Introduction and Overview to Making Dental Restorative Models

Formlabs Form 3B - May 2020 - Version 1

formlabs | dental

3D printing is a technology that is unlike anything the dental industry has seen. It allows the ability to rapidly produce unique parts at scale that will meet the current and future demands of dental health. Digital impressions from a 3D IOS (intraoral scanner) for restorative dentistry often requires a 3D printed model to confirm fitment and function of crowns and other restorations. To make this process seamless 3D printed restorative models need to be accurate and consistent. The Form 3B allows dental professionals to affordably and reliably 3D print high quality restorative models.

Formlabs was born from the advent of making professional 3D printing accessible to everyone. To further that vision the Formlabs dental team has spent months testing and validating restorative model workflows and created these guides that outlines in detail how anyone can reliably produce restorative models using the Form 3B.

There are two options for 3D printing restorative models:

- Solid models with working dies
- Removable die models

We found that solid, ditched, models with working dies allow technicians to confidently check, wax, and finish margins on an extra die while being absolutely certain on abutment or die position while checking for contacts and occlusion. Using these models removes many variables in workflow and in CAD settings, which is ideal for any dental business with multiple printers like a Form 2, Form 3B, or other dental 3D printer. The goal is to simplify workflows while providing the most consistent results possible.

Important: If you want to produce removable dies models start by reviewing the **entire workflow** and after, follow the **instructions here** **to print a test block**. The test block and process will allow you to find what offset is appropriate for your 3Shape Model Builder or ExoCAD Model Creator software. This is critical to die fitment.

Restorative Model Guides and Workflow

1.	2.	3.	4.
Dental CAD Software Model Builder	Job set-up in Preform Nesting or CAM	Post-processing Wash, Cure, and Finish	Using and Testing for Removable Die Models Fitment, ejection, and offsets

---

1. Dental CAD Software - Model Builder

The Dental CAD guides below include settings, how to set-up jobs, and the step-by-step process to make restorative models using 3Shape Dental System and ExoCAD.

3Shape Restorative Model Guides	**ExoCAD Restorative Model Guides**
- Solid models with working dies - Removable die models	- Solid models with working dies - Removable die models

---

2. Job set-up in Preform - Nesting or CAM

Once the models are built in CAD they are brought into Formlabs Preform software. The guide breaks down how to best set-up, support, and position restorative models for 3D printing on the Form 3B.

Restorative Model Guide for Preform Guide

---

3. Post-processing - Wash, Cure, and Finish

After the models are printed on the Form 3B it is critical to have proper post processing protocols. This next guide provides detailed information on how to prepare, wash, and UV cure restorative models.

Restorative Model Guide for Post Processing Guide

---

4. Finishing, Using, and Testing for Removable Die Models **(unnecessary for solid models)**

The test, tools, and workflow outlined in this guide will ensure repeatable fitment of removable die models.

Finishing, Using, and Testing for Removable Die Models Guide

formlabs | dental

Solid Models with Working Dies - 3Shape

Formlabs Form 3B

formlabs | dental

The written and video guide in this document outlines and describes how to best use 3Shape Dental System and the Formlabs Form 3B to produce solid models with working dies for restorations.

formlabs | dental

Download and install the Formlabs Dental 3Shape materials library **here**
Watch a video tutorial on how to install the Formlabs Dental 3Shape materials file **here**

Tip: Learn how to select a default material type for order set-up in 3Shape here, it saves time!

The video version of the guide can be found here

Introduction

There are three 3Shape applications that will be used to build a model in 3Shape Dental System

1. 3Shape Dental Manager
2. 3Shape Dental Designer
3. 3Shape Model Builder

For this application guide we used 3Shape Dental System 2019. The workflow is similar in previous versions of the software.

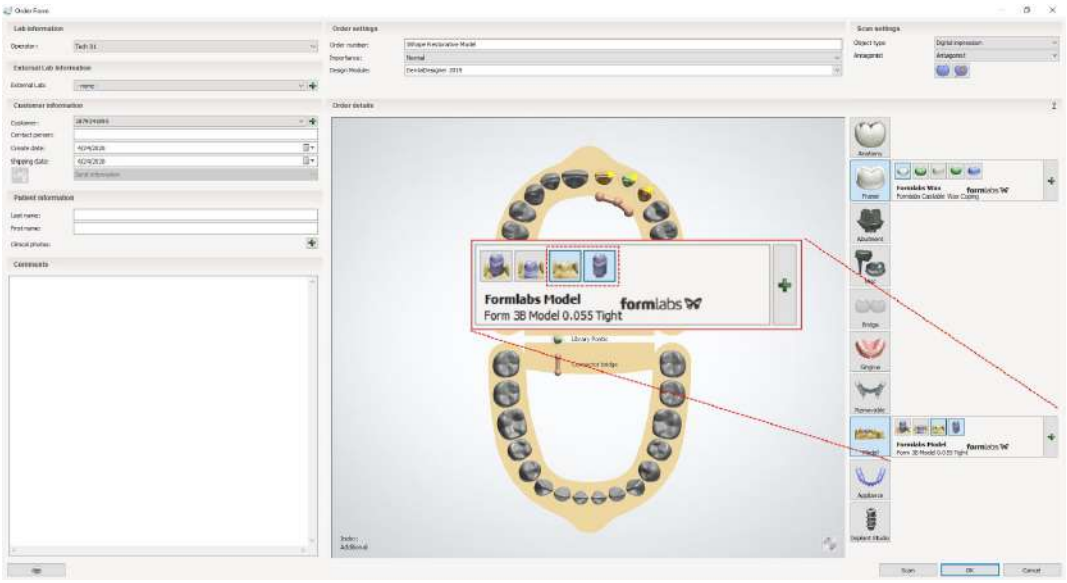
Order Set-up

In 3Shape Dental Manager create and set-up your order like normal

To build a model from a 3D IOS file first select “Digital impression” from the “Object type” pulldown in the bottom right of the order form

With a tooth or restoration selected click the “Model” button near the bottom right of the order form

Once selected in the new menu on screen there are four icons. For a solid model with working die make sure the third and forth icons are selected indicated by the button being blue



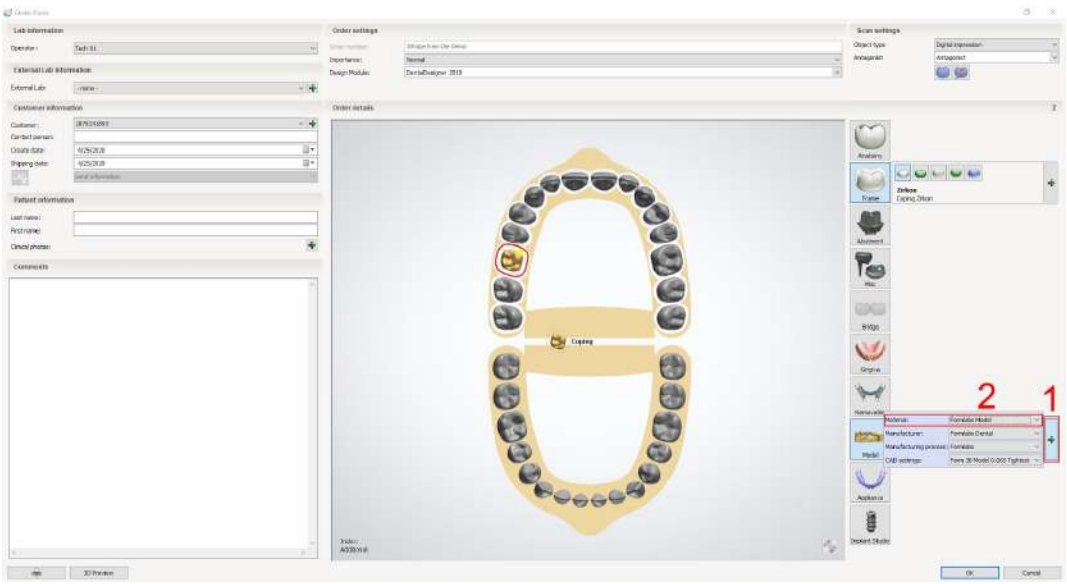
Hover over the “+” sign to the right

Select “Formlabs Model” under the material selection

Manufacturer and manufacturing process should have Formlabs selected automatically

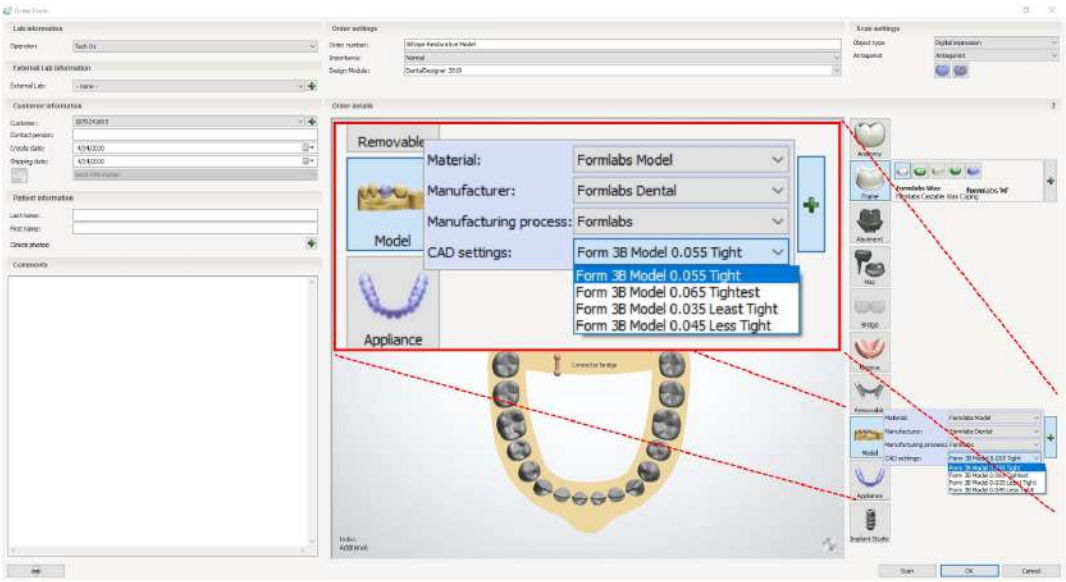
Lastly under “CAD settings” select any of the following settings:

- Form 3B Model 0.065 Tightest
- Form 3B Model 0.055 Tight
- Form 3B Model 0.045 Less Tight
- Form 3B Model 0.035 Least Tight



Since solid models do not rely on varied offsets all of these settings are the same.

Accept and import the 3D IOS scans like normal



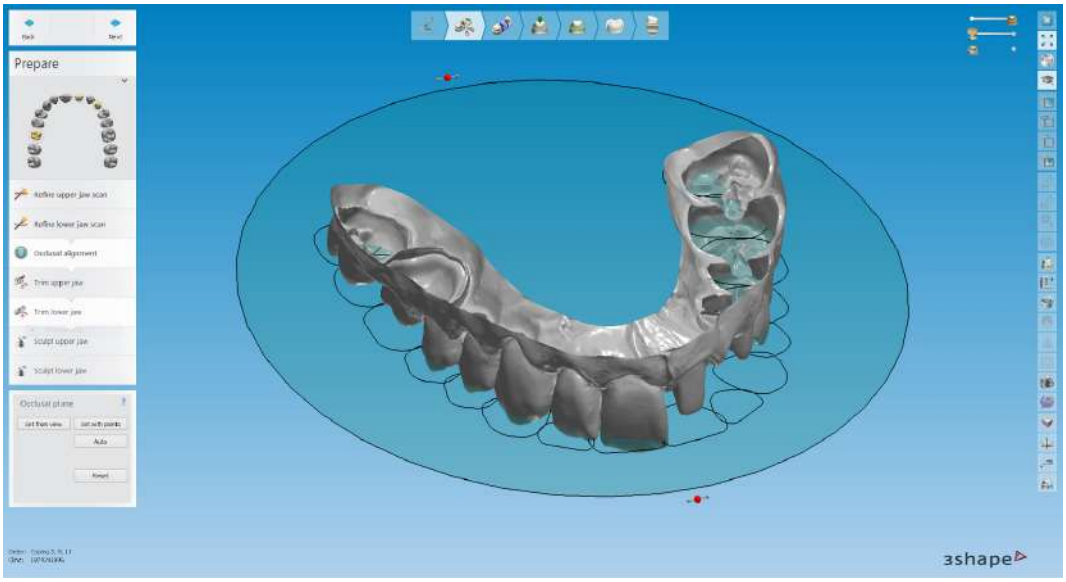
Design Stage

In the design stage of the process the first two steps will affect how the model is built

The first stage is “Prepare”

In “Prepare” the tools that will help with model building are:

- Refine jaw scan
- Occlusal alignment
- Trim jaw



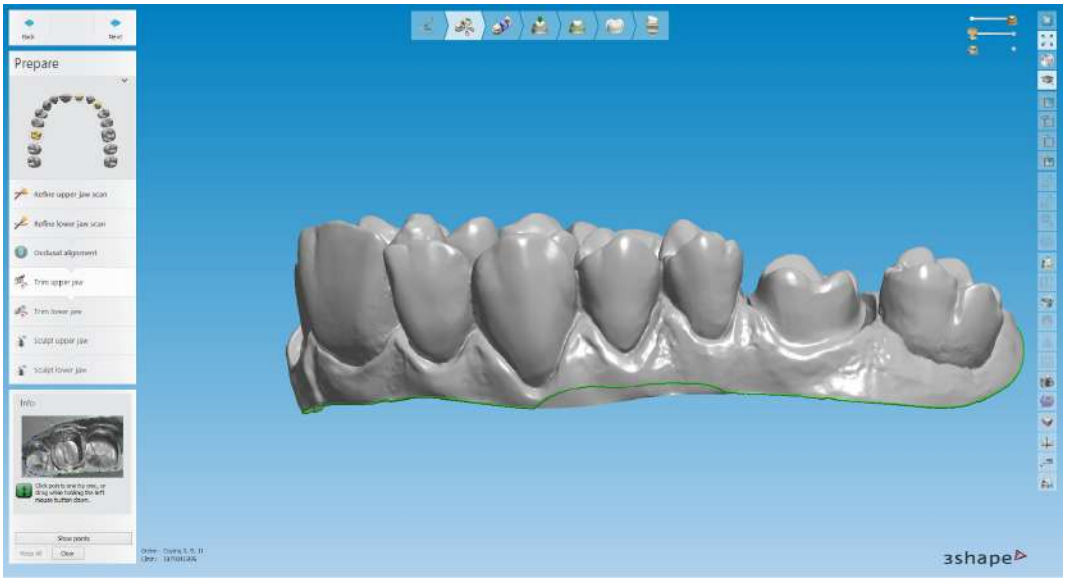
“Refine jaw scan” tool allows users to fill holes and clean the mesh from the 3D IOS

“Occlusal alignment” is a very important tool that should be moved into proper position on the teeth and the occlusal plane

The occlusal plane will determine the angle of the model and the insertion of the dies

“Trim jaw” tool gives the ability to trim the upper or lower jaw scans by clicking “Trim upper jaw” or “Trim lower jaw”

We recommend trimming as much extraneous data as possible allowing for the shortest, yet complete, model possible reducing material usage and print time



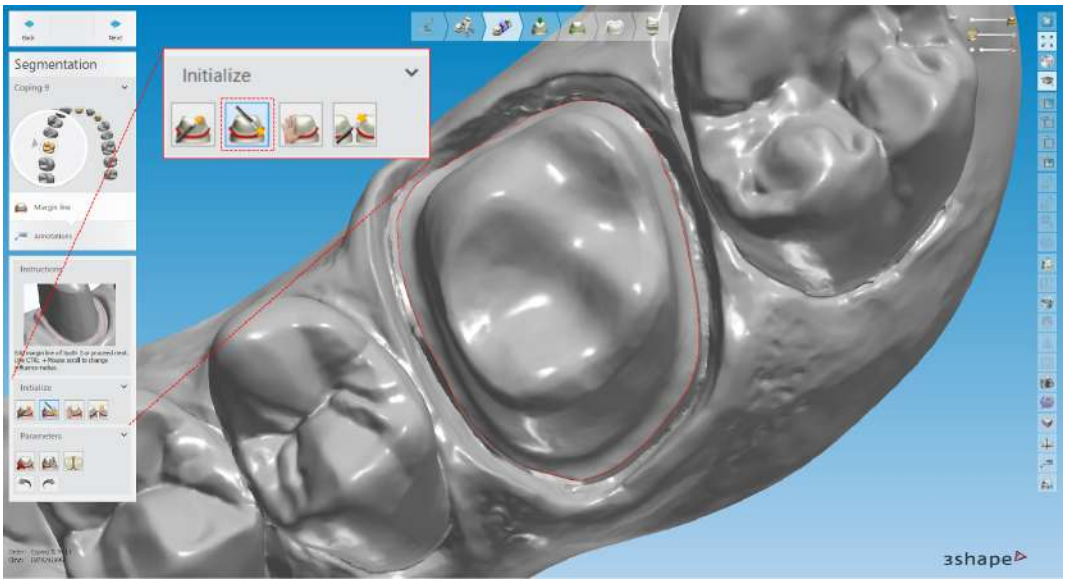
Second is the next step called “Segmentation”

This is where the preparation will be cut from the model and we recommend marking the margin like normal in this stage, in the interface stage when margin marking is initialized it will copy the margin set here

Tip: Use the “click on margin” tool highlighted in the image

Design the case as normal

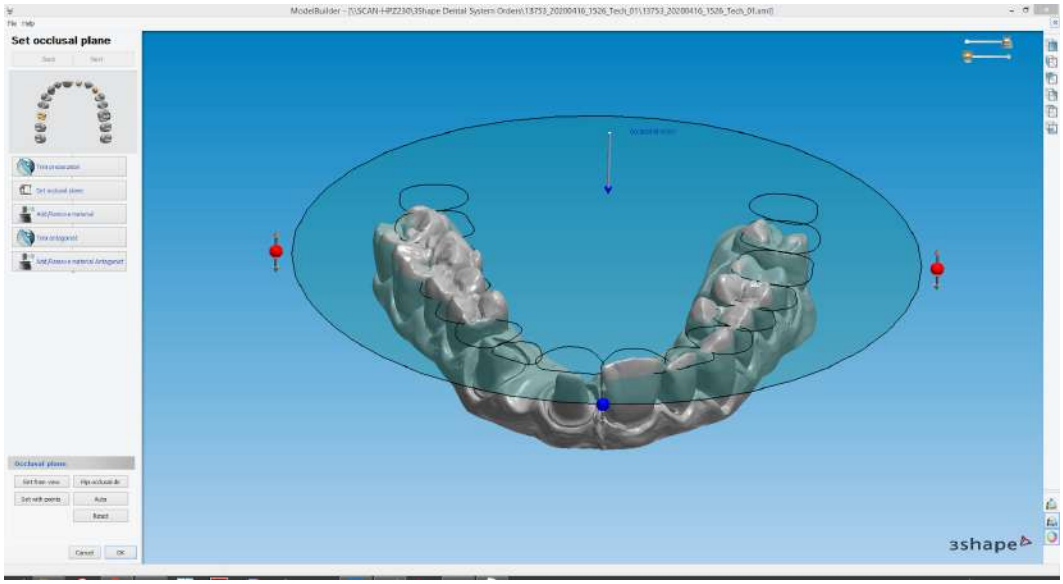
After finalization it will proceed to enter into 3Shape Model Builder



Model Building Stage

Once the case opens in model builder the first step allows users to edit the occlusal plane and mesh

If done correctly in the design stage nothing needs to be done here

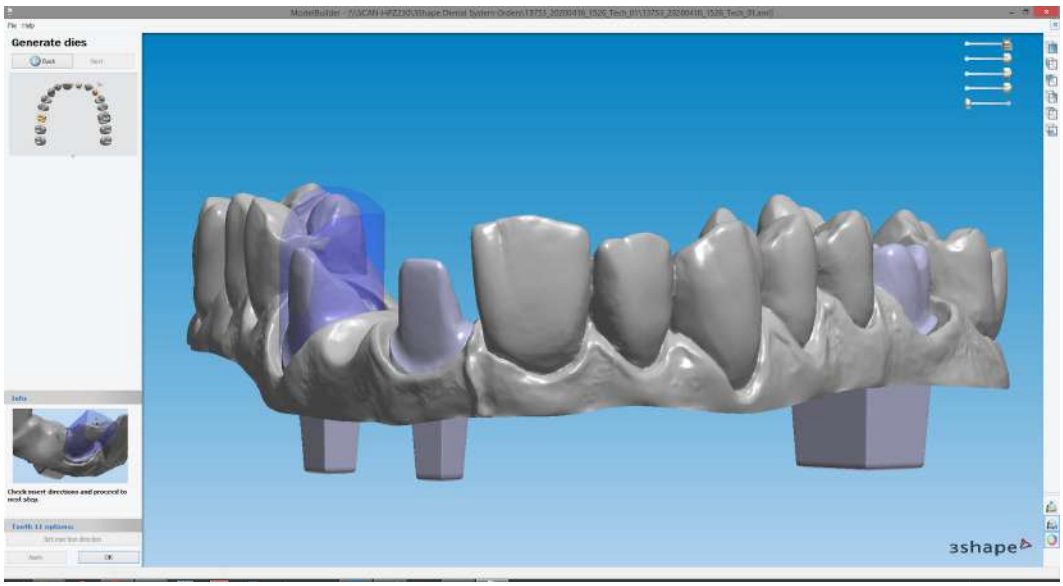


The next stage allows you to add a removable neighbor or adjacent tooth

This step can be skipped for solid model production

Next Model Builder generates the dies and you have the ability to angle the dies insertion direction

