How to benefit from Autodesk Inventor's iCopy tool

How to create and place multiple, infinitely variable copies of an existing iCopy Template Assembly (includes a Bonus mini tutorial on Skeletal modeling).

iCopy

If you've ever tried copying and reusing an Autodesk Inventor assembly, you'll know that it can be a fiddly job. However, *if you know in advance* that you will want to create an Assembly that has many variations in size and shape – Autodesk Inventor's iCopy tool could be just what you need.

The iCopy tool uses adaptivity and skeletal modeling to automate the process of copying and positioning similar components within an assembly. For this reason I would put learning how to use iCopy in the 'Intermediate' level bucket.

There are quite a few steps to designing, testing and creating a template Assembly with iCopy. However the process is quicker than it might seem. This tutorial should take about 30min to complete.

In this exercise we will use iCopy to create an adaptive sheet metal cladding panel.

***Note**: iCopy is a new tool that was added to Inventor as an Autodesk Labs plugin for Inventor 2010. From Inventor 2011, iCopy is included in Inventor.*

iCopy Vs iAssembly

iCopy is slightly different from an iAssembly, in that the iCopy tool creates infinite *sizes* of a design from a template Assembly. An iAssembly is usually used to create a limited number of *variations* controlled by a master table.

iCopy assemblies are used in conjunction with a 'Skeleton' part (much like the Frame Generator). The iCopy Assembly is referenced to the skeleton part using Autodesk Inventor's adaptivity feature and will update when the skeleton part updates.

iCopy can also be used to automate adding patterns of Assemblies, like rungs on a ladder or curtain walling panels. iCopy handles the creation and naming of the new assembly file and all its component parts. Unfortunately there is currently no option to choose how the iCopy tool handles the file name increments

An iCopy assembly is best used when the shape of the design is likely to change rather than the configuration.

***Note**: There is no reason why iAssemblies and iCopy couldn't be used in conjunction with each other (although the thought is pretty mind boggling!).*

The iCopy ingredients list

To create and use iCopy assemblies, you will need:

- An iCopy 'Template' assembly.
- A 'Host' assembly, containing a skeleton part

Creating the iCopy template assembly

An iCopy template assembly contains an adaptive master part file, which contains an under constrained adaptive sketch.

This sketch will be derived into every part in the iCopy assembly that needs to adapt - this technique is called 'Skeletal Modeling' (not to be confused with the Skeleton part).

When placed, the sketch will adapt to suit the skeleton part. As the skeleton part re-sizes, the sketch will re-size and all the

parts referencing the Master sketch will also be resized.

What is Adaptivity?

Adaptivity allows parts which include under constrained sketches or features to adapt to suit other parts within the context of an assembly.

***Note:** Components can only be adaptive inside one assembly at a time.*

Creating the Master part

Create a new part and save it as 'Panel Master.ipt'.

***Note**: Make sure that 'Constraint Persistence' is toggled off – or hold down the CTRL key as you sketch.*

In the default sketch on the XY plane, project the centre point into the sketch, and sketch out a rectangle.

Constrain the bottom left hand corner of the rectangle to the centre.

No other constraints are required.

Finish the sketch. Now right click on the sketch and choose 'Adaptive', then save the file.

Great, that's the first step done!

***Tip**: You can add temporary Dimension constraints to your sketch to size it, but delete them before we get to the next step. I have made my Base Rectangle 500mm Square.*

Next we will create the template assembly:

Create a new assembly, and save it as 'iCopy Panel Assembly.iam'

Place the Panel Master.ipt into the iCopy Panel Assembly.iam

For the iCopy tool to work correctly, the Master Part needs to be constrained to the origin and grounded. A quick way to do this is using the 'Ground and Root' tool:

Assembly Tab > Productivity Panel > Ground and Root

Finally Right click on the part and chose 'Adaptive' then save the file.

***Note**: It is very important that both the under constrained master sketch and the part itself are marked as Adaptive.*

Preparing to Test the iCopy Template Assembly

'What?' – I hear you cry – 'Are we ready to test this already!?'

