to do was define the face of each picket that you wanted to be in contact with the frame.



Turn off the Contact Constraint icon. 

Double select the Offset Constraint icon.  You should still be in stack mode.

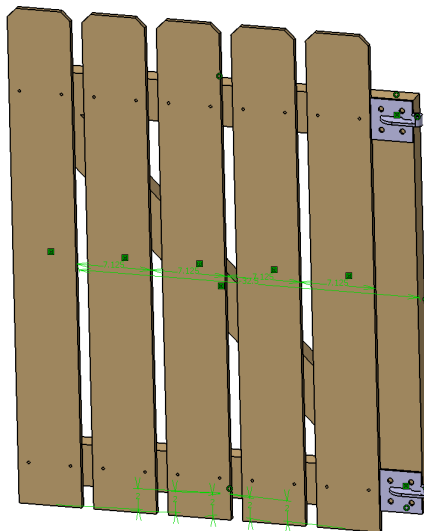
Select the bottom face of the frame and the bottom face of a picket as shown below. The *Constraint Properties* window appears.




Make sure the *Orientation* is *Same* and change the *Offset* to 2.0 and select *OK*. The picket moves down. You will put the rest of the offset constraints in the same manner on the other four pickets.

For the other four pickets, select the bottom face of the picket, make sure the *Orientation* is *Same* and change the *Offset* to 2.0 and select *OK*. All the pickets should be fully constrained.

Turn off the Offset Constraint icon.  Your product should appear similar to the one shown below.



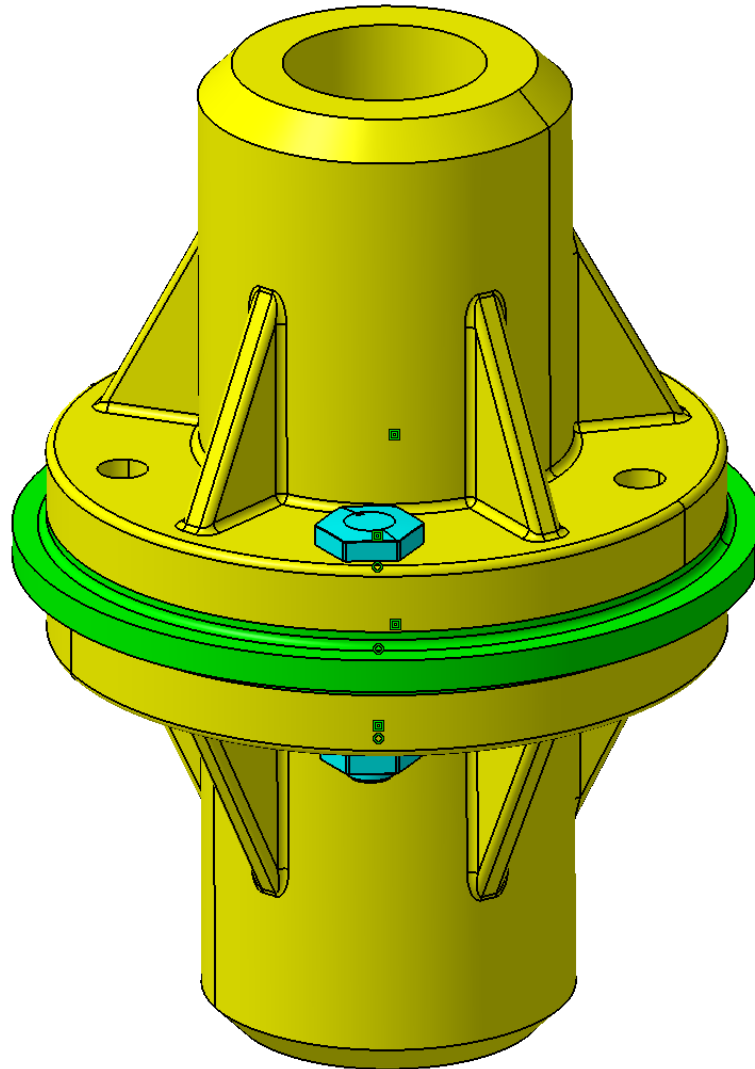
Select the Default Mode icon.  You will want to leave this mode on unless you run into a situation where the other modes are beneficial.

Save and close your document.


