Autodesk University 2012

Make It Yourself: From 3D Design to Digital Fabrication Tools

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MI4309

Learning Objectives

At the end of this class, you will be able to:

- Get some tips and tricks to maximize your 3D design to physical object experience
- Understand best practices for reality capture, editing and fabrication
- Know the potential of each platform for your workflows
- Link consumer product apps with your professional products

About the Speaker

Guillermo has worked for Autodesk since 2006, first as an application engineer based in Argentina, then as senior product manager for AutoCAD® in San Francisco, later as senior product manager for Suites Technology Group and currently as Product Line Manager for Personal Design & Fabrication.

He has been responsible for free-form design, surface modeling, parametric and overall 3D enhancements in AutoCAD 2010 and 2011.

He also worked in Autodesk® Materials and UI enhancements across applications, and in Suite Workflows for the 2013 family.

Currently he is Product Line Manager for the 123D line for consumers (123D Design, 123D Catch, 123D Make).

Prior to this, Guillermo was part of the reseller channel in Uruguay, as well as an architect and professor at two architecture schools. He has performed training and implemented multiple instances of AutoCAD, AutoCAD Architecture, Autodesk Inventor®, AutoCAD Revit® Architecture, Revit Structure, and Autodesk 3ds Max®. Guillermo spends his free time playing video games or rocking hard with his collection of bass guitars.

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About 123D family

Personal Design and Fabrication, along with an easier access to 3d printing is becoming not only a trend in the market, but it also starting a new revolution. Makers now have a better control of the production of their design, and this is a fundamental change in the way we have understood production so far.

Let's see what we have done in order to provide makers and overall design enthusiasts with the right tools for capturing reality, editing, modeling, and fabricating.

In this class we'll talk about 123D Catch (desktop, online and for iOS), 123D Design (desktop, online and for iOS), and 123D Make (mainly focusing on desktop and online, even though there is a mobile version too).

So what makes the 123D family unique? First of all, each product covers a broad range of platforms and form factors, from desktop to browsers to tablets. Secondly, and most important, 123D provides a quite direct access into fabrication.

Another important aspect to consider is the target audience. 123D family targets not only makers, but design enthusiasts who may not necessarily have a strong background in CAD applications. So a critical guiding principle when creating this new line was to not taking any knowledge for granted. The experience through capturing reality, modeling, editing and fabricating should be delightful for the savvy and natural enough for the beginner.

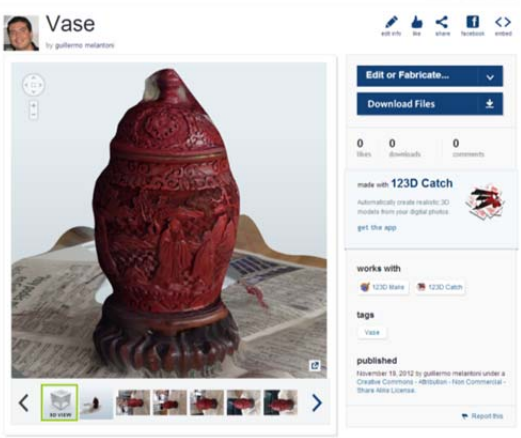
Capturing and editing reality: 123D Catch

123D Catch desktop

Regarding 123D Catch desktop, a lot was already said in a class at AU2011, so it doesn't make sense to repeat all the concepts. Please refer to: AC4056: It's a Snap! Take a photograph and create a 3D Model by Dominique Pouliquen.

An important question to answer is probably where to create your catch, since you now have not only the desktop solution, but also online and iOS based.

The answer for the mobile version is easy. Catch Mobile is the best tool for getting quick photos, uploading and getting a mesh anytime, anywhere. Since this mesh goes into your repository in the cloud, you can then open it in any of the Catch applications.



MyProjects

MyProjects is the repository for all your projects made in any of the 123D applications. Depending on the product and platform, you may have a way to save locally. Whenever you save into the Cloud, you are saving into MyProjects. The benefit of doing this is that you get derivative files created automatically. Let's see the ones made for this vase that I captured with my iPad.

So based on the file created with Catch, you got not only the 3DP file (Catch native), but also the STL file and the OBJ file. You can download a package with all needed for the OBJ file, the photos of the project and the STL.

This also allows fabrication workflows to be quite seamless. If we wanted to print this vase, we could simply go to Order 3D Print without having to figure out which is the right format to transfer. This is yet another way to make the process more transparent for non-experts.

123D Catch online

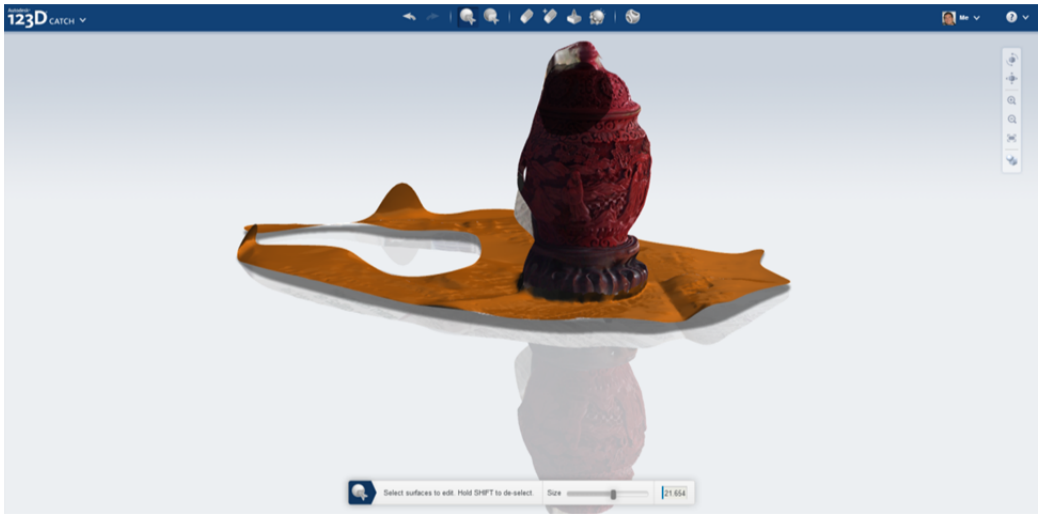
Let's see what we can do with this example in 123D Catch online. Once we sign in and open from MyProjects, you will see your model on the screen. The overall visual language of this page is consistent across other 123D applications, as we'll see in later examples of Design and Make. This helps in providing familiarity on the common aspects of the applications.

In order to use 123D Online, you will need to install a plugin. This plugin is not needed until you want to use any of the tools presented in the application, which are grayed out before install of the previously mentioned plugin.

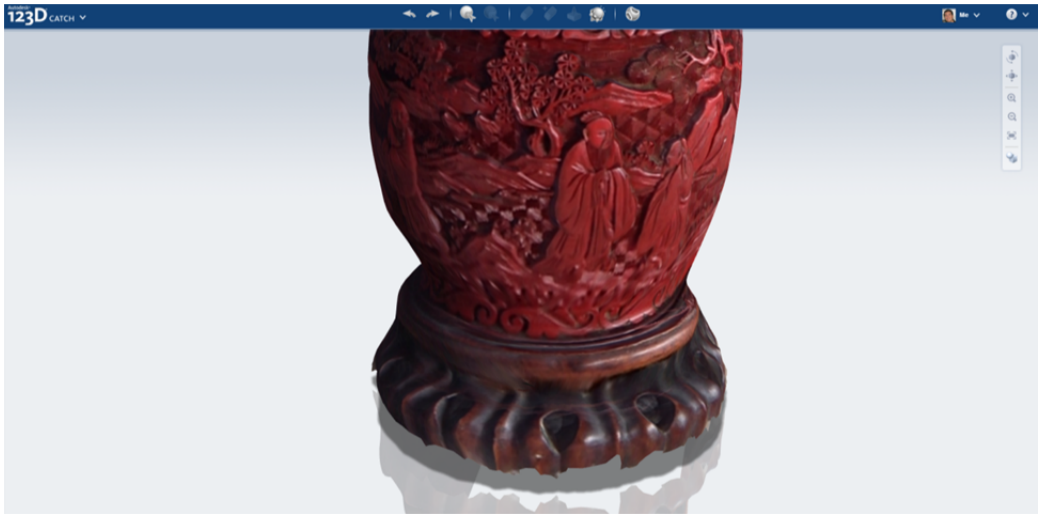
Catch desktop had some specific features only found in that application, like being able to resize based on a reference dimension, or do a manual stitching in case of missing information.

123D Catch Online provides a quite interesting set of mesh editing tools that we'll explore now.

The first thing you can do (common with Catch desktop) is to select some parts of the mesh you want to get rid of. In this case, I had a newspaper on the bottom, which helped in the calculation, since it provided a lot of texture in a very matte surface. So a lot of reference points to match, and no reflections whatsoever. This is a great tip for capturing small objects.

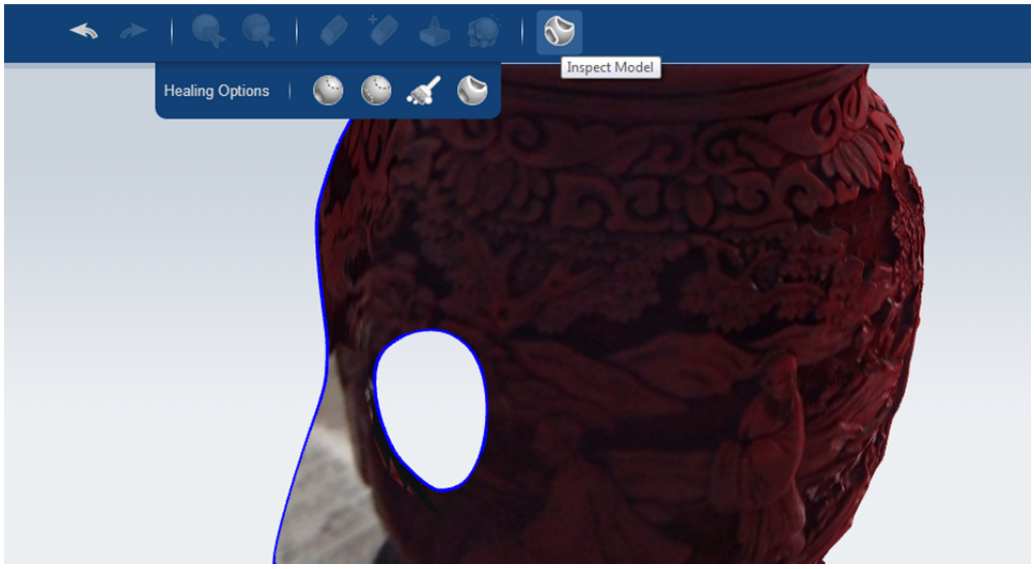


Once we select and hit Delete, we now have the vase we want. A good set of photos can bring up a lot of amazing details, as you can see. Something very nice to print, for sure.

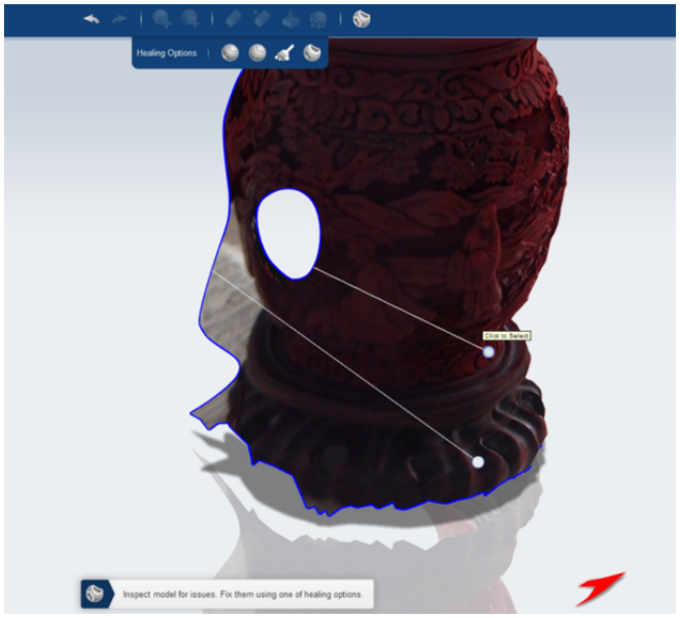


But not everything is perfect, and we can have significant gaps for different reasons. Maybe not enough photos were taken, or some of them were severely underexposed. 123D Catch online provides a tool call Inspect Model, that offers a series of healing options.

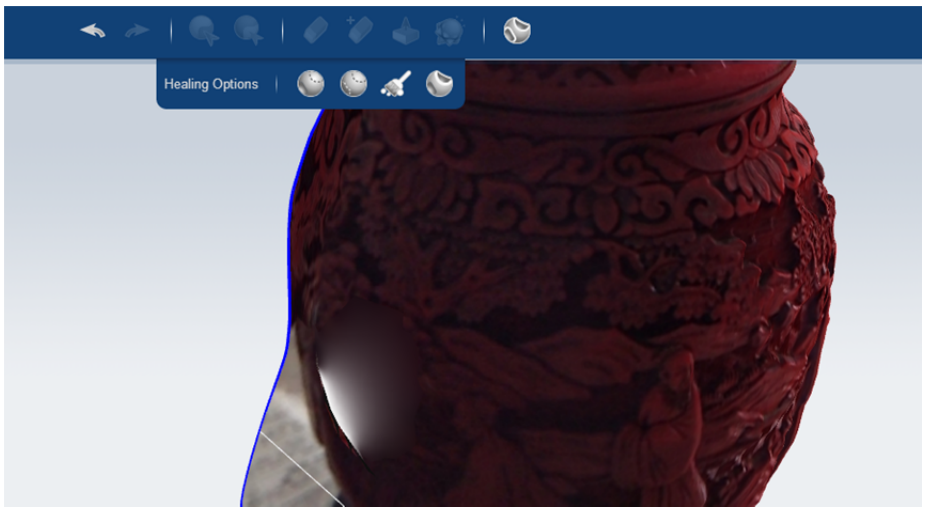
You can try to heal all the gaps or heal selected ones, depending on what you want to achieve



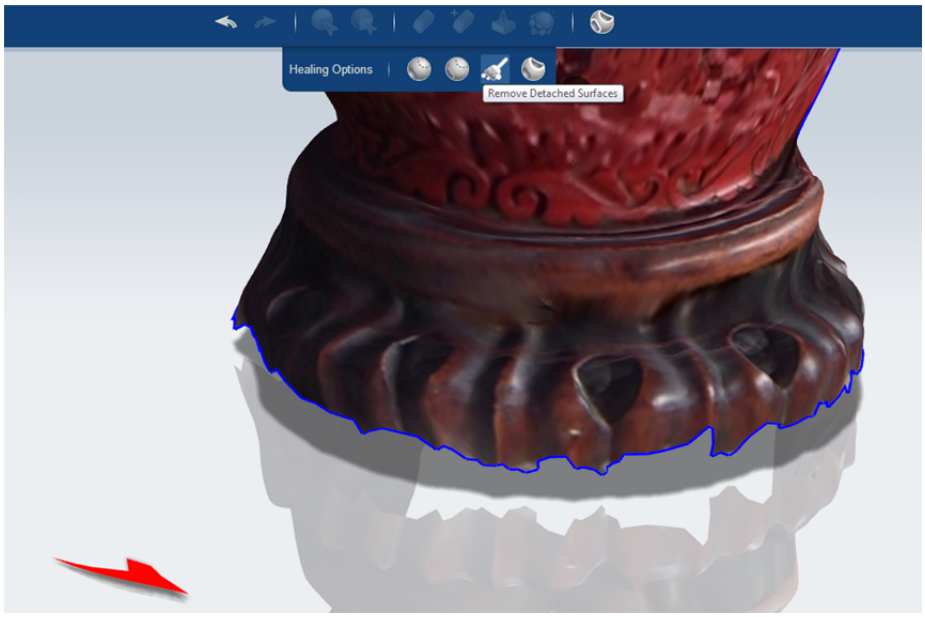
If you want to select which gaps to heal, you will be prompted with a series of bubbles. You will now select the one you want to fix, and then you will see that the gap is gone, having been replaced with a mesh that provides continuity with the surrounding one.



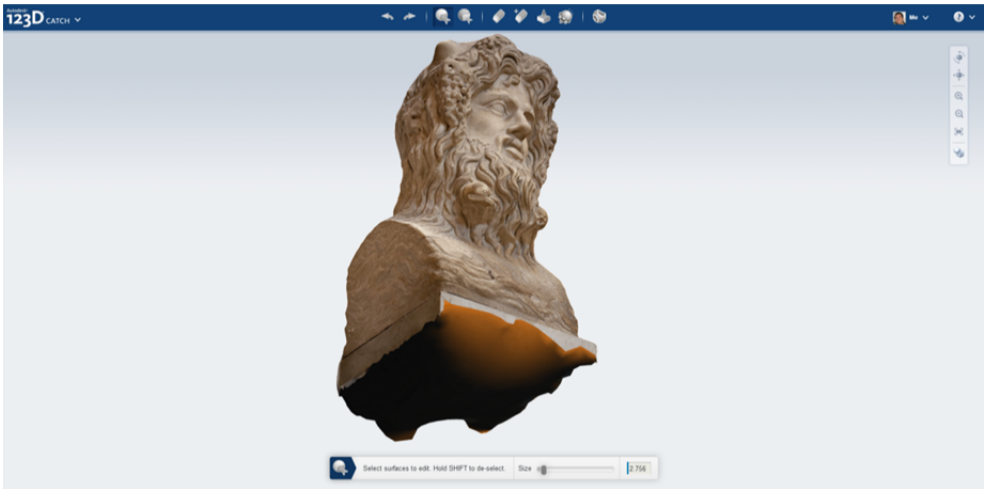
The gap is healed, though there are no textures. This is just a mesh created based on continuity with the boundary, so it is not related to the textures that were calculated. Retexturing a healed mesh is probably a nice feature for the future.



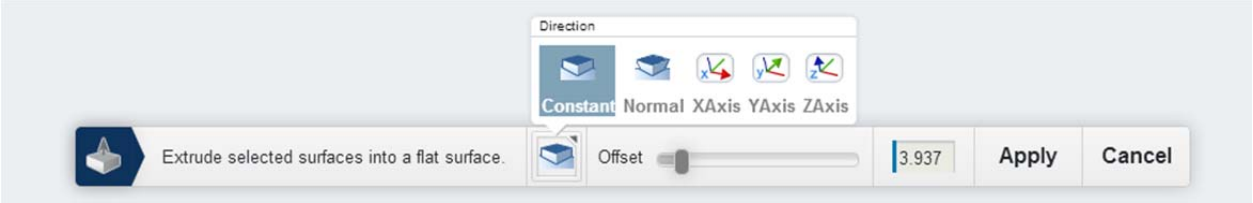
Another thing that Inspect Model can do is delete detached surfaces. In this case, cleanup of any pieces of mesh that may have been left is quite easy with the option Remove Detached Surfaces.



Let’s change the example into this sculpture, which has less unresolved areas. First thing is to figure out how to print this model and add a pedestal. So we’ll get the bottom of the mesh, and perform an extrusion. Catch online has great technology for editing the mesh.



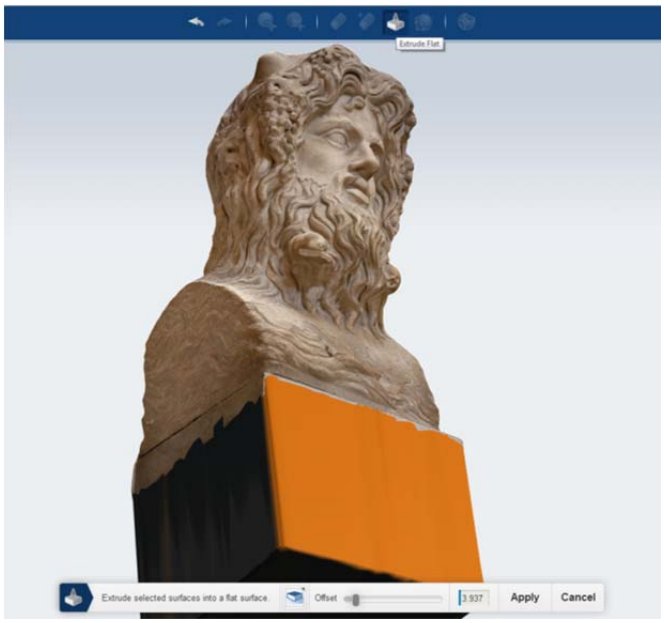
The option Extrude Flat activates when a selection is made. You can then extrude a specific value based on a slider. There are several options when extruding. The default is set to Constant, which will extrude in a very predictable way.



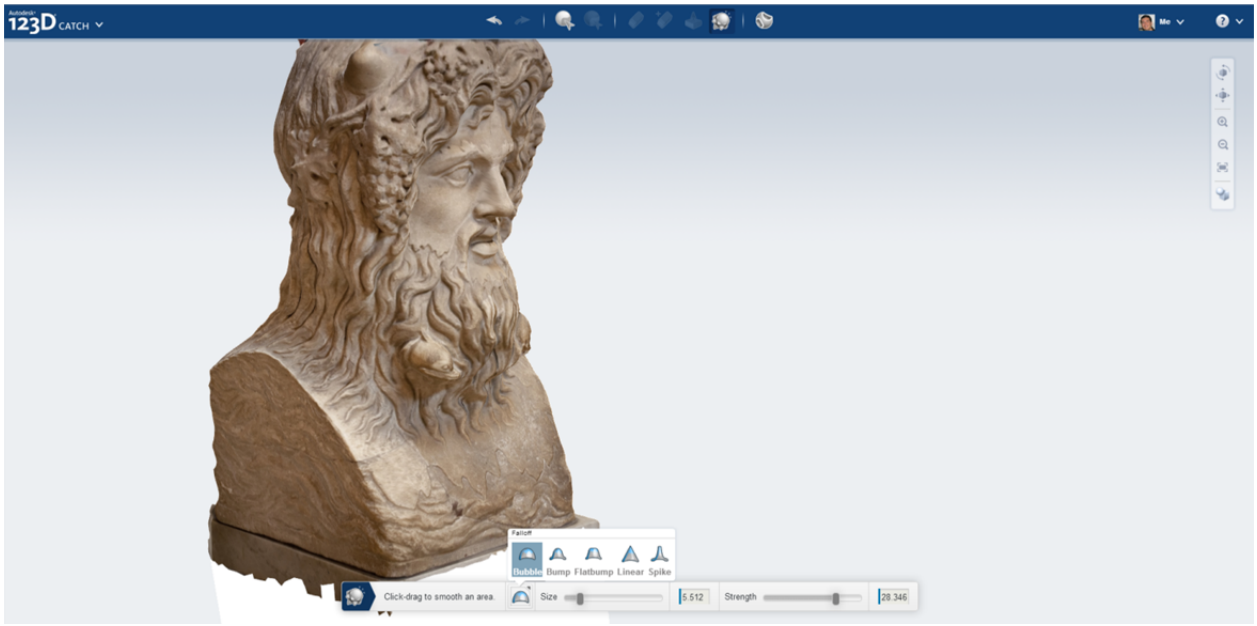
Normal will extrude perpendicular to each face of the selected mesh. Not exactly what you want in this case, since the bottom faces may not have been perfectly aligned.

Extruding along the X, Y and Z axis help in cases where the geometry is not aligned to the main axles, but you want to honor them in the extrusion. Think for example, extruding the leg of a dinosaur want wanting that to be constrained to the Z axis, while the mesh itself was slightly oblique.

Here’s the progress when dragging the slider, and the final result. The resulting mesh appears in white.



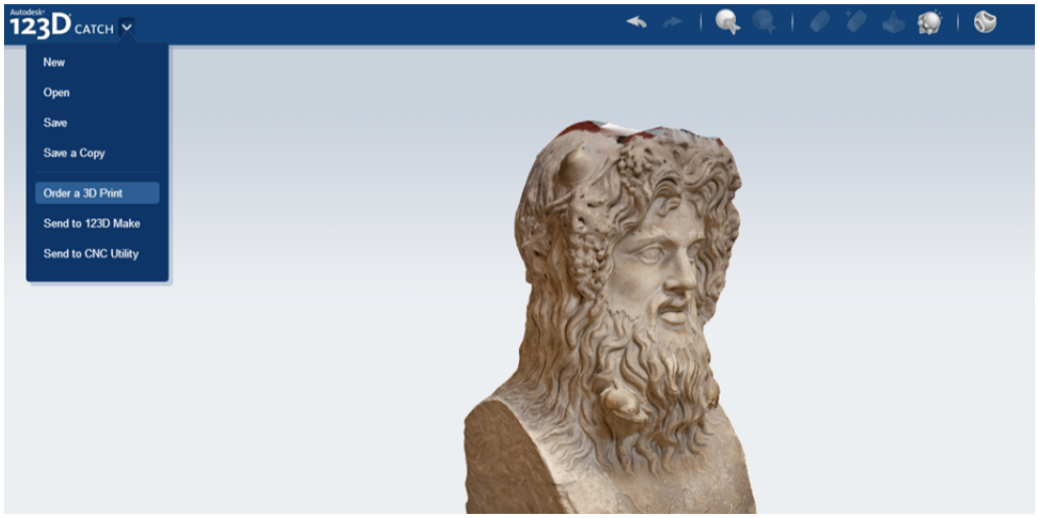
Another feature worth explaining is Smooth Brush. After you select the type of brush you want to use and also define size and strength, you can polish your mesh, and do some organic modeling on top if needed. In this particular case I used it to smooth the surface in some places where the mesh had some unwanted spikes. The whole idea was to keep the design intent as untouched as possible.



Order 3D Print workflow

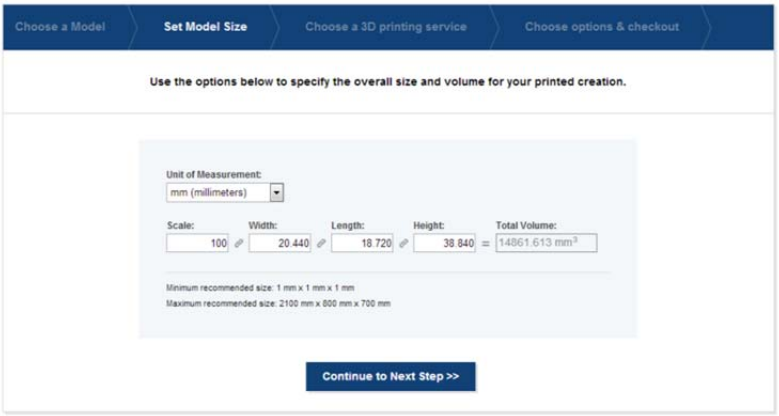
As you finish the work on your model, you may now wonder how to create a physical asset from it. Let's start with 3D printing. In this particular case, let's see how to use one of our 3D printing partners, assuming you don't have a 3D printer in your house/shop.