Yes we are. Testing at this stage lets you know you've got the adaptivity correct before you go building a hundred parts into your iCopy Template assembly! The more complicated your Master sketch is, the more important this stage is.

Turning the assembly into an iCopy template assembly

With the iCopy Panel Assembly.iam open, fire up the iCopy Author tool:

Manage Tab > Author Panel > iCopy Author

The iCopy Author tool will prompt you for a 'Layout Part'. Pick your Panel Master.ipt

You will notice that the Geometry tab and the parameters tab are now available.

Pick the geometry tab - The geometry tab allows you to pick and name control points

that you will use later when placing your iCopy assembly into your project.

Use the Point column to pick the corner sketch points from the sketch in the Panel Master.ipt

Use the Label column to give each point a name, number or description that will help you to remember the order in which the control points should be placed.

***Note**: The Parameters tab can be used to make your Custom parameters available when the iCopy Assembly is being placed. We will get to this tab later.*

Save your brand new iCopy Template Assembly. We are done with that stage, and we are ready to test!

Testing the iCopy Template Assembly

To test your iCopy Template Assembly you will need a host Assembly, which contains a 'Skeleton' part.

The Skeleton part simply needs to be a part containing a solid, sketch or work feature that you want to use to host your iCopy Assembly.

***Note**: The Autodesk Labs iCopy plugin for Inventor 2010 requires a Work Point in the host assemblies' skeleton part for each control point in the iCopy Assembly.*

From 2011 onwards you can use any point or corner feature, but the iCopy Assemblies control points must land on the same feature of the same component – i.e. the same sketch or solid.

Inserting an iCopy Assembly

Once you have your test rig all set up fire up the iCopy 'Insert' tool:

Assemble Tab > Component panel > iCopy

You will be prompted to pick your iCopy assembly. Browse out and pick your gleaming new 'iCopy Panel Assembly.iam'

You will be prompted to pick points on your skeleton part file to place the iCopy Assembly.

Did your iCopy Assembly behave how you expected? Great! You've mastered the hardest part of the procedure – the rest is icing…

***Tip**: You can create a copy of your iCopy Template assembly at this stage to use as the basis for future iCopy designs.*

Icing your iCopy Assembly

So you've created an iCopy Assembly containing a single Part which contains a Sketch which adapts to suit a Skeleton part in the host assembly…

You want more huh?

Well, the next step is to add in all the other parts we want in our iCopy Assembly.

We can add two kinds of parts to our iCopy assembly. We can add regular parts that aren't designed to adapt with the assembly. These can be simply added to our iCopy Template Assembly and constrained into position.

We can also use the Skeletal modeling technique to add parts that will adapt with the Master sketch.

What is skeletal modeling?

Skeletal modeling is a technique which uses Inventor's 'Derive' tool to create relationships between Parameters, Geometry and Features in separate part

files. With this technique a master part file can be created which controls the features in any number of 'Derived' part files.

Creating parts for your iCopy Assembly

(A bonus mini tutorial on skeletal modelling).

To add parts to my iCopy Assembly, I have first gone back to the Panel Master.ipt and added in some more information.

First I've added in some custom parameters for my critical dimensions.

Next I've added in some work geometry and features, which will host my sketches.

Finally I've added sketches that I will use to create my parts.

***Tip**: In this case, all my parts will use the same profile, so I've used a Sketch block to keep the memory overhead down.*

Notice that I have created all the geometry I need to create every part, as if I was going to build the entire assembly in one part file. This is an essential concept in skeletal modeling.

As we create each part, its position in space will be defined by the geometry that created it. *We won't need to use constraints to hold the Assembly together* (Whoot!) You'll see how this works as we move on through the tutorial.

Once you have added all the extra parameters and geometry you will need to your Master part, you can begin creating your parts.

Creating the Derived parts

We will start by creating the Panel component itself.

To create parts using the skeletal modeling technique and the 'Make Part' Tool:

Open your Panel Master.ipt.

Click on the 'Make Part' tool:

Manage Tab > layout Panel > Make Part

This will open the 'Make parts' dialogue. There's quite a bit going on here – so stick with me.

Derive Style

The first control you will see is 'Derive style'. You can derive the features from a part out as a single body, multiple bodies or even a surface. In this case we are only deriving out a sketch, so this control doesn't apply.