Reusing Patterns

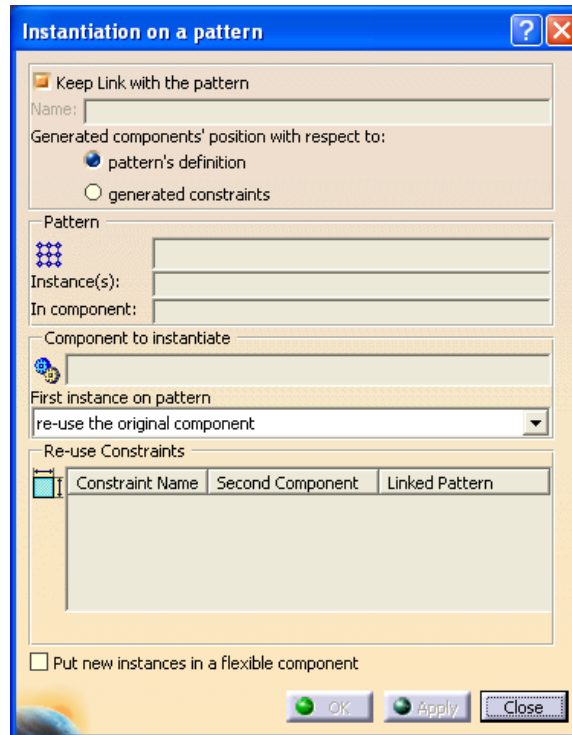
The reuse pattern option allows you to use an existing pattern within a part to help position and constrain components. This is very useful for constraining fasteners to patterns.

Open the Reuse Pattern document located in the *Reuse Pattern* directory. You should see a couple of casings being attached with a bolt and nut. You are going to put the rest of the bolts in the assembly.



Expand the *Products* branch and expand the *Casing.1* branch in order to see the patterns available. The *CircPattern.2* is the one you are going to reuse

Select the **Reuse Pattern icon**.  This icon will allow the user to reuse any pattern used in a part design. The *Instantiation on a pattern* window appears.



Keep Link with the pattern Updates the number of instances as the pattern is modified and creates a link back to the pattern

Generated components' position with respect to

pattern's definition Positions the instances with respect to the pattern's definition

generated constraints Positions the instances and generates constraints

Pattern Contains the pattern that is going to be used

Instance(s) How many instances the pattern contains

In component The component that the pattern exists in

Component to instantiate The item you are going to use in this pattern

First instance on pattern

re-use the original comp... The original component is used and others are added

create a new instance The component is copied and then placed into the pattern locations

cut & paste the original... The component is deleted by being cut and then pasted into the pattern locations

Re-use Constraints Allows you to specify which constraints will be used

All All constraints are reused

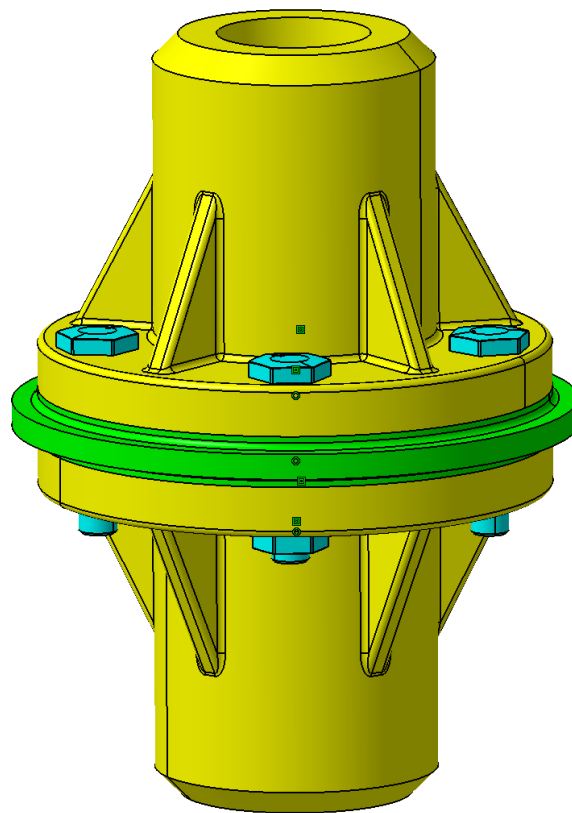
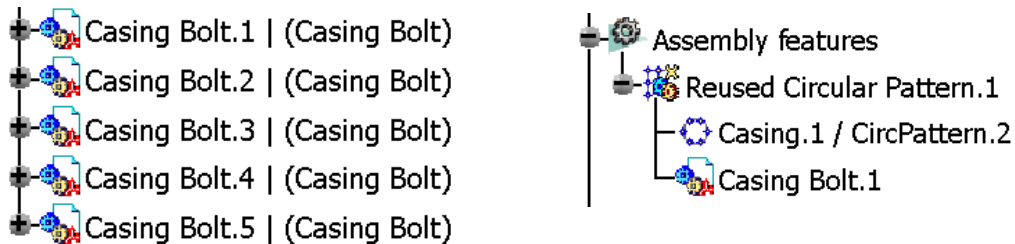
Clear No constraints are reused

Put new instances in a flexible component Places all new instances into its own flexible assembly


Make sure the *Keep Link with the pattern* option is on and select the *pattern's definition* option.