The process seemed to be manual, in which you created an exchange format (STL), and then uploaded it to a 3D printing company. We have made this much easier for you.



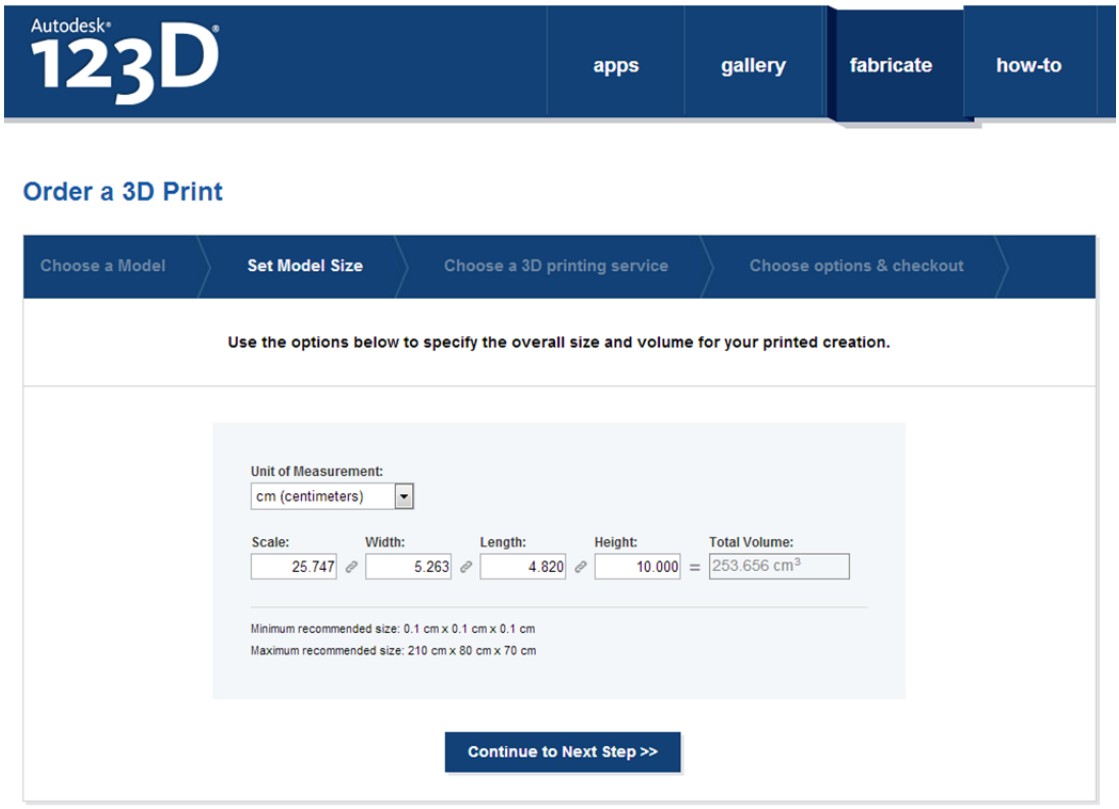
The application menu contains a series of workflows you can launch from within. The first one is **Order a 3D Print**. This workflow will automatically create the exchange file you need and upload it into the landing page of our currently three 3D vendors.

STL files are not exactly aware of units, so you may need to define the unit of measurement you want to use. Coming from 123D apps, this should already be ok, but just check dimensions out. Of course you can also change dimension by adjusting the scale or any of the three input fields for Width, Length and Height.

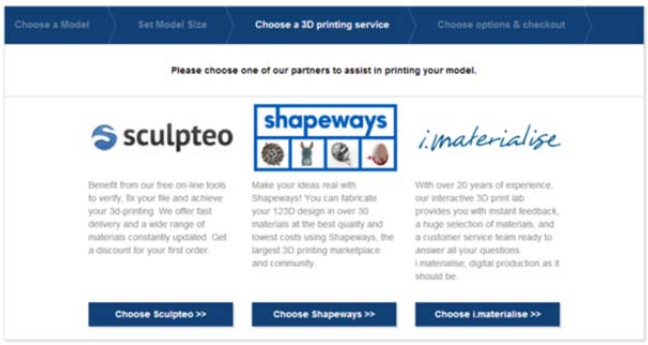


Changing the units does not convert, but simply changes the reference units. Remember that STL does not support units, so any conversion would be dangerous. So if you had 36mm and now you choose cm, you will see 36cm and not 3.6cm.

In this case I'll define that the statue has to be 10cm high.

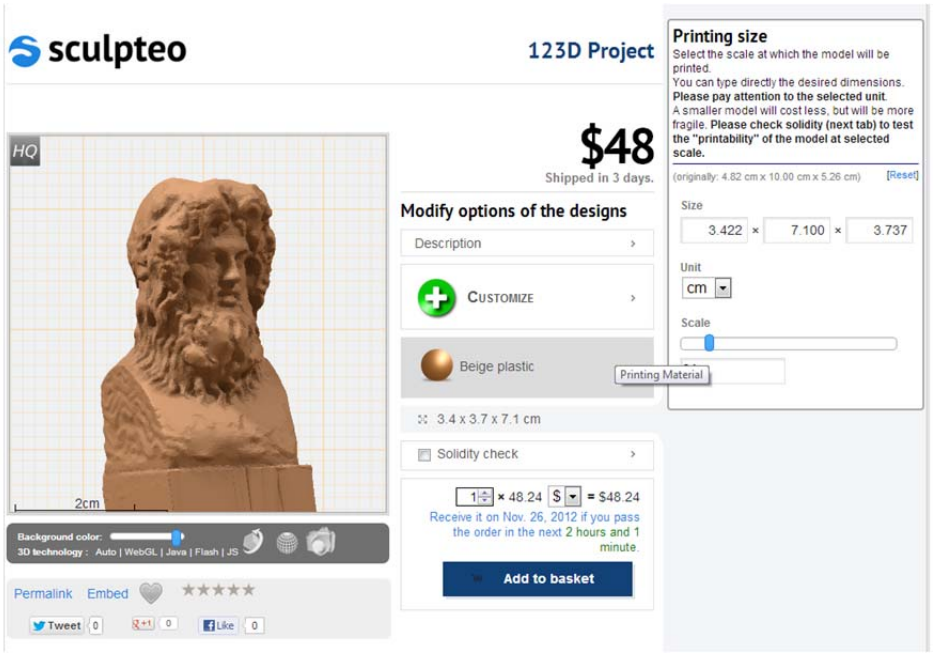


In the next step we'll select the vendor we want. Each of them has different features and advantages, so I encourage you to try and navigate with the same model and find the differences.



In this case I'm showing Sculpteo's frame inside our website. As with the other two vendors, you can select material, some extra features, size and you will get a quote. As you see, the experience is extremely curated for someone that does not necessarily have a good grasp of 3D printing.

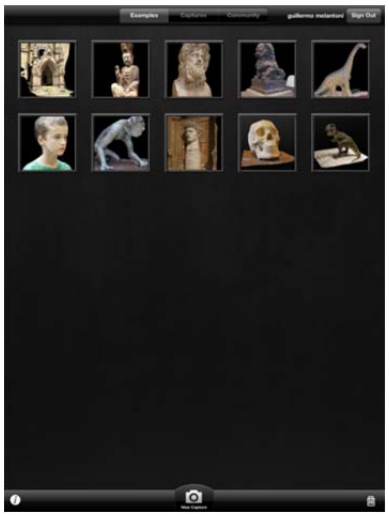
You can also do a solidity check, just in case the model has any issues.

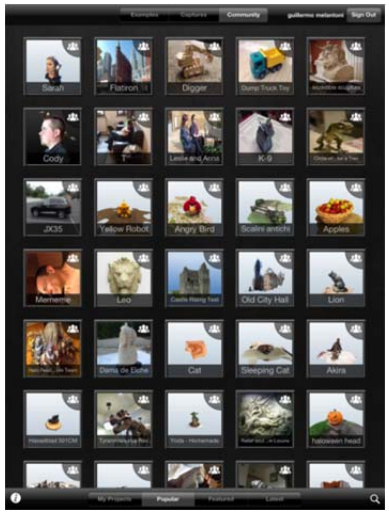


123D Catch mobile

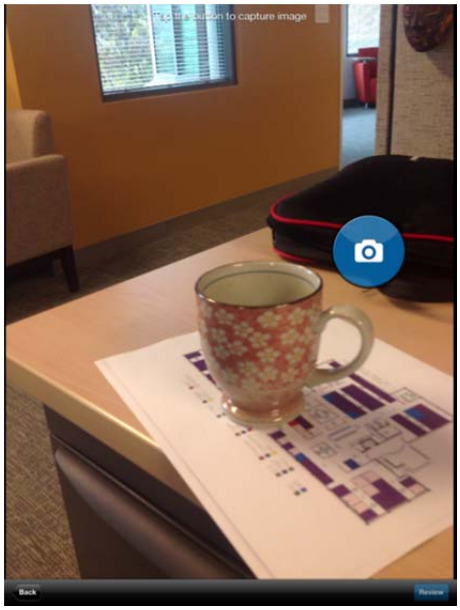
123D Catch mobile is the latest addition to the Catch family. Available for iPad and iPhone, it has given our users unprecedented power, especially with the quality and features of cameras in iPhone 4S and higher, and on iPad (3rd generation) and higher.

The UI is pretty simple. You get access to a set of Examples, then you have the captures that are local to your device, and then you get access to Community, where you get access to your repository in the cloud (MyProjects). In MyProjects you will also find catches done in other platforms too.

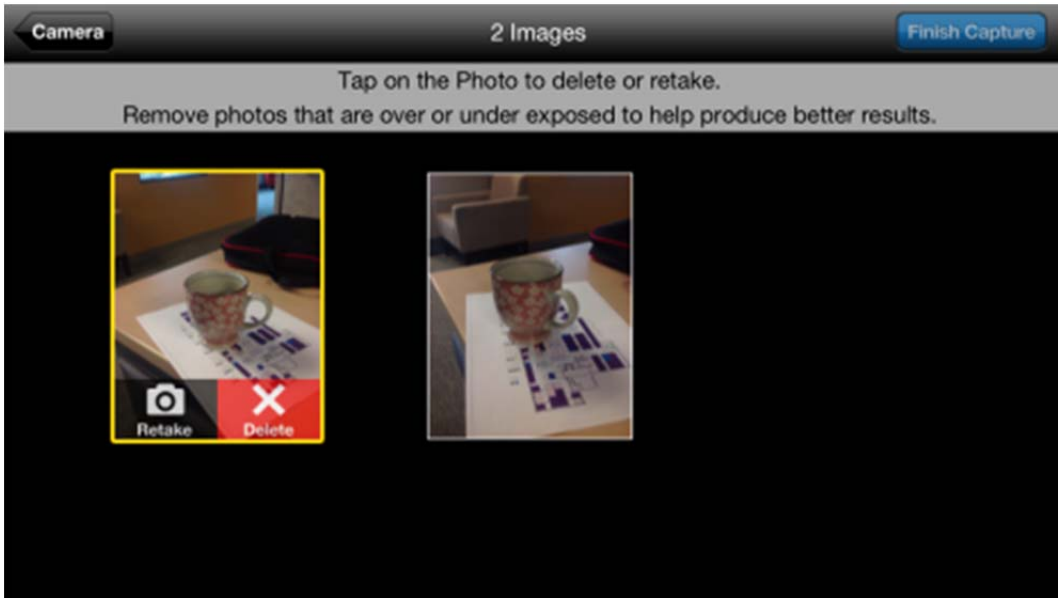




The main aspects you want to know about Catch mobile is that with the new devices, we get access to define the point of interest, meaning that light and focus just got dramatically better. Since over and underexposure, and blurry images are the main issues when catches fail, the failure rate has dropped considerable.



Not only you have the option to define point of interest, but you can also preview the images you are about to upload, detect problems, delete and retake some of the images. The good thing about being allowed to retake is that you can try to match the same point of view.



Natural solid modeling: 123D Design

123D Design is the new member of the family. It's a solid modeler that has integrated a set of very natural interactions, as well as a new way of working with content. If we add to this the ability to launch workflows for fabrication, we got a great tool for any design enthusiast that's willing to create a design based on existing content, design by aggregation of parts, or even design from scratch.

We'll cover 123D Design for desktop, browser and iPad, and different scenarios where we can use them together.

Who is this for?

The 123D family in general is targeted to a consumer that may or may not have CAD background. They are makers, tinkerers, and design enthusiasts with quite different levels of expertise. The challenge was to create something appealing for the widest spectrum of our target audience.

Many of the decisions around interactions were taken considering this target audience, and trying to not take for granted anything we have seen as common or familiar in traditional modelers targeted for professionals.

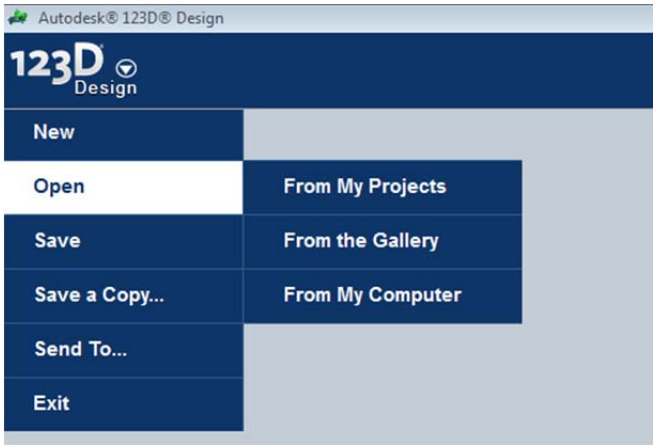
123D Design desktop

The first product we'll cover is 123D Design desktop. We'll focus on some of the basic interactions that have been defined. The rest of the features are quite common to other solid modelers like Inventor Fusion, so it doesn't make much sense to dig deep on them in this document.

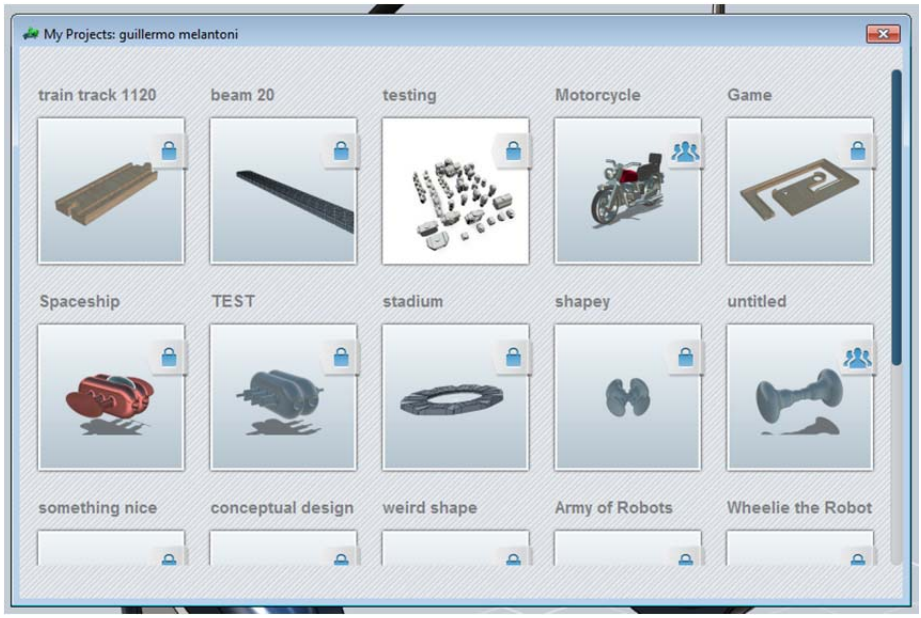
First of all, you'll notice a very simple UI, with a single toolbar with all the supported commands. Many of them are also accessible as context menus based on the current selection. There's a mini navigation bar below the toolbar, and the quite known Viewcube.

The application menu provides access to all the potential location for files.

The first one is MyProjects (which requires Sign In). This option takes you to your repository of files in 123Dapp.com, and only shows 123D Design files (filtering out Catch, Make, and all derivative files).



When you save a file, you have the option of making it Private or Public. The Private files appear with a padlock. The Public files have a different icon (the three heads). Public files can be accessed by anyone visiting the Gallery in 123Dapp.com.



Primitives

The first drop down in the toolbar is about Primitives. Here we can already see something distinctive. We have added 2D primitives to the basic 3D primitives we normally get on a solid modeler.

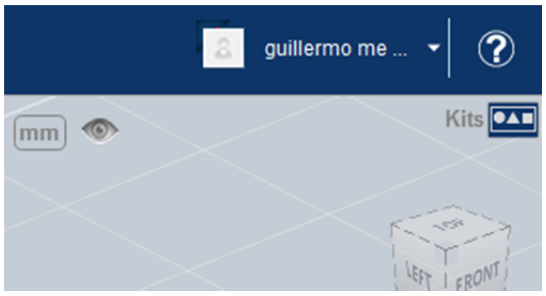
The reason for having both 2D and 3D primitives together (and sketching separate) is because we want users to have the option to start from something very fast, without having to think about sketching on a blank canvas. The abstraction of sketching is taken for granted by professionals (although it's not always under complete control), but completely overwhelming for a consumer with little to no CAD background.

Once a primitive is placed in the canvas, it assumes the ground plane as default location, which avoids the need to define a work plane. This is already avoiding a major roadblock when starting to work.

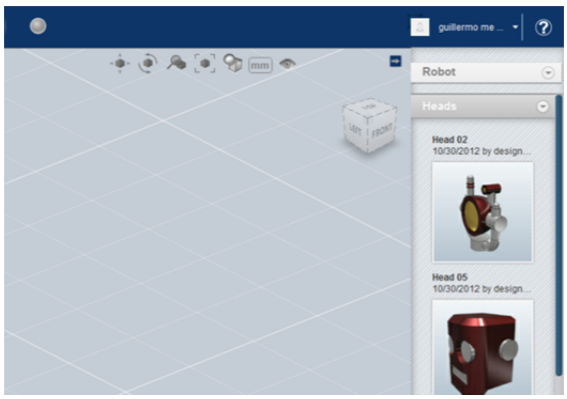
Parts Bin

The Parts Bin is a repository of content living in the cloud, currently curated by Autodesk, that provides a series of categories of content that you can use. Instead of only offering you complete models (which we do in the Gallery), we also provide parts that can create several different versions of models.

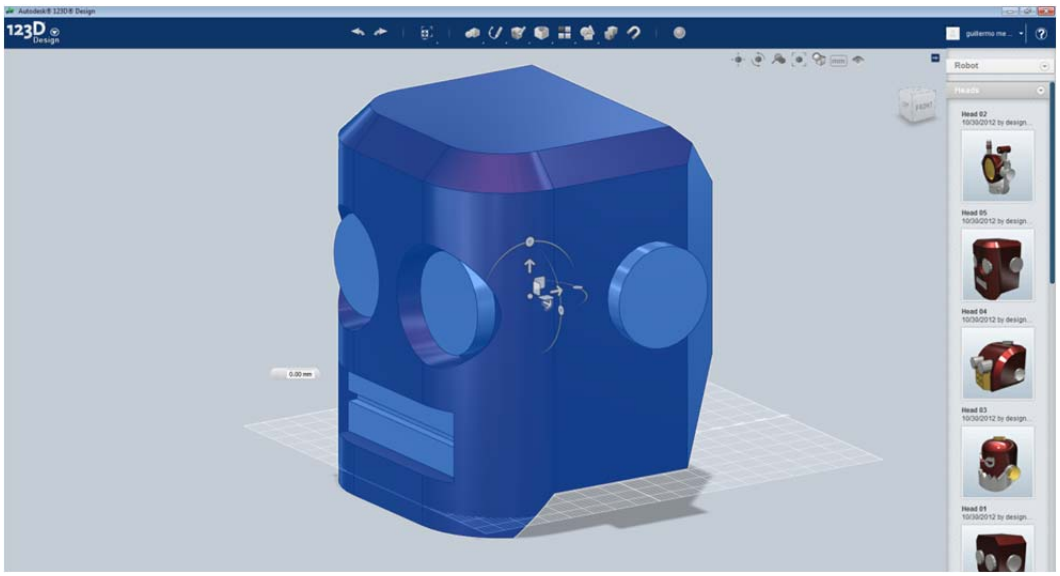
The Parts Bin is located on the far right, and if it is not displayed, simply click on the Kits option, and a panel will open.



You will find several categories on the top. These will grow and change based on new content that we can publish at any time, and you will see as soon as you open the application, or even with the session open, by simply closing and opening again the Kit.

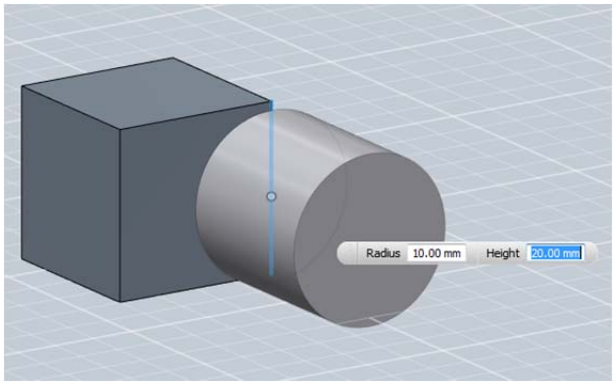


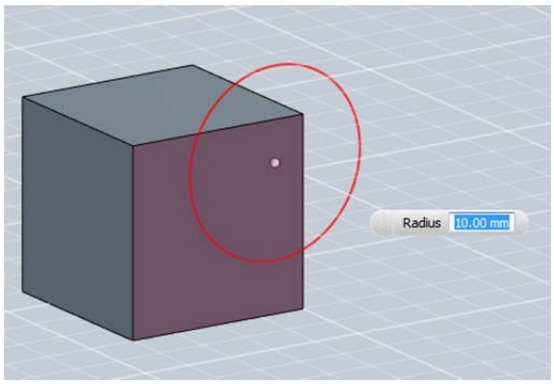
In order to insert any of that content into the scene, simply click on the thumbnail, and the part will appear in the canvas, ready to be moved/rotated.



Cruising

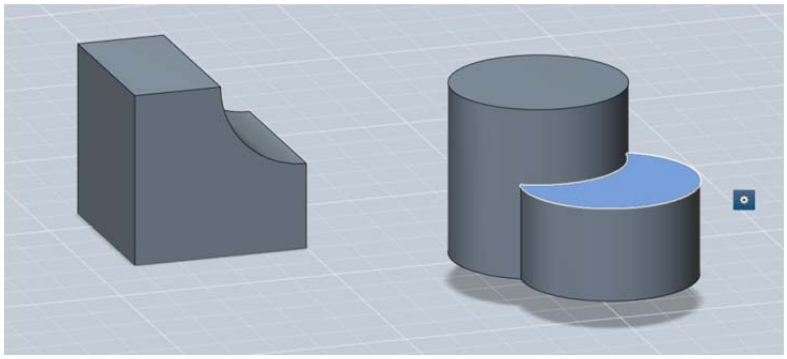
If you already have a body in the scene, the 2D or 3D primitive will cruise and align to the faces being hovered with the mouse.

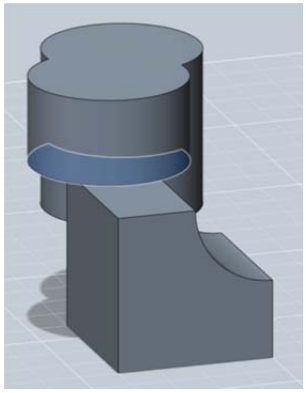


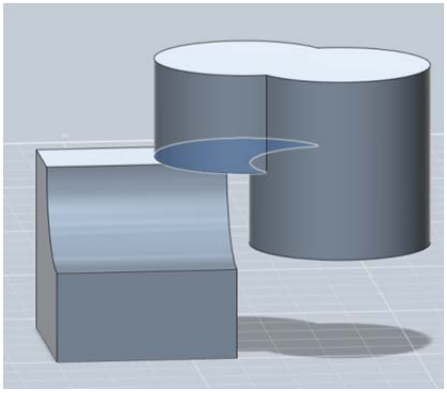


You can also achieve the same result with anything already living in the canvas. Simply select the body, drag from a face, edge or vertex, and this will become the focus for aligning and snapping against anything you hover. We are calling this interaction by the name of cruising.

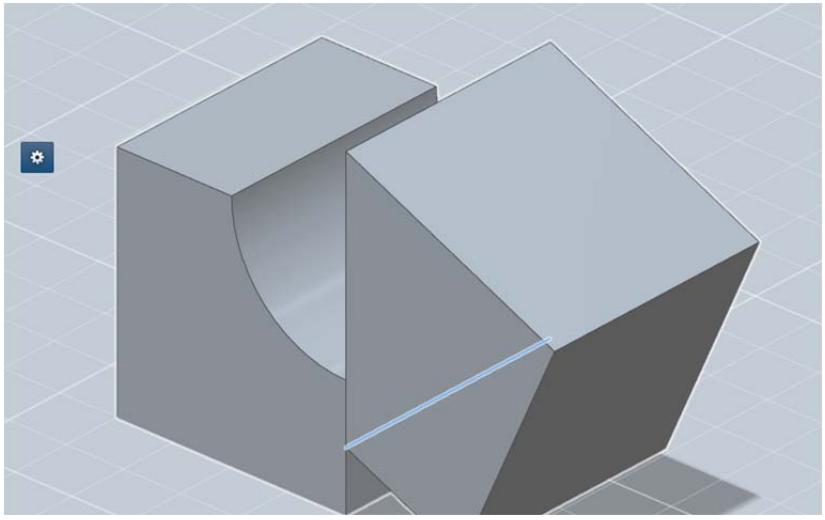
In the example below, I started dragging from the highlighted face, so this is the one aligning when cruising. When dragging from a face, we assume the center of the face as the source point.