Status tree

The next control relates to the feature tree in the box below. We can browse up and down this tree to pick and chose which features we want to derive out into our new part file. The yellow circle means that it will be derived; the grey circle means it won't.

In this case we need to derive our master sketch, our parameters, our work features and the sketches that we will use to create our parts.

Part Name

This area of the dialogue allows us to name our part and choose where it will be created. Start by clicking on the folder icon at the end of the *'New File location'* box.

You will be prompted with the following message:

'Do you want to create a new part? Select no to select an existing part.'

I always have to stop and think about this one! But the answer is that we DO want to create a new part – so click on the 'Yes' button. Name your part 'Panel.ipt' and chose where to save it.

The final step is to choose what Template you want to use for your part. In this case we are creating the folded panel – so I am going to pick the 'Sheet Metal.ipt' template.

Check the box marked *'Place part in target assembly'* and move on to the next area in the dialogue.

***Note**: Notice that you can also set the BOM Value of the part here*.

Target Assembly Name

The Target Assembly name area of the dialogue is very similar to the Part Name area of the dialogue. Once again start by clicking on the Folder icon at the end of the *'New File Location'* box.

You will be prompted with a familiar message:

'Do you want to create a new target assembly? Select no to select an existing target assembly.'

Again the pause while I digest this…

In this case the answer is NO. We want to use an existing Assembly – the iCopy Panel Assembly.iam that we created earlier.

Browse out and pick your iCopy Panel Assembly, then hit '*Open'* to return to the Make Part dialogue.

Scale factor and Mirror Assembly

We don't need these today. Just pretend you didn't see them…

OK

Hit the OK button to see your iCopy Panel Assembly.iam magically open with your new derived part contained within. This is a quick and easy way of creating parts that contain derived features. Notice that the part you have created has already been inserted relative to the origin and Grounded.

***Note**: Although the new part appears in the assembly, it hasn't yet been created on disk. Hit save now to write the new file out.*

Adding features to the part

Open the Panel.ipt part file up for edit. You can see that it contains geometry referenced from the Master part. We will use this geometry to build our part features.

Because the part is built on geometry referenced from the Master part, if the Master part changes this part will change too. This is important, because our Master part is going to adapt when we use iCopy to place it into the host assembly.

***Note**: Reference geometry cannot be edited from within the derived part file. You have to go back to the Master part file to edit the geometry, and then use the 'Update' tool to update the geometry in the derived part.*

I've use Inventor's sheet metal tools to build up the face panel, but I won't go into sheet metal any further here. We'll save that for another time.

Creating the rest of the parts.

I've used exactly the same technique to create the rest of the part files for the Panel's frame.

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***Tip**: We will need a number of derived parts to complete this exercise. You don't need to use the 'Make Part' tool every time – just copy the derived part, re-name and edit it, before inserting it into the Assembly.*

If you follow the tip above you will need to manually ground the parts at the origin. To do this, right click on each part and choose iProperties.

In the iProperties dialogue choose the '*Occurrence*'tab. Under '*Current offset from parent origin'* use the X, Y & Z controls to set the parts origin within the assembly to zero, and check the 'Grounded' option from the '*Properties'* area.

A quick way to do this is to use the 'Ground and Root' tool that we discussed earlier. In this case the extra constraints added by the Ground and Root tool are not required (Fully constrained AND grounded is overkill right?) so you can delete these constraints if you wish.

Testing the Assembly

Now is a good time to test your iCopy Template assembly. Edit the geometry in the master part file. Go back to the assembly and hit the 'Update' button (you may need to hit the update button twice). All the parts in your assembly should update to suit your master part.

The great thing about Skeletal modeling is - No constraints = No Constraints to Fail!

Bonza - You're doing great!

Don't forget your BOM

If everything is working out in your assembly, now is the time to get your BOM in order. If necessary, go into your part files and add reference parameters to call out the dimensions of your parts. Change the materials of your parts. Activate your Parts list and sort and number your parts.