Select *CircPattern.2* from the specification tree and select the *Casing Bolt.1*. The available constraints appear in the *Re-use Constraints* area but you will not be using them.

Choose the *re-use the original component* option for the *First instance on pattern* and select **OK**. Four more instance of the bolt appear in the tree along with an *Assembly features* branch showing the link to the pattern.



You should note that the original bolt was used and then four more instances were created.

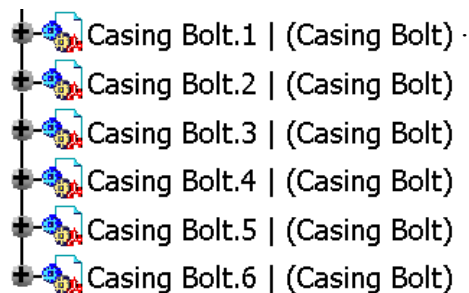
Select the Undo icon to undo the creation of the bolts. 


Select the Reuse Pattern icon.  The *Instantiation on a pattern* window appears.

Select the same pattern and the bolt again. This time you will change the *First instance on pattern* option.

Change the *First instance on pattern* option to create a new instance and select **OK**.

Notice that the bolt is instanced five more times instead of four. This is because you told it to create a new instance of the bolt instead of reusing the one you selected. The original instance still exists along with the five for the pattern.

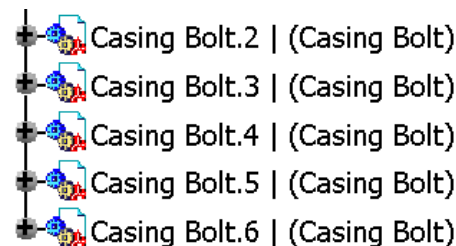



Select the Undo icon to undo the creation of the bolts. 

Select the Reuse Pattern icon.  The *Instantiation on a pattern* window appears..

Select the same pattern and the bolt again. You will change the *First instance on pattern* option again.

Change the *First instance on pattern* option to *cut & paste the original component* and select **OK**. Notice that the bolt is instanced five more times but the original one no longer exists.



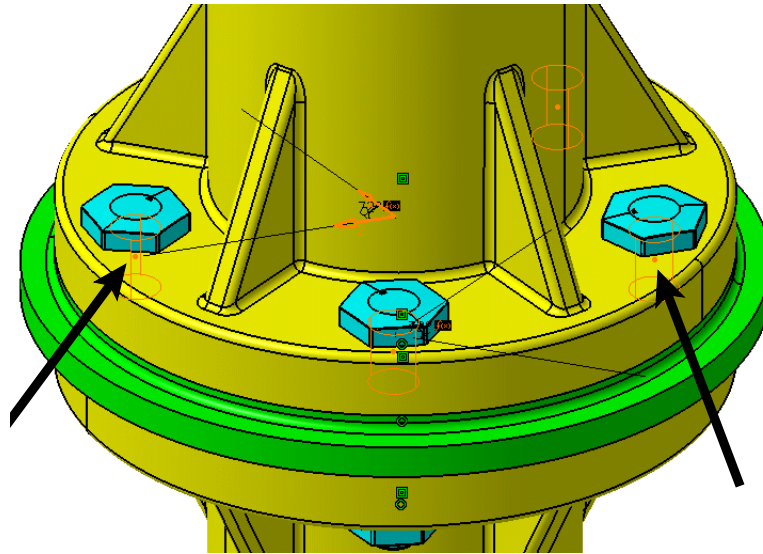
Select the Undo icon to undo the creation of the bolts. 

Select the **Reuse Pattern** icon.  The *Instantiation on a pattern* window appears.




Select the same pattern and the bolt again, make sure the *re-use the original component* option is selected and select **OK**. You get four more instances of the bolt.