Since the solid model workflow does not create sockets the default angle should be vertical and can be kept without change



Once the dies are set it moves into “Articulator Interfaces” where you can engrave the model and add an articulator on the model

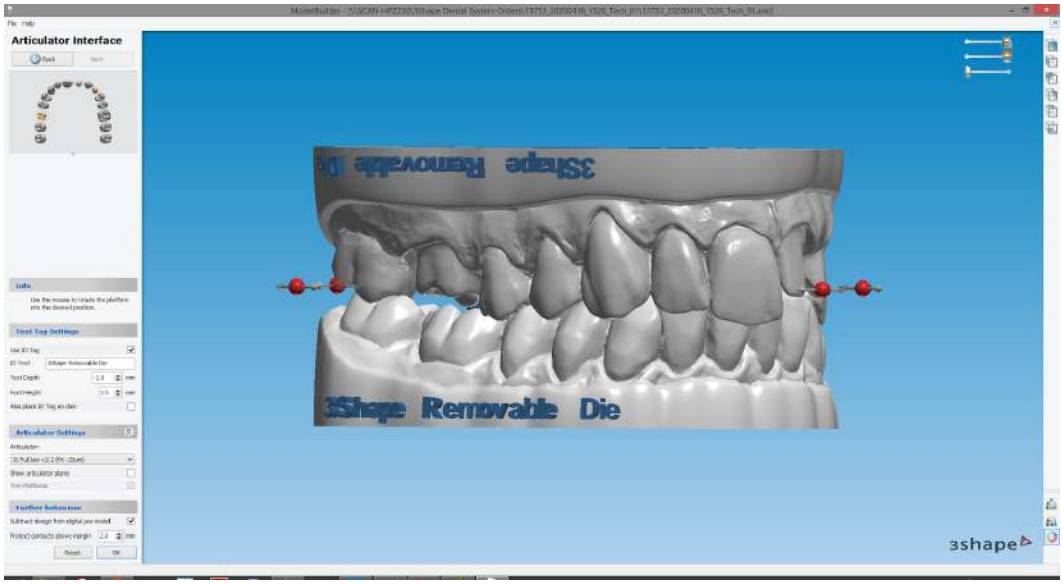
The “Text Depth” should be default at **-1.0 mm**

The negative value means the text is pushed into the model, opposed to extruded out of the model

Left click and drag the text to its final position

Lastly you can select the desired articulator

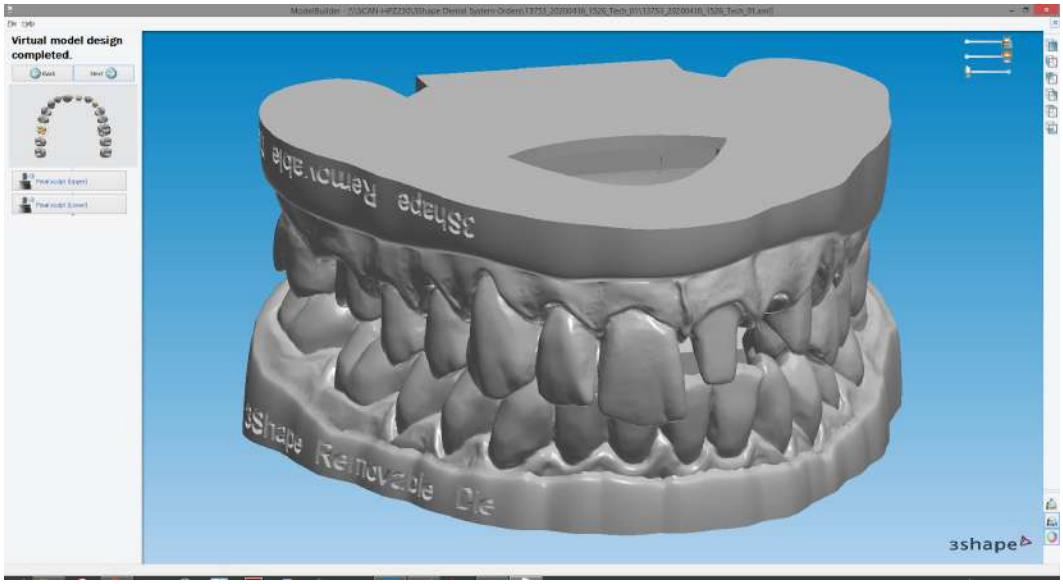
Tip: Some articulators like “Vertex” can be found in the final step in model builder under “attachments”



This stage is optional and can be skipped

The final step in Model Builder allows any final edits desired to the mesh:

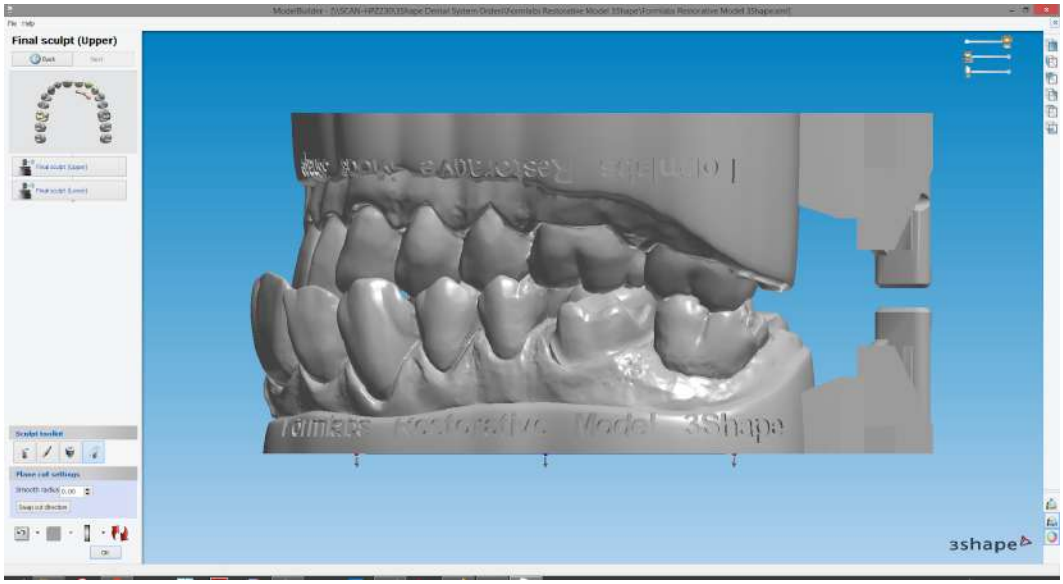
- Adding and removing material
- Adding attachments
- Plane cutting the model



Using the “Plane cut tool” you can trim the base shorter on the opposing model, reducing print time and material usage or add a bevel or chamfer on the model

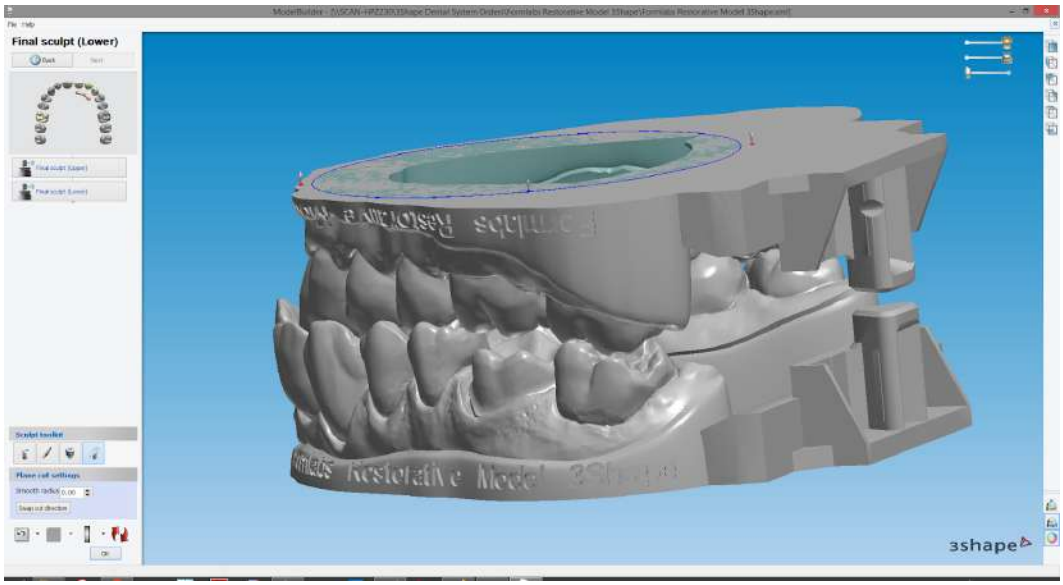
Left click and drag where you want to cut

Tip: Use the view controls on the top right to ensure the cutting angle

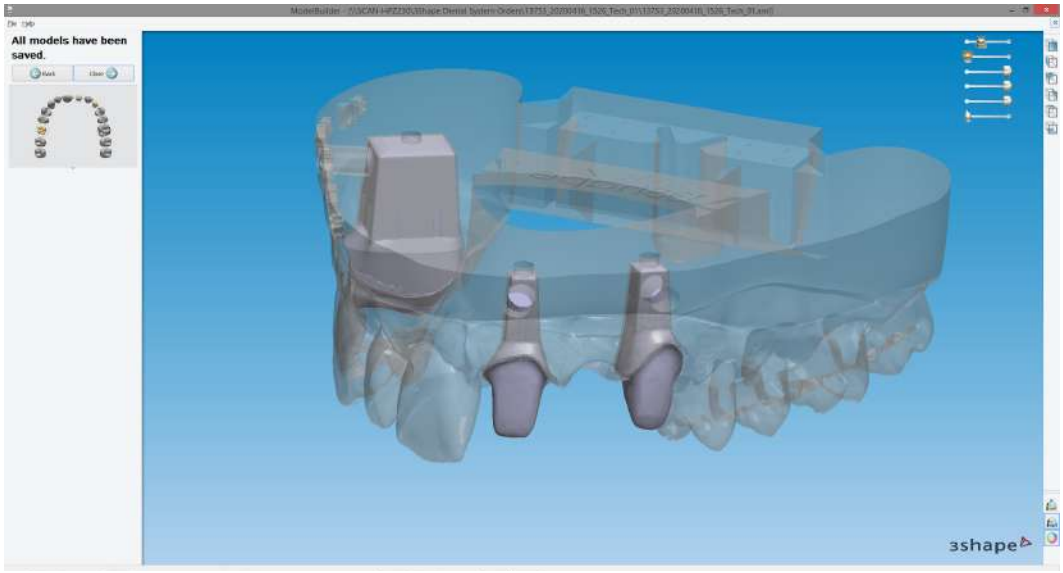


If the model is being cut in the wrong direction click “Swap direction” on the bottom left

If you want to change the angle or position of the cut use the red and blue handles on the cut plane



Once Final sculpt is complete the next stage finalizes the model and saves the case

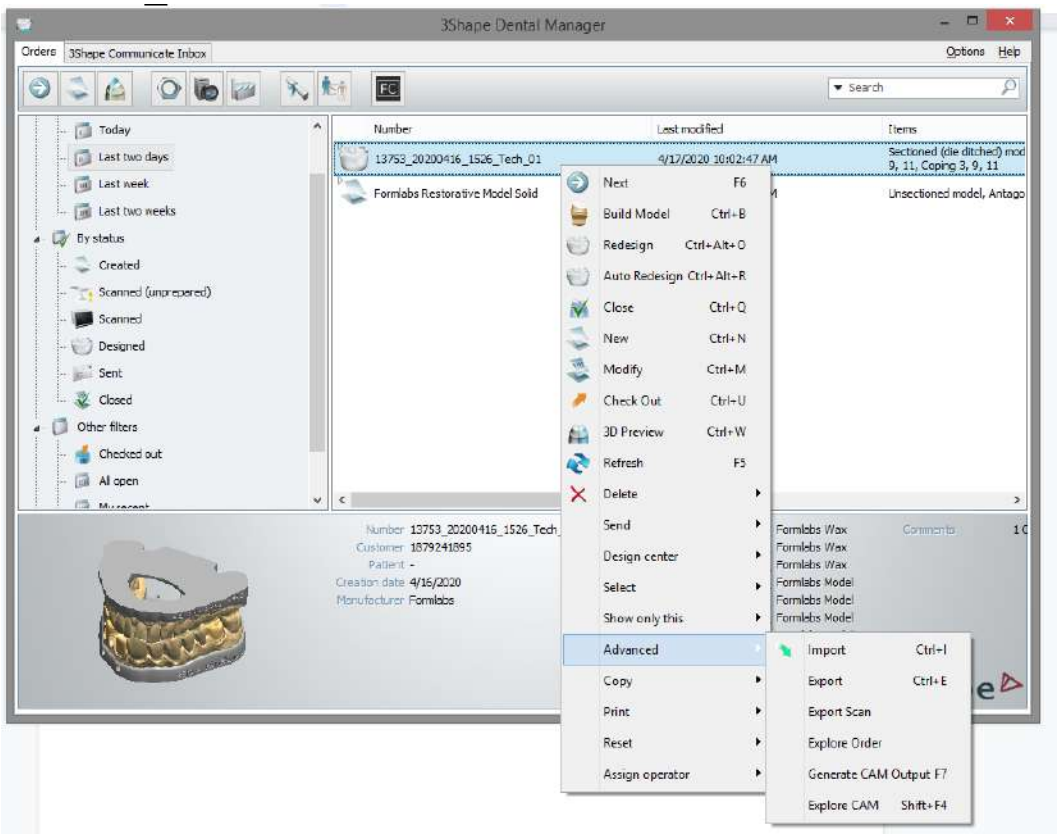


Final Stage

After closing Model Builder and clicking back to Dental Manager right click on the case, scroll down to advanced, and finally “Generate CAM Output”

Repeat those steps but this time select “Explore CAM”

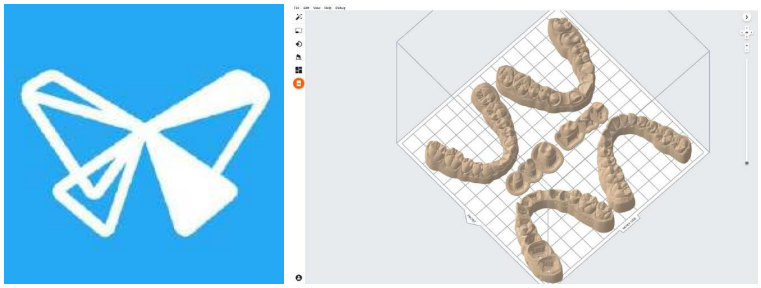
This opens the location of your restoration and model manufacturing files



Next Step - Preform

The next step to 3D print the model is to open the files into and prepare them for the printing using Formlabs Preform software

Proceed the next step “Preform and Nesting”



formlabs | dental

Removable Die Models - 3Shape

Formlabs Form 3B

formlabs | dental

The written and video guide in this document outlines and describes how to best use 3Shape Dental System and the Formlabs Form 3B to produce removable die models for restorations.

We recommend using solid models with working dies for the easiest and scalable way for dental laboratories to 3D print restorative models. For more information on how and why please visit our restorative model overview page.

Before creating any removable die models review the post processing, finishing, guides and **run a test print** specific to 3Shape Dental System to determine your ideal socket to die offset

formlabs | dental

Download and install the Formlabs Dental 3Shape materials library **here**
Watch a video tutorial on how to install the Formlabs Dental 3Shape materials file **here**

Tip: Learn how to select a default material type for order set-up in 3Shape here, it saves time!

The video version of the guide can be found **here**

Introduction

There are three 3Shape applications that will be used to build a model in 3Shape Dental System

1. 3Shape Dental Manager
2. 3Shape Dental Designer
3. 3Shape Model Builder

For this application guide we used 3Shape Dental System 2019. The workflow is similar in previous versions of the software.

Note: In 3Shape Dental System 2019 has the ability to scale for tooth or preparation size when generating dies. This is a critical feature to ensure fit consistency of removable small anterior and large posterior dies.

Order Set-up

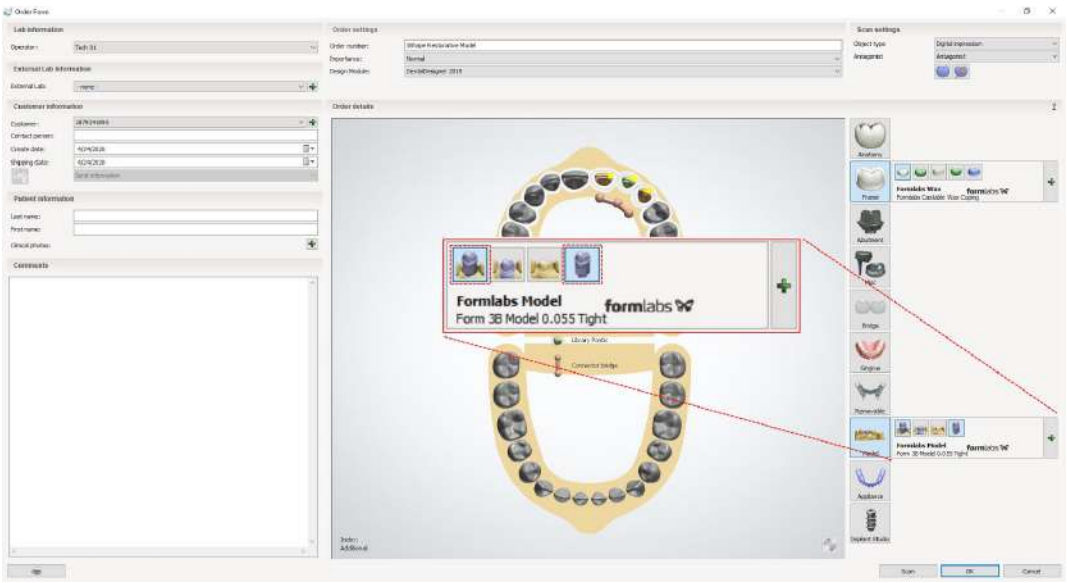
In 3Shape Dental Manager create and set-up your order like normal

To build a model from a 3D IOS file first select “Digital impression” from the “Object type” pulldown in the bottom right of the order form

With a tooth or restoration selected click the “Model” button near the bottom right of the order form

Once selected in the new menu on screen there are four icons.