***Tip**: Don't forget to set the BOM property of your Master part to 'Phantom'. You can make your Master part Invisible within the context of your iCopy template assembly file.*

Preparing the assembly for iCopy (again)

Now is the time to decide whether you want to have any additional functionality in your iCopy assembly. Any of the custom user parameters that you added to the Master.IPT file can be included in the iCopy template assembly and adjusted as the iCopy template assembly is inserted into the Host assembly.

To do this, fire up the iCopy Author tool once again:

Manage Tab > Author Panel > iCopy Author

The Panel Master.IPT should already be highlighted. Skip over the 'Geometry' tab and switch to the 'Parameters' tab. Your custom parameters from your Panel Master.IPT should already be highlighted in the left hand box.

You can chose which Parameters from your Master part can be edited during iCopy insertion here, by using the arrow buttons (>>) to make sure that they show up in the right hand column.

Testing the iCopy Template assembly in the Host file

Hurrah! Were finally ready to stick that bad boy into our host assembly to see how it behaves.

Open up your host assembly that contains your Skeleton model part.

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Fire up the iCopy insert tool:

Assemble Tab > Component panel > iCopy

Browse to your iCopy Template.

Pick control points on your Skelton part as directed in your Instructions.

Bad-a-bing, what did you get?

You should find that your iCopy Assembly will automatically re-size itself to suit your Skelton model. The iCopy tool will automatically create a copy of the iCopy Template assembly.

Notice that the new copy of the iCopy Template file is also marked as adaptive. Changes in the Skeleton part will be reflected in the new referencing assembly.

***Tip**: Adaptive components place a great load on Inventor. Inventor will always check to see if adaptive components need to be updated – even if the underlying geometry hasn't changed.*

You can turn adaptivity off by right clicking on a component and un-checking 'Adaptivity'. You can turn adaptivity back on again the same way. You only need to do this on the top level component. You don't need to chase it down the feature tree.

If your iCopy assembly worked as you expected you are an iCopy Master. Draw yourself an 'I Mastered iCopy with AUGI' badge and take an extra cookie.

Error checking hit list

If your iCopy Assembly threw an error you may need to go back through and check your working. Here is a short hit list of items to check.

- Is the Master sketch unconstrained?
- Is the Master Sketch Adaptive?
- Is the Master Part Adaptive?
- Is the Master part grounded AND fully constrained within the iCopy Template Assembly?
- Does your skeleton model work in the context of the iCopy Template Assembly?
- Are the constraints on any non skeletal (i.e. constrained) parts fouling the works?
- Have you applied the control pints in the same order as they were set with the iCopy Author tool?

Patterning with iCopy

For your final trick you can also use iCopy to create patterns from your iCopy assemblies.

To make use of this, you will need to add some extra geometry into your Skeleton part.

- You will need geometry which defines the path of each control point.
- You will need geometry to define the path for the pattern.
- You will need a work plane tangent to the path.

To access the iCopy Pattern tools, start up the iCopy Insert tool:

Assemble Tab > Component panel > iCopy

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Click on the 'Pattern' button in the bottom right of the dialogue to expand the dialogue and show the pattern tools.

Follow the prompt to pick the path and work plane for your iCopy assembly to follow.

Enter a number for the number of assemblies you with to create and a distance for the pattern.

Congratulations you made it!

Thanks very much for sticking with me through this tutorial. While iCopy might seem quite involved, in fact the steps are pretty much the same for every iCopy template you will need to create. Of course, the amount of time you spend building your iCopy assembly will depend on the complexity of your design.

iCopy is a great tool for creating lots of similar assemblies that need to vary in size and shape. I hope that you found this tutorial useful. Until next time…

The iCopy Workflow

Create the iCopy assembly template

- Create an under constrained Master sketch
- Make the Master sketch adaptive
- Place Master Part into iCopy Template assembly
- Constrain Master Part to origin
- Make part adaptive
- Use iCopy Author tool

Test iCopy assembly template

- Create skeleton part
- Create Host assembly
- Test iCopy Assembly

Complete the iCopy Assembly template

- Go back to iCopy template & derive Master sketch into part files
- Create parts for iCopy template assembly
- Create iCopy template assembly
- Manage bill of materials
- Final test
- Good to go.