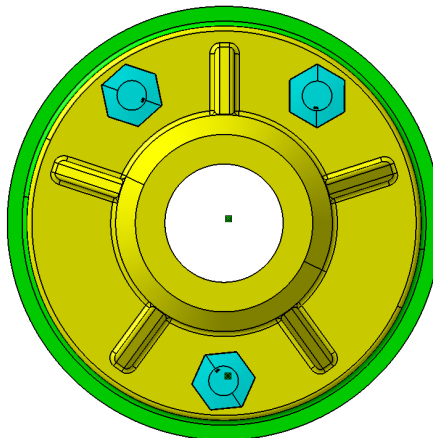
Double select on the *PartBody* of *Casing.1*. This makes that part the active component.


Double select on *CircPattern.2* and remove the two instances shown below and select **OK**. This will modify the pattern to have only three holes.




Double select on the *Reuse Pattern* product. This makes the top level assembly the active component and the number of instances of the bolt changes. This is due to the link to the pattern. The diagram shown below has the product rotated.

-  Casing Bolt.1 | (Casing Bolt)
-  Casing Bolt.2 | (Casing Bolt)
-  Casing Bolt.5 | (Casing Bolt)



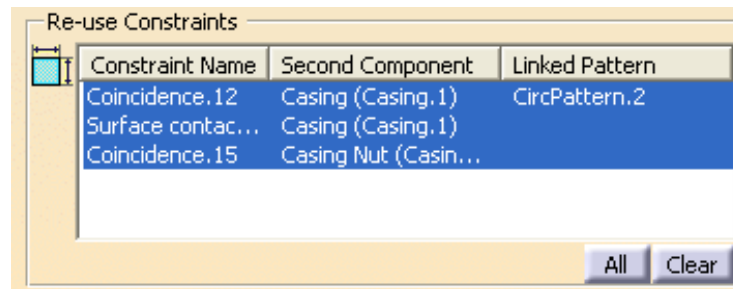
Select the **Undo icon to undo the change to the pattern and to undo the instancing of the bolts.**  You will now reuse the pattern without linking to it.

Select the **Reuse Pattern icon.**  The *Instantiation on a pattern* window appears.

Turn off the *Keep Link with the pattern* option. The generated constraints option automatically turns on. This time instead of selecting the pattern and the bolt you will just select the constraint that is common to both.

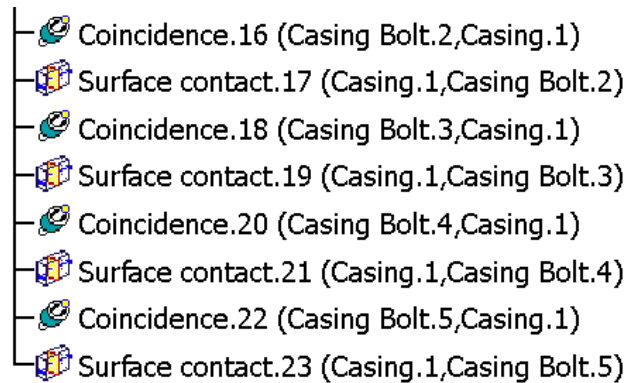
Select the *Coincidence.12* constraint. This is an alternative way of defining the information. By selecting a constraint that is between a component and a pattern it will automatically use the pattern and the component that the constraint is associated with. This method is available whether you are keeping link or not to the pattern.

Look at the *Re-use Constraints* area in the window. This shows all of the constraints associated with the component and allows you to specify which ones you want created with each new instance. Notice that only the *Coincidence.12* constraint is linked to the pattern. This means that this is the only one that would change based on the location of the instance in the pattern. The other two constraints will be associated with the same elements as the original.



Select the *Coincidence.12* and *Surface contact.13* constraint in the window. You will have to use the Ctrl key to select both. You do not want the other coincidence constraint since it is tied to the nut and will cause the new instances to be over constrained since the nut is not being replicated. The surface contact constraint is fine since the surface it is using on the casing is the same surface for all of the instances. The coincidence with the casing will change to be at each location of the pattern due to the link with the pattern. You always have to be careful about which constraints you want to reuse.

Select OK. The bolts appear with the two constraints for each one. Notice that there is not an *Assembly features* branch since you do not have a link to the pattern.