When dragging from an edge, we will assume the center or the vertices, depending on the proximity to midpoint or endpoints of the edge. Again, no need to define a specific snap point (another thing we take for granted from the professional world).



Implicit Grouping

Once you explicitly cruise, align and snap two bodies together, you will notice that when you try to select one of them, you will select both. This is because we make a decision of grouping automatically bodies that are explicitly snapped.

Back to the concept of making it easy, pretty much anyone without CAD background has surely seen or used applications like PowerPoint, where in order to get into an object living in a group, you click again. We have adopted double clicking on a body contained in a group as the way to select it. Even if it is nested within a hierarchy of groups, you can simply select any body by double clicking.

Of course you can then use Ungroup or Ungroup All (depending on the hierarchy) to separate all bodies.

Selection

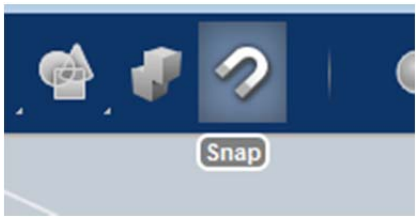
Instead of digging deep into faces and edges when selecting a body, we select the highest hierarchy (group, body). Once we have this one selected, we can then hover and get to faces, edges or vertices. This is exactly opposite to what we see on mechanical solid modeling. The reason is that when you need to get a higher hierarchy, you tend to go to the feature tree. We don't use one, and so far we have proved we don't need one either.

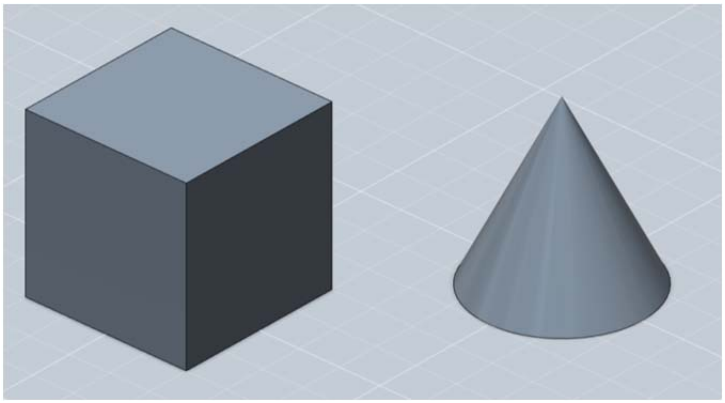
As a tip, once you select a body and want to select a face or edge within it, you may need to hover out of the face where you initially clicked and hover back in.

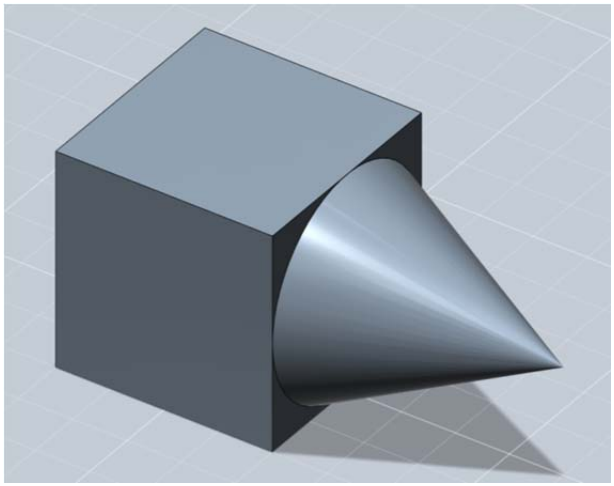
Manual Snap

We also added a manual snap for some situations where cruising doesn't help. For example, if the target and source faces are not visible at the same time, there is no way to cruise and tumble at the same time.

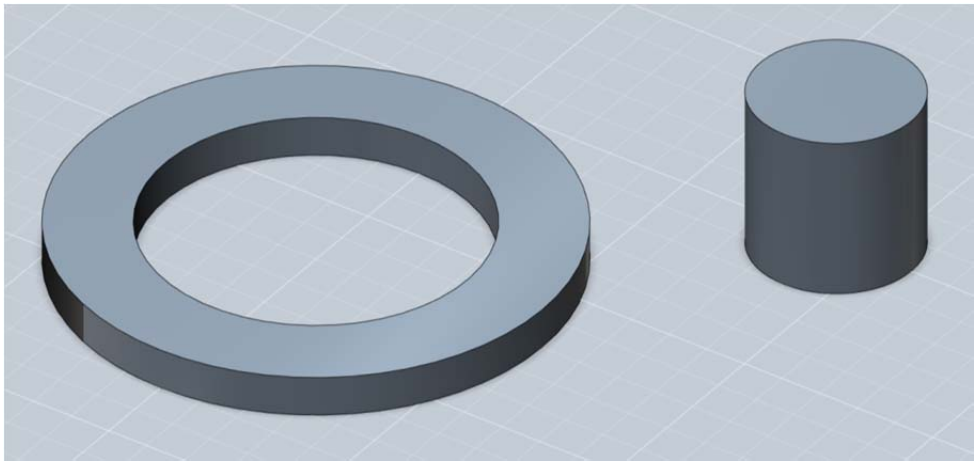
Manual snap enables you to select source face and target face, and they will snap based on center of faces.

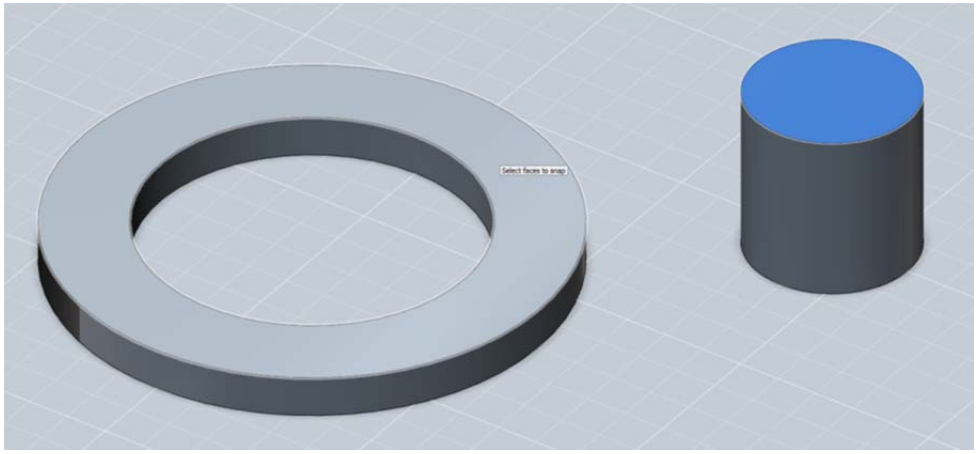


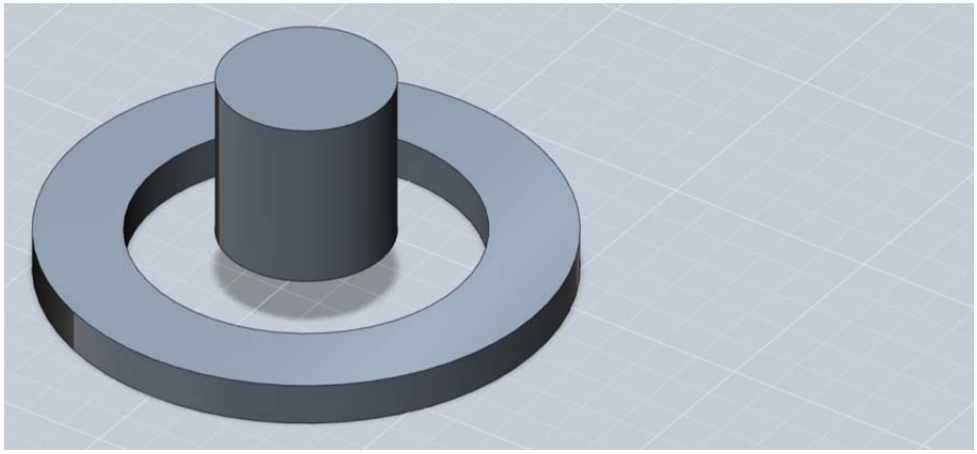




This is also useful when trying to make a concentric alignment of a cylinder inside a cylindrical hole.







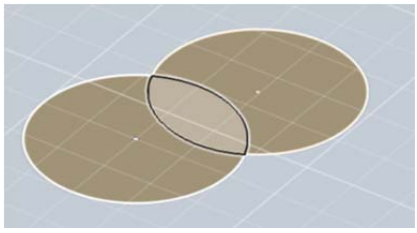
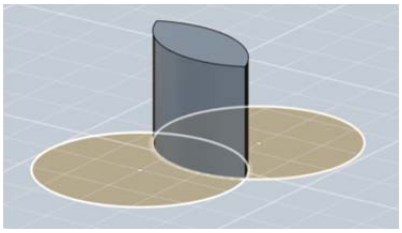
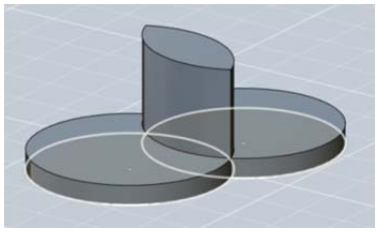
Manual snap has a limitation. If you are trying to use manual snap with an object living in a group, it will only snap and align the body selected and not the whole group. In these cases, cruising works well but this manual snapping does not.

Sketching

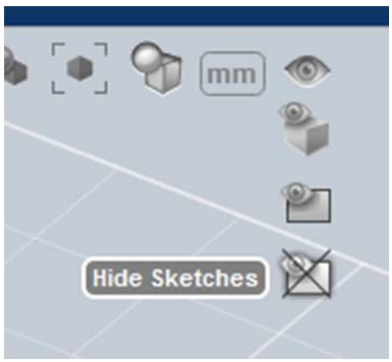
Sketching in 123D Design desktop is not much different than Fusion, except it has a couple less features. As I said before, sketching is a rather more abstract operation that may not be leveraged by a wide piece of our target audience. These may use 2D primitives, but maybe not that much of sketching.

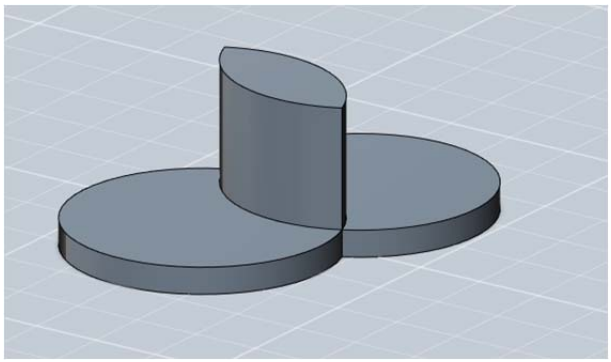
There are some basic differences between sketching in 123D and in Fusion:

- Starting a sketch is almost immediate if you want to use the default grid (instead of looking for a workplane)
- If you overlap 2D primitives in the canvas, they don't actually intersect when doing a modeling operation. If you need an intersection of two sketches, they need to actually be within the same sketch. The way to do it is to add the first 2D primitive (let's say, a circle), and then draw a circle using the option in the Sketch drop down. At that point, you will get prompted to select a sketch plane, and you will select the 2D primitive. Then anything you draw there will overlap.

- When a sketch is consumed with a modeling operation, the sketch is not lost
- 123D Design added visibility for sketches in the mini navigation bar

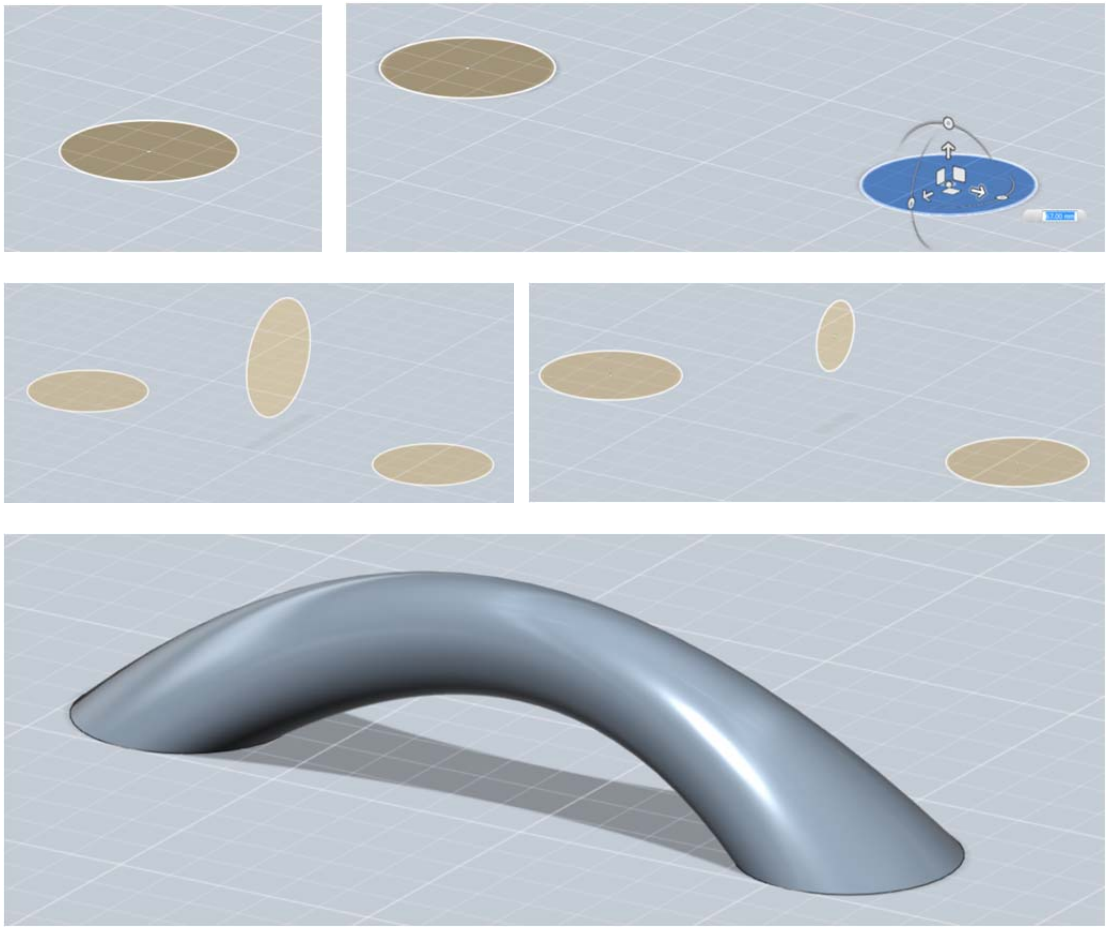




Copy-Paste bodies and sketches

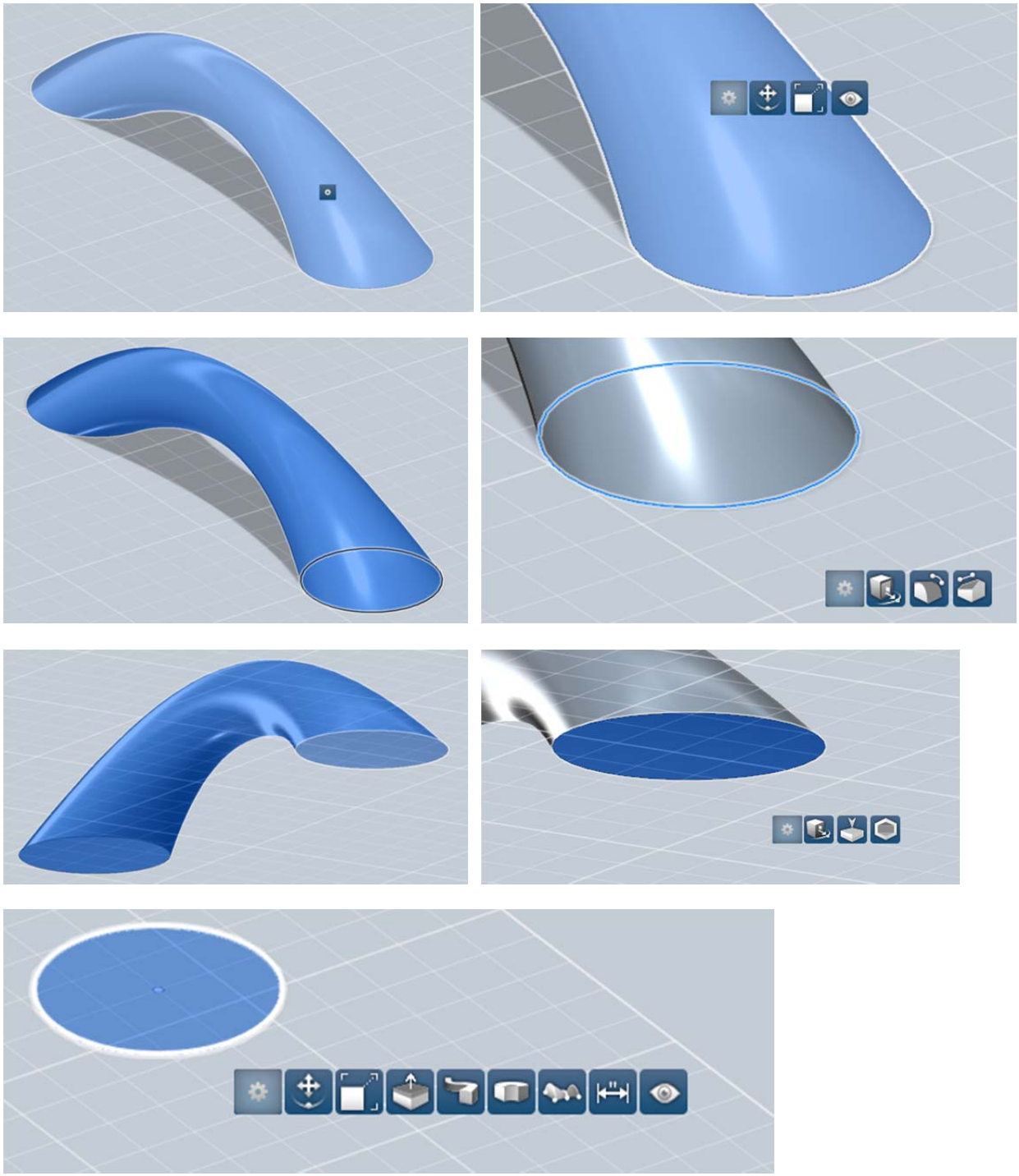
Another aspect we worked on was copy paste. When doing this on sketches, you can actually forget about workplanes.

Let's see an example. In this case, I'll start with a circle, will copy, paste and move, and then copying again, rotating 90 degrees and move along Z. Then I'll make a loft.



Context Menus

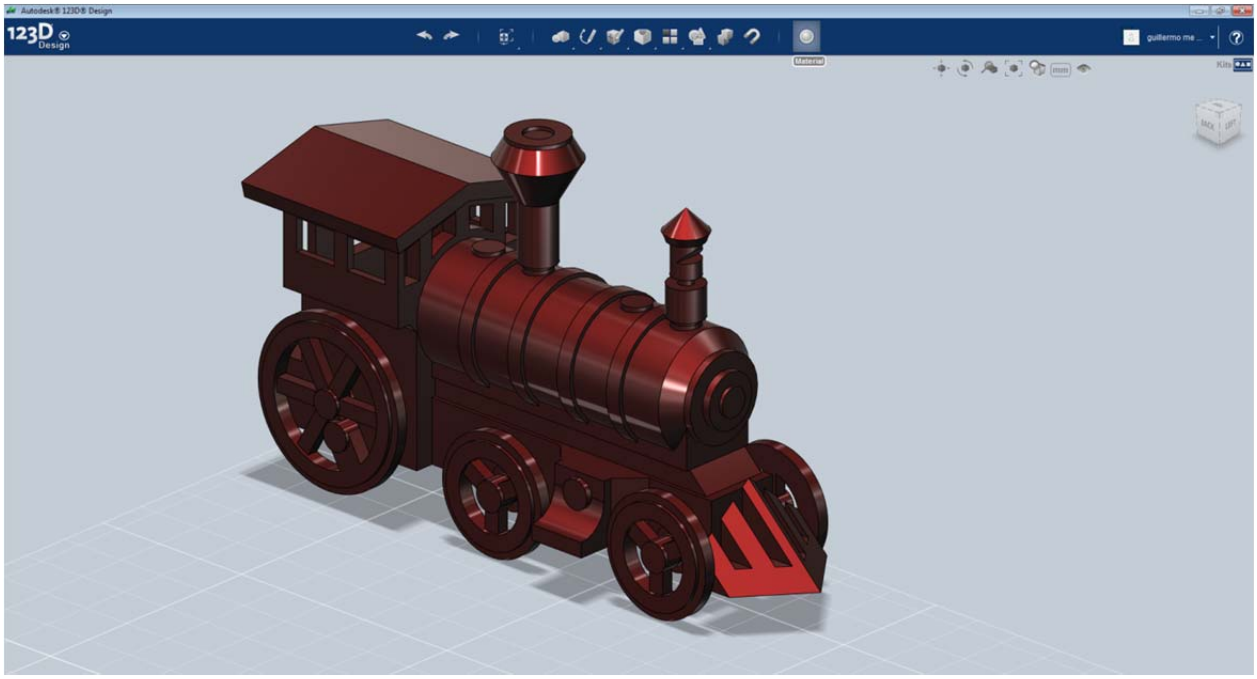
Depending on the selection, you will get different options. This is known behavior in other applications anyways. 123D Design cleaned up the options to add more clarity.



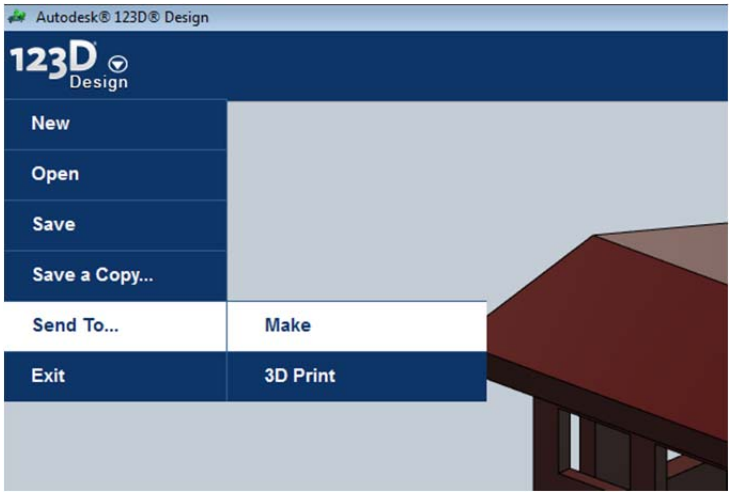
Starting workflows from 123D Design

123D Design also allows workflows for fabrication. Particularly Order 3D Print and Send to 123D Make.

Let's go through what happens when sending to 123D Make, since we already covered Order 3D Print when talking about 123D Catch.



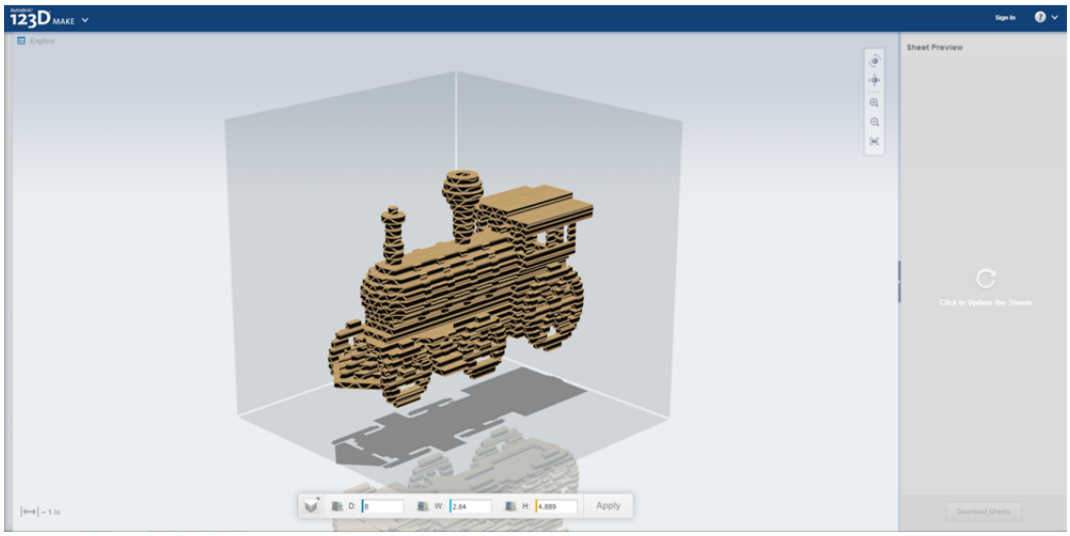
Simply select Send to Make in the application menu, and the workflow will start. The transfer file will be automatically uploaded and once ready, 123D Make online will open.



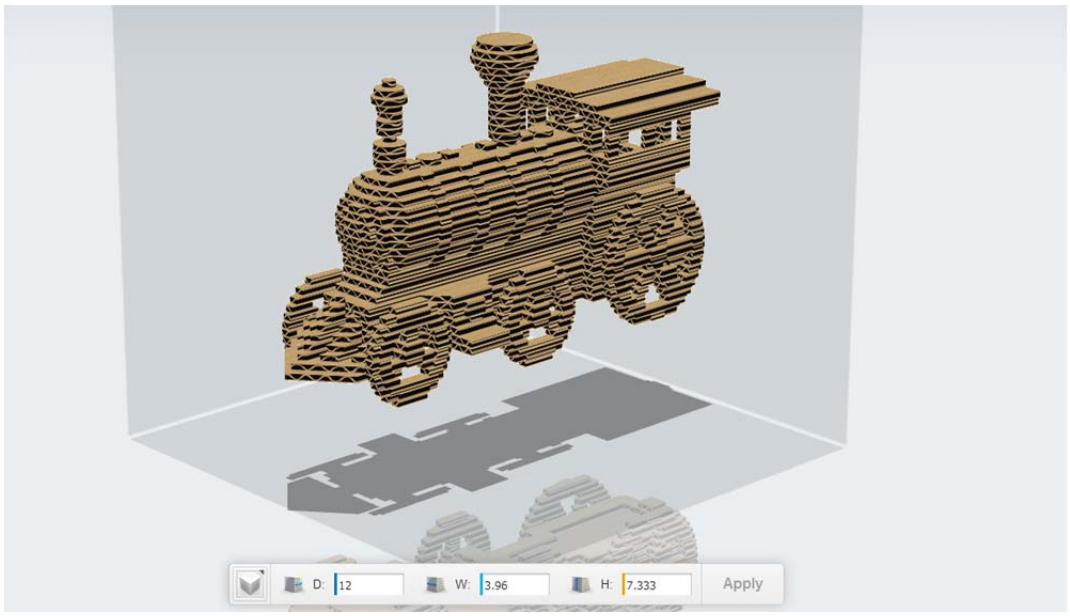
Stacked Cardboard Slicing

Once 123D Make opens in the browser (you may need to install a plugin first), then you'll see your model already processed as Stacked Cardboard Slices. The bar at the bottom is called the Attributes Manager, and in this case it controls the size of the model, as well as some construction settings.