For a removable die model make sure the first and forth icons are selected indicated by the button being blue



Hover over the “+” sign to the right

Select “Formlabs Model” under the material selection

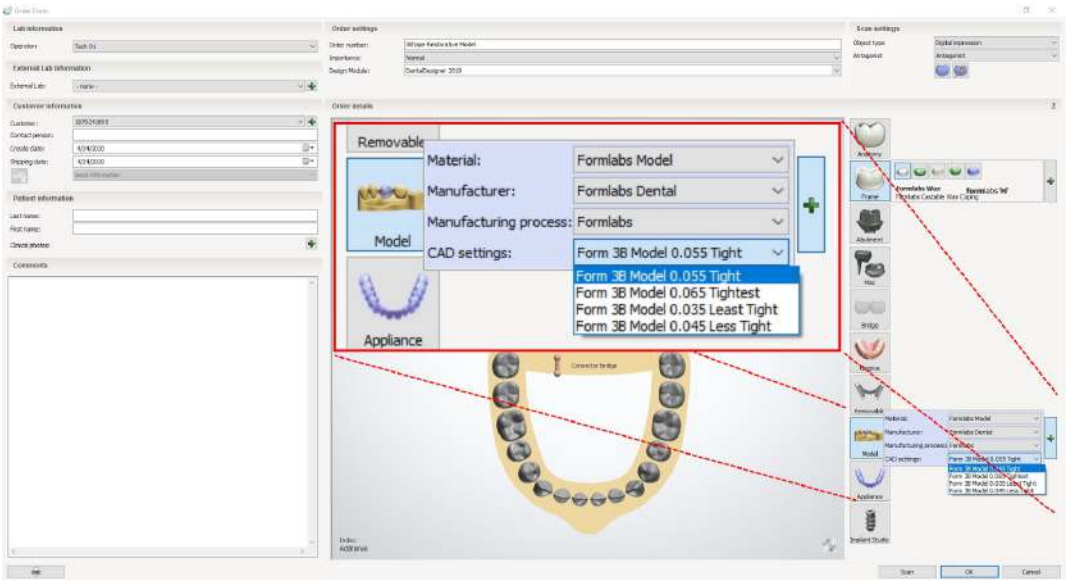
Manufacturer and manufacturing process should have Formlabs selected automatically

Lastly under “CAD settings” select one of the following settings:

- Form 3B Model 0.065 Tightest
- Form 3B Model 0.055 Tight
- Form 3B Model 0.045 Less Tight
- Form 3B Model 0.035 Least Tight

To find out what setting or offset works best for you print and follow the testing procedure [here]

Accept and import the 3D IOS scans like normal



Design Stage

In the design stage of the process the first two steps will affect how the model is built

The first stage is “Prepare”

In “Prepare” the tools that will help with model building are:

- Refine jaw scan
- Occlusal alignment
- Trim jaw

“Refine jaw scan” tool allows users to fill holes and clean the mesh from the 3D IOS

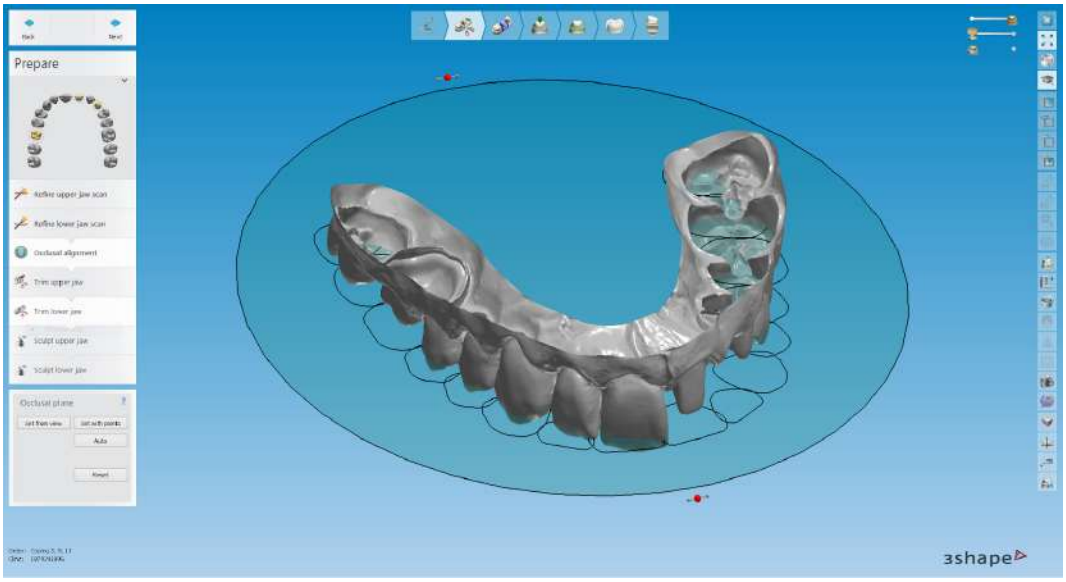
“Occlusal alignment” is a very important tool that should be moved into proper position on the teeth and the occlusal plane

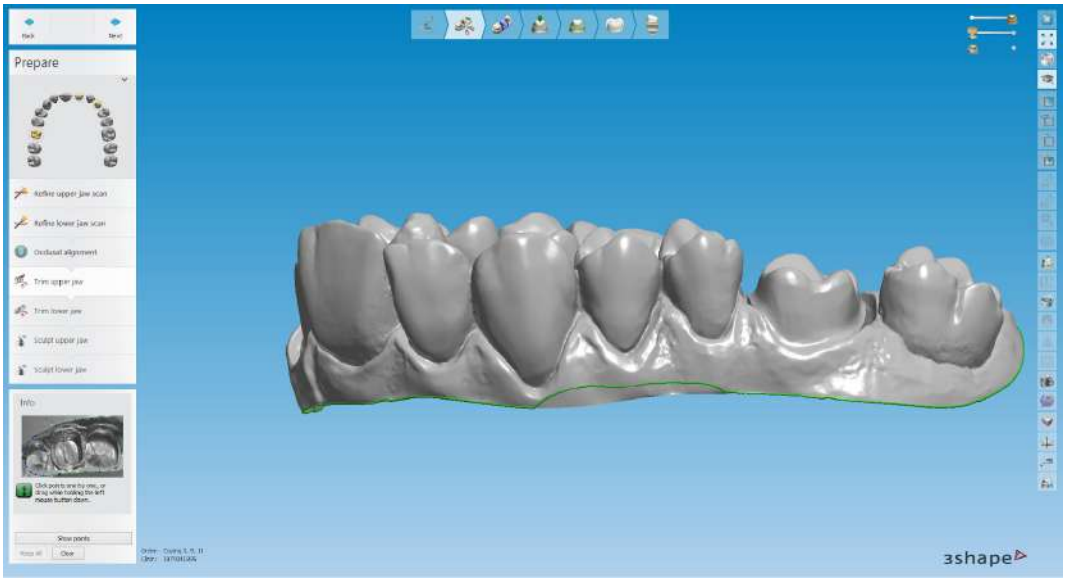
The occlusal plane will determine the angle of the model and the insertion of the dies

“Trim jaw” tool gives the ability to trim the upper or lower jaw scans by clicking “Trim upper jaw” or “Trim lower jaw”

For anterior dies it is important to maintain a vertical insertion direction and to help prevent thin walls during construction trim the impression as close to the preparation as possible

Generally we recommend trimming as much extraneous data as possible allowing for the shortest, yet complete, model possible reducing material usage and print time





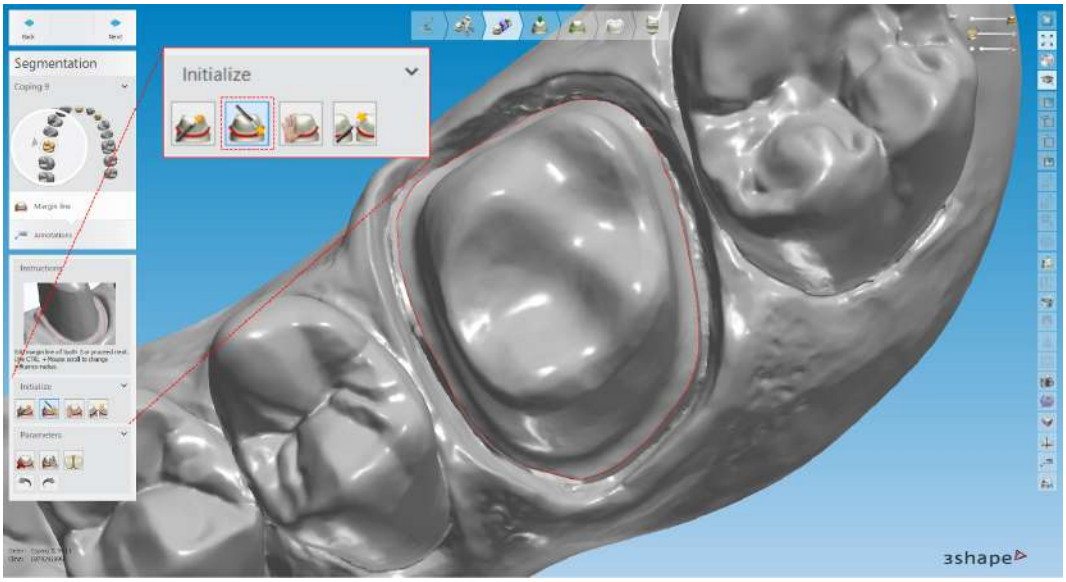
Second is the next step called “Segmentation”

This is where the preparation will be cut from the model and we recommend marking the margin like normal in this stage, in the interface stage when margin marking is initialized it will copy the margin set here

Tip: Use the “click on margin” tool highlighted in the image

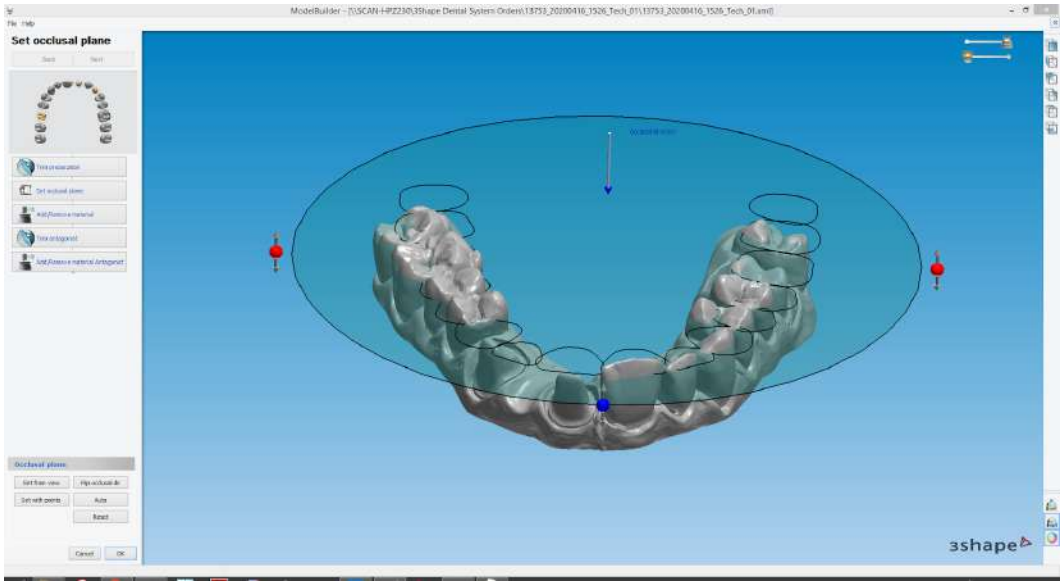
Design the case as normal

After finalization it will proceed to enter into 3Shape Model Builder



Model Building Stage

Once the case opens in model builder the first step allows users to edit the occlusal plane and mesh. If done correctly in the design stage nothing needs to be done here

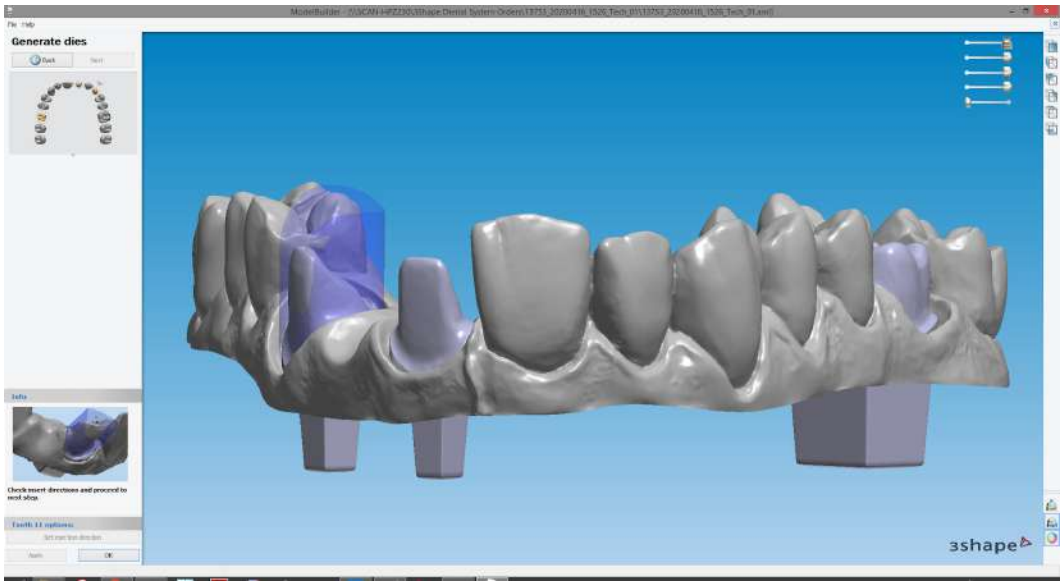


Next is the section stage where you can add a removable neighbor or adjacent tooth by clicking the “Neighbor” button on the bottom left, clicking the tooth, and altering the perimeter as desired

The next step Model Builder generates the dies and you have the ability to angle the dies insertion direction

We highly recommend not changing the insertion path of the die and keeping them vertical

Angelation of dies can change the fitment of parts



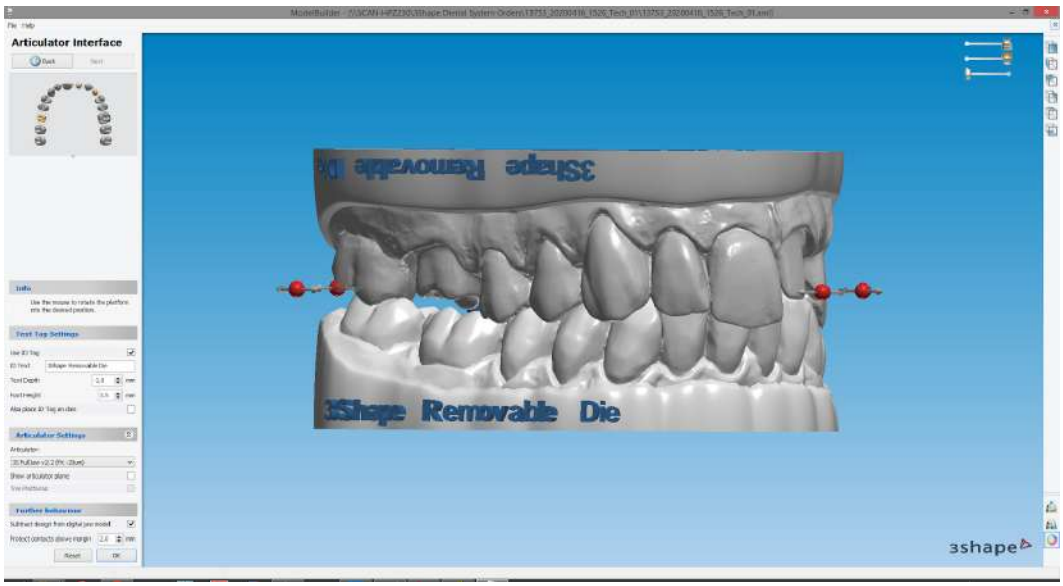
Once the dies are set it moves into “Articulator Interfaces” where you can engrave the model and add an articulator on the model

The “Text Depth” should be default at **-1.0 mm**

The negative value means the text is pushed into the model, opposed to extruded out of the model

Select the desired articulator

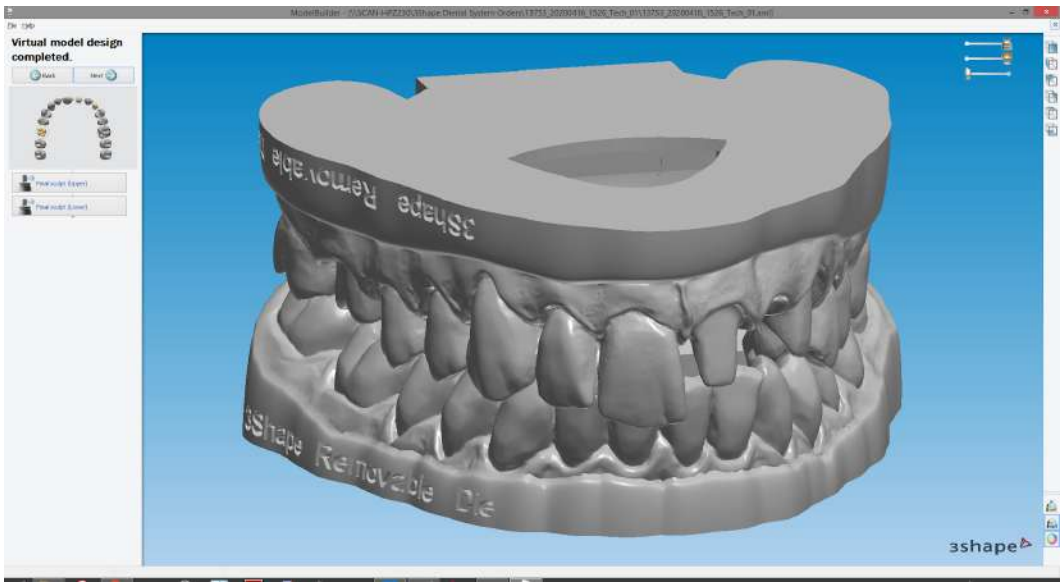
Tip: Some articulators like “Vertex” can be found in the final step in model builder under “attachments”



This stage is optional and can be skipped

The final step in Model Builder allows any final edits desired to the mesh:

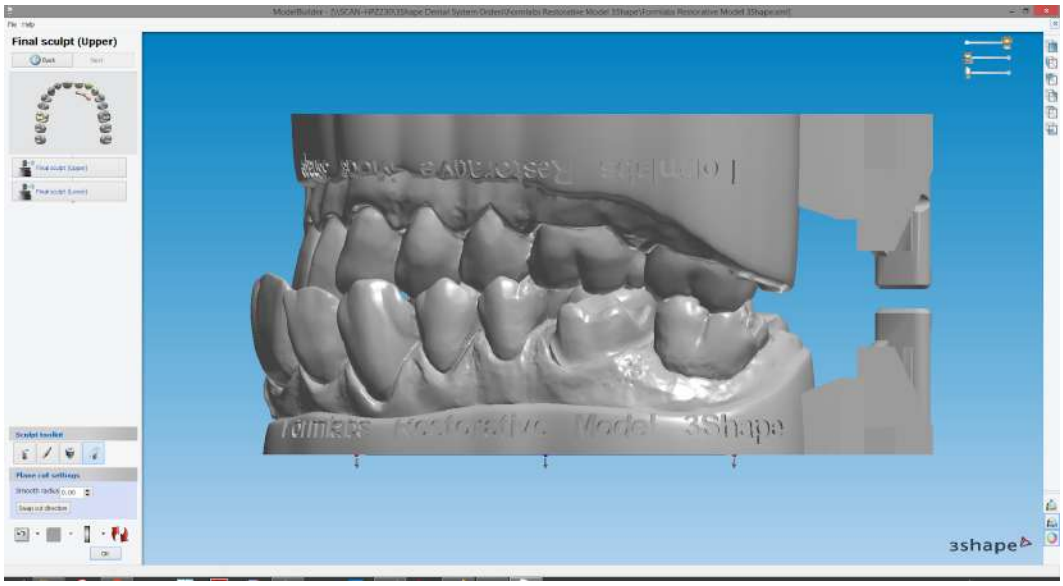
- Adding and removing material
- Adding attachments
- Plane cutting the model



Using the “Plane cut tool” you can trim the base shorter on the opposing model, reducing print time and material usage or add a bevel or chamfer on the model

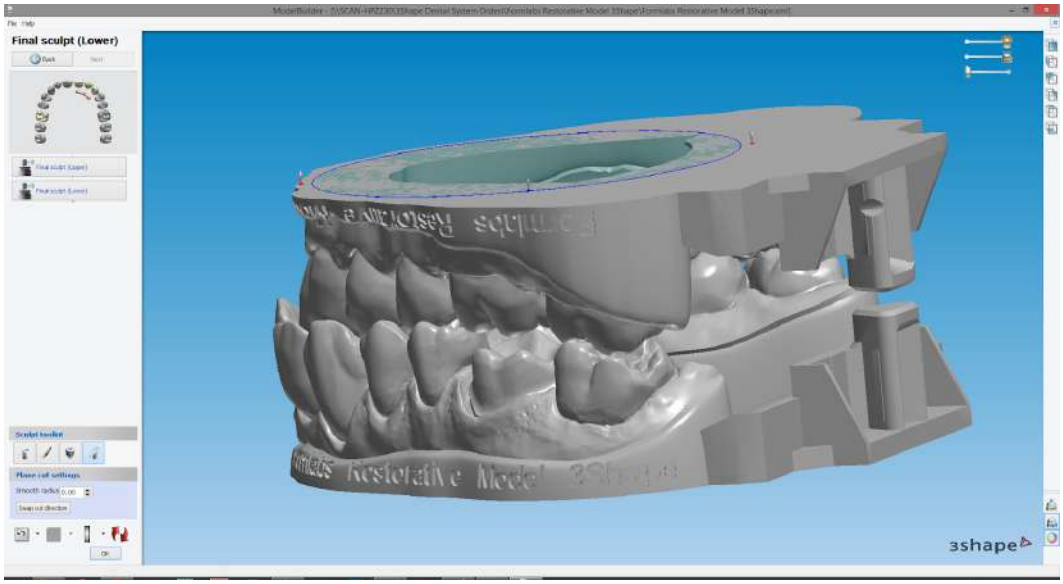
Left click and drag where you want to cut

Tip: Use the view controls on the top right to ensure the cutting angle

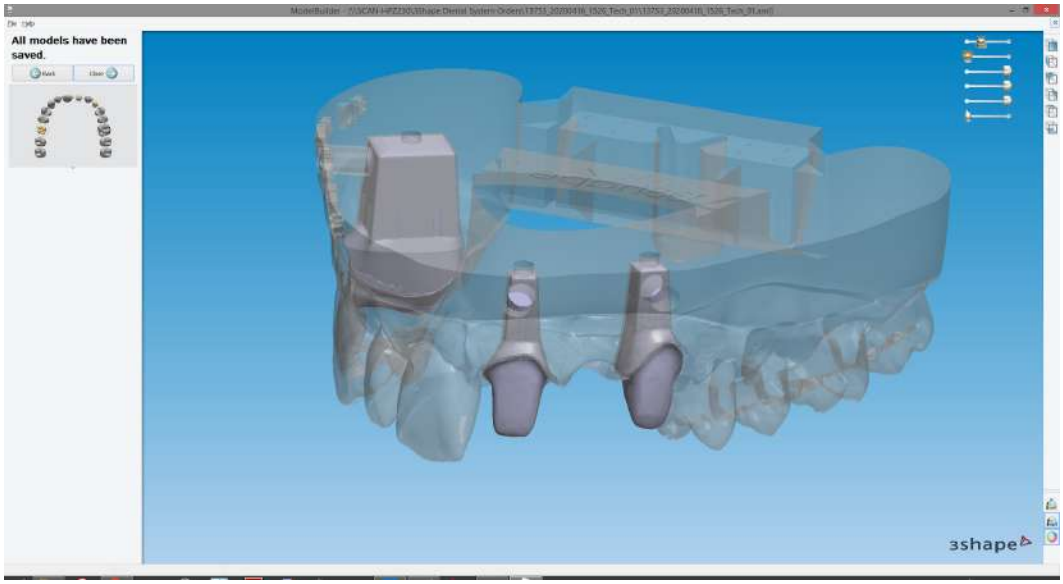


If the model is being cut in the wrong direction click “Swap direction” on the bottom left

If you want to change the angle or position of the cut use the red and blue handles on the cut plane



Once Final sculpt is complete the next stage finalizes the model and saves the case

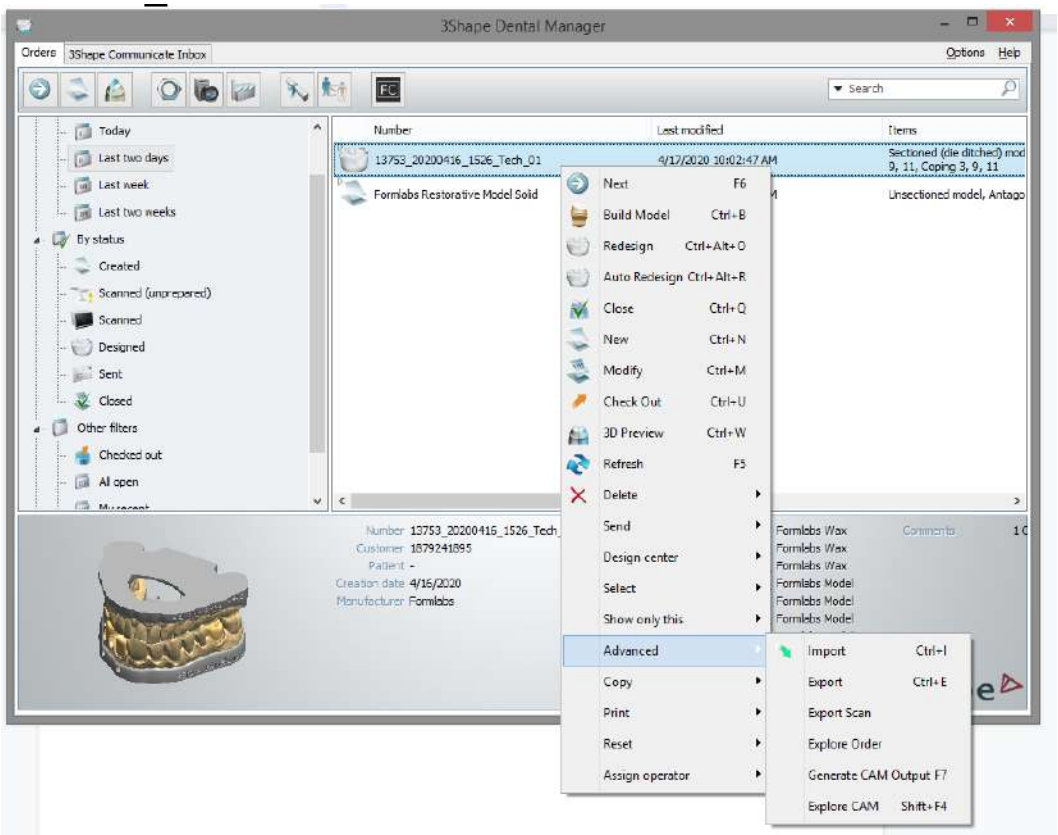


Final Stage

After closing Model Builder and clicking back to Dental Manager right click on the case, scroll down to advanced, and finally “Generate CAM Output”

Repeat those steps but this time select “Explore CAM”

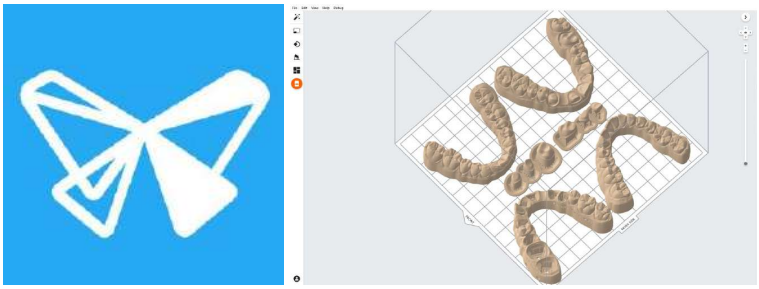
This opens the location of your restoration and model manufacturing files



Next Step - Preform

The next step to 3D print the model is to open the files into and prepare them for the printing using Formlabs Preform software

Proceed the next step “Preform and Nesting”



formlabs | dental

Solid Models and Working Dies - ExoCAD

Formlabs Form 3B

formlabs | dental

The written and video guide found in this document outlines and describes how to best use Exocad and a Formlabs Form 3B to produce solid models with extra dies. We recommend using solid models with working dies for the easiest and scalable way for dental laboratories to 3D print restorative models.

Note: This work-flow was developed and tested on Exocad versions Valetta, Matera, and Plovdiv.

The video version of the guide can be found **here**

Prepare your Exocad System

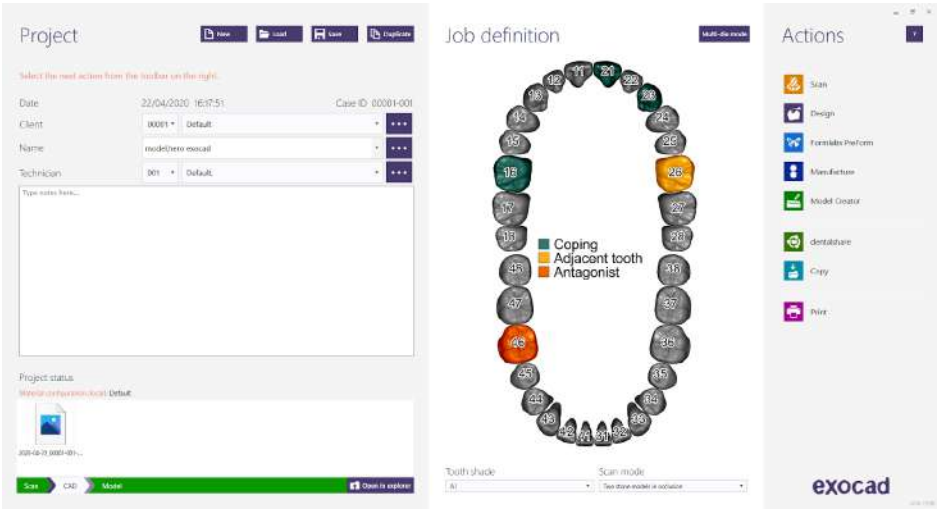
Download and install the Formlabs Exocad model presets: **library**
Download and install the Formlabs Exocad model attachments: **library**
Watch a video tutorial on how to install the Formlabs Dental Exocad materials file: **here**

Order Setup

Setup your order as usual

Material choices are only for Restorations. The Material of the model will be defined later using the provided Exocad model creator presets

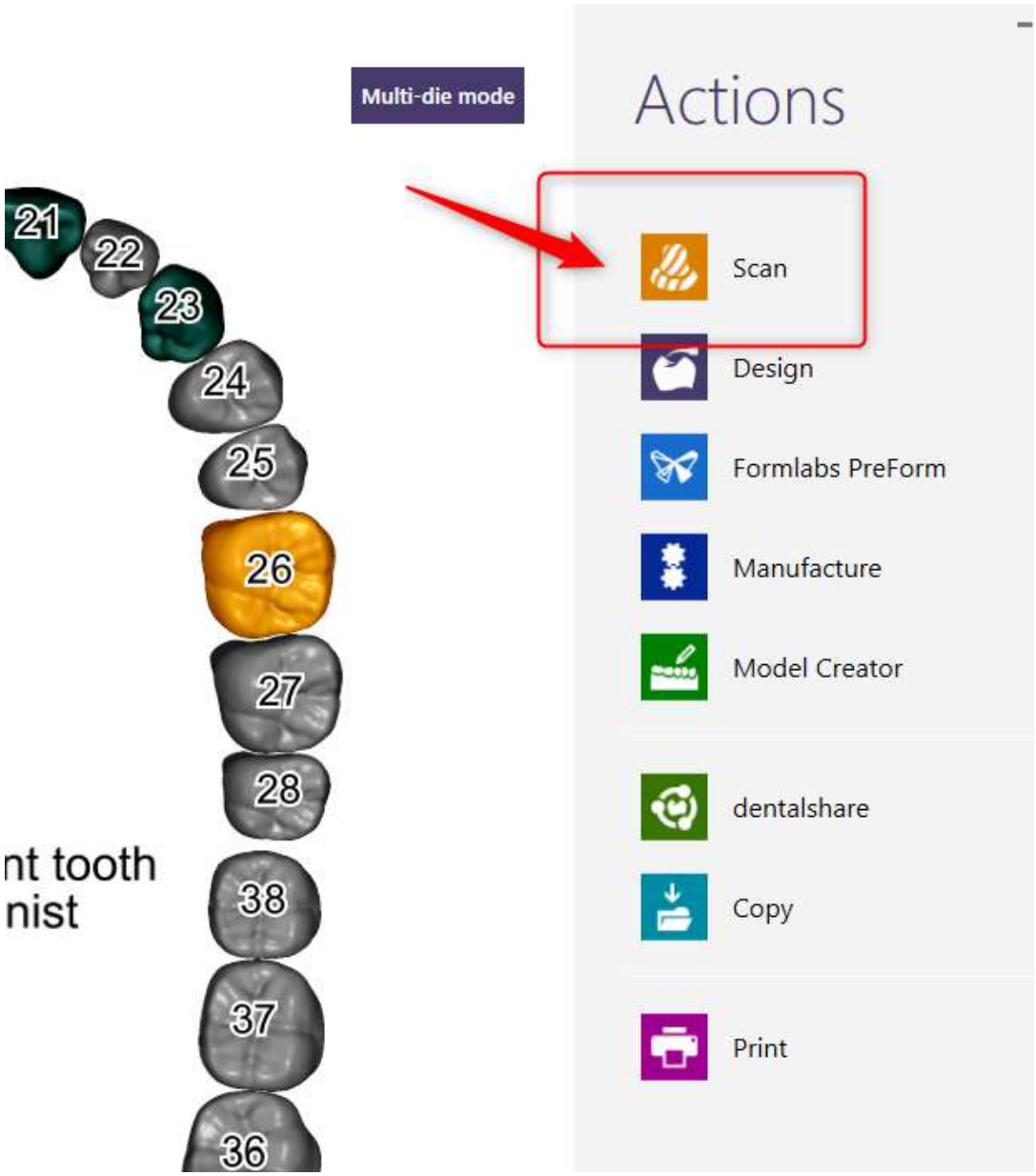
If you haven't done a test print, we recommend using the preset **"Formlabs solid model with extra dies"**



Note: Exocad allows the model to be designed before the restoration. You will have to set the margin line in the model creator. You will not have to redo this step when doing the actual design. In the design process for the restoration, you can always readjust the margin line. But keep in mind, that if you do so, the restoration margin and the model margin will not be the same.

Choose a preset and orient the scan(s)

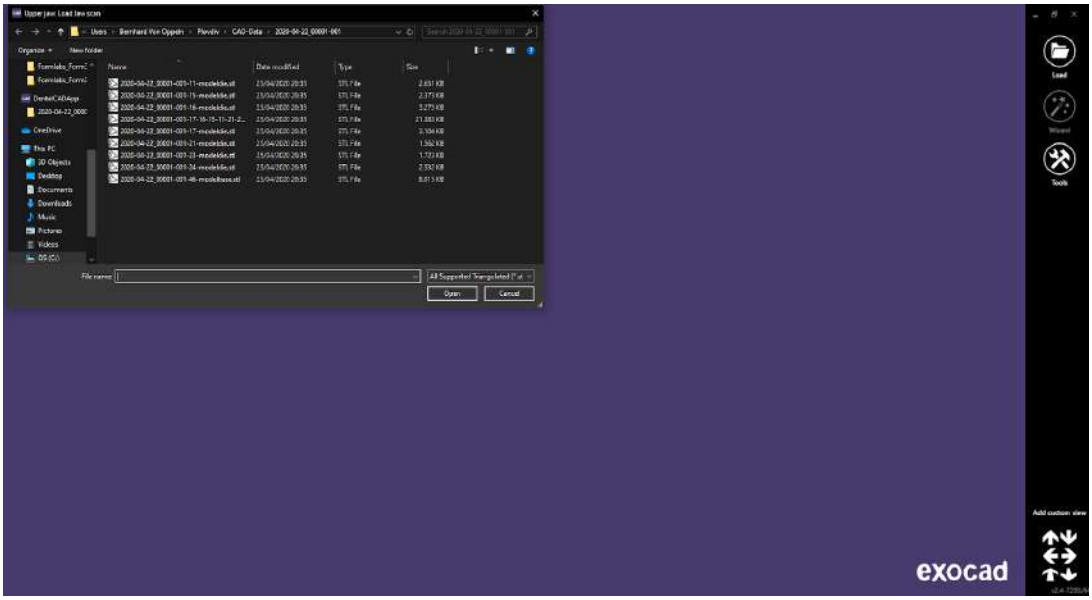
If you have scanned the model using the scan button in Exocad DentalDB, the scans will be loaded automatically



If you are not using this function, Exocad will ask you to choose the scan(s) using the operating systems file explorer

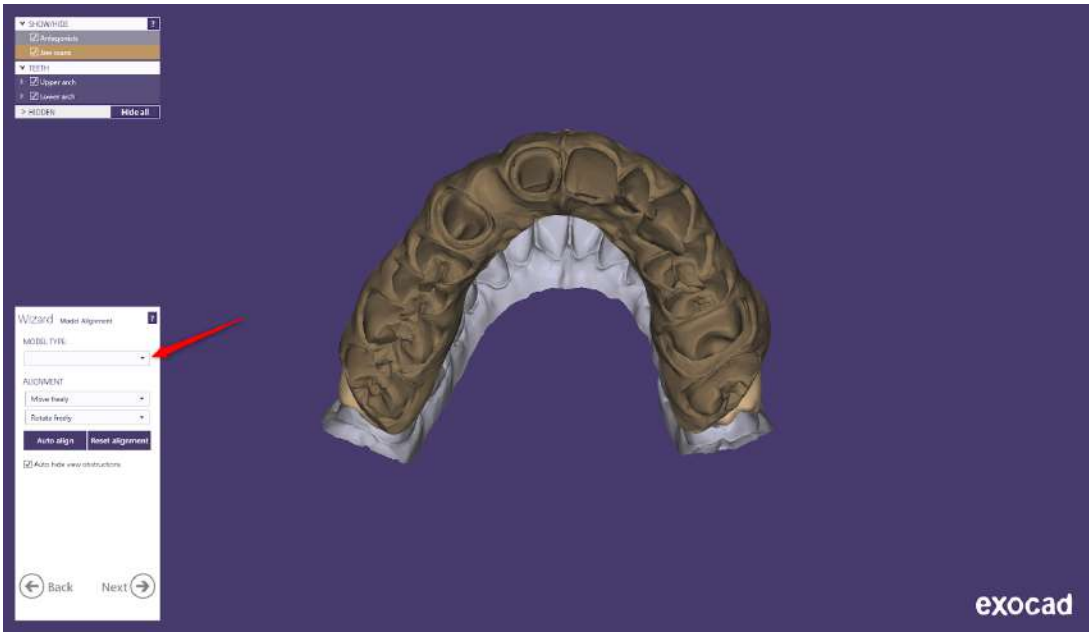
You will be asked for upper and lower scans according to your order setup

Exocad can import a couple of different mesh file formats, among which are STL, PLY, OBJ and DCM



You now will choose the preset you want to use

Here we are using the preset for solid models with extra dies



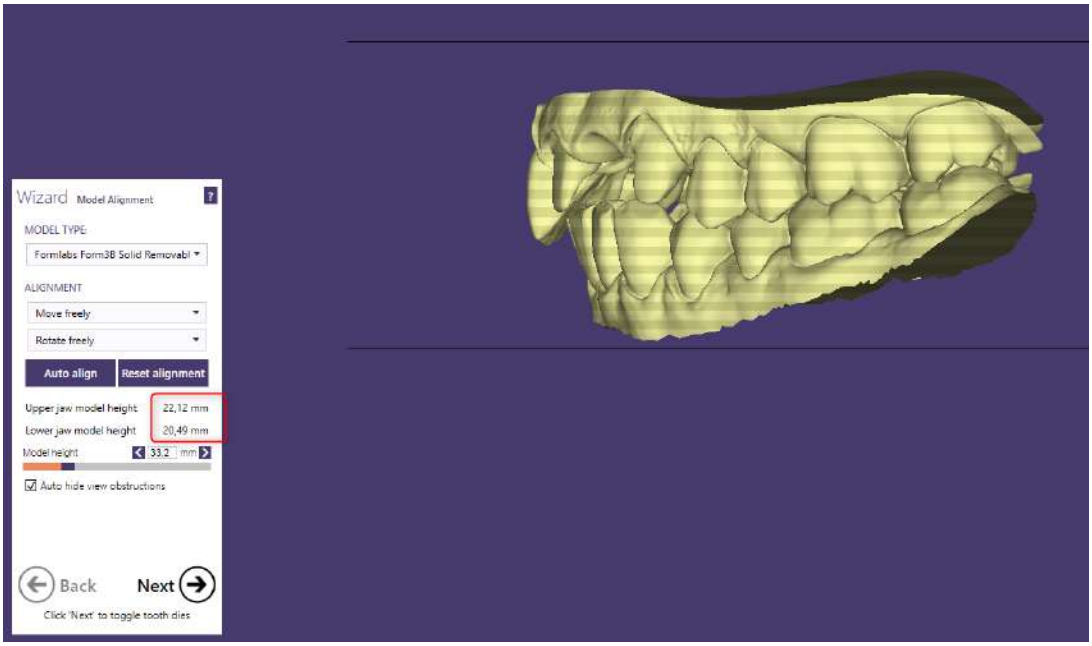
Next, we align the models

Depending on the scanner output, the scans can have all kinds of misalignment

In our case, the models are facing in the wrong direction

Adjust the orientation so each model has a size of 18-25 mm

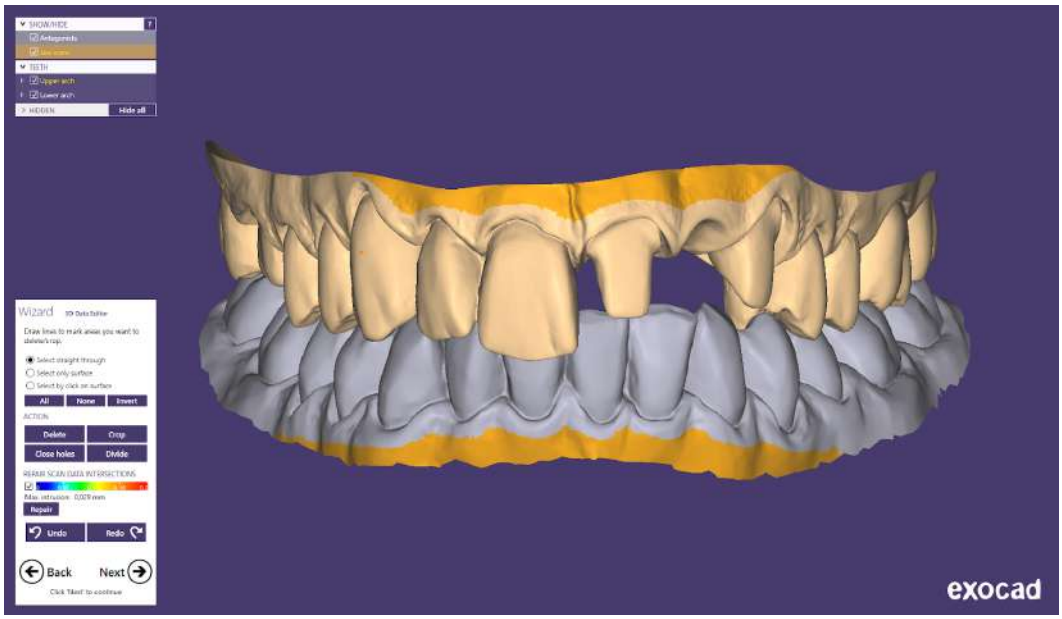
The lower can be around 2mm smaller. Find out more about orientation in the documentation video

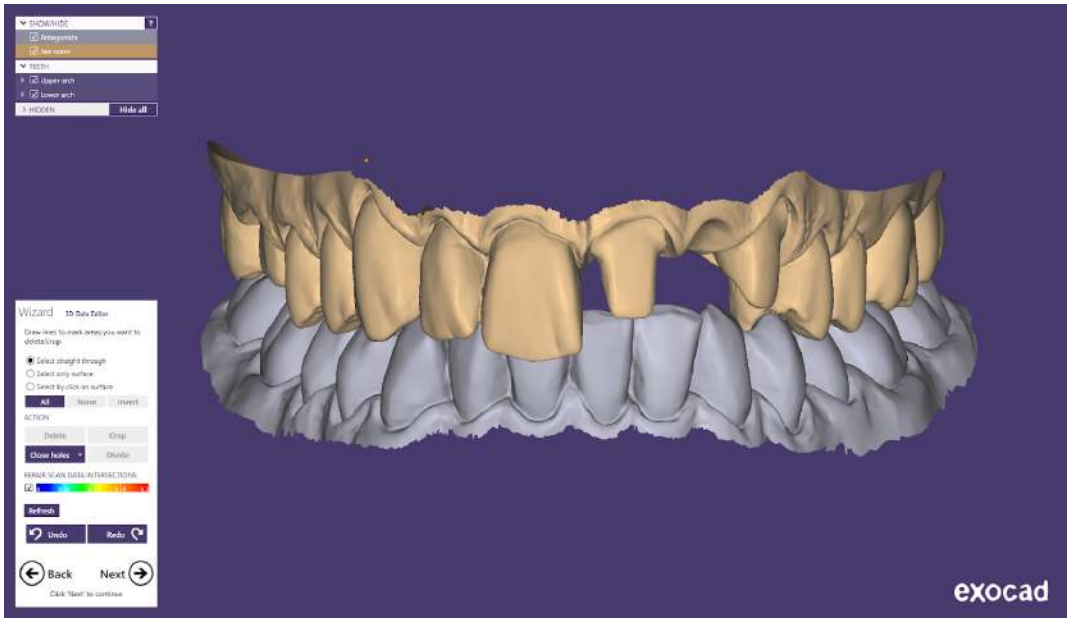


Trim scans if needed

We will remove overhanging parts of the soft tissue in the anterior region

This step is not mandatory for solid models with extra dies

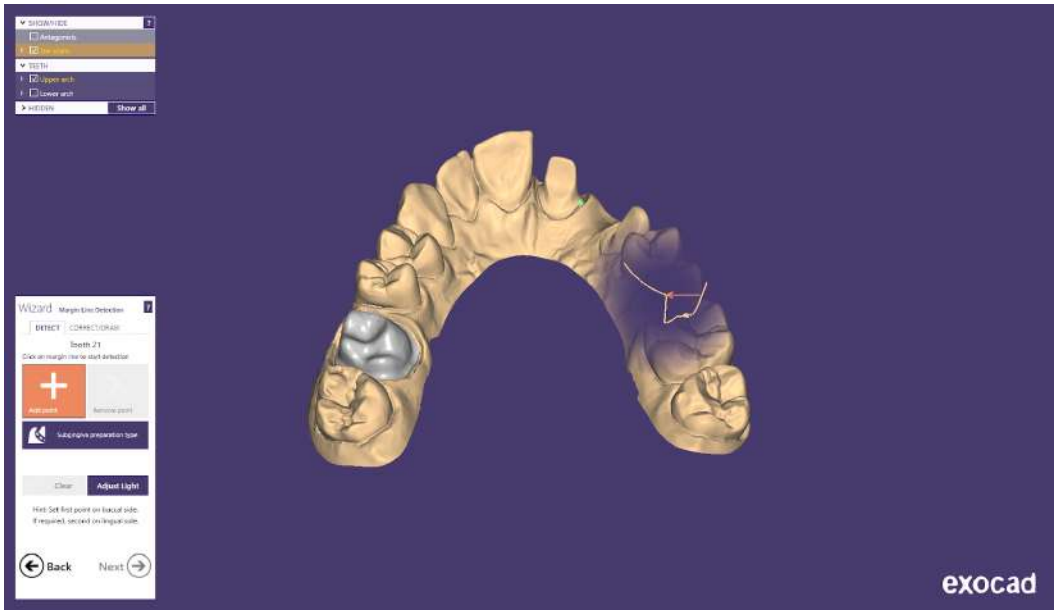




Define margins and adjacent teeth you want to be removable

Use the automatic margin detection and inspect and correct it if necessary

This step is obsolete if you already have designed a restoration



In the next step, you are asked which adjacent teeth you want to be removable

The prepared teeth are automatically marked as removable

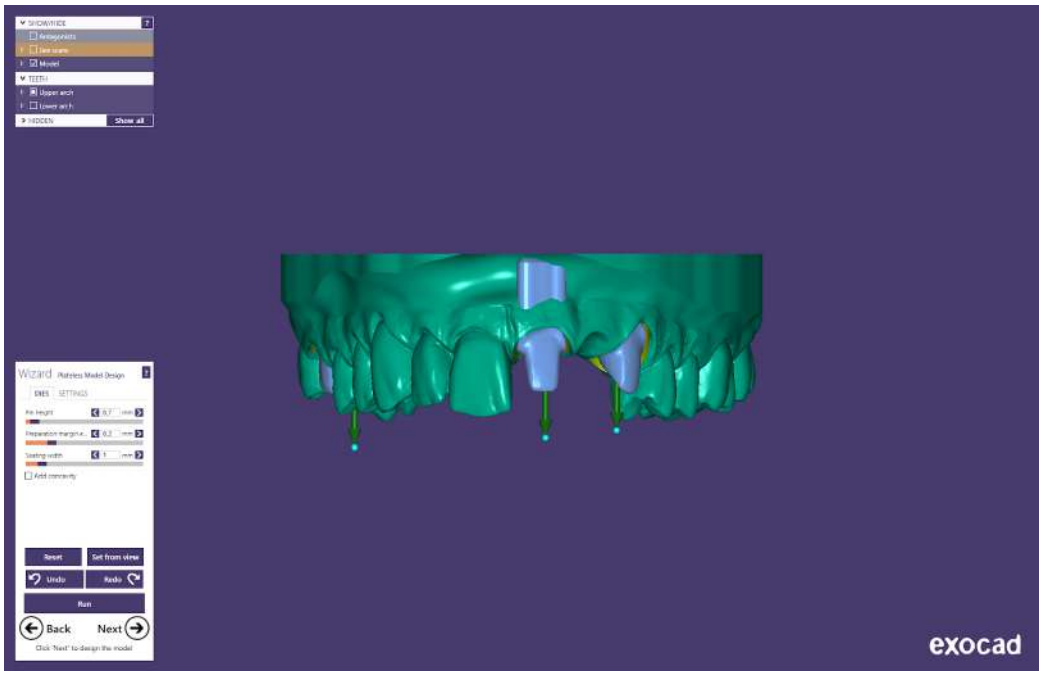
You will not be able to make adjacent teeth removable with this solid model preset

Ignore this step in the wizard and click next

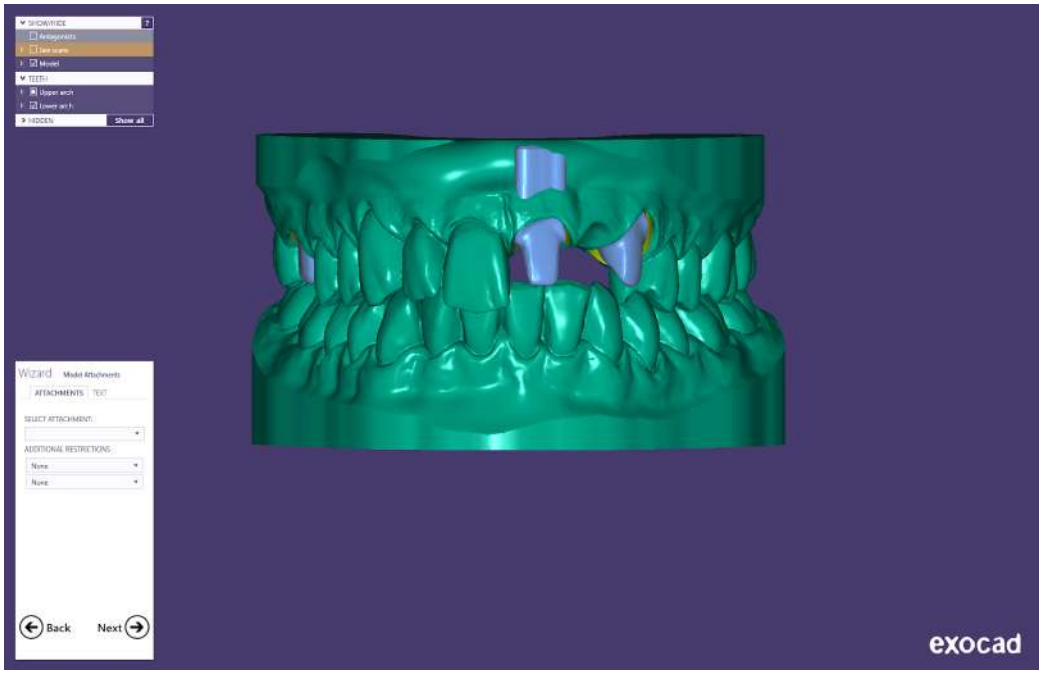
Generate models and dies

You don’t need to adjust the insertions axis since the dies are not going to be inserted into the model

Just click run



Do the same for the lower jaw



In the next step, you can add attachments to clip models on to an articulator interface

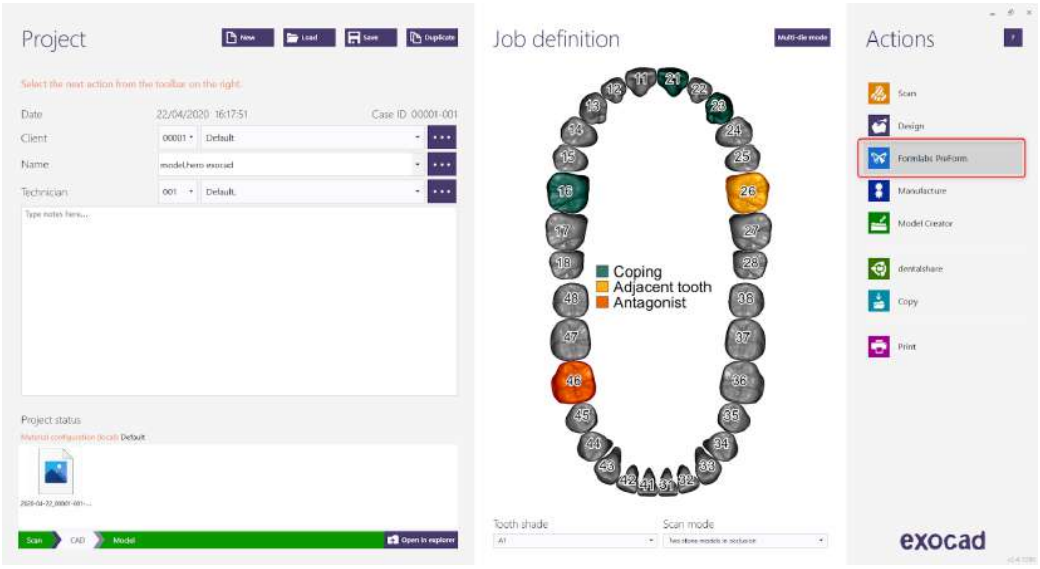
You can also add text like an order number or patient name

Please watch the video for further information: Link

Save you files and send them to Preform

In the latest version of Exocad, you will have a Preform button if Preform is installed on your computer

Sending files to your printer now is as easy as clicking this button and telling the Program which files you like to send to Preform



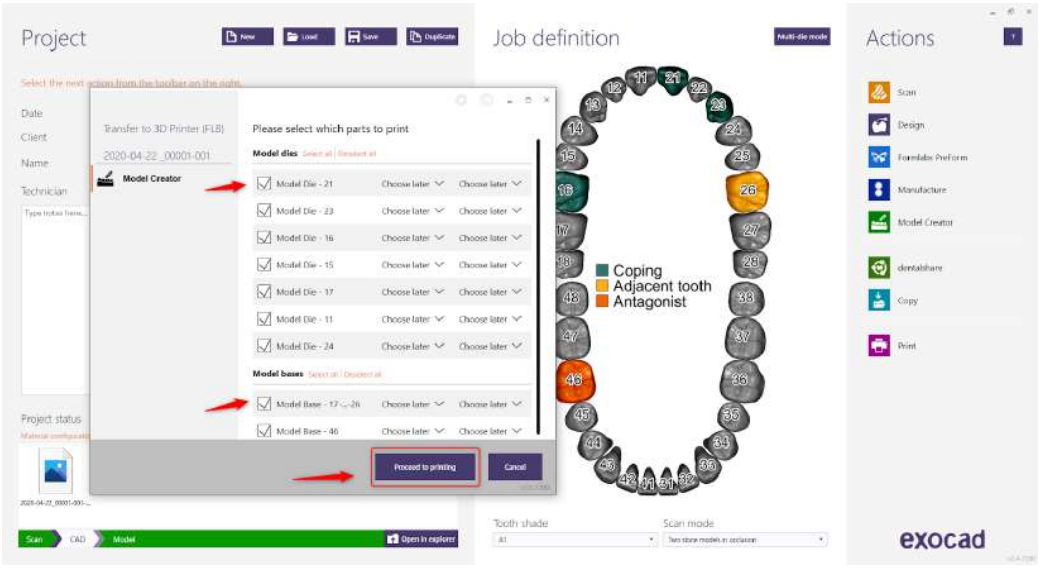
The print dialog allows you to check/uncheck designed parts you want to print

If you have already designed your restorations, they will appear in this dialog

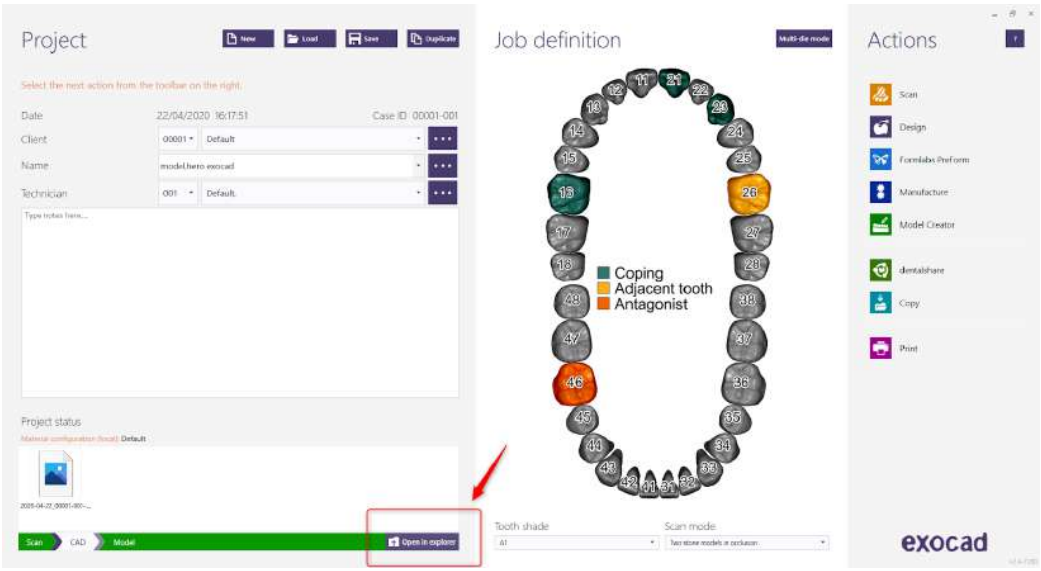
Uncheck everything that is not part of the model and click “proceed to print”

This will launch Preform and import these files into the print job

If you have a running instance of Preform open already, the object will be added to the current print job, so you can populate your build plate

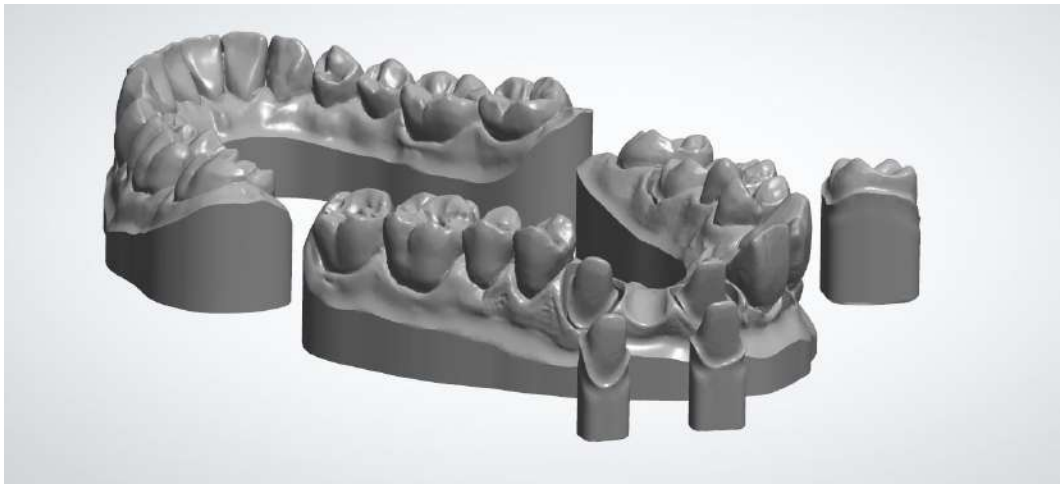


If you have a previous version of Exocad, click on “open” in Explorer, and drag and drop the files you want to print into Preform

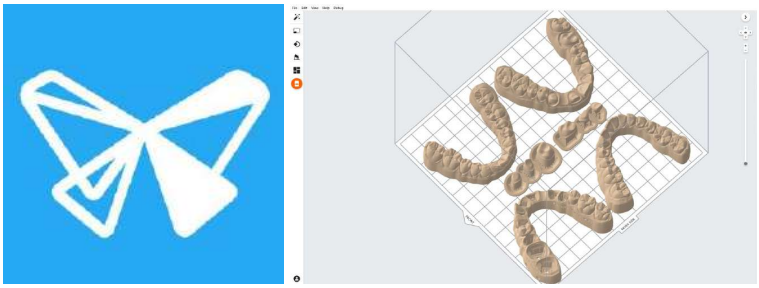


Next Step - Preform

The next step to 3D print the model is to open the files into and prepare them for the printing using Formlabs Preform software



Proceed the next step “Preform and Nesting”



formlabs | dental

Removable Die Models - ExoCAD

Formlabs Form 3B

formlabs | dental

The written and video guide found in this document outlines and describes how to best use ExoCAD and a Formlabs Form 3B to produce removable die models for restorations.

We recommend using solid models with working dies for the easiest and scalable way for dental laboratories to 3D print restorative models. For more information on how and why please visit our restorative model overview page.

Before designing any models review the post processing, finishing, guides and **run a test print** specific to ExoCAD to determine your ideal socket to die offset

Note: This work-flow was developed and tested on Exocad versions Valetta, Matera and Plovdiv.

The video version of the guide can be found **here**

Prepare your Exocad System

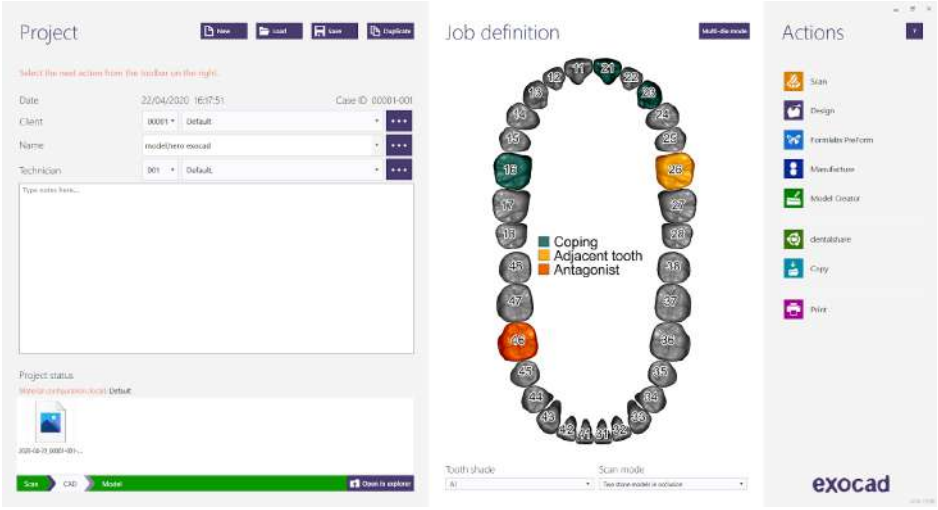
Download and install the Formlabs Exocad model presets: **library**
Download and install the Formlabs Exocad model attachments: **library**
Watch a video tutorial on how to install the Formlabs Dental ExoCAD materials file: **here**

Order Setup

Setup your order as usual. Material choices are only for Restorations

The Material of the model will be defined later using the provided Exocad model creator presets

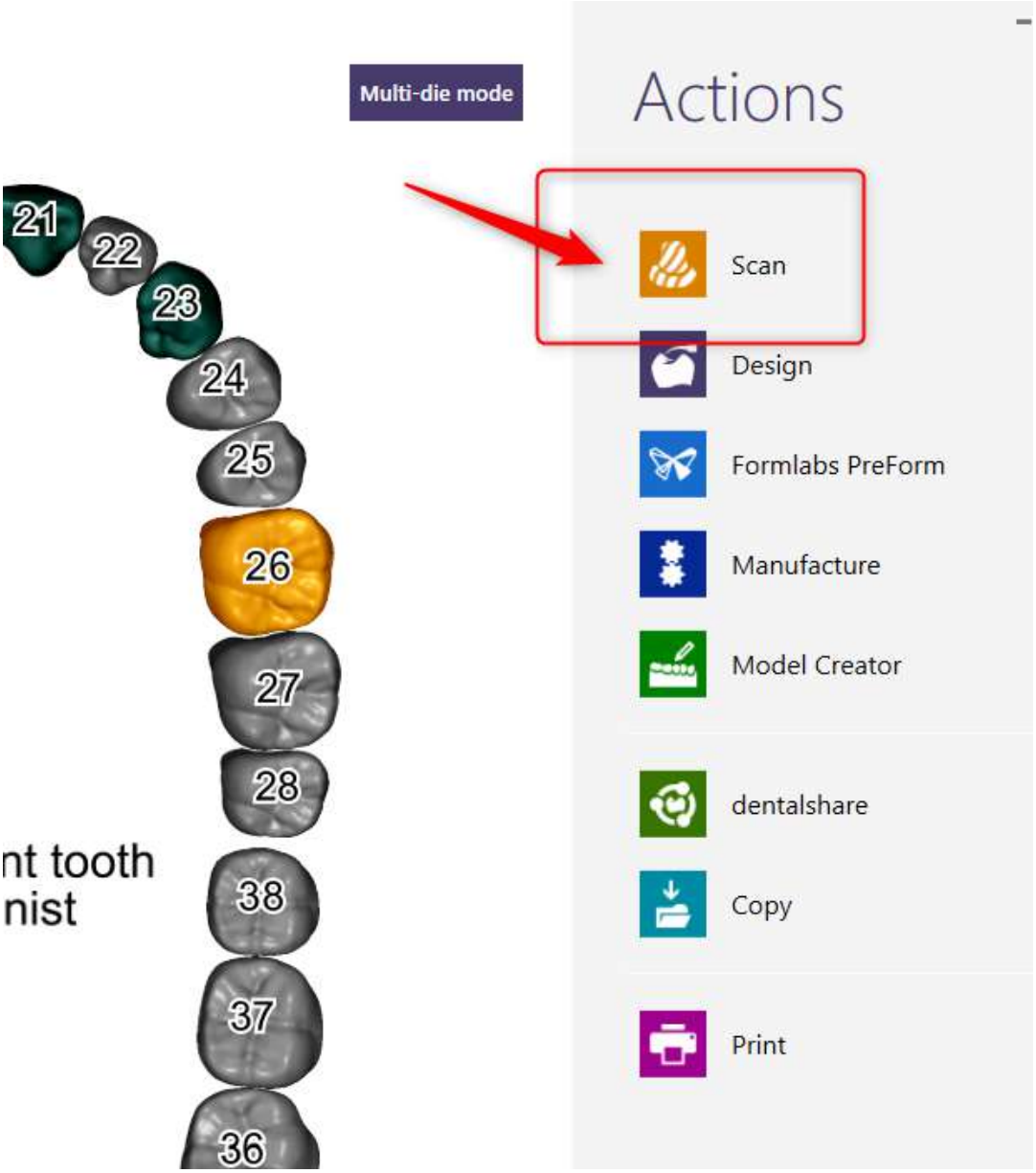
If you haven't done a test print, we recommend using the preset **"Formlabs Form3B Solid Removable Dies Model -10µm - tight"**



Note: Exocad allows the model to be designed before the restoration. You will have to set the margin line in the model creator. You will not have to redo this step when doing the actual design. In the design process for the restoration, you can always readjust the margin line. But keep in mind, that if you do so, the restoration margin and the model margin will not be the same.

Choose a preset and orient the scan(s)

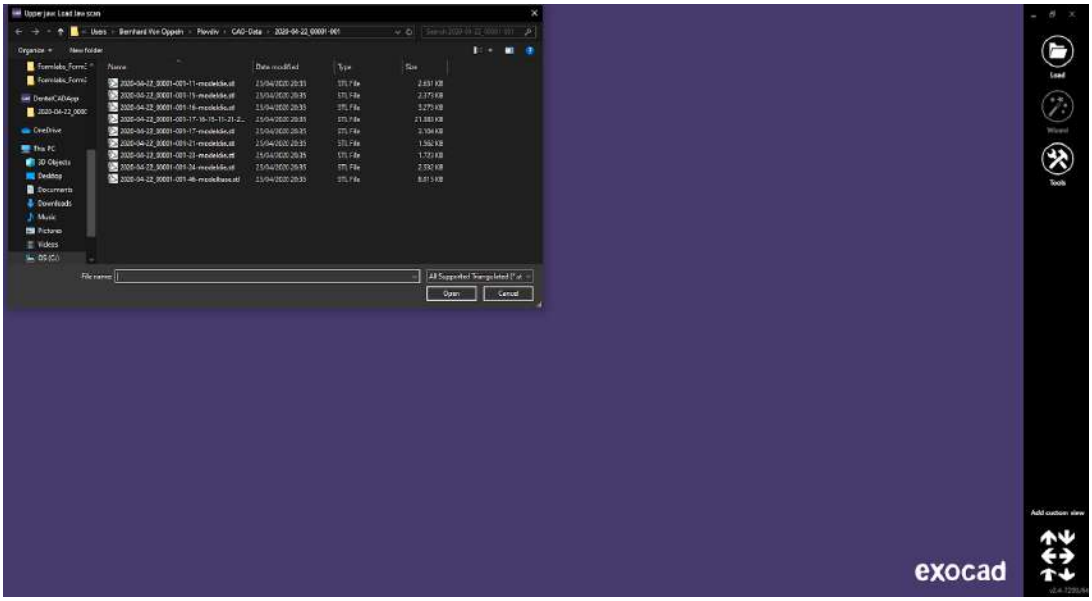
If you have scanned the model using the scan button in Exocad DentalDB, the scans will be loaded automatically



If you are not using this function, Exocad will ask you to choose the scan(s) using the operating systems file explorer

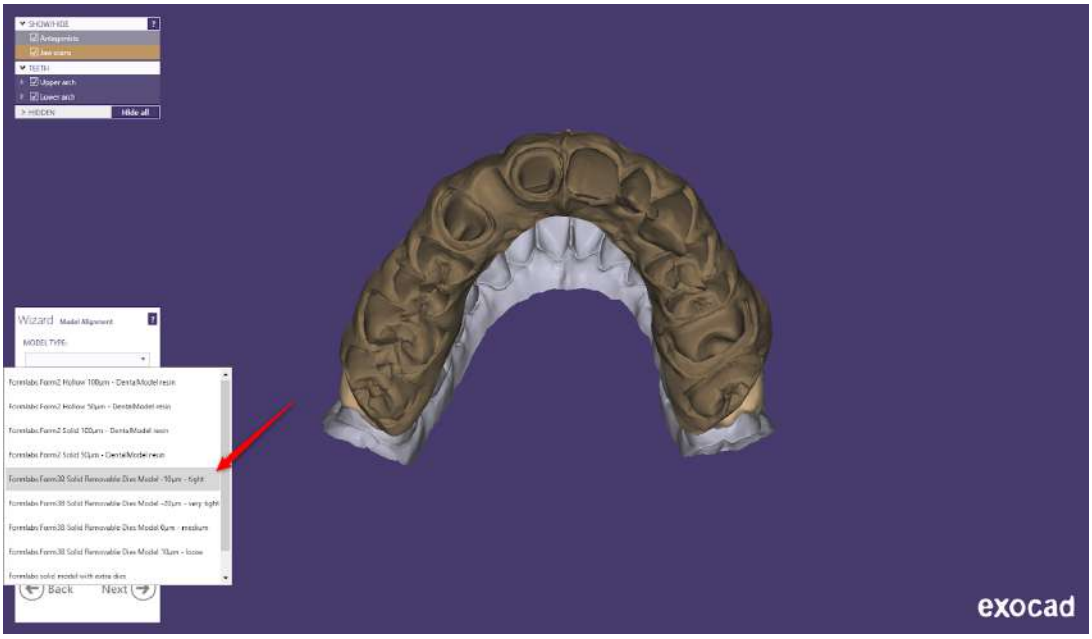
You will be asked for upper and lower scans according to your order setup

Exocad can import a couple of different mesh file formats, among which are STL, PLY, OBJ and DCM



You now will choose the preset you want to use

Here we are using the preset for removable dies models with -10µm horizontal die to model offset



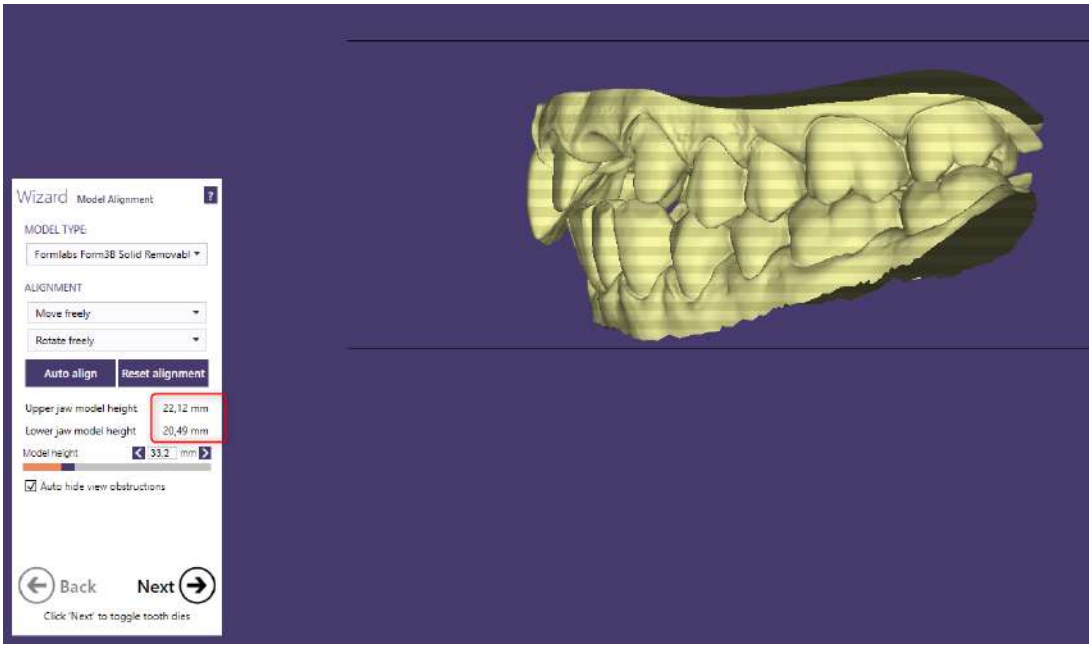
Next, we align the models

Depending on the scanner output, the scans can have all kinds of misalignment

In our case, the models are facing in the wrong direction

Adjust the orientation so each model has a size of 18-25 mm

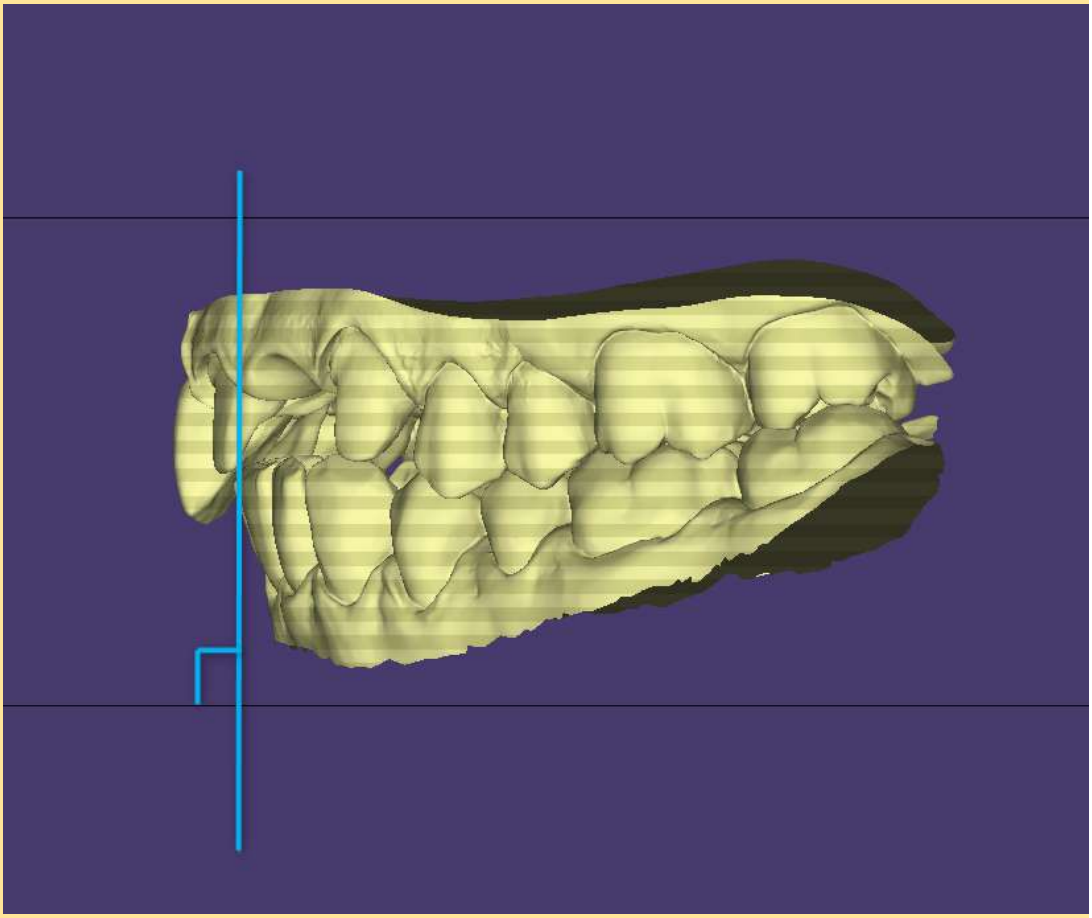
The lower can be around 2mm smaller. Find out more about orientation in the documentation [video]



Note: The alveolar region of the front teeth often has a pronounced undercut

We want the dies to be as perpendicular as possible to the models base, which can lead to missing wall thickness of the sockets for these teeth

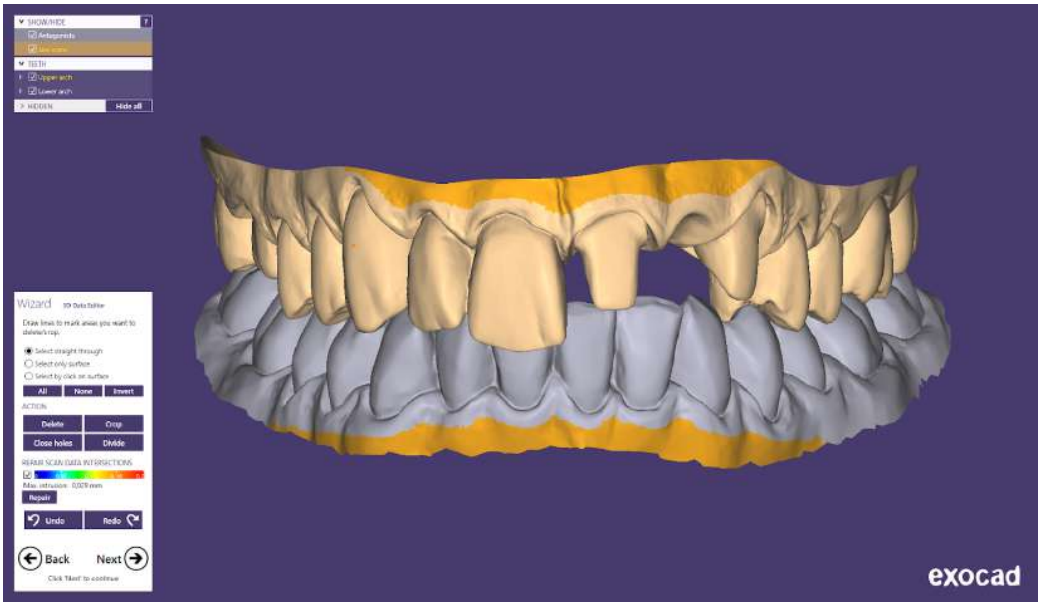
We can reduce this effect by tilting the model in the sagittal direction, to help the alveolar parts be more perpendicular to the models base

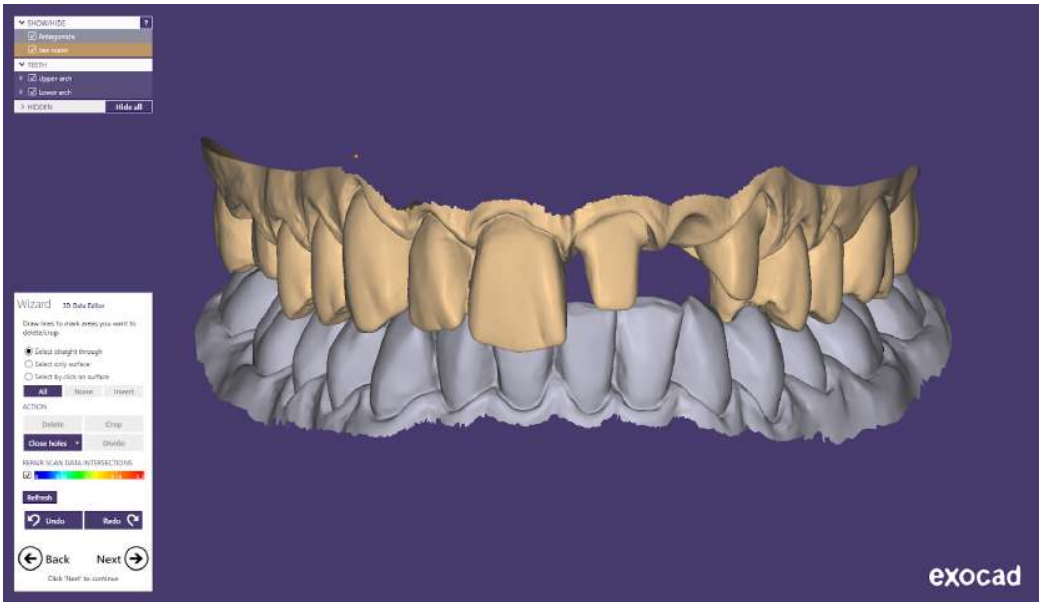


Trim scans if needed

For the same reason we tilted the models in the previous step we will remove overhanging parts of the soft tissue in the anterior region

This way we get more room for the walls of the die sockets

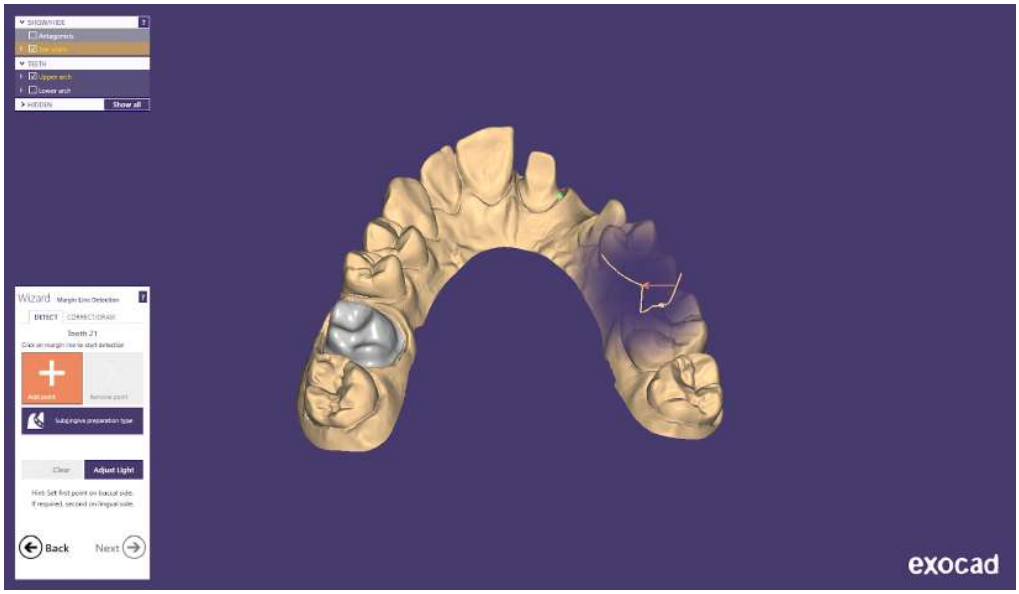




Define margins and adjacent teeth you want to be removable

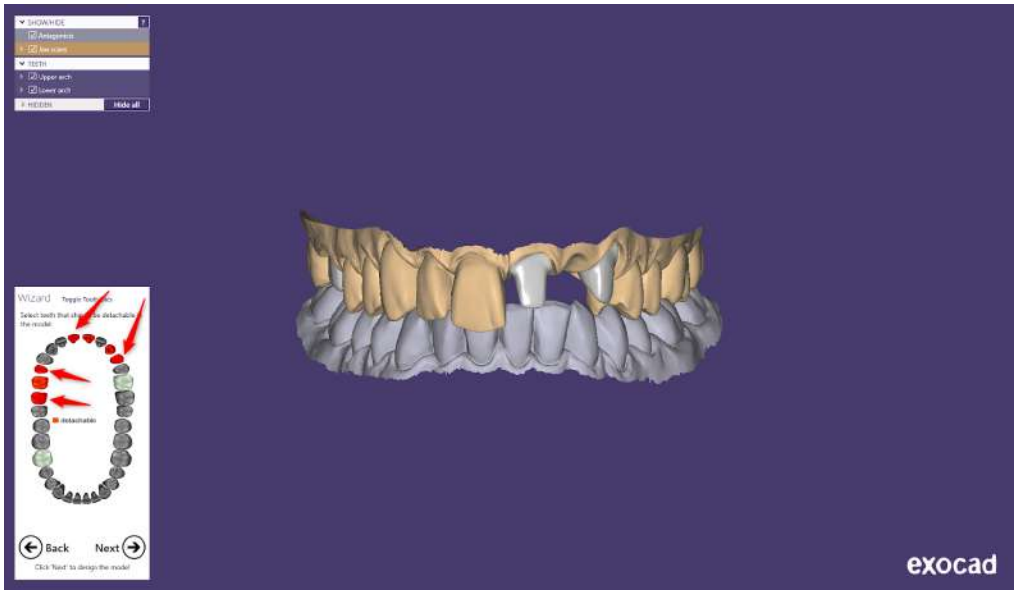
Use the automatic margin detection and inspect and correct it if necessary

This step is obsolete if you already have designed a restoration.



In the next step, you are asked which adjacent teeth you want to be removable

The prepared teeth are automatically marked as removable

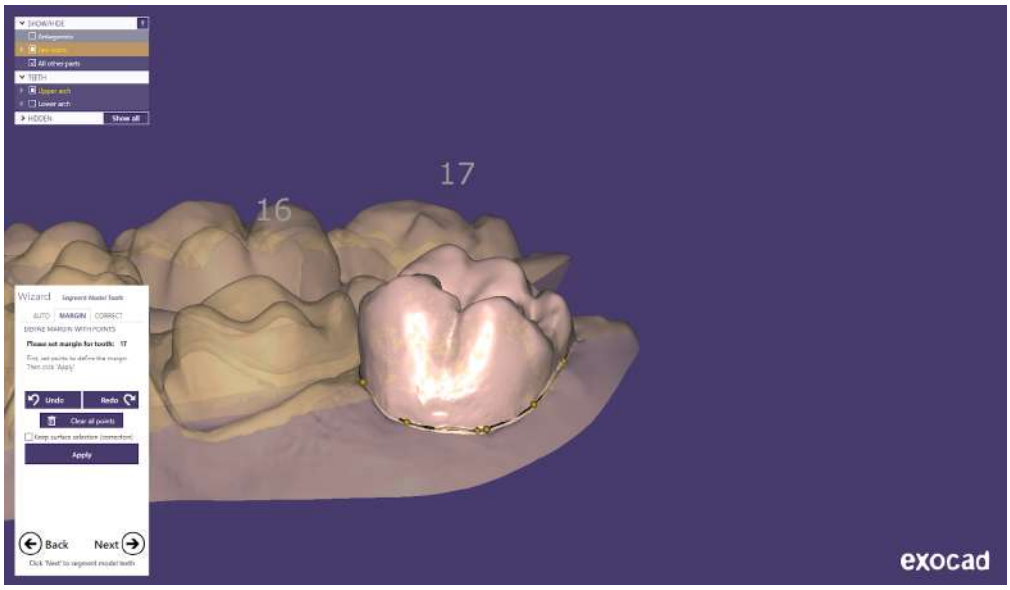


Define margins of adjacent teeth

According to our choice in the previous step, we need to tell Exocad where the margin of the extra removable teeth are

Use the automatic function of the model creator, by clicking on the tooth

This algorithm is pretty impressive, but you might still need to manually adjust these margins



Generate and inspect the model(s)

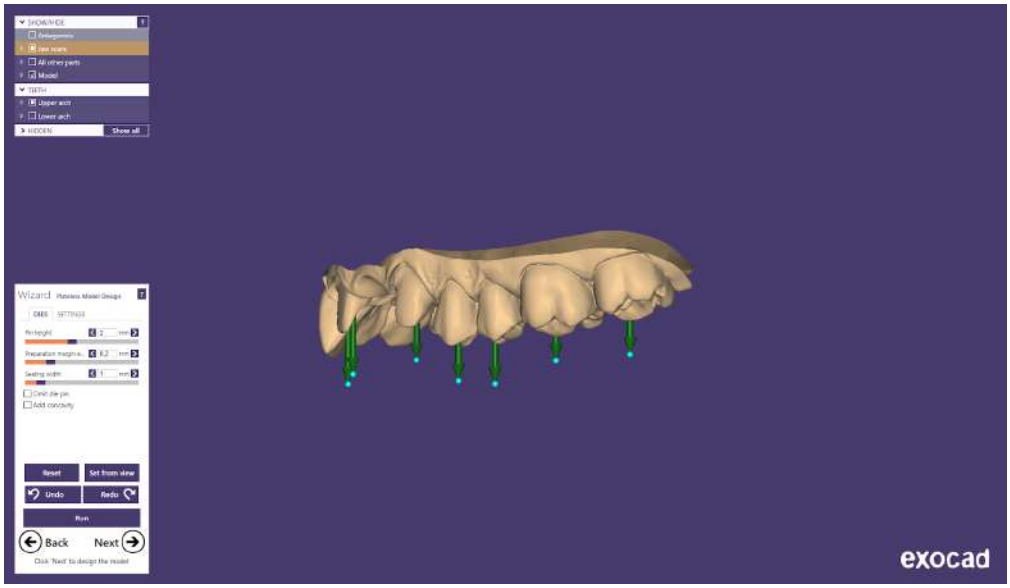
We want the dies to be perpendicular to the models base, angled dies sockets in the model will affect the fit of the dies

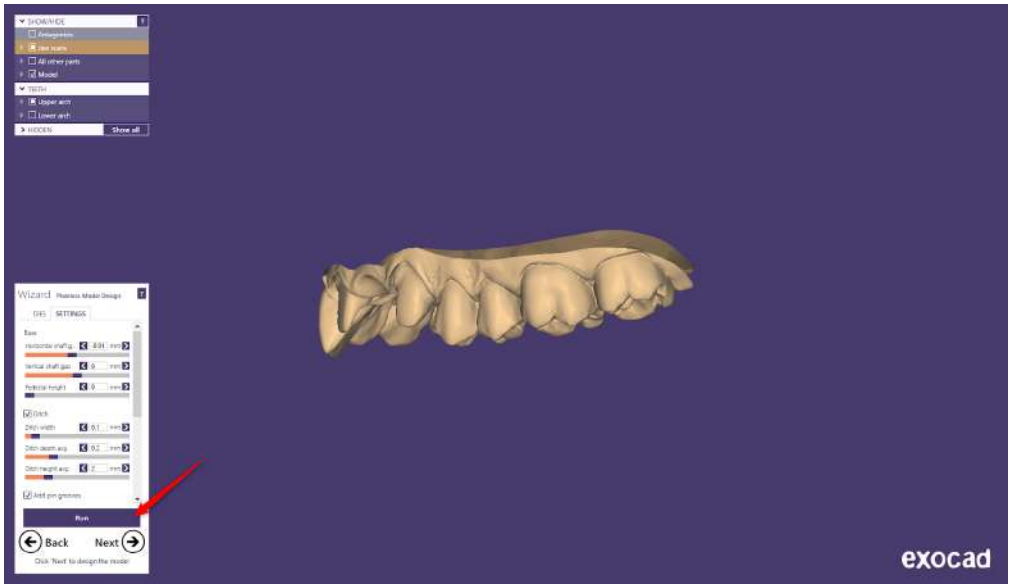
They can be tighter or looser than expected

When the dies dialog opens in model creator, the dies insertion axes are perpendicular to the base of the model

We will try to keep this orientation

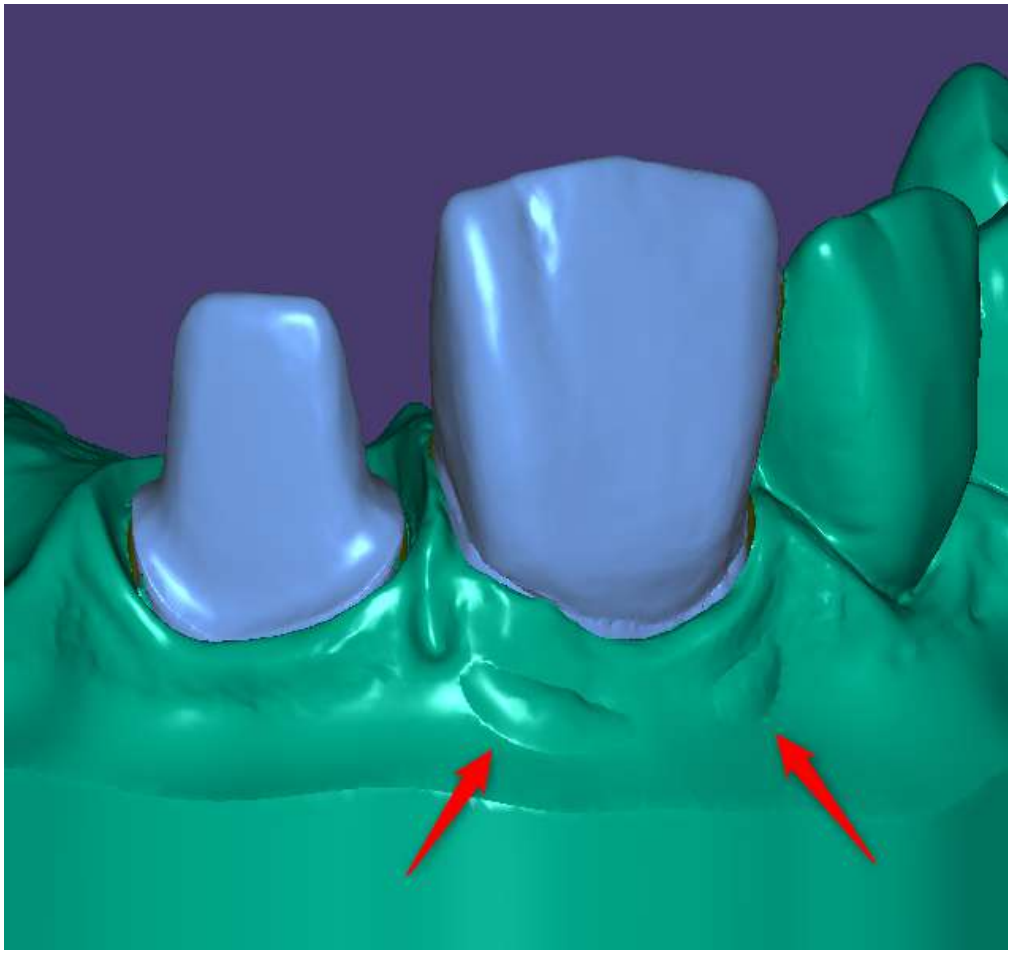
By switching to the “settings” tab for the model and clicking “run”, the model is generated and can be inspected before progressing in the workflow

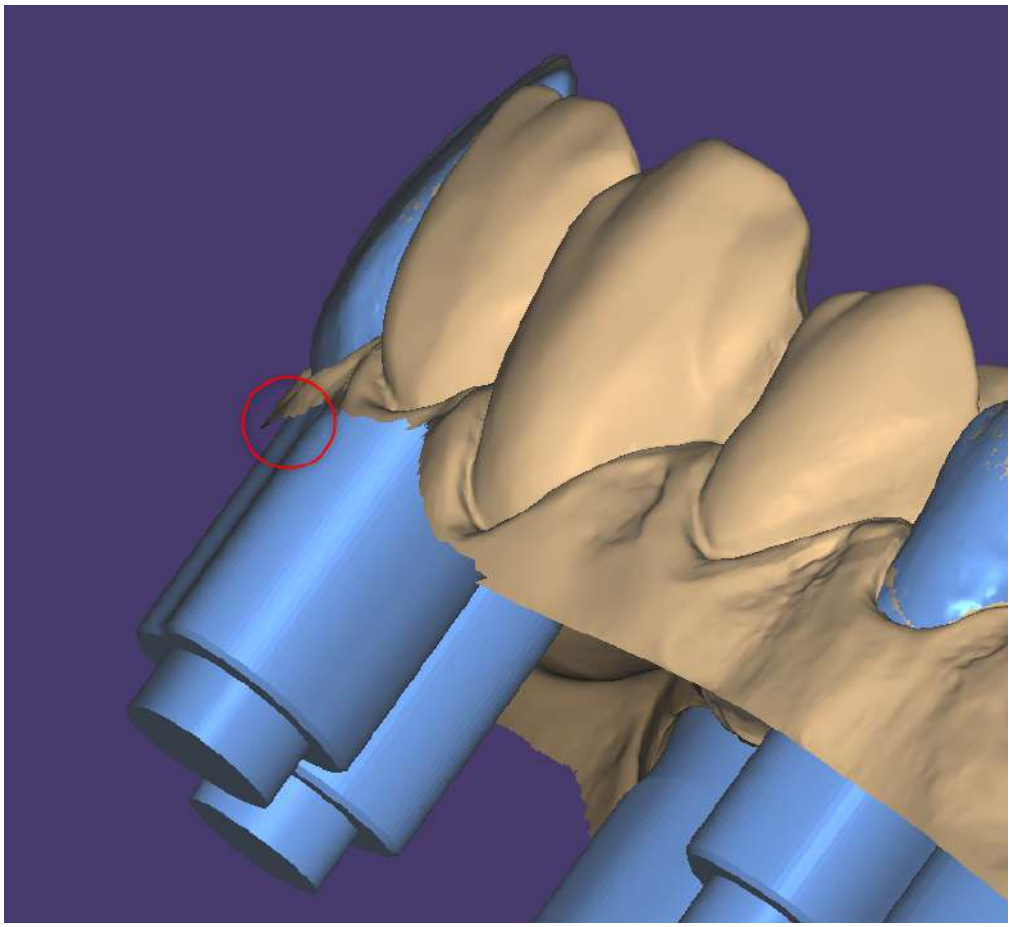




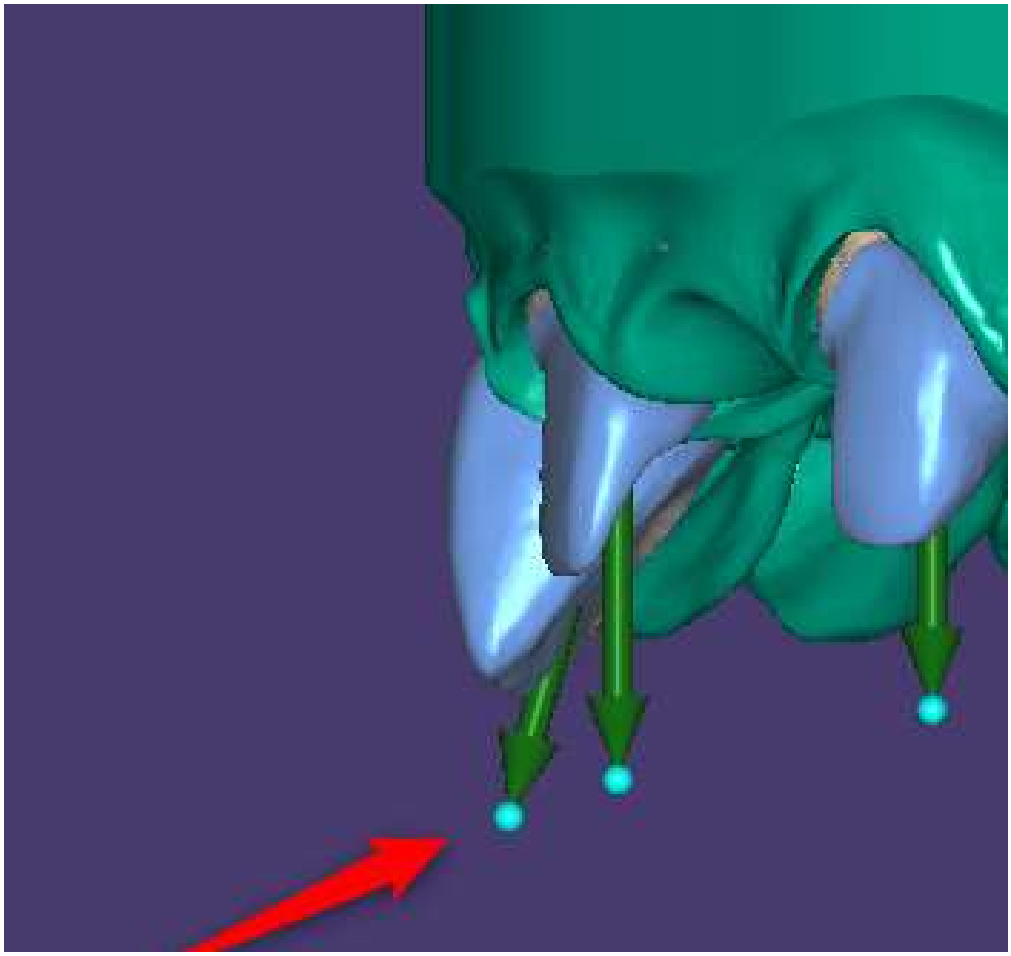
Inspecting the generated model reveals very thin areas in region 8 (FDI: 11), though we tilted the model and trimmed the soft tissue

Exocad tried to augment the wall thickness here, but the result can be better by angulating the insertion axis of this tooth





Tilting the insertion axis of tooth 8 solves this problem



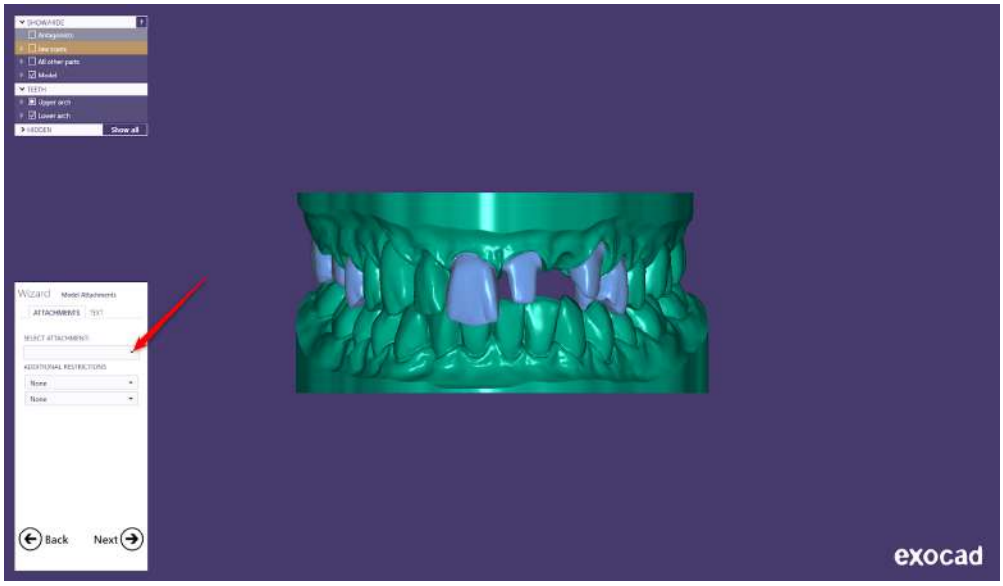
We have found that different angles of insertion are ok if they are not bigger than 10-15°. The bigger the angle, the tighter the die will be for Exocad models

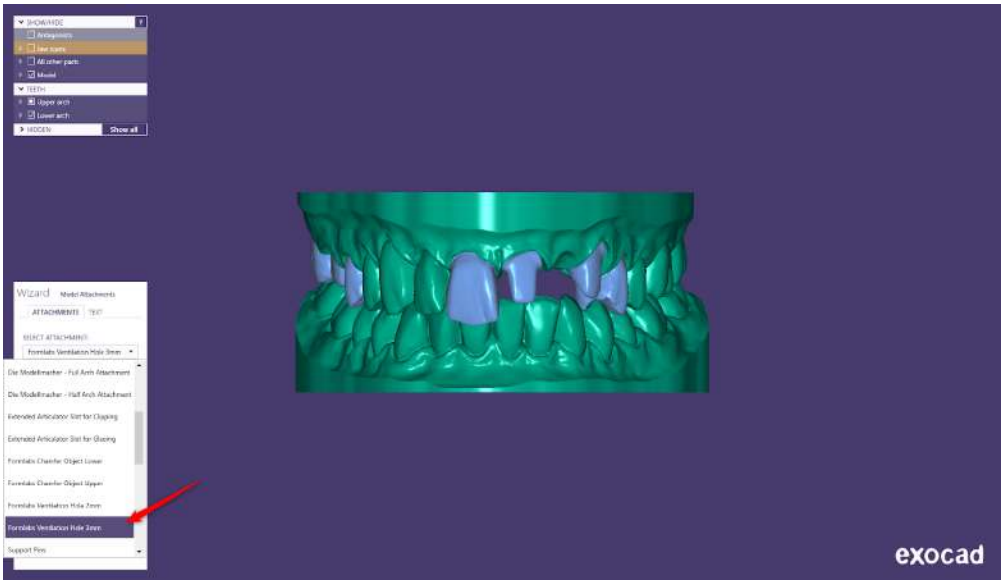
---

Optional: add attachments and/or holes for visual inspection of die fit

Exocad doesn't offer to add holes for die fit inspection natively

But if you installed our library for attachments, you can use the “ventilation hole 3mm” object to add these holes





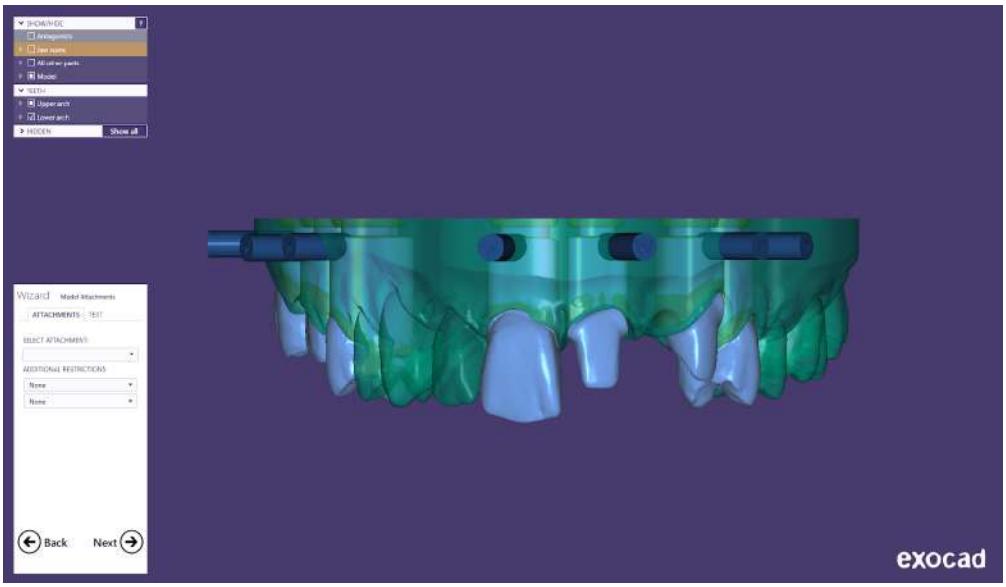
Click on the model where you want to place them

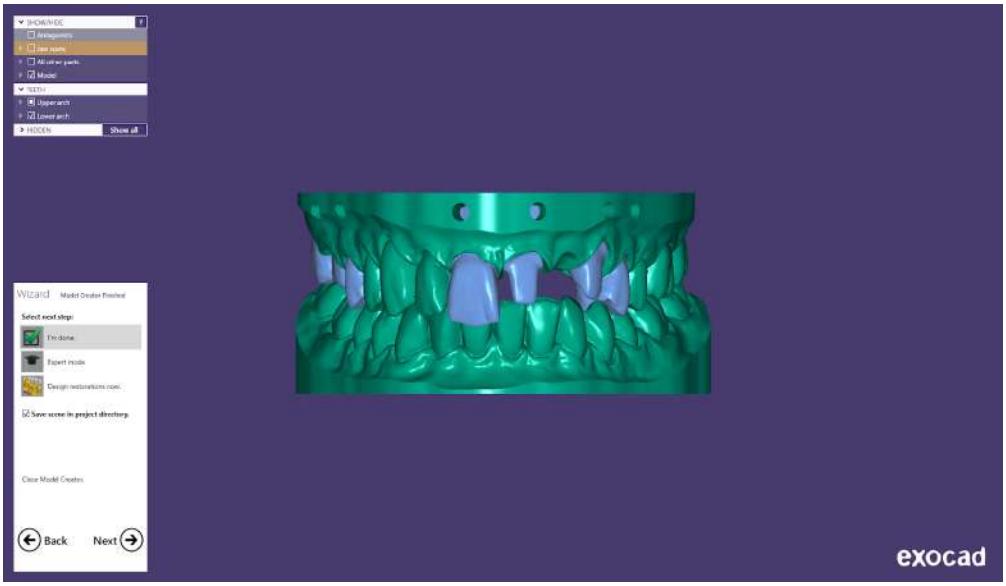
Repeat for each removable die socket

Adjust the position so the cylinder is just cutting a hole at the bottom of the die socket

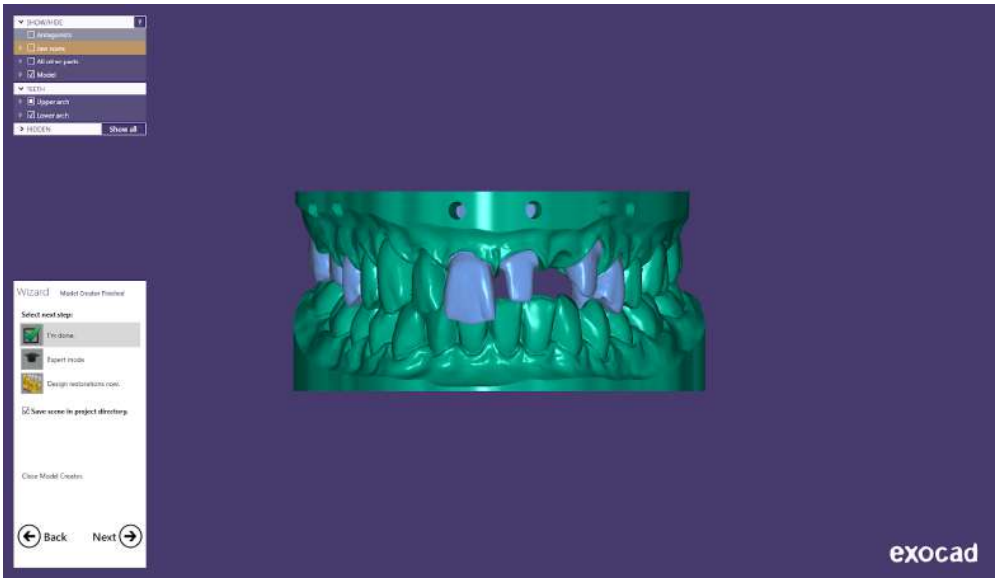
Add other attachments as needed, then click next

The cylinders will be subtracted from the model and you will have your inspection holes





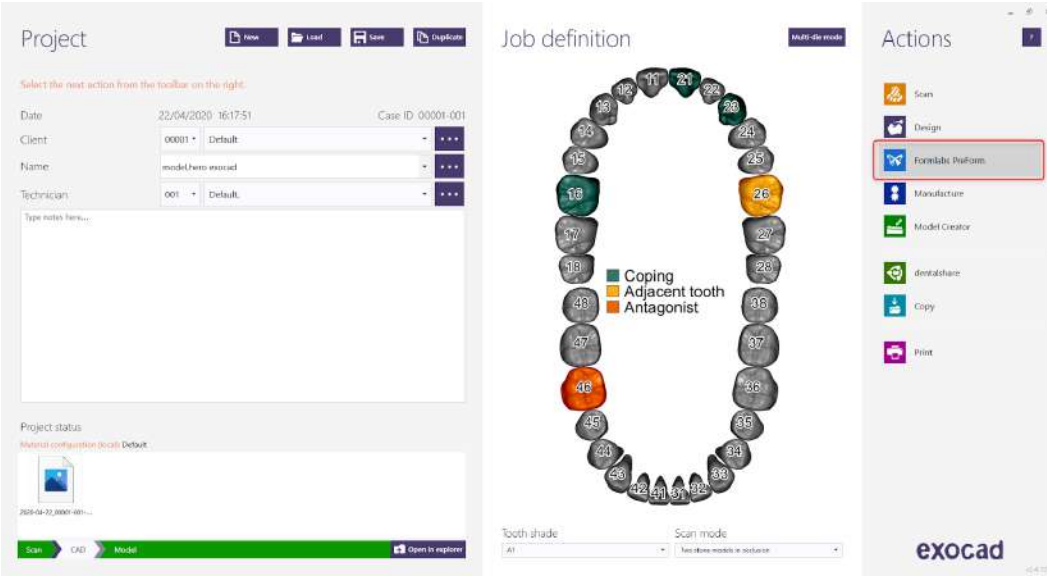
The lower jaw model generation in this example will be the same, except that you will not have removable dies



Save you files and send them to Preform

In the latest version of Exocad, you will have a Preform button if Preform is installed on your computer

Sending files to your printer now is as easy as clicking this button and telling the program which files you like to send to Preform



The print dialog allows you to check/uncheck designed parts you want to print

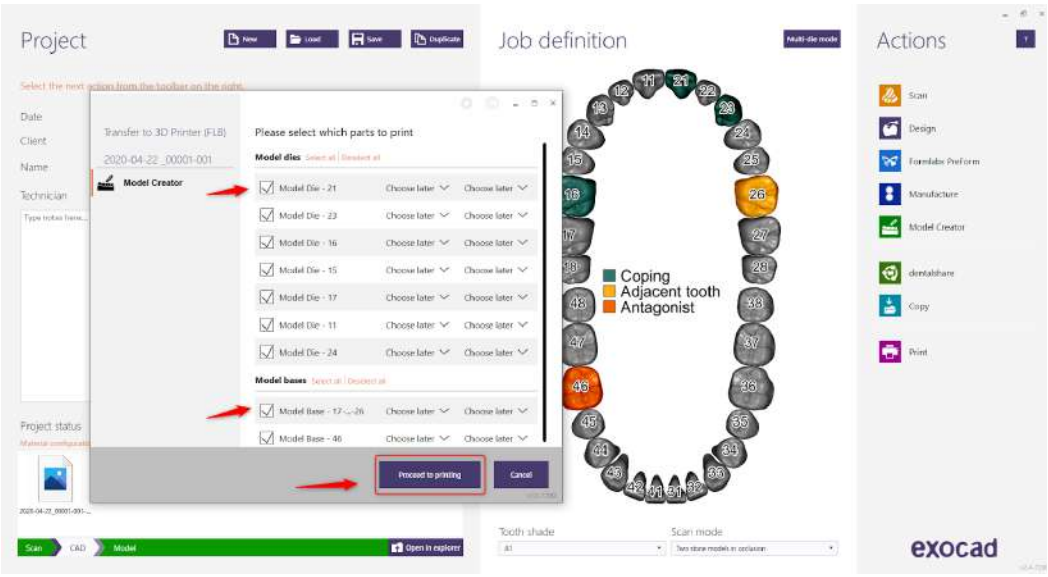
If you already designed your restorations, they will appear in this dialog

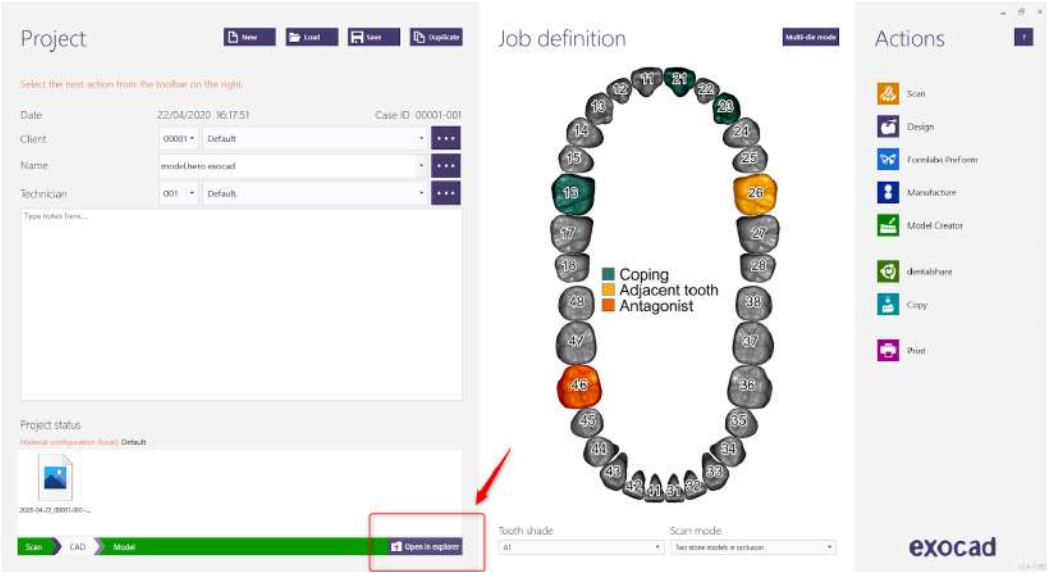
Uncheck everything that is not part of the model and click “proceed to print”

This will launch Preform and import these files into the print job

If you have a running instance of Preform open already, the object will be added to the print job, so you can populate your build plate

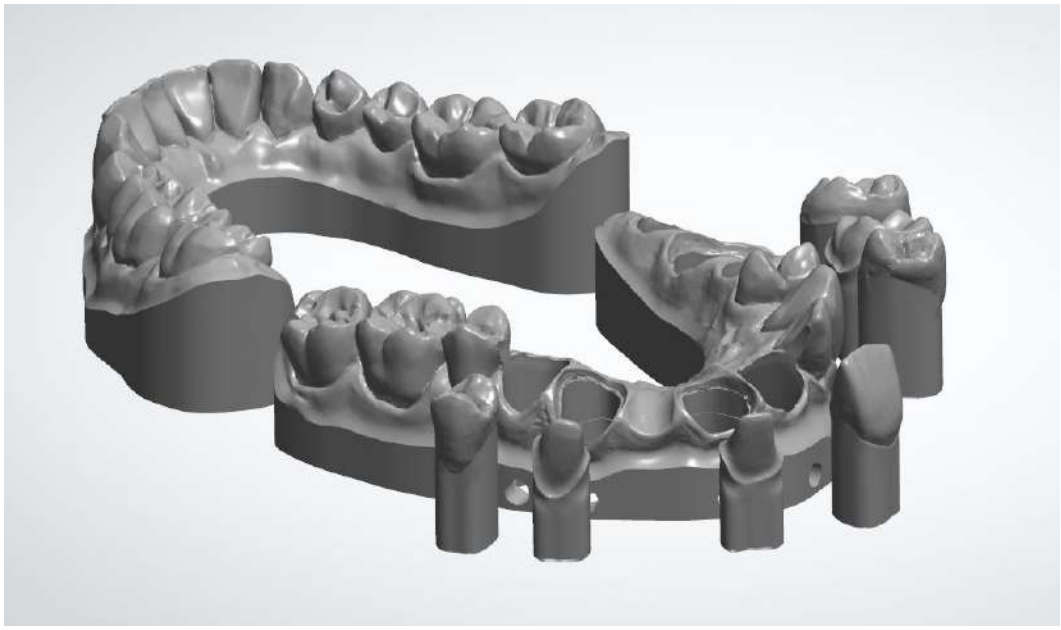
If you have a previous version of Exocad, click on open in Explorer, and drag and drop the files you want to print into Preform



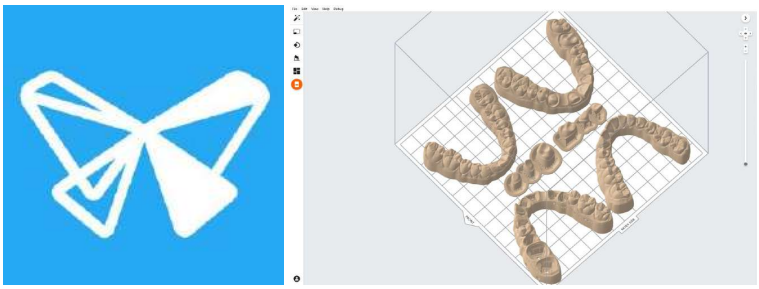


Next Step - Preform

The next step to 3D print the model is to open the files into and prepare them for the printing using Formlabs Preform software



Proceed the next step “Preform and Nesting”



formlabs | dental

Preparing Restorative Models Jobs in Preform

Formlabs Form 3B

formlabs | dental

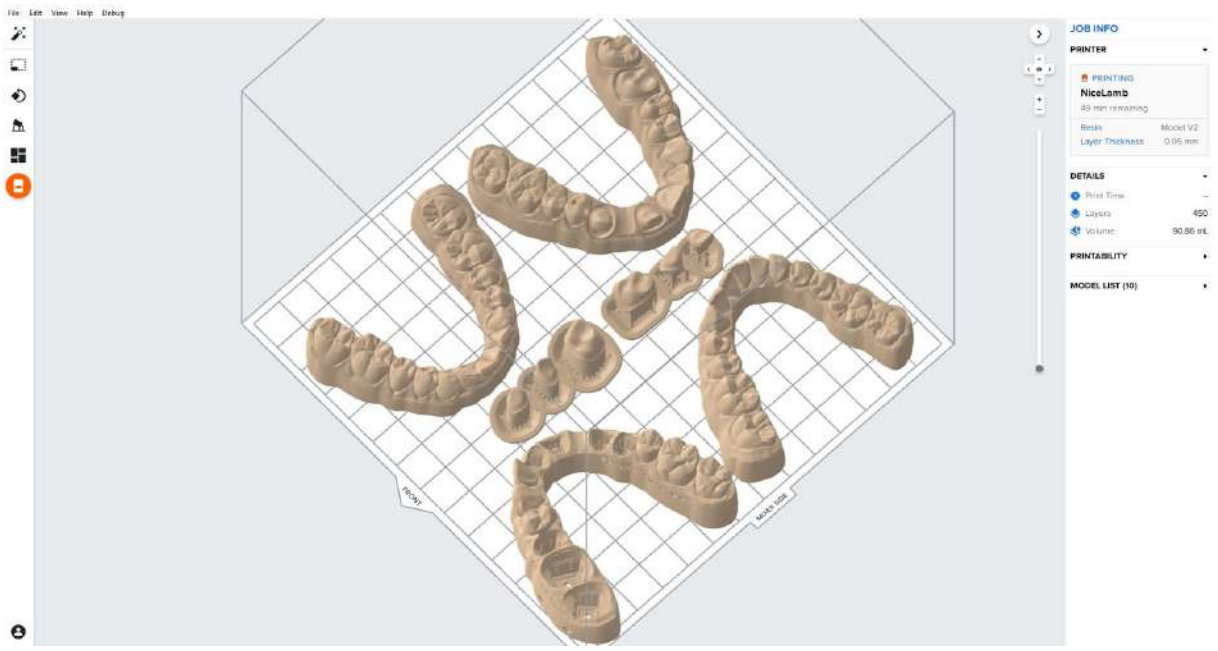
This guide goes through the best practices for preparing restorative model jobs in Preform for the Form 3B LFS 3D printer. The introduction page of the restorative model workflow has information on how the model files in this guide are built in 3Shape or ExoCAD, including their associated settings.

Be sure to be running the latest Preform software and Form 3B firmware

Video version of this guide

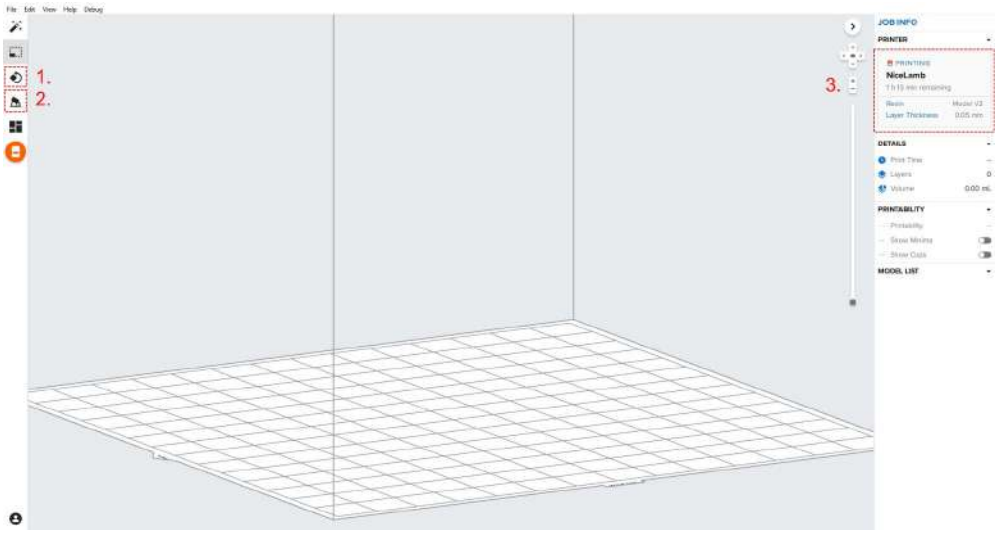
Formlabs Model Resin should be used for for restorative models

- Use 100 or 50 micron layer height or settings
    - Both layer heights produce accurate models that are ideal for restorative models
    - Try using both heights to see what surface quality works best for you
- We are not recommending 25 micron layer settings at this time



Opening Files and Orienting Parts