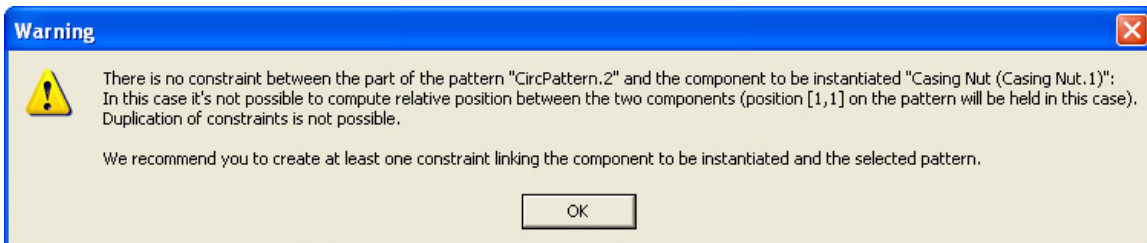


If you were to modify the pattern as you did before, the two bolts would still exist but their coincidence constraints would have an error. This is due to them being driven by constraints and not the definition of the pattern.

Select the Reuse Pattern icon.  The *Instantiation on a pattern* window appears.

Make sure the *Keep Link with the pattern* option is turned off. The generated constraints option automatically turns on.


Select the *CircPattern.2* and the *Casing Nut.1*. A *Warning* window appears. Since the nut does not have a constraint that involves the pattern it is recommending that you create one in order for the reuse pattern to work correctly.



Select OK. Notice that you cannot reuse the pattern.

Select Close. You will modify the coincidence constraint of the nut to use the centerline of the hole of the casing instead of the centerline of the bolt since the hole in the casing is created with the pattern.

Modify *Coincidence.15* to use the centerline of the hole instead of the bolt.

Select the **Reuse Pattern** icon.  The *Instantiation on a pattern* window appears.

Make sure the **Keep Link with the pattern** option is turned off. The generated constraints option automatically turns on.

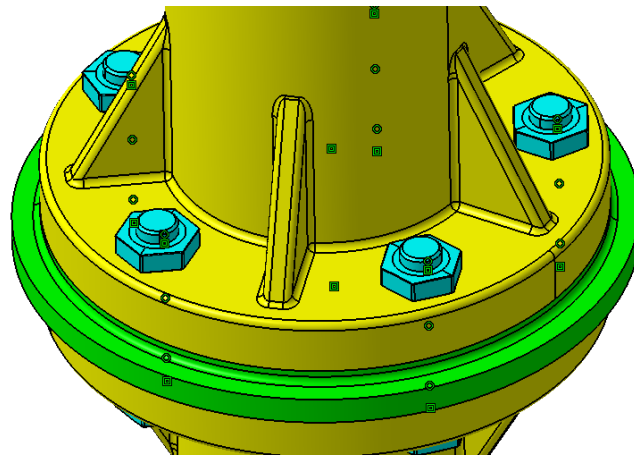
Select the **CircPattern.2** and the **Casing Nut.1**. This time you do not get a warning since a constraint exists between the nut and the pattern.

Change the **First instance on pattern** to use the **cut & paste the original component** option. You want the operation to create five new instances without leaving the original.

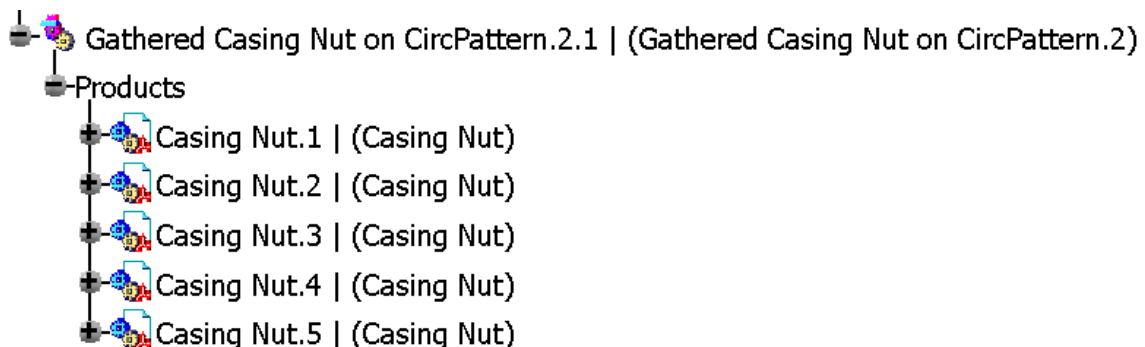
Select **All for the Re-use Constraints**. This ensures that both of the constraints will be generated with each instance.

Turn on the **Put new instances in a flexible component** option. This will put the generated instances in their own component and it will be flexible. Flexible components will be discussed in greater detail later in the course.