On the top right we have a mini navigation bar, and then a panel that will get populated with the sheets once we are ready. This panel can be collapsed from a control in the middle.

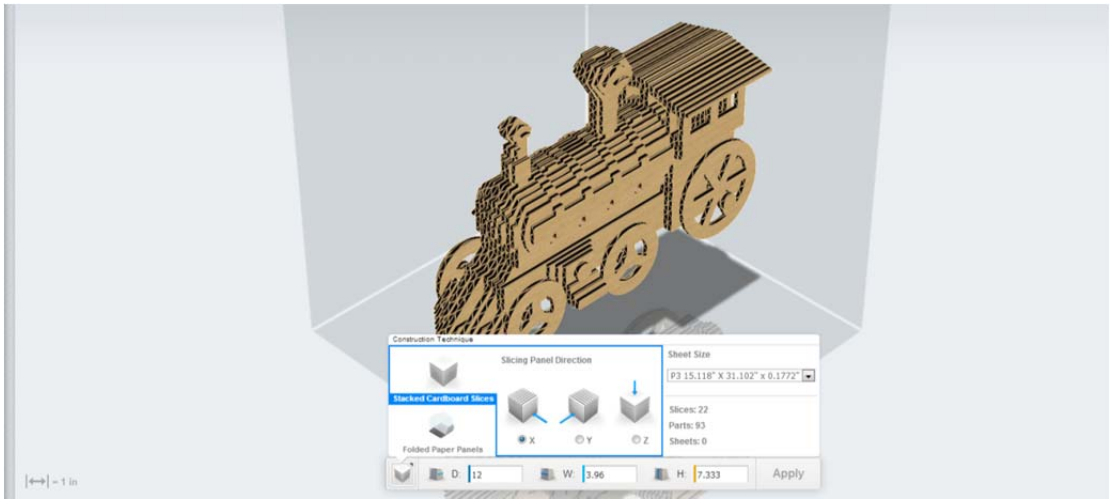


Let's change the size and see what we can do. Hit Apply to see the resulting changes.

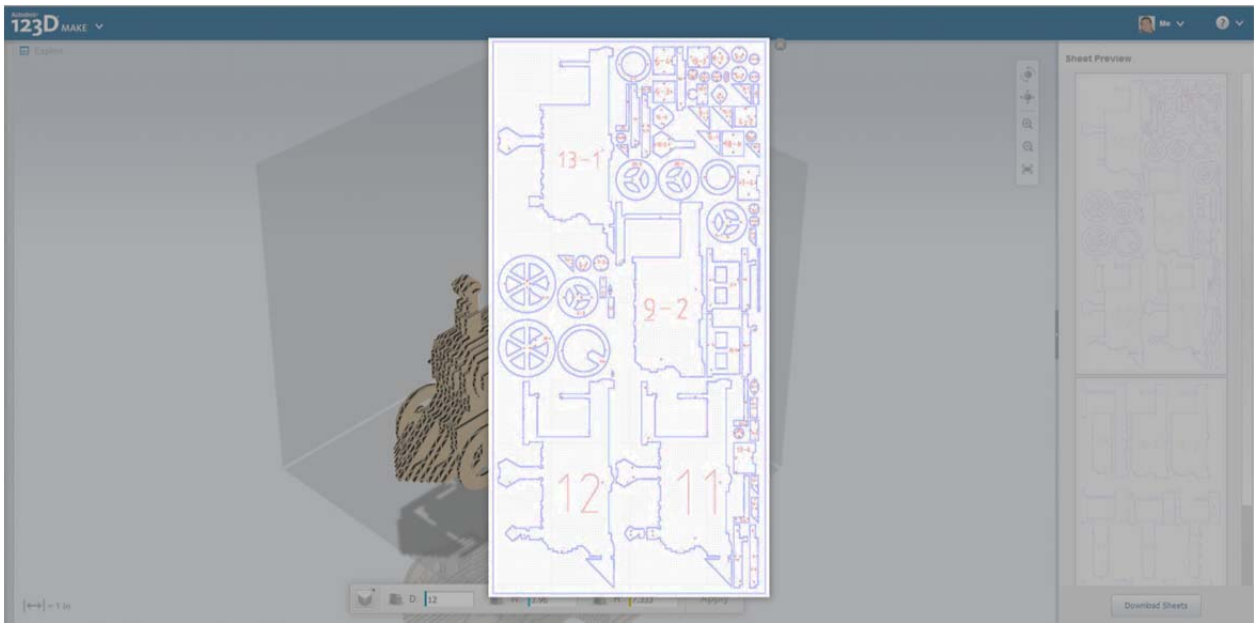


The first icon allows you to access the method for fabrication.

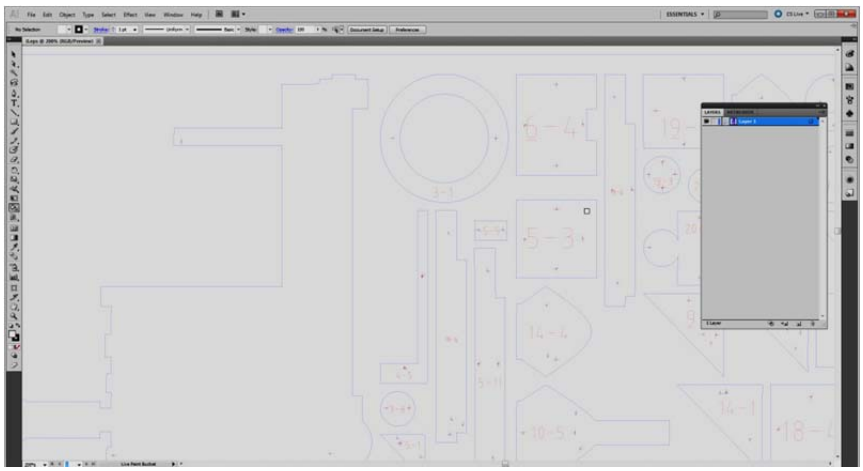
Stacked Cardboard Slicing allows you to define the direction for the stacking. You can preview by hitting Apply. Preview is quite critical, since the visual feedback will let you realize which direction is right for the model. In this case, stacking across X seems better since you can get the wheels in a single slice. Imagine the time you'd spend gluing cardboard in the other two directions.



Next step is to produce the sheets for laser cutting. First select the size of the cardboard sheet you plan to use. Click on Sheet Preview, and you will see the parts. Then you will be able to download them. 123D Make online will create a zip package with one EPS file per sheet.

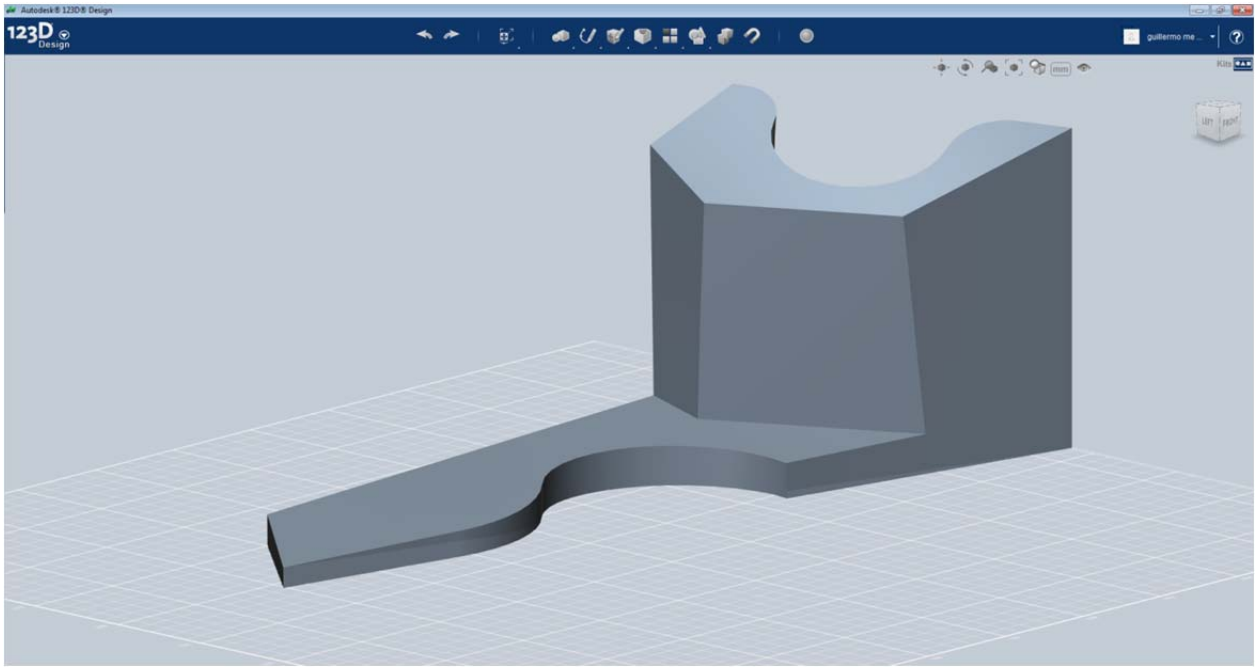


If you want to clean up the EPS, you can open it in different applications. In this case, I use Adobe Illustrator. You can move or resize the numbers, make other edits, or even add some details that were not in the model.

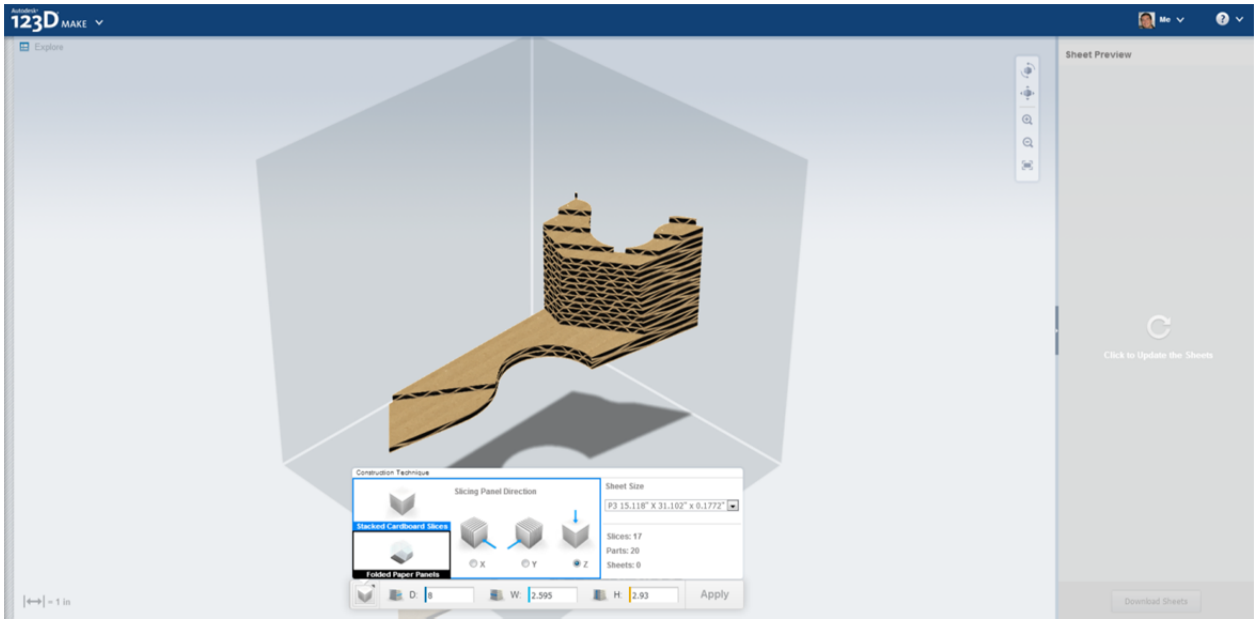


Folded Paper Panels

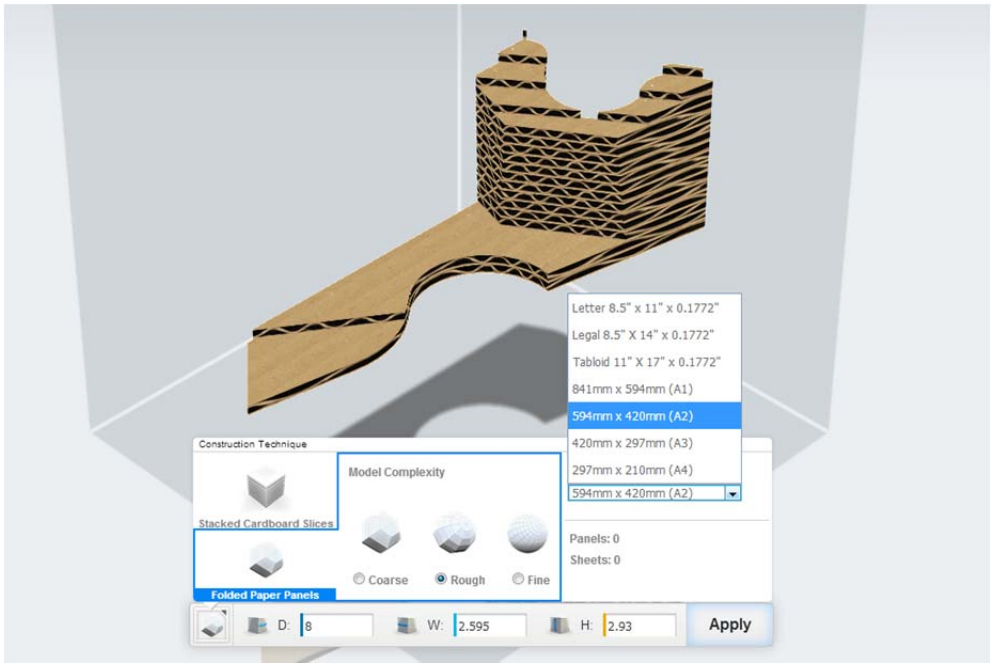
Let's explore the other fabrication method available in 123D Make online. Paneling makes more sense in models where you have quite defined planes. In this case, I made a simple conceptual model for a building.



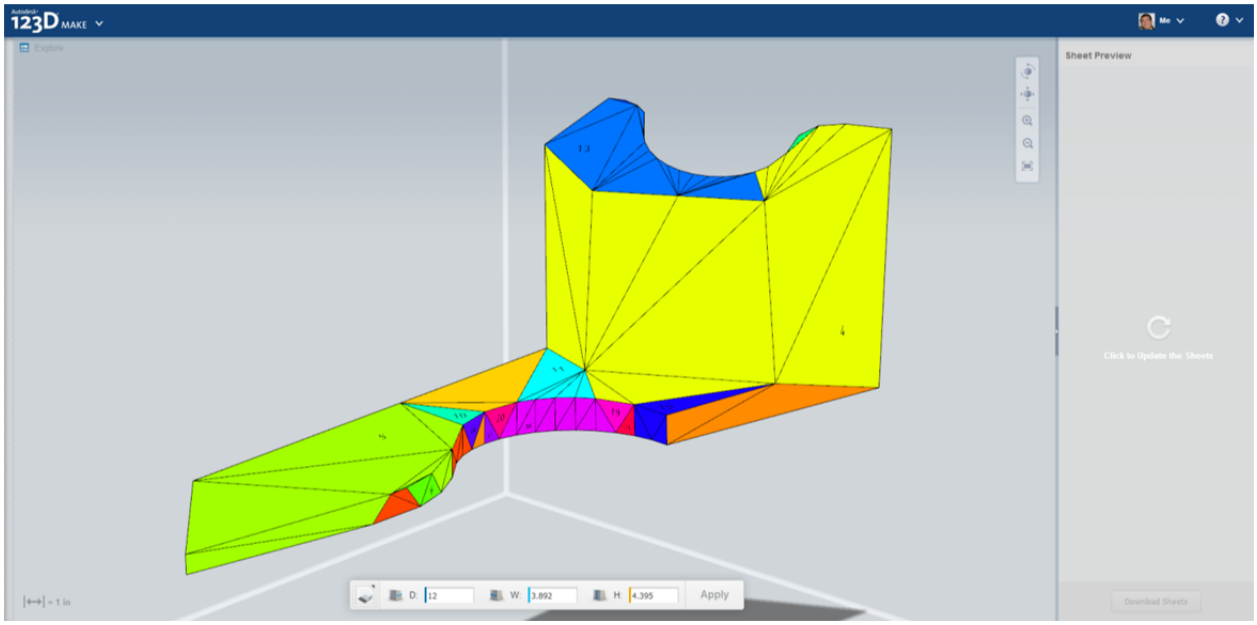
After hitting Send to 123D Make online, the default is the Stacked Cardboard Slices method, so we'll click on Folder Paper Panels.



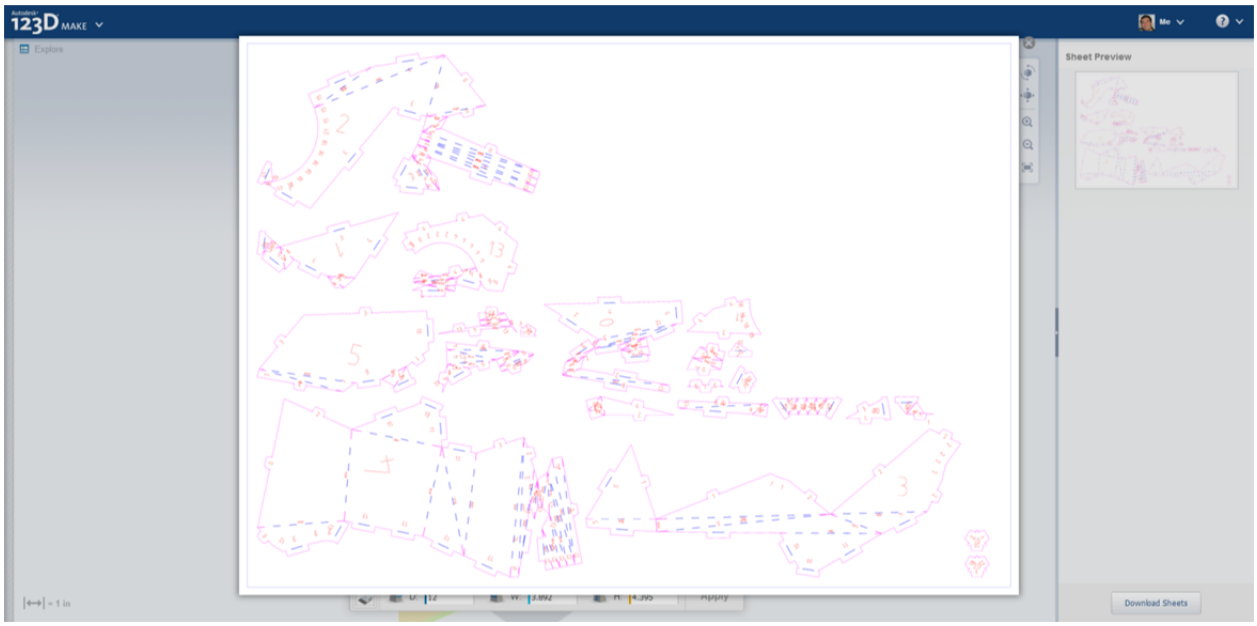
Let's see the options. In this case, Model Complexity is the focus. This parameter affects curved faces, and the amount of faceting we want to accept. If you want a more accurate paneling, then we should choose Fine. That will also provide a lot of faces. In this case, let's stay in the middle and choose Rough.
The other choice defines the size of the paper to be used.



Once we hit Apply, 123D Make will display each panel in different colors. You may want to recalculate with different complexity just to make sure you made the right decision. Remember there's a lot of paper to cut if you go for more complexity.



Accessing the sheet is exactly the same process than Stacked Cardboard Slicing.



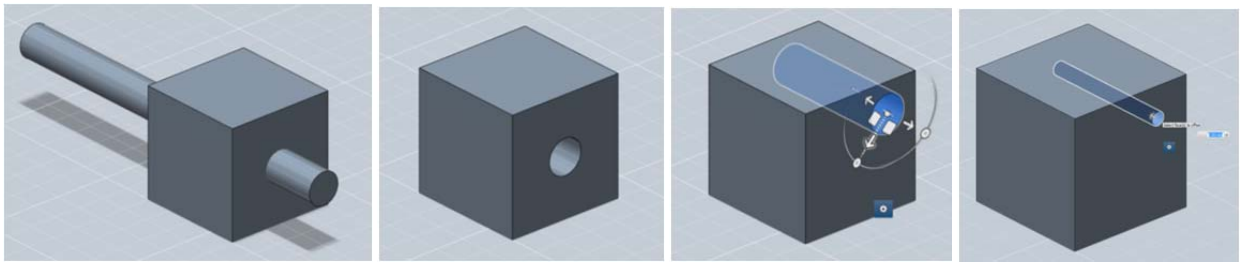
123D Design online

123D Design online is a solid modeler working in a browser by simply installing a plugin. It's a great solution if you don't want to install a whole application like 123D Design desktop, or you want to access your files from another computer.

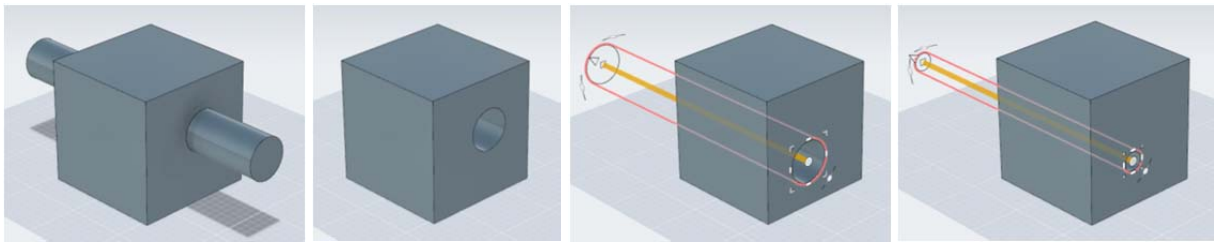
123D Design online provides a set of very interesting features, especially around the interaction.

123D Design desktop is a direct modeling solution, while 123D Design online provides history based modeling. What does it mean?

If you make a subtraction in Design desktop, in order to edit it, you will need to edit the resulting faces, since there is no trace of the original object.



In Design online, you can get access to the original object and edit it, and the operation will show the update.

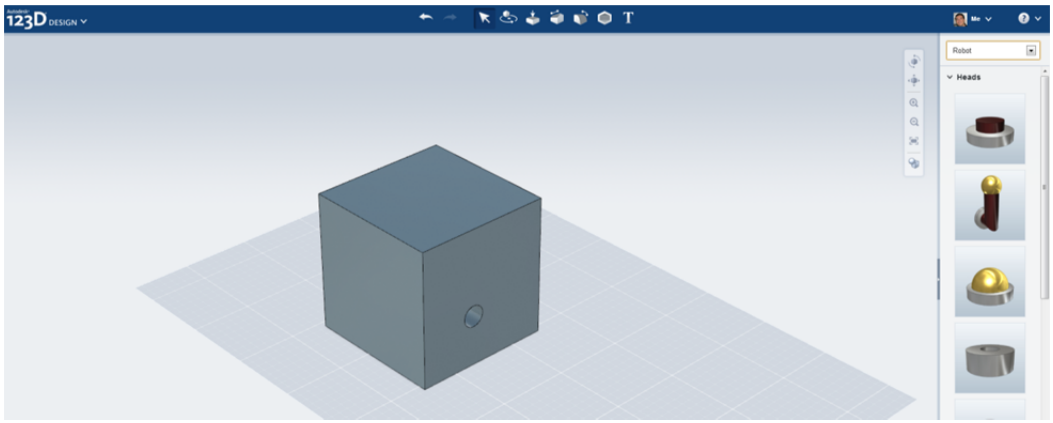


If you save a file from123D Design online in MyProjects and open it in 123D Design desktop, it will come flattened, so you'll still be able to edit it, but not with the original geometry.

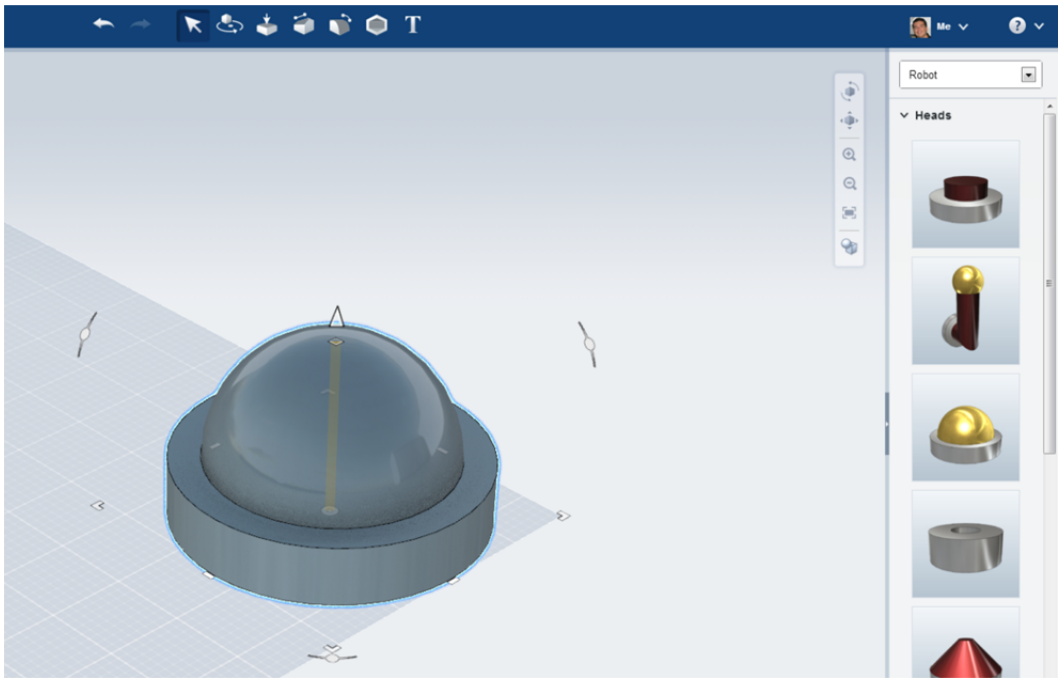
Parts Bin

123D Design online has the same Parts Bin as 123D Design desktop. So whenever we add content, you will access it from both.

The only difference is that in 123D Design online, adding content is based on a drag and drop interaction rather than a click.

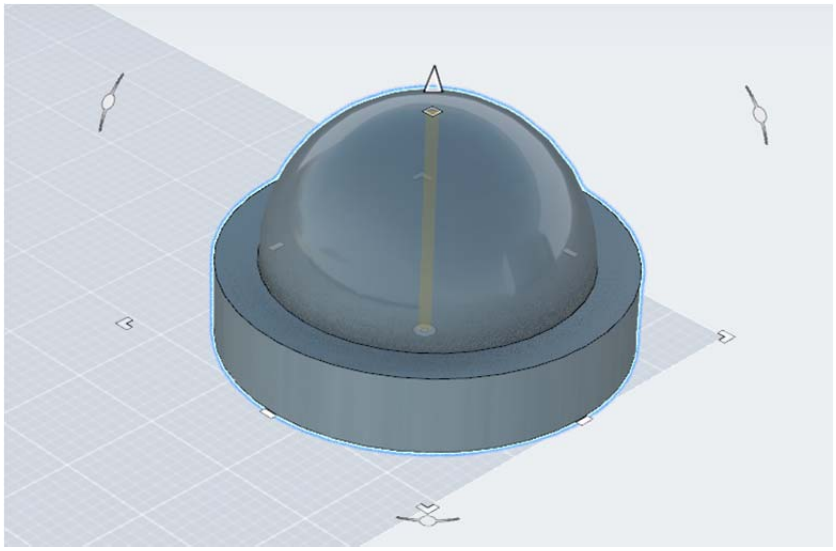


Once the object is in the scene, it will show the manipulator, which we call Box Gizmo.



Box Gizmo in 123D Design online

This is a completely different manipulator to what you may have seen around other Autodesk applications. It's maturing fast, and expect to see changes and enhancements in subsequent releases, and as we get feedback.



The manipulator contains:

- 4 corner grips for non-uniform scale along X and Y simultaneously
- 4 middle grips for non-uniform scale along the X or the Y axis.
- 3 rotation handles
- 1 control for non-uniform scale along Z (a square)
- 1 control for moving along Z (an arrow)

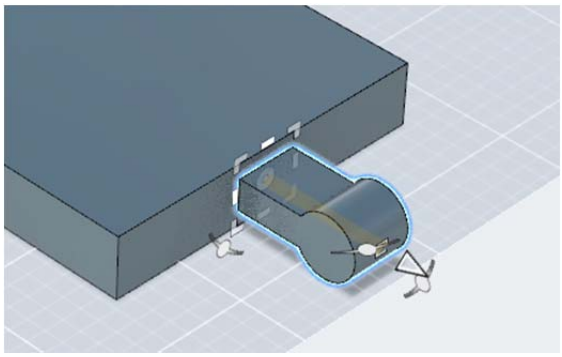
There are two clutch keys you need to know. Clicking Shift will make the scaling uniform. Clicking Ctrl, the scaling will get done along the center of the object. The clutch keys work exclusively on the grips at the bottom of the model.

Each part will display the Box Gizmo at the bottom. When rotating, the Box Gizmo will also be following the original face to which it was attached.

There is another control at the center, and this is the one for Cruising.

Cruising

As we mentioned for 123D Design desktop, cruising is an action that allows us to drag an object, and find alignments and snapping points along this dragging. In 123D Design online this is done using the Cruising control. If we drag from any other part, we'll simply move the part along the plane which is currently hosting the Box Gizmo.

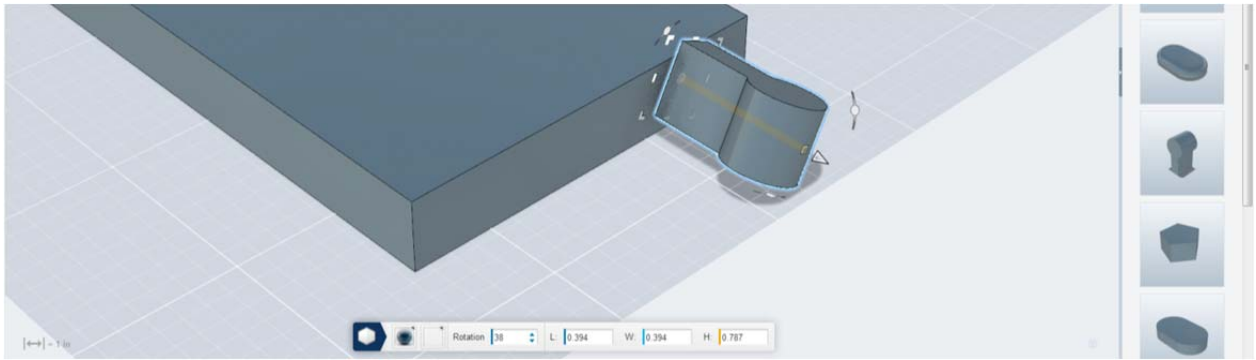


A couple of shortcuts you also need to know:

- R and L rotate the part clockwise and anticlockwise
- Spacebar flips the part along the Box Gizmo's plane
- Shift while Cruising will constrain the current orientation. You can use this when you want to keep a specific orientation, but still want to move and snap to other objects
- Ctrl copies the object (Ctrl C – Ctrl V also copy)

Attribute Manager

Whenever you want to have better control through numeric input, take a look at the options in the Attribute Manager. Its content is dynamic and depends on the action being performed. For example, no rotation value is displayed until dragging rotation. Stopping an interaction in the canvas does not commit the action, so you can keep dragging, or add a value.



Another important part to understand in the Attribute Manager is when we are working with Bodies and when we are working with Features.

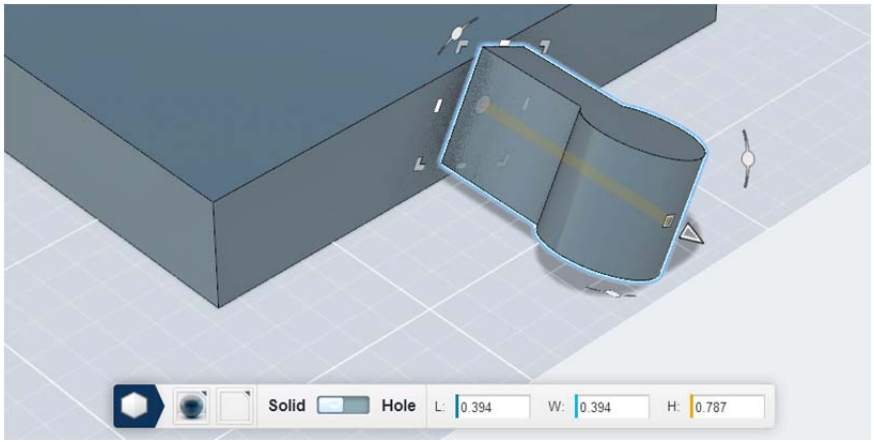
Bodies vs Features

This is a rather technical distinction, but in order to fully leverage 123D Design, you need to understand it.

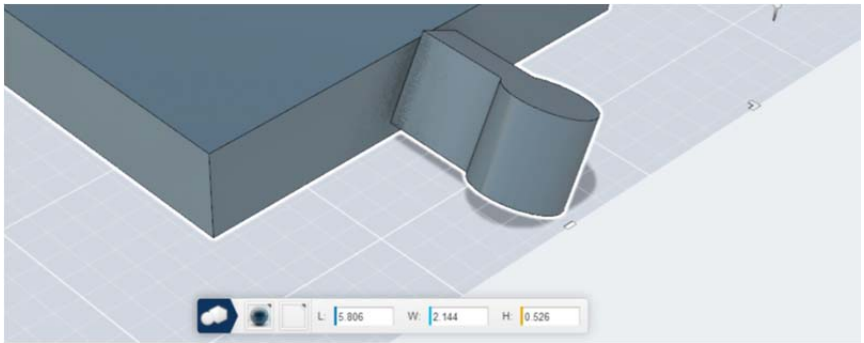
When the Attribute Manager displays the icon shown below, it means that you have selected a body (you could think it as a part). You can have multiple bodies in the scene. Each body can have different materials. Each body can be snapped and aligned against another body. Right now, we don't do unions and subtractions between bodies. This means that if you want a cylinder to cut a box, they both need to be treated as features.

When we talk about features, these are basically the pieces that form the body. All parts in a body need to have the same material (although they can have different color). Unions and subtractions can be done between features. If you actually snap two features together, you will see a new toggle called Solid - Hole.

In the image below, the keyhole part is a feature. The blue icon in the Attribute Manager displays the image of a single object.



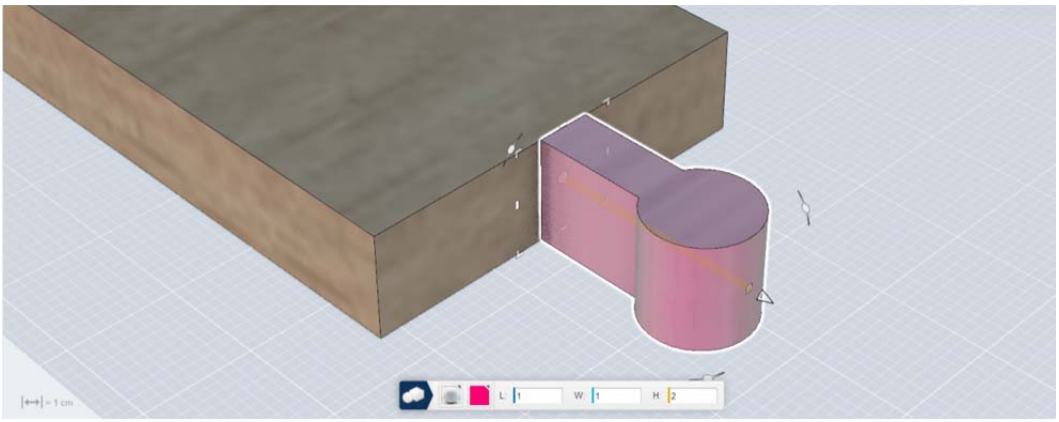
In this image, I just selected the whole body (box and keyhole). As you can see, the first icon is different. This indicates it is a body.



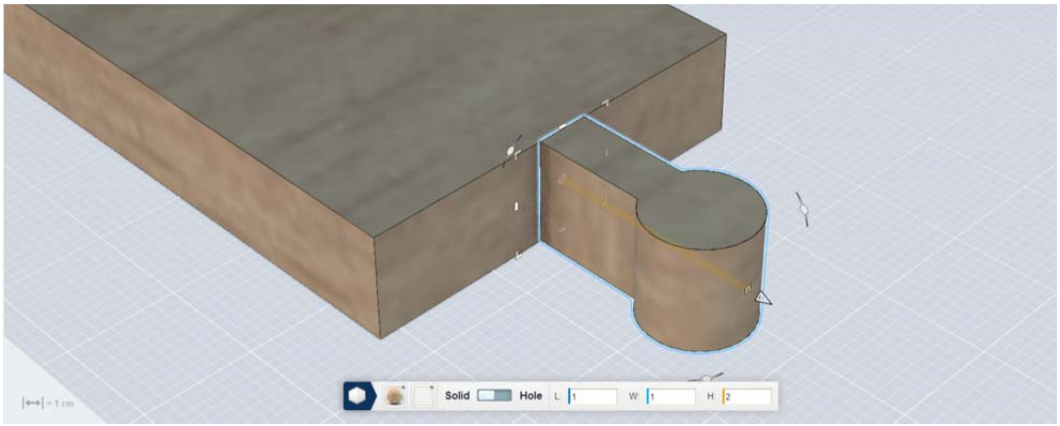
When you insert a part from the Parts Bin, they act as features, so if they get snapped into something else, they adopt their material, and they are ready for Boolean operations.

If you insert a part from Parts Bin into the canvas and leave it isolated, the next time you select the object, it will behave as a Body. A second selection will get a level deeper and show it as a part.

So if for example I am building a train track and I have the track itself as wood and then the keyhole as plastic, then I will snap them, using the Cruising control that appears on the first selection, when it is a body.



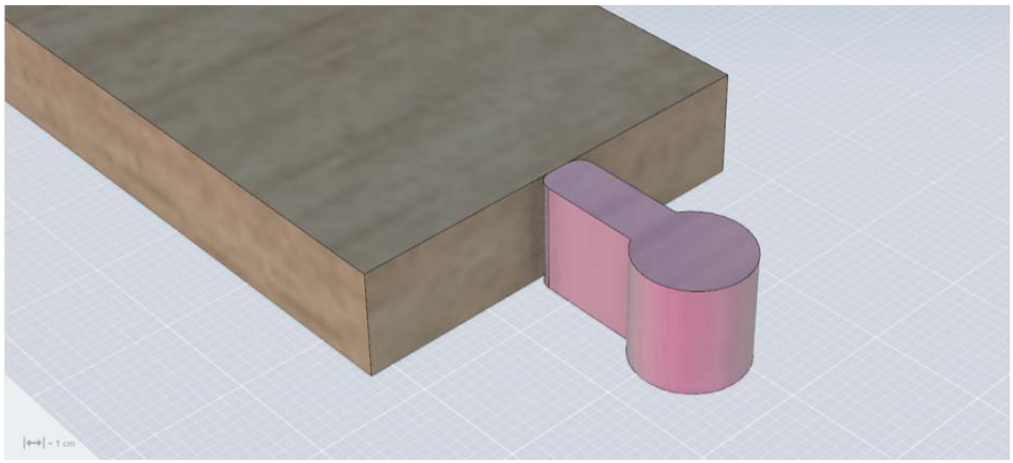
If I want the keyhole to get blended to the track, then I'll Cruise with the control that appears on second selection.



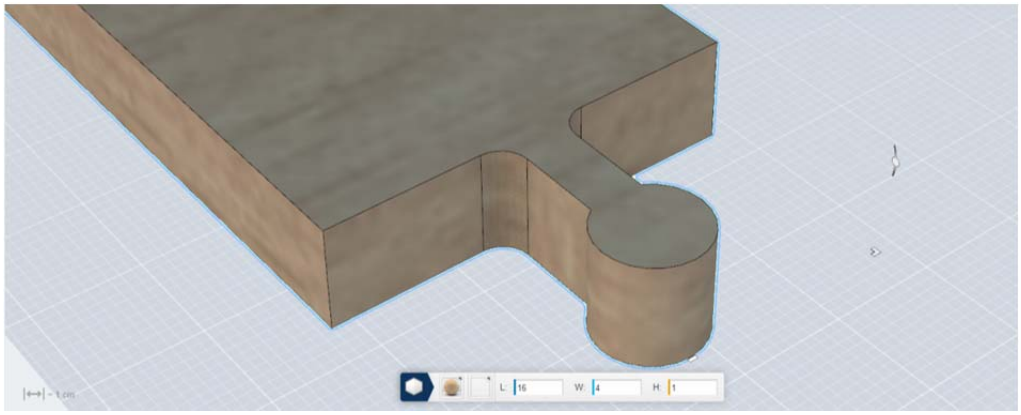
Please also note that the Solid-Hole toggle only appears when the keyhole is snapped as a feature.

An interesting difference between these two approaches is that some tools will react differently. Let's see what happens if we fillet the base of the keyhole in both examples.

The keyhole as a separate body does not blend with the track, so the fillets are done to the keyhole itself.



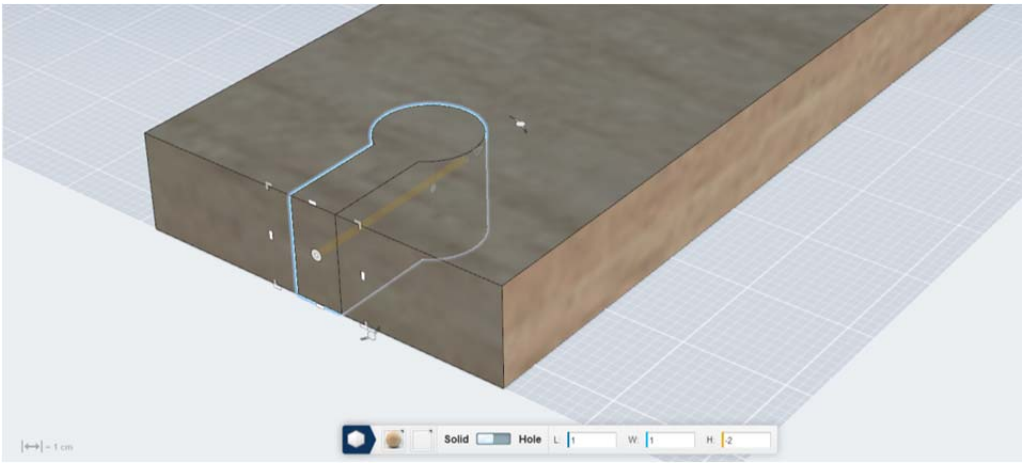
The keyhole as a feature of the body that also contains the track blends with the box, and then the fillets are acting on the union of these two. Once the fillet is done, the two features are flattened into one feature.

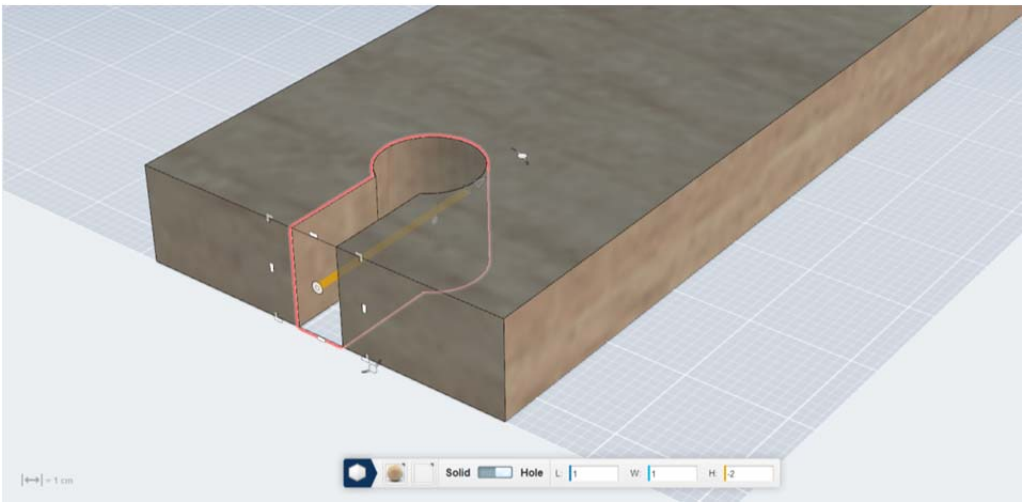


Solid-Hole

Instead of asking the user to learn a bunch of Boolean operations, we have added a toggle that makes a feature additive or subtractive.

Features are combined automatically when they are overlapping or adjacent to another feature. When a feature intersects another feature, toggling Solid to Hole creates a subtraction. You can still select the original feature and edit it. You can also copy it and keep working.





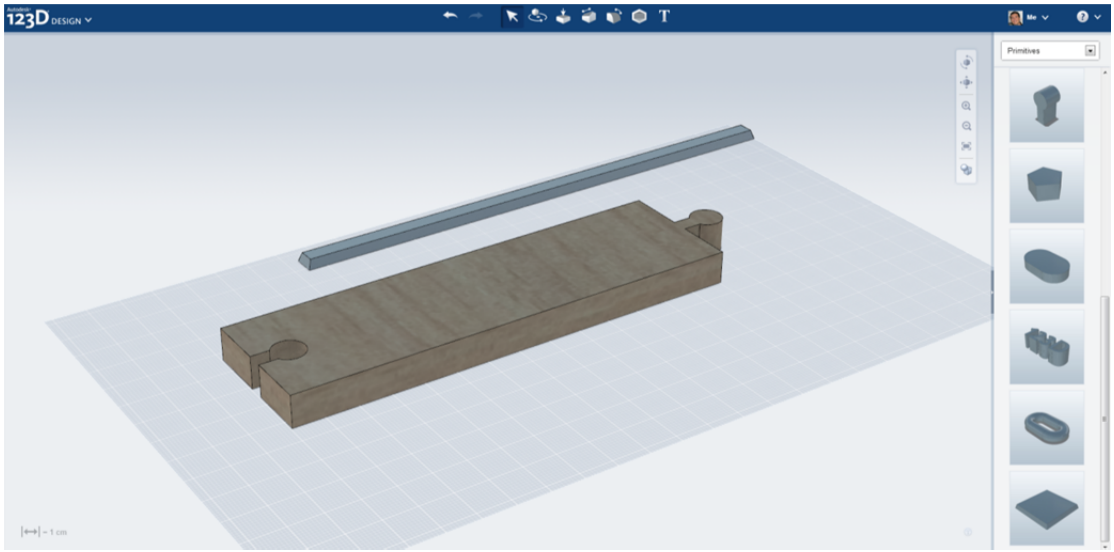
Smart Position

This is a great tool for aligning and snapping in cases where Cruising is not enough. For example, if the face you need to align is not the bottom of the Box Gizmo, or not at the center of it.

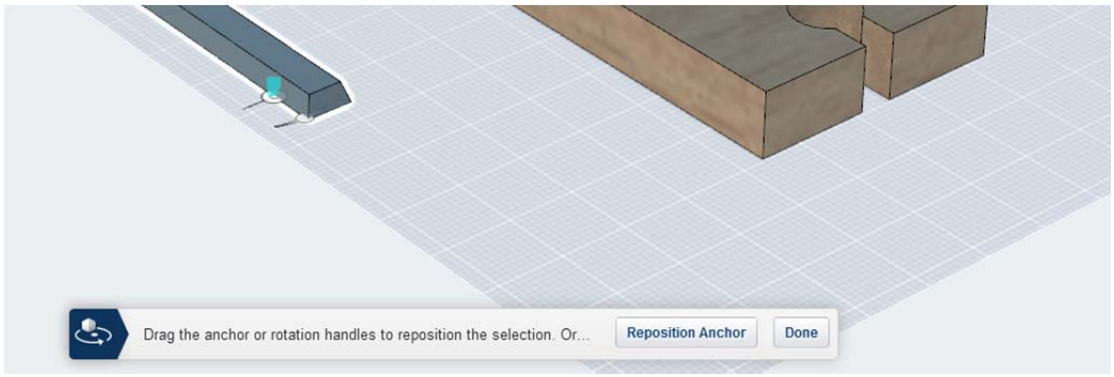
Let's see how it works. Once you click on Smart Position and select the body or feature, you can drag the control, which will then interact in the exact same way as the Cruising control.

This widget has an additional feature which allows rotation based on the pivot point defined by Smart Position.

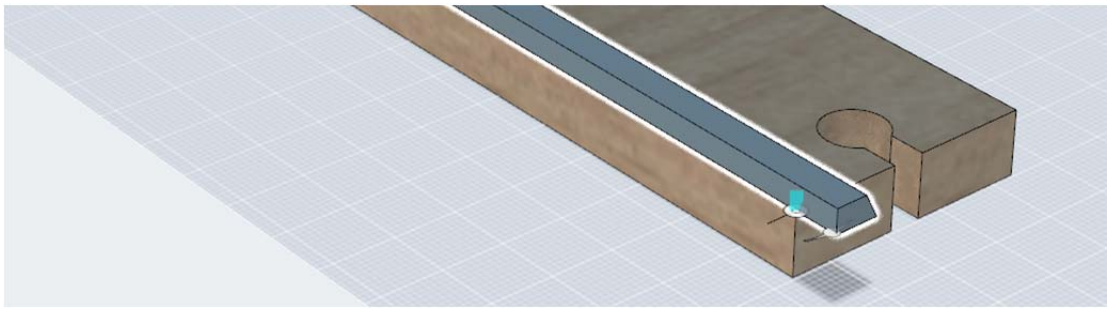
We're going to keep building the train track. Now it's time to create the tracks themselves. First thing is to insert a trapezoid into the scene.

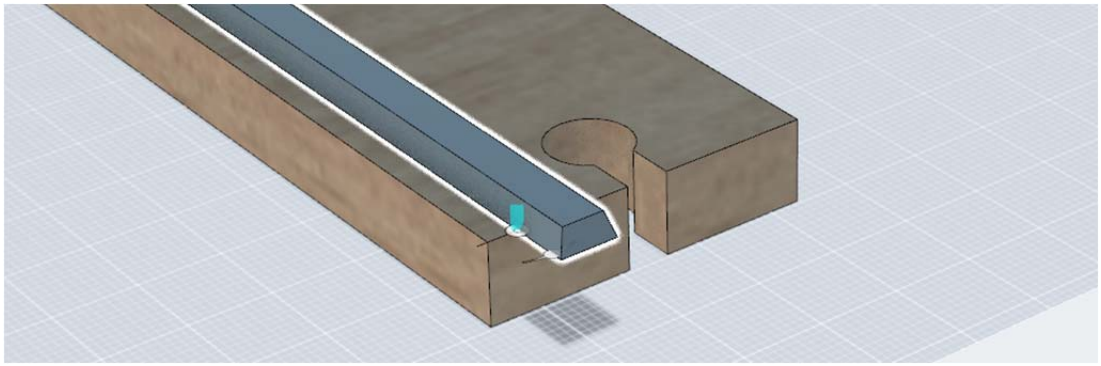


Cruising the trapezoid would not be of much help, so we'll invoke the Smart Position tool, and drag the Anchor to the position you see below. Since the trapezoid is tapered, selecting the endpoint would not help.

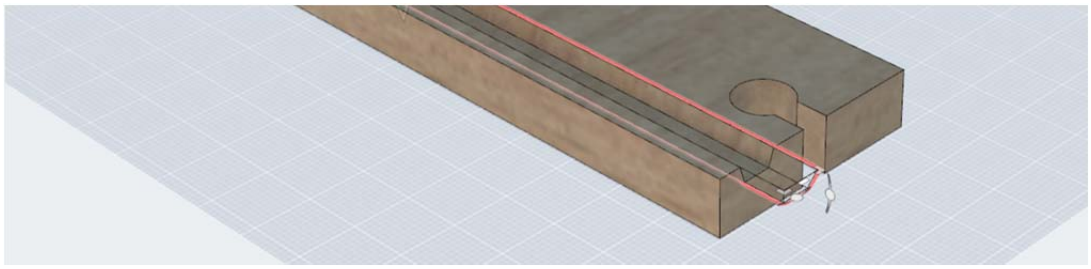


Now we can drag the feature just like when cruising.

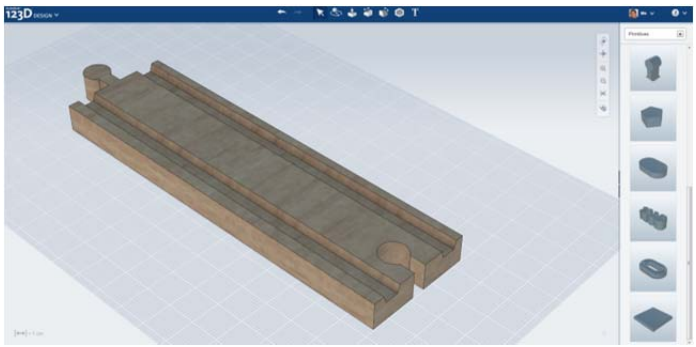




Once it's in its right position, we can flip it (Spacebar), and create a Hole.



Last, we do Copy-Paste and we move the new Hole to the opposite side of the train track, and we are done.



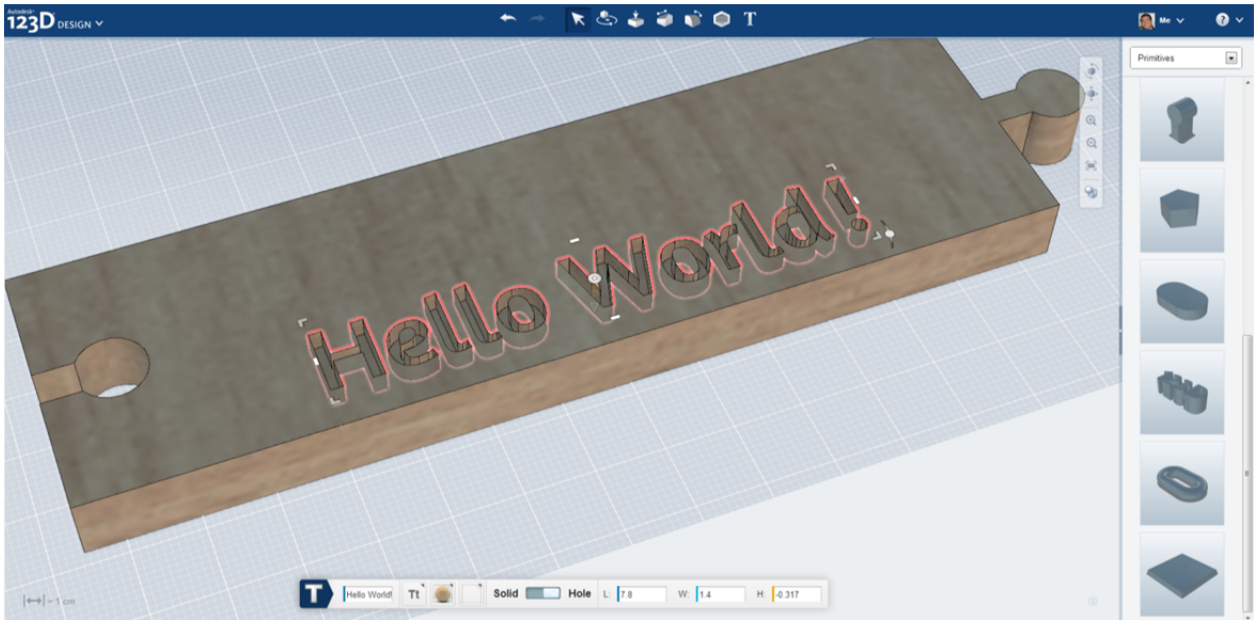
Smart Primitives

Talking about the trapezoid, let's mention the concept of Smart Primitives. So far, I used two already: the keyhole and the trapezoid.

What are Smart Primitives? They are features that are driven by a set of rules, which can be changed at any point, and the whole feature rebuilds.

For example, in the keyhole, if it was a simple solid, a non uniform scale along Z would have deformed the circular extrusion, but you can see this not happens here. It's just because the shape is made of a box and a cylinder, with specific geometric rules.

Text is also a Smart Primitive, where you can change the content of the text, the fonts, and the overall size. It's a pretty powerful feature worth trying.



Editing tools

Editing tools in 123D Design online are constrained to Shell and Tweak for faces, and Tweak, Fillet and Chamfer for edges.

These tools work pretty much in the same way as 123D Design desktop, so no need to expand on them.

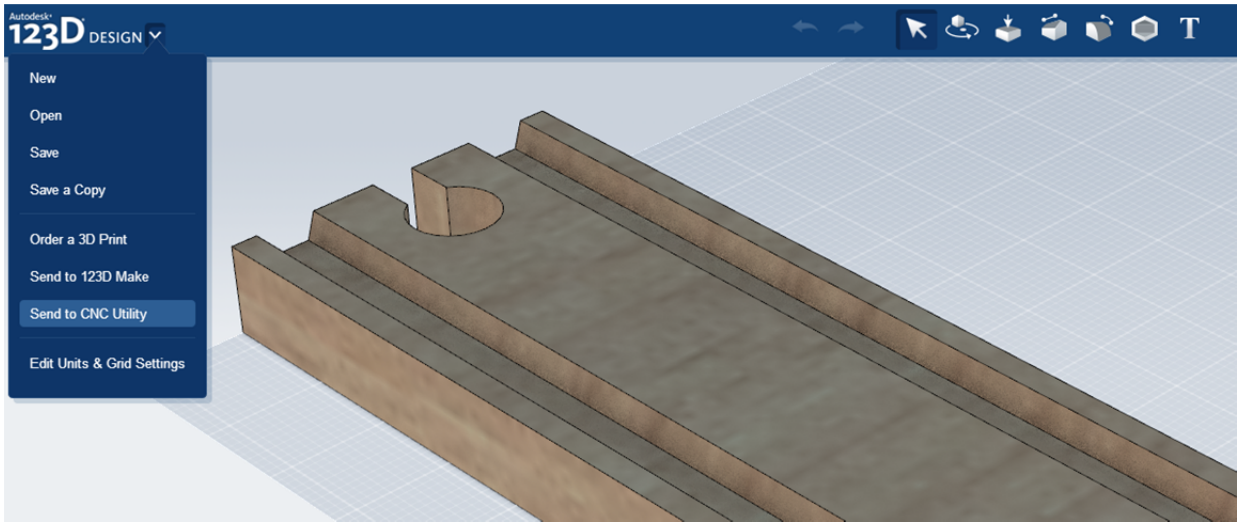
Let's simply note a couple of aspects:

- Any editing will flatten every feature that is adjacent.
- You can do multiple selections for editing.
- You can access numeric input from the Attributes Manager

Starting CNC Utility from 123D Design online

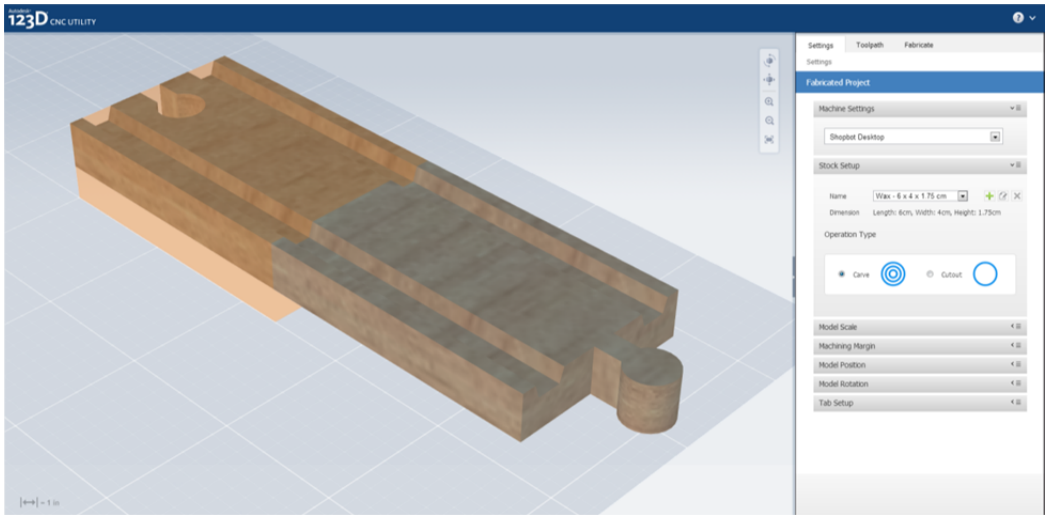
Let's keep using the train track for showing how to fabricate this model by using CNC. In this particular case, let's assume you have access to a Shopbot CNC.

123D Design has an option for Send to CNC Utility, which works exactly in the same way as the rest of the Send To… workflows.



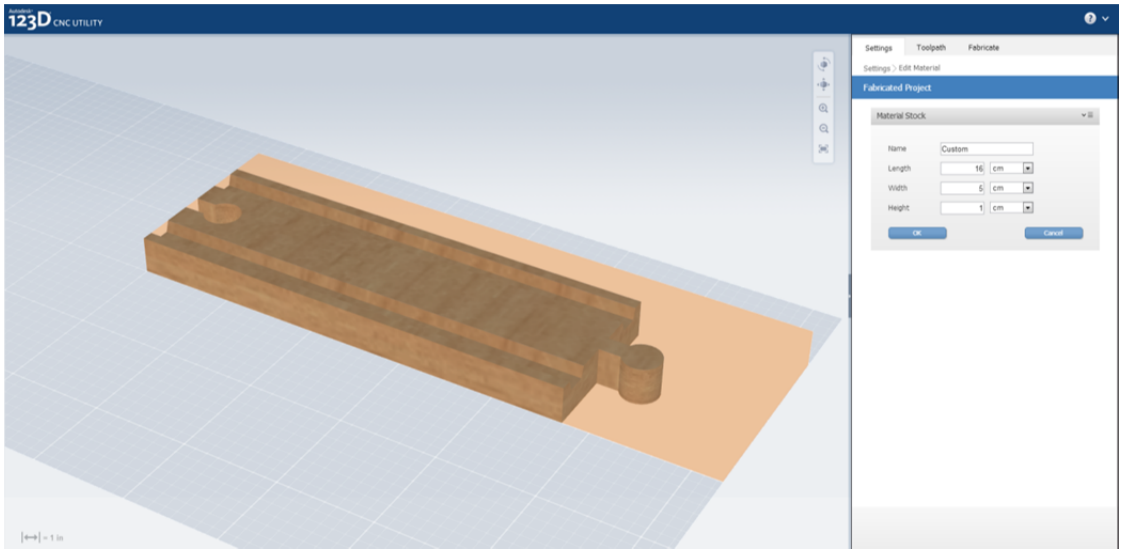
Once we click on that option, we'll see the CNC Utility open, load the file and we are ready to prepare the part for fabrication. For this handout, I'll assume some basic understanding on how CNC works, and simply comment on some of the basic features and workflows within the application.

So here's the track in the CNC Utility. As you can see, it has the same visual language, same location of main elements of the UI. Everything is ready for you to start working.



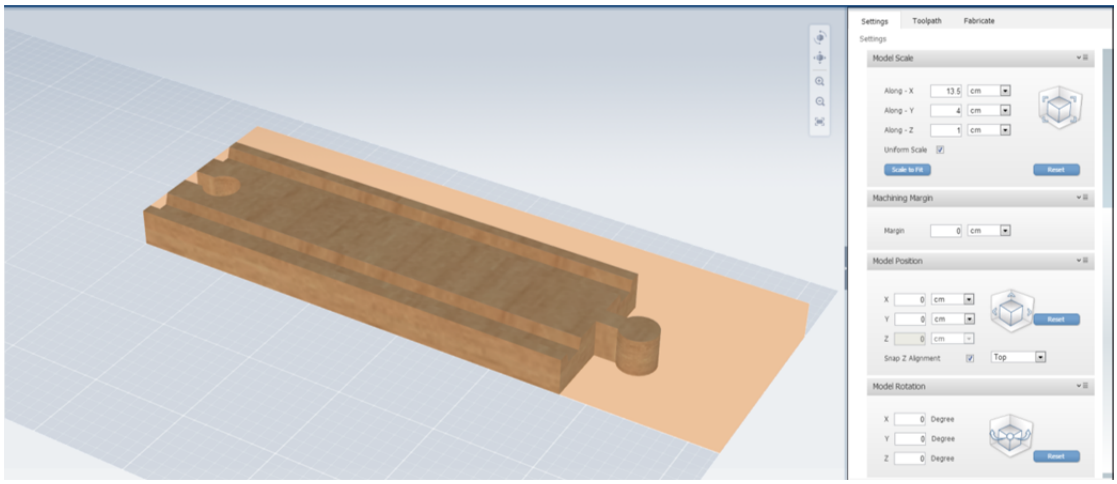
First thing to do is define the device that will make the cutting. In this case, we'll choose Shopbot Desktop.

Then we need to set up the stock, which is the piece of material we're going to cut. We are going to use a piece of wood of the same height as the train track, and slightly larger. So we will create a custom material that has the size of the stock we will use.

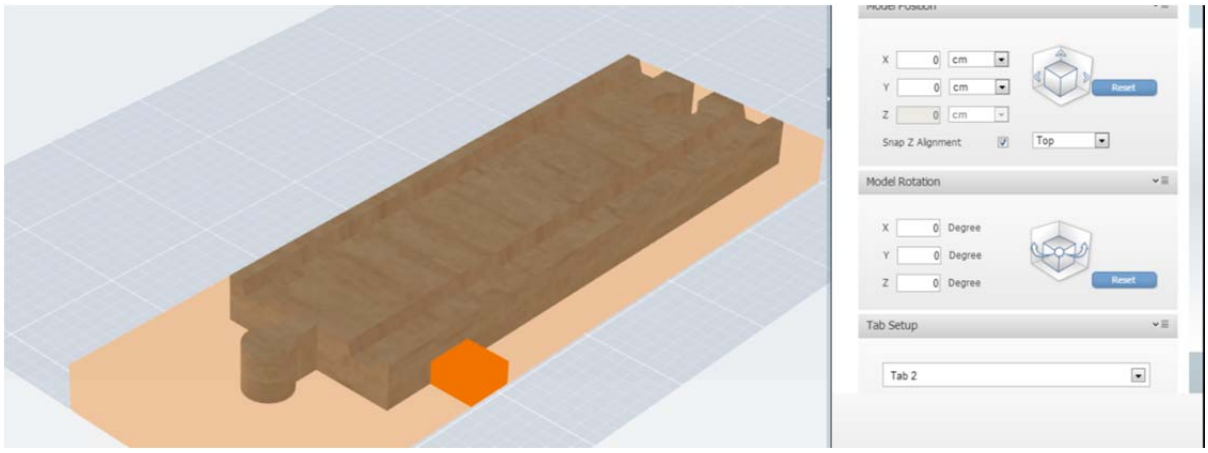


The operation type in this case would be Carve, since Cutout would require a piece that is only based on an extrusion. We have the two tracks that we have to carve.

Then we have a set of options for model position, size and rotation. In this case, we are going to use exactly the size coming from 123D Design. The CNC Utility can resize uniformly and non-uniformly, as well as rotate, move and add a margin to the part.



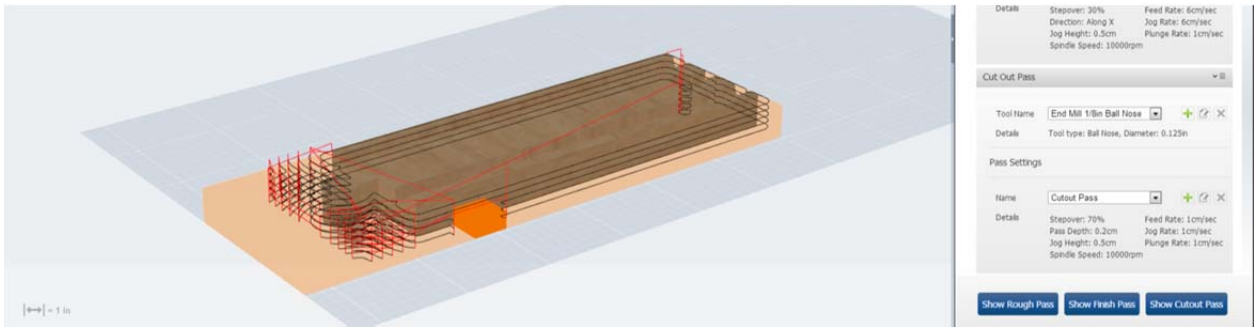
Sometimes you want to add some tabs attached to the model, so it is not completely cut and can move. The tabs will detect the model. You can add as many as you need.



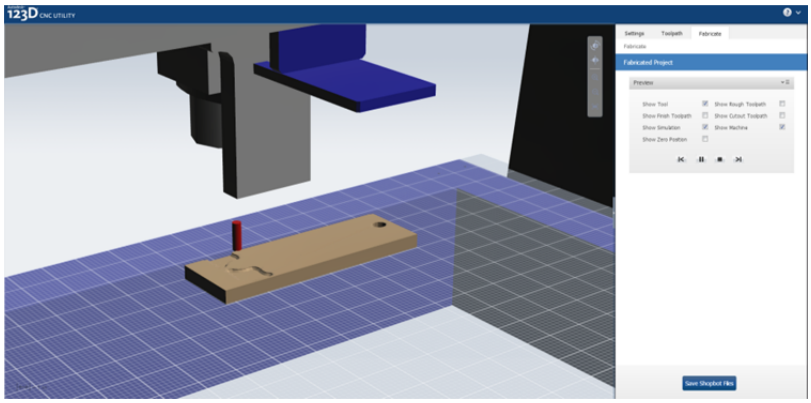
The next step is around selecting the right tool for the three passes you can have: rough pass, finish pass and cutout pass. Refer to CNC instructions for a better understanding on how to set up the tools you want to use, and which are the best options.

Once you define the tools, you can see the toolpaths displayed on the model.

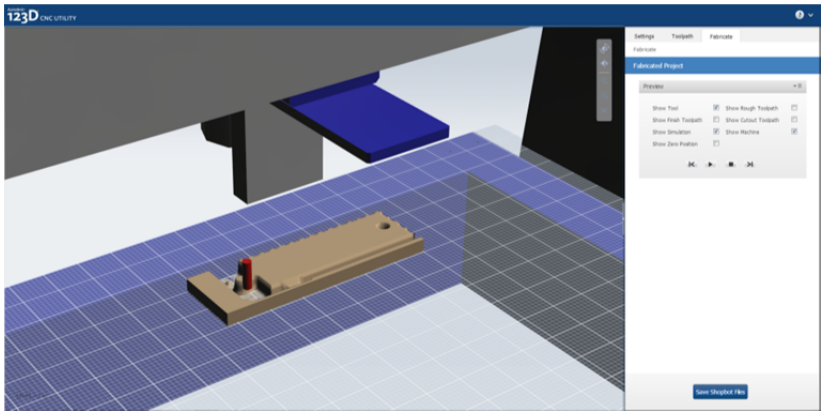
Note how the toolpath is interrupted on the tab (which is what we wanted)



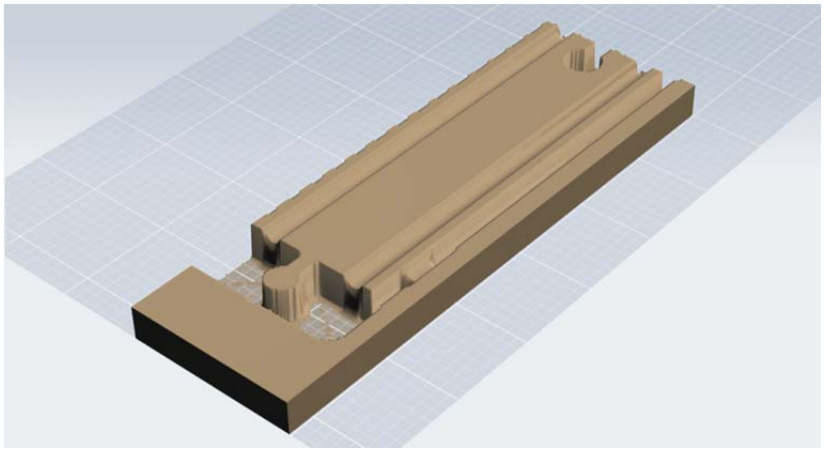
The next step is to create the file for fabrication. You can also see a simulation of how the toolpaths will work if you want.



You can also move forward and see the result after each pass without having to see the whole animation.



Here's the final result. Save the Shopbot file and you are ready to cut!



123D Design mobile

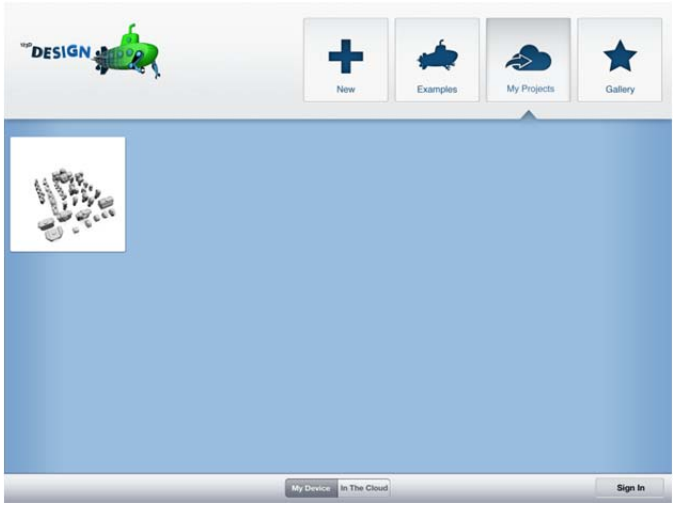
123D Design mobile for iPad is the third and last of the Design family. It's also the first solid modeler on the iPad, which is not trivial.

123D Design mobile has quite similar features as 123D Design online respecting solid editing. It has a very powerful set of manipulators for move, rotate, scale, and manual snapping.

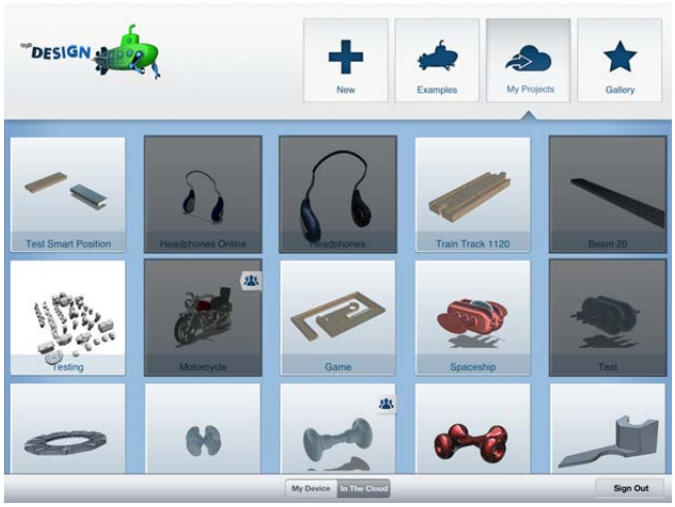
It also presents the same concept of Parts Bin, with some of these living in the device, and the rest accessible online.

Let's start with the landing screen.
As you can see, you have access to MyProjects (same as all the rest of the products), to the Gallery and to some Examples which are stored in the device. You can also start a new file without further questions.

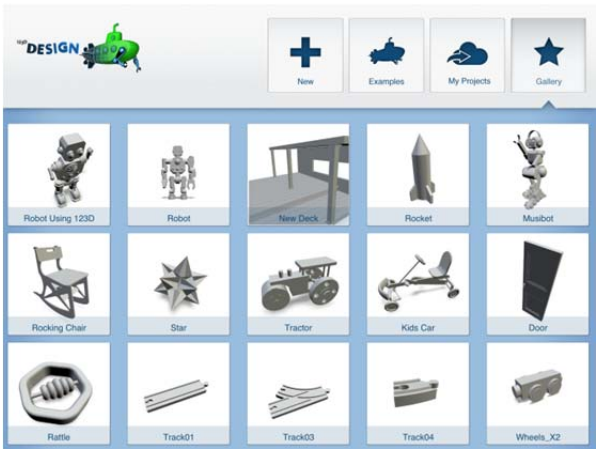
Within MyProjects in 123D Design mobile, there is a local repository so you can work while not having a connection, and you have the connection to MyProjects in 123Dapp.com



The other one is the same MyProjects we access from any other 123D application. You can actually see all the files you have created, with the same icon when a file is Public. The one grayed out are files that exceed a number of triangles that compromise performance and stability of an iPad.



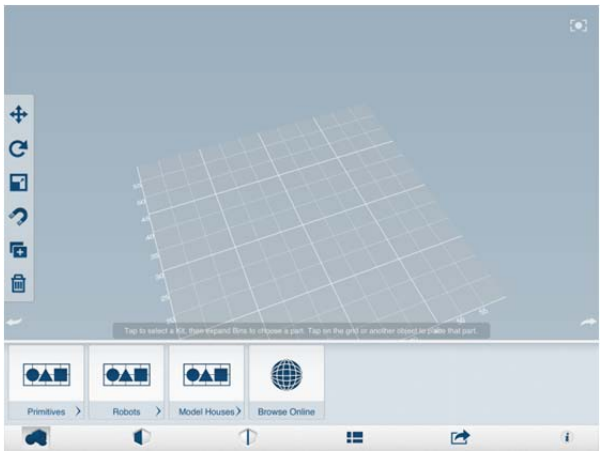
Examples is an offline collection of samples, while Gallery leads you to the 123Dapp.com gallery.

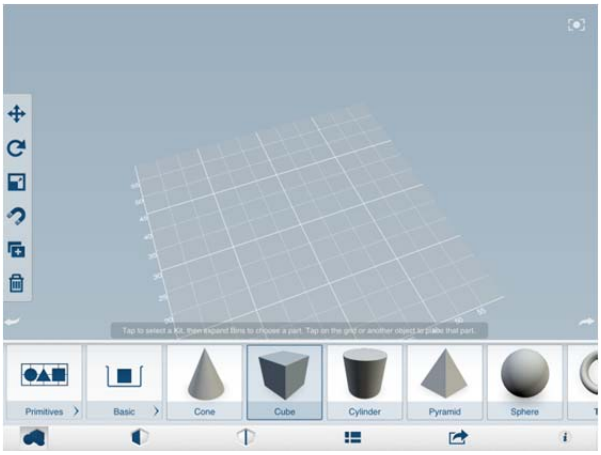


Parts Bin

As with every 123D Design application, we also have a Parts Bin in 123D Design mobile. You can access it with the first icon in the toolbar at the bottom of the screen. By clicking on the Kit, you get access to the Bins within the Kit.

The interaction in 123D Design mobile consists in tapping the part you want, and then you tap on the screen. If you tap on the grid, it will insert on the grid. If you tap on top of an object, it will insert in the face tapped. This way, you can already have a good approximation to the place where you want the part to be in.

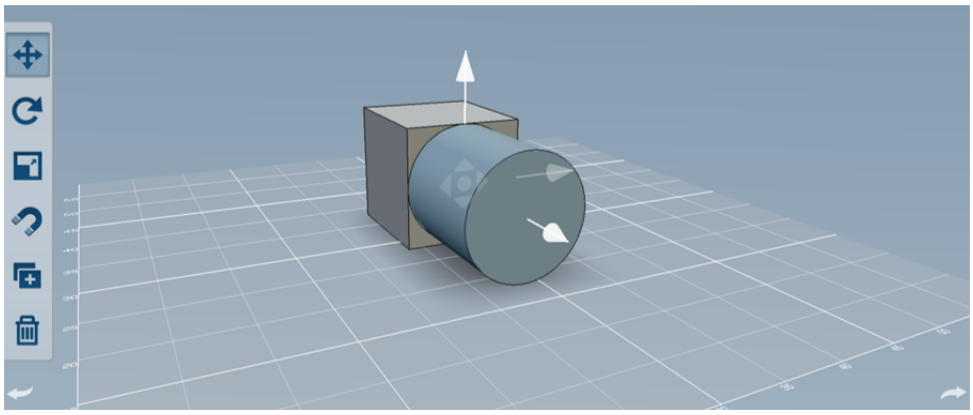




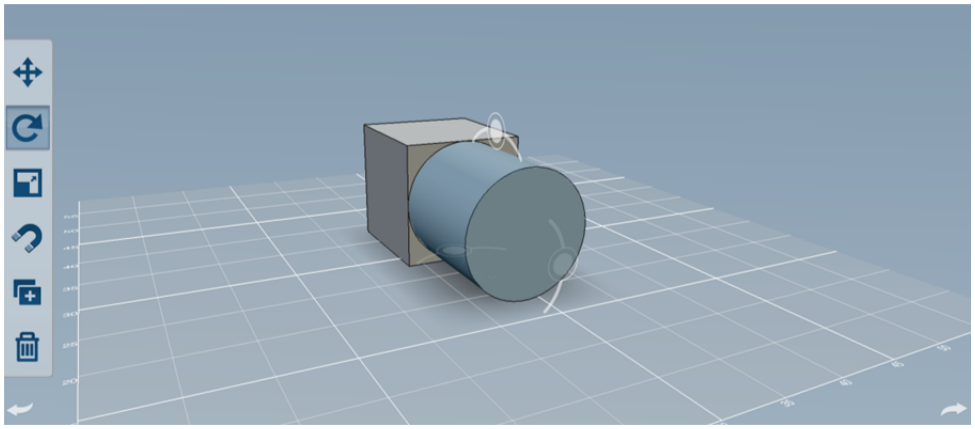
Manipulators

The toolbar for manipulation is located on the left of the canvas, and is always present, since these are the most used interactions.

The **Move** gizmo has a Cruising control and three axles. By dragging from the axles, you can move and constrain along these directions. If you drag from the Cruising control, you can move freely and align the part to any face the interaction finds. Once you release, the part is snapped to the center of the face you found when cruising.



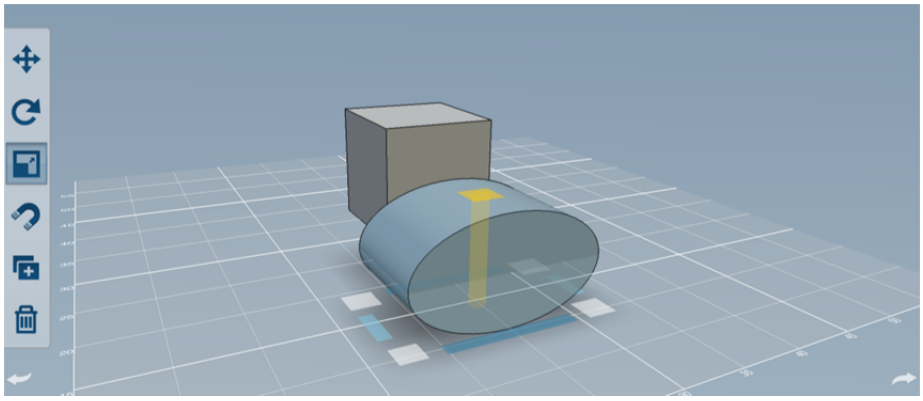
The **Rotate** gizmo is quite straightforward. Simply drag and the part rotates along the selected axis. Now, if you tap on the rotation handles, you will be able to rotate 90 degrees.

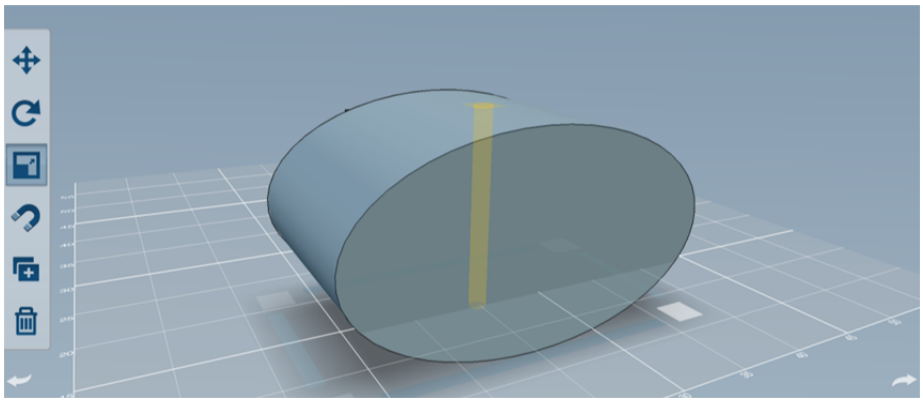


The **Scale** gizmo has three specific interactions you need to know. Dragging from the blue middle handles, you can do a non-uniform scale along X and Y. The yellow control does the same, for the Z axis.

Dragging the corner handles allows for a uniform scale.

A good tip for any interaction in 123D Design mobile is to first click on the control you want to drag, and in some milliseconds you will notice that the control activates. Start dragging once this happens.

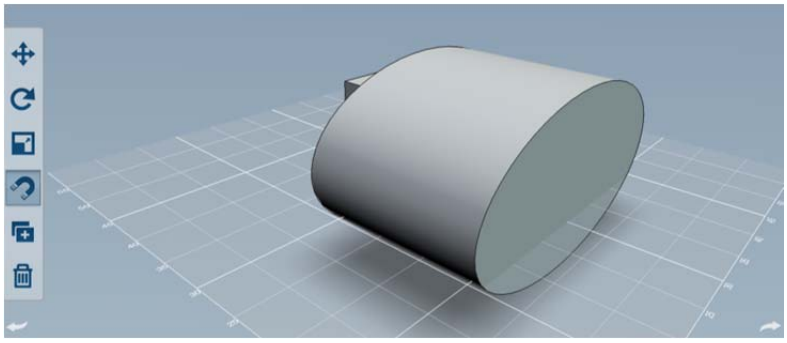


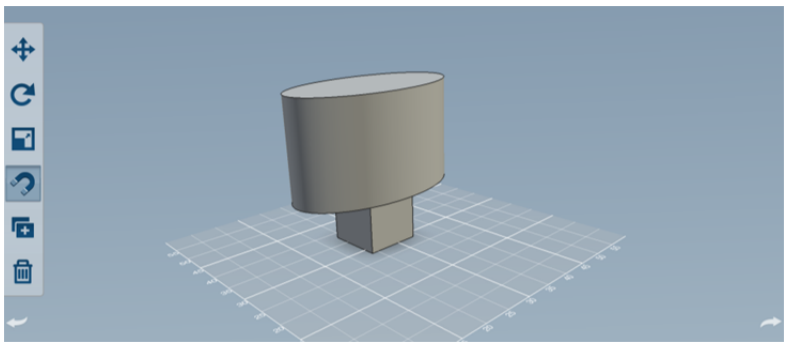


Manual Snapping

123D Design mobile adopted the same manual snapping from 123D Design desktop. Simply tap on the Snap command, then tap on the face from the body you want to move, and then tap on the target face.

Both bodies will snap based on the center of those faces.

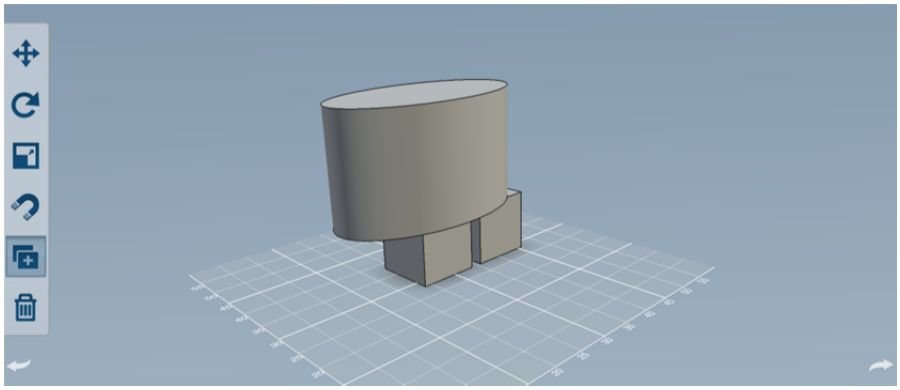




Duplicate

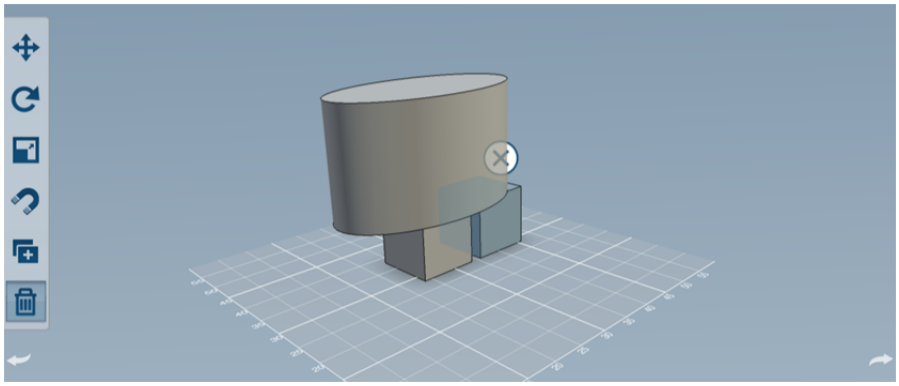
The duplicate tool is quite simple. It works for single bodies.

Just tap the command, tap on a body, and a copy of that body will appear close to the original object.



Erase

Deleting a body is also quite straightforward. Simply tap on the body you want to delete, and then tap on the checkmark.

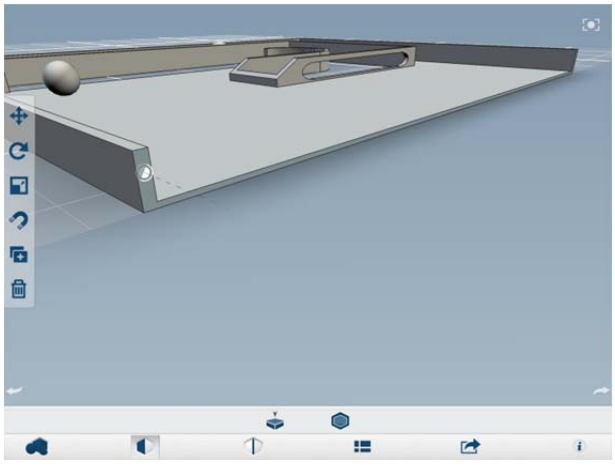


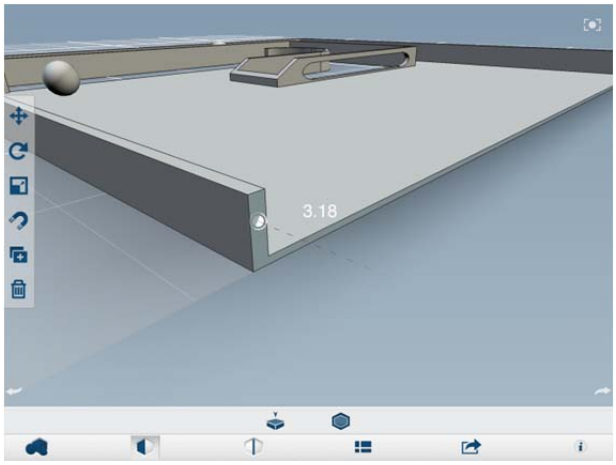
Editing tools

123D Design mobile has tools for editing faces and edges separately.

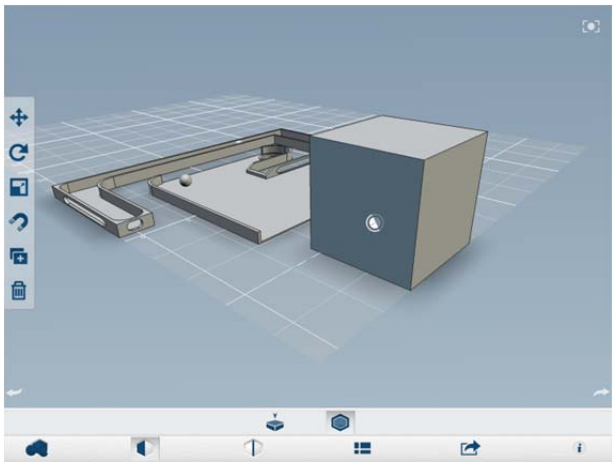
Let's start with **face editing tools**.

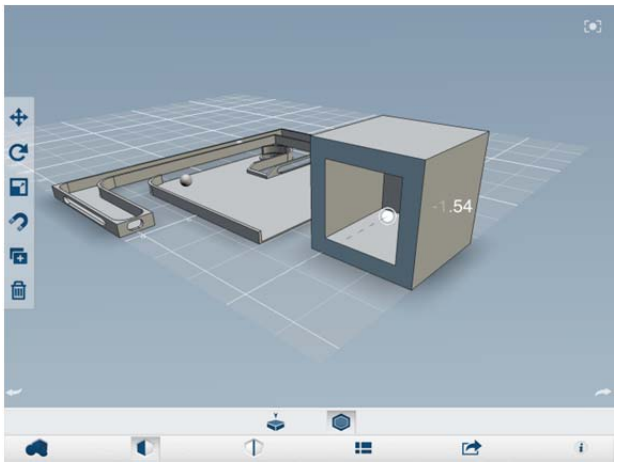
The first tool is **Press Pull**. Tap on the Press Pull icon, and then select the desired face. You will get a control which you will tap and drag. You also get feedback on the offset distance.





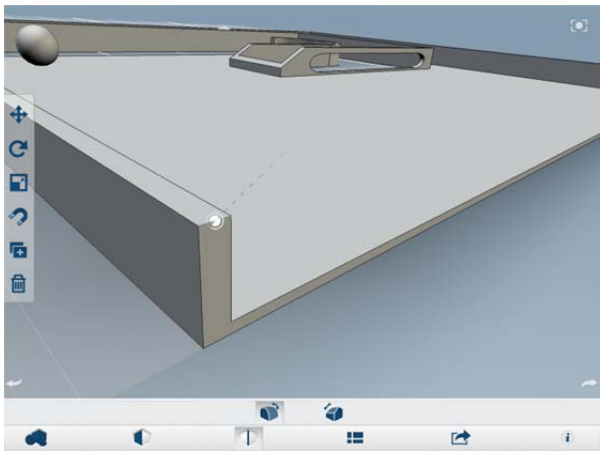
Shell is the second tool from Edit faces. Simply tap on the Shell icon, and select a face. Once the control appears, you can drag it and see how that face disappears, and you get the envelope.

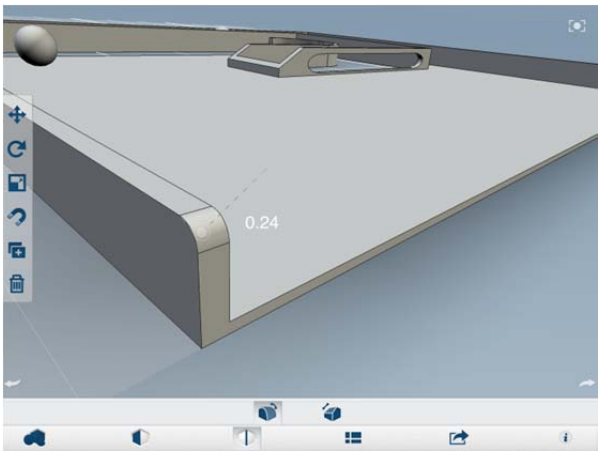




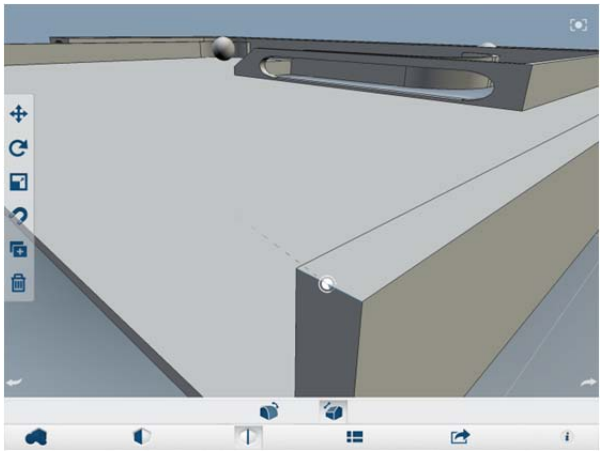
Now we can focus on **edge editing tools**.

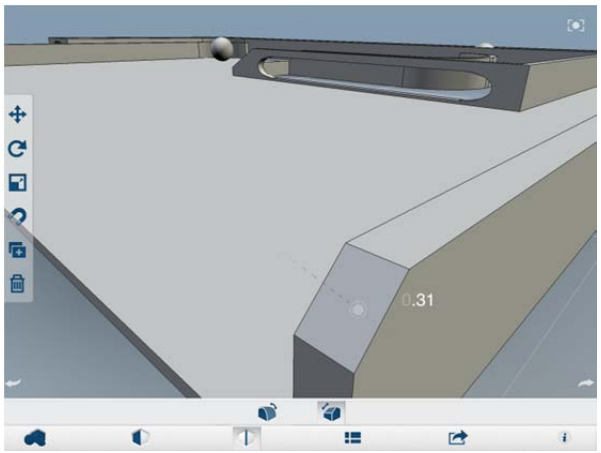
Fillet allows you to blend two faces using a radius. Tap on the Fillet icon, select an edge, and start dragging the control until you get the result you need. Keep in mind that any solid operation has rules, and they may fail if you drag past a moment in which there is no accurate solution.



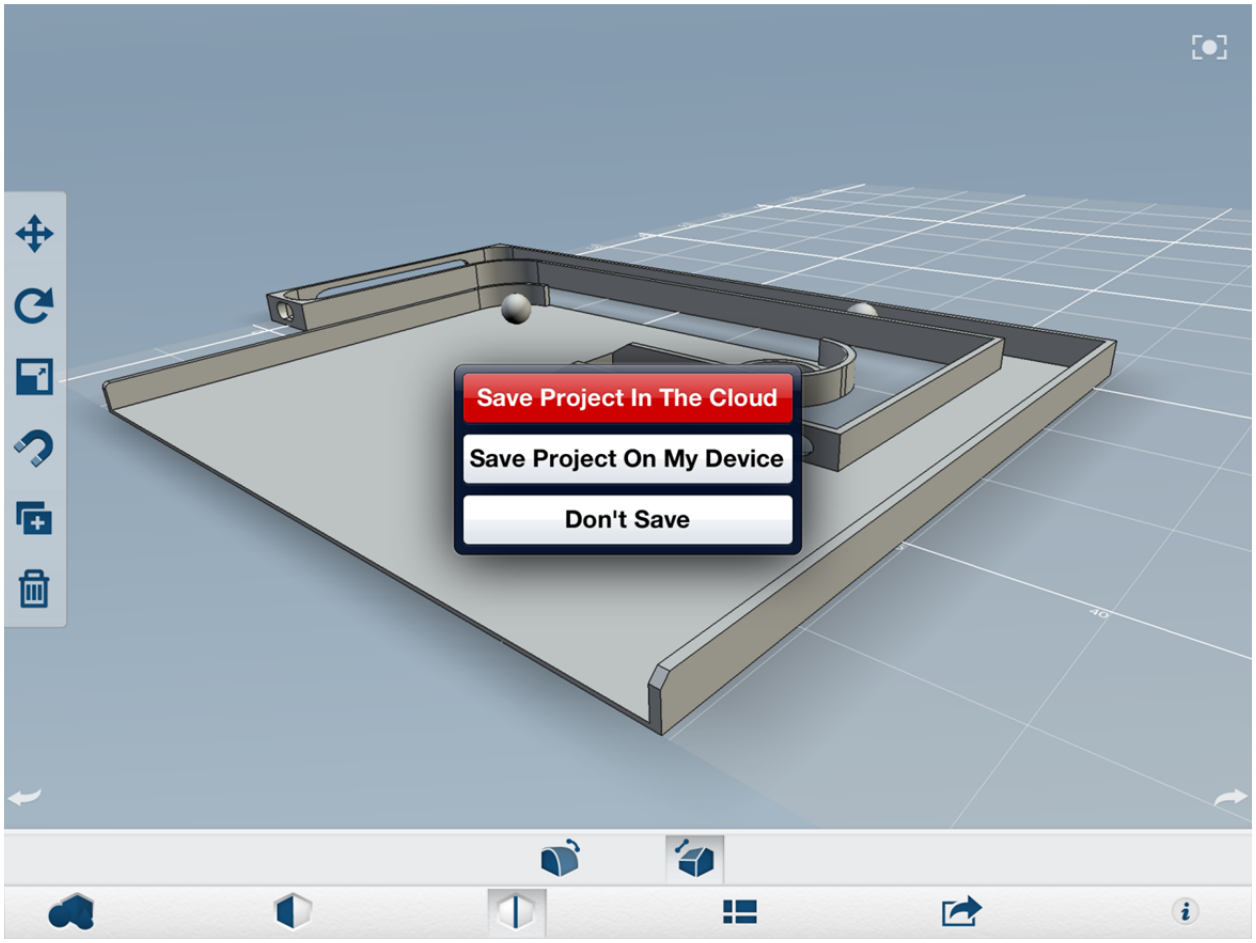


Chamfer has the same rules as Fillet. Select an edge, and when dragging, you will create a new face based on a distance from the selected edge.





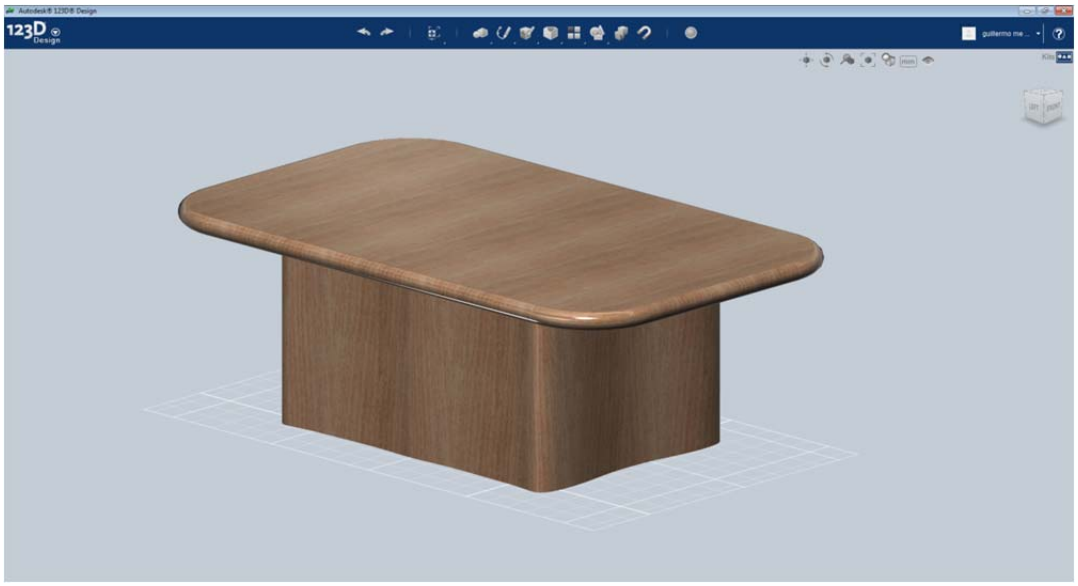
Saving a file from 123D Design mobile offers the option to save local or save to the cloud. You can always save to the cloud after saving locally, so if you are working offline, you can still be operational, and then save to MyProjects later.



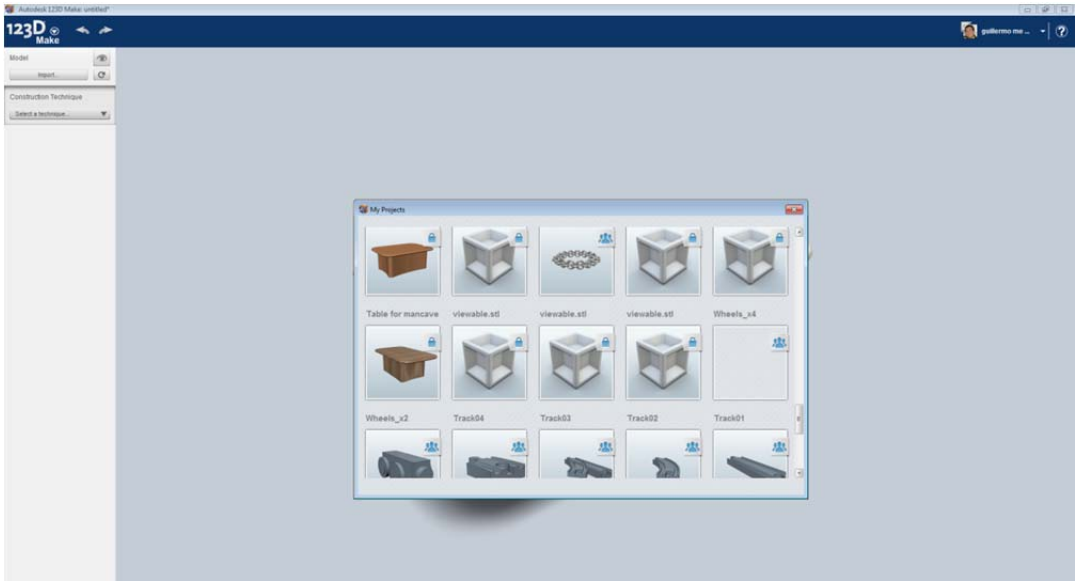
Let's make something now: 123D Make

Note: some of the features shown in this section will be available some weeks after the class

123D Make desktop is definitely where the most power is for preparing a model for fabrication. Let's see what we can do with this table designed in 123D Design.

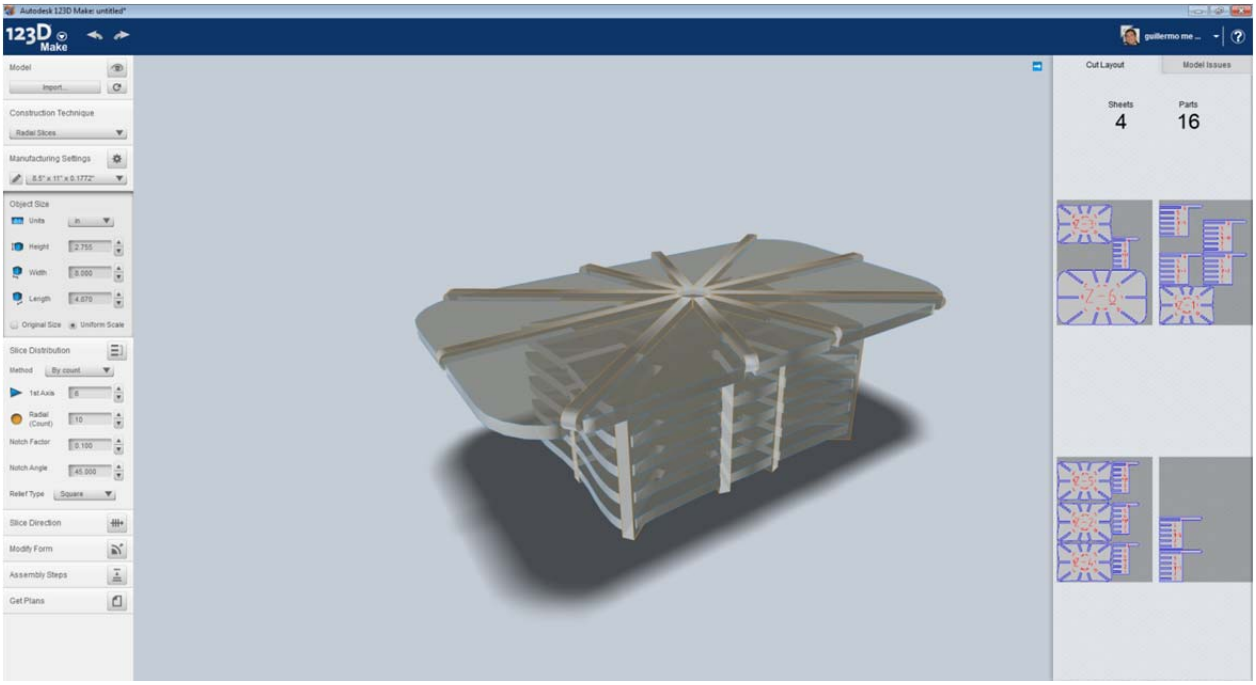


Once in 123D Make, we can open MyProjects, and get one of the derivative files created by 123D Design. In this case, this file is an STL. You can also directly import a file if you want.

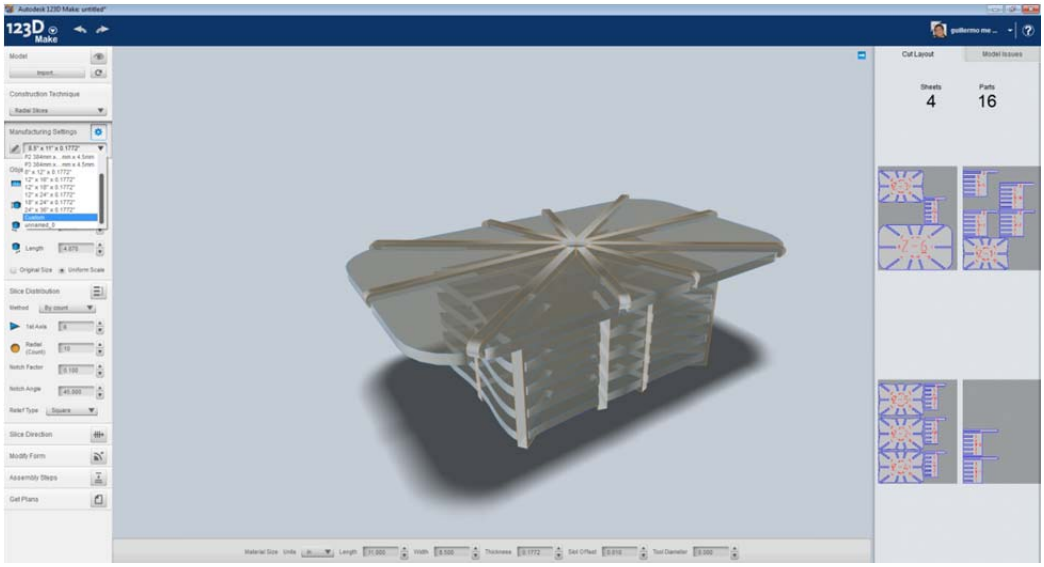


Once the model is inside 123D Make, you will select the Construction Technique. We'll use Radial Slices, so we can illustrate a different workflow than the ones we described in 123D Make online.

As soon as we define the technique, we'll get the preview on the screen. Let's see what we can do with its settings. This particular technique is quite interesting, since it can also become new design intent. I started with a solid table, and suddenly this technique provides an idea for creating shelves with the structure displayed on screen.

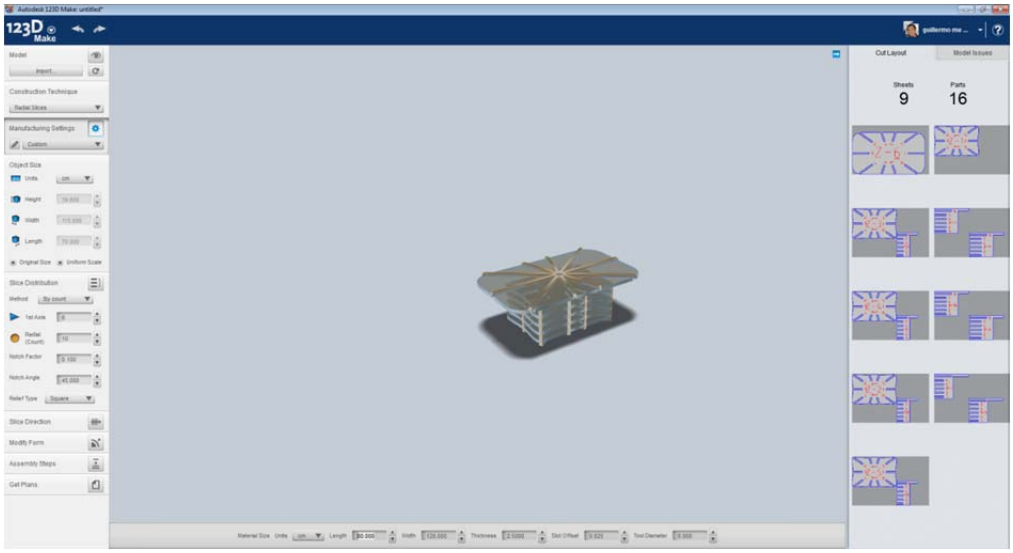


Selecting the material becomes important too. If this project is going to be cut with CNC, we want to define the maximum size we can cut. Any slice bigger than this material will be displayed in red.

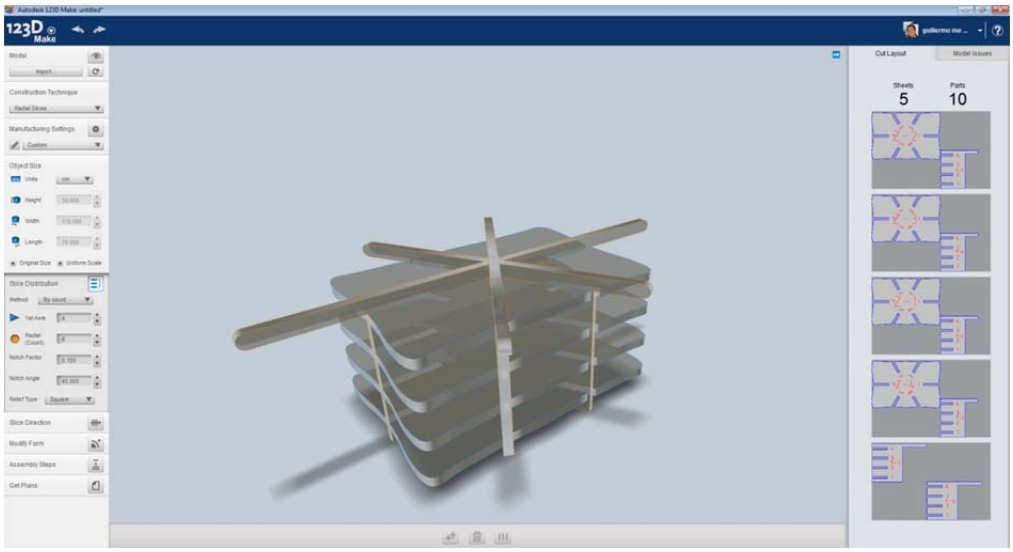


By default, 123D Make assumes a specific size that can be cut easily with cardboard. But we know we want to cut wood, so we want the real size. STL files don't carry units, but they do carry the idea of size, so if we check Original Size, the fields for Height, Width and Length will display the real values. We just need to tell the system which is the unit you were working on. After this, we are set to start working.

The material size is also displayed on the bottom of the screen, as in an Attribute Manager. All parts should not be in red if everything is correct.

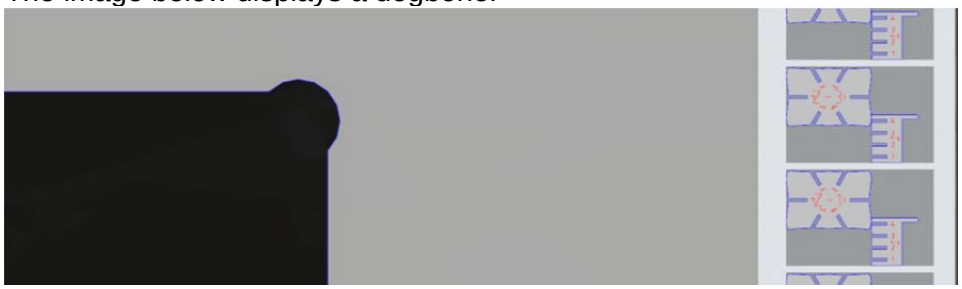


Let's alter **Slice Distribution** and see what happens. Slices can also be modified manually if needed. After doing this, Slice Distribution will be grayed out.

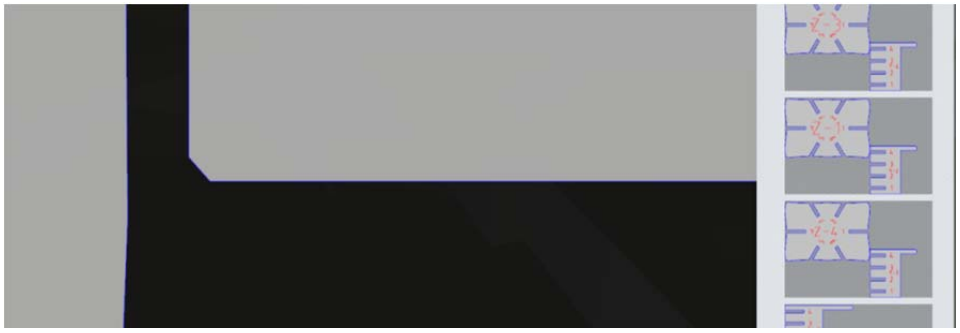


We can also set **Relief Type** as Dogbone. This creates a circle in each internal angle, so the tool can work and not break the part. Once you define which relief you are going to use, you will see it displayed both in the model and in the Cut Layout. It's easier to see the dogbones in the Layout, so make sure you verify this. The size of the dogbone is related to the tool's diameter.

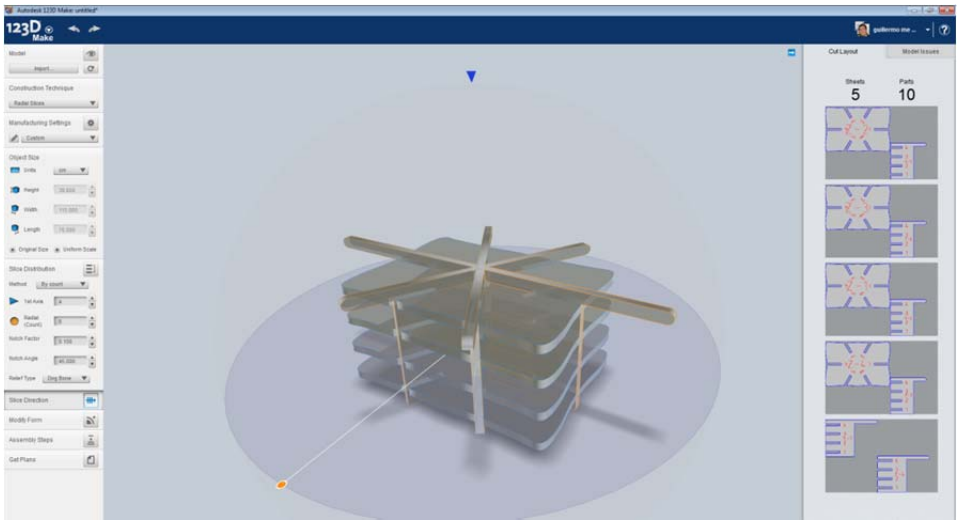
The image below displays a dogbone.



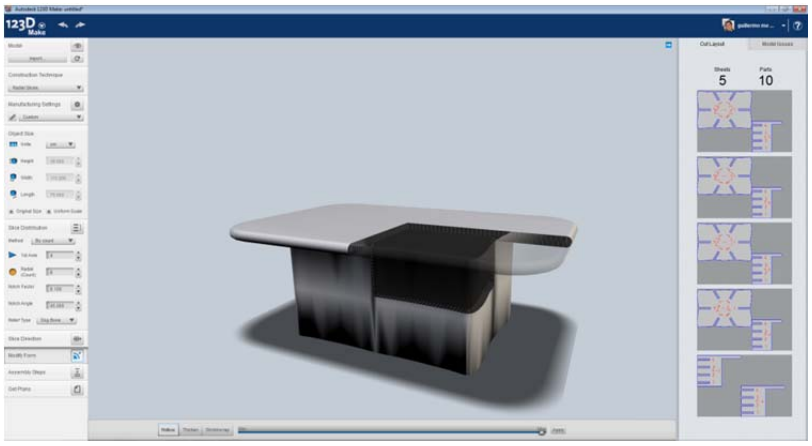
The following image represents another helper for construction. It's a chamfer in the intersection between the slice's boundary and the slots. This helps for putting all the parts together.

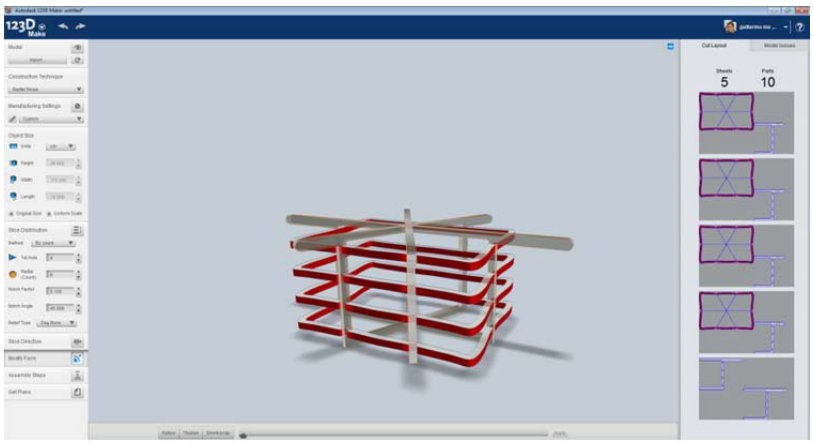


Let's see a couple of things you can do with 123D Make.
First one is **Slice Direction**. It does not make much sense in this particular example, but we can use the widget in the image below to rotate the slices and get instant feedback on the result.

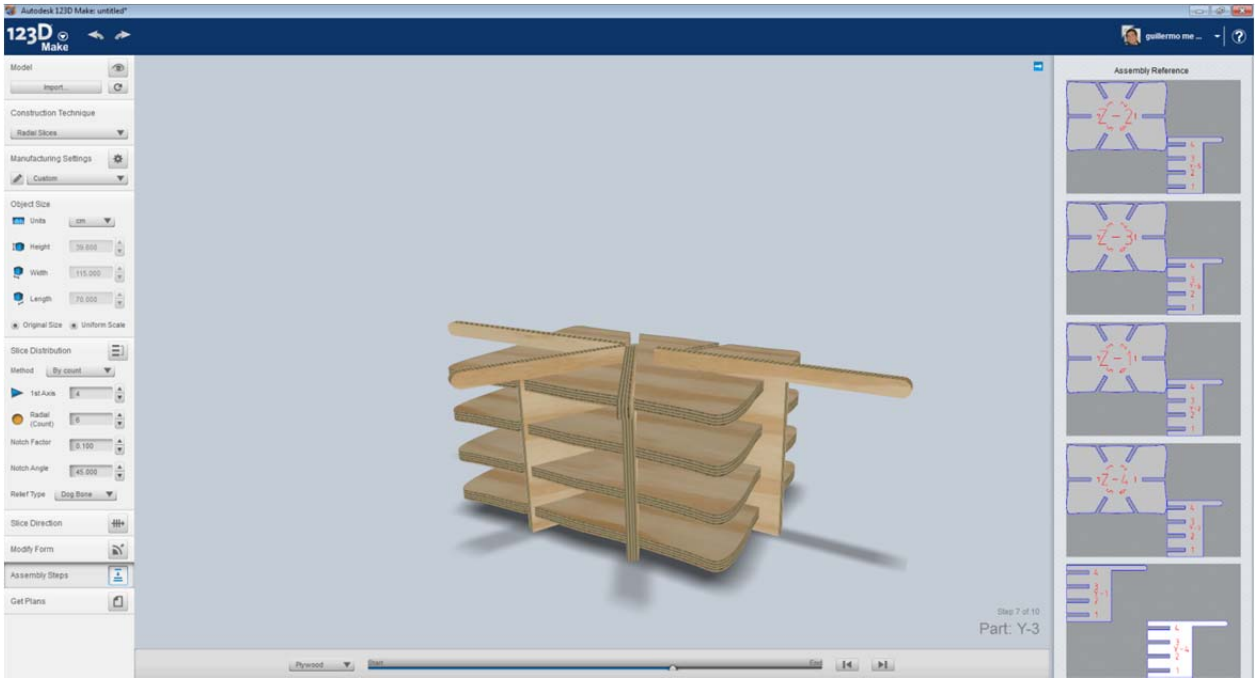


Modify Form is another new feature that allows us to deal with the mesh, and do some operations like Hollow, Thicken and Shrinkwrap.
Let's do Hollow and see what happens. The slider will allow you to get instant feedback on how we are transforming the table from a solid object into an envelope with some thickness. Once we apply, we will see the Construction Technique updated.

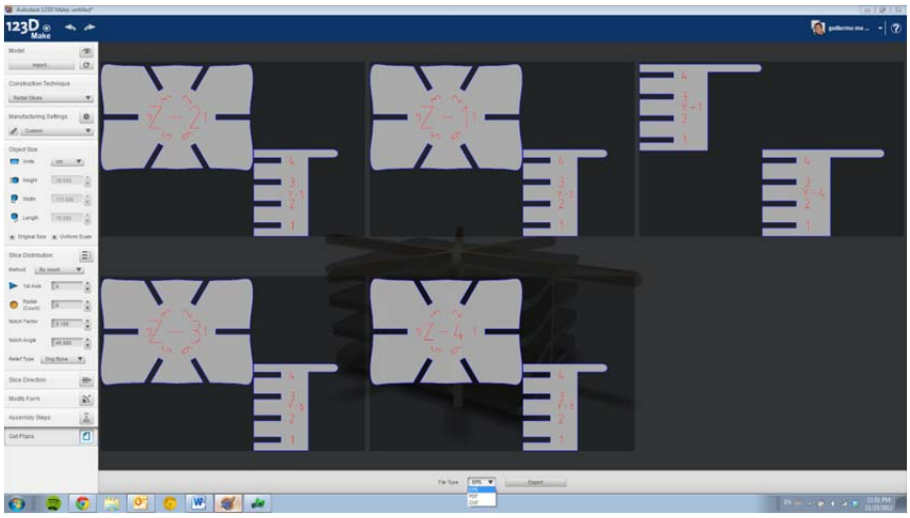


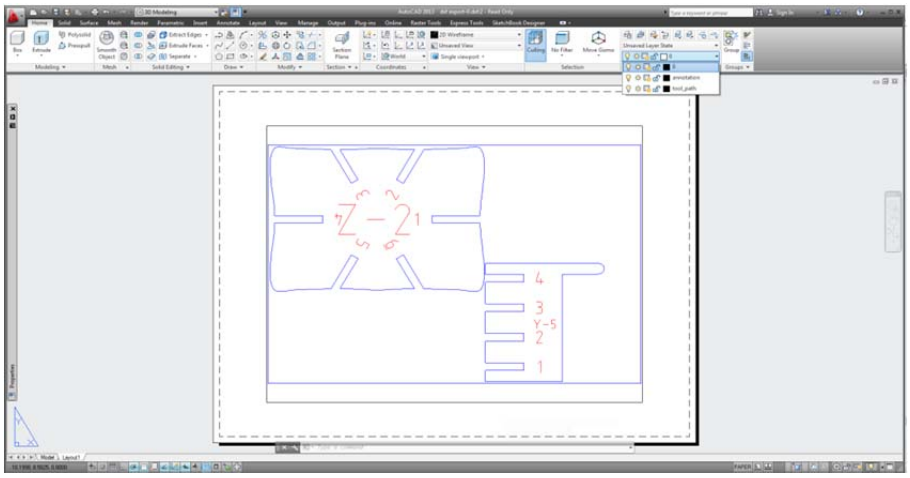


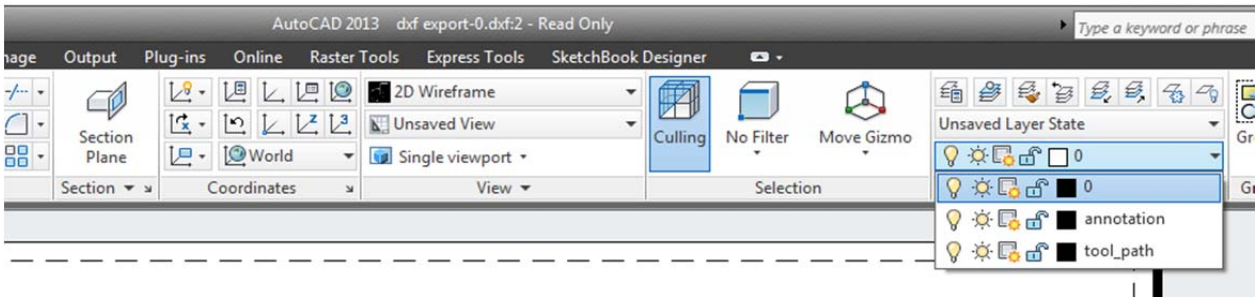
Assembly Steps is a great helper for understanding how to build the model. You can see the animation and use the slider to get a better idea on the assembly.



We can export the **Cut Layout** in different formats. We have already seen EPS when dealing with 123D Make online. Now let's focus on DXF, which is another format quite used in the industry. DXF also allows us to have layers, so we'll have a layer for the part itself, and another layer for annotation. We can then open the DXF in many different applications, including AutoCAD, and make some edits if necessary.







From consumer apps to professional workflows

The 123D line is not exactly geared towards professionals, but you can definitely incorporate some workflows for your daily tasks.

You can use the complete line for tasks you may want to do as a side job, but there are some aspects that you should also consider.

- Using 123D Catch for creating references on your model is a great workflow.
- Converting a mesh from Catch into a solid will allow us to do new things:
    - Measure volume (for volume comparison between the same mesh taken at different moments)
    - Slice the resulting solid
    - Hollowing the resulting solid

For converting a mesh into a solid, you can use different workflows. You can use the STL and convert mesh to solid or surface in AutoCAD (out of the box), or in Inventor (with a mesh utility in Autodesk Labs)