Select **OK**. The nuts appear. The assembly was rotated around for the picture shown below.



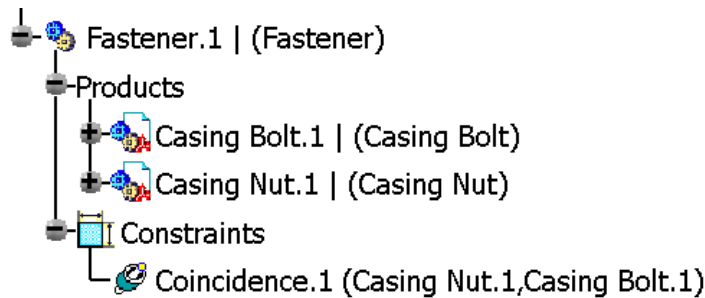
The nuts are all put into their own component and the component is flexible (pinkish purple gear).




Save and close your document.

Open the Reuse Pattern2 document located in the *Reuse Pattern* directory. This will have you replicate the bolt and nut by having the bolt and nut be in a sub-component. This way you can replicate both parts by reusing the pattern once.

Notice that the assembly contains a *Fastener* component which contains the bolt and nut and it is constrained to the pattern in the casing.

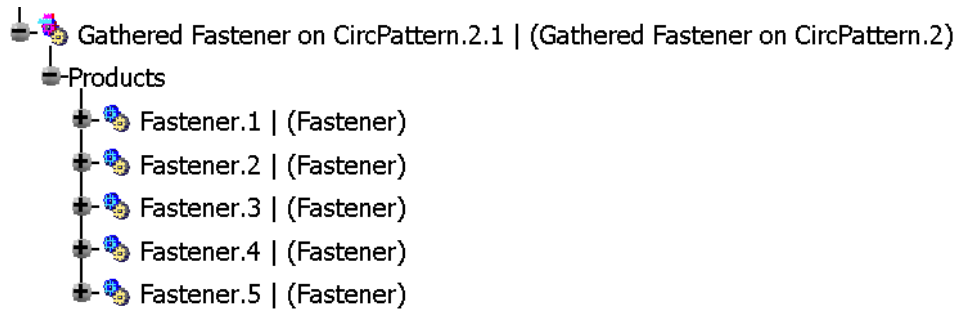


Select the **Reuse Pattern icon**.  The *Instantiation on a pattern* window appears.

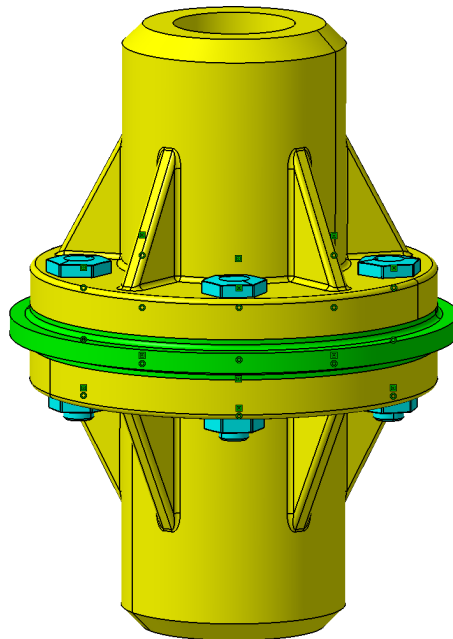
Make sure the *Keep Link with the pattern* option is turned off and the *Put new instances in a flexible component* is turned on.

Select the *CircPattern.2* in the *Casing.1* instance and select the *Fastener.1* component. You are going to want to use all of the constraints since these are used to constrain all aspects of the fastener.

Change the *First instance on pattern* to use the *cut & paste the original component* option and select *OK*. The *Fastener* component is replicated and put under a flexible component.



This provides another method of replicating the bolt and nut. This method created a component that contained both entities and then reused that component with the pattern. Previously you reused the pattern once for the bolt and once for the nut. It just depends on how you want your product structured.



Reusing patterns can be very beneficial however the right circumstances need to exist in order for it to be used effectively. You have to have a common component that you want replicated at locations defined by a pattern of a part. If you are having it generate constraints you must make sure that the constraints you choose are valid for each new instance. If you choose to have it link to the pattern then you will have an assembly feature in your product which some PLM solutions do not handle very well (This is discussed later in the course). However, if these circumstances are met then you can save a lot of time reusing a pattern.

Save and close your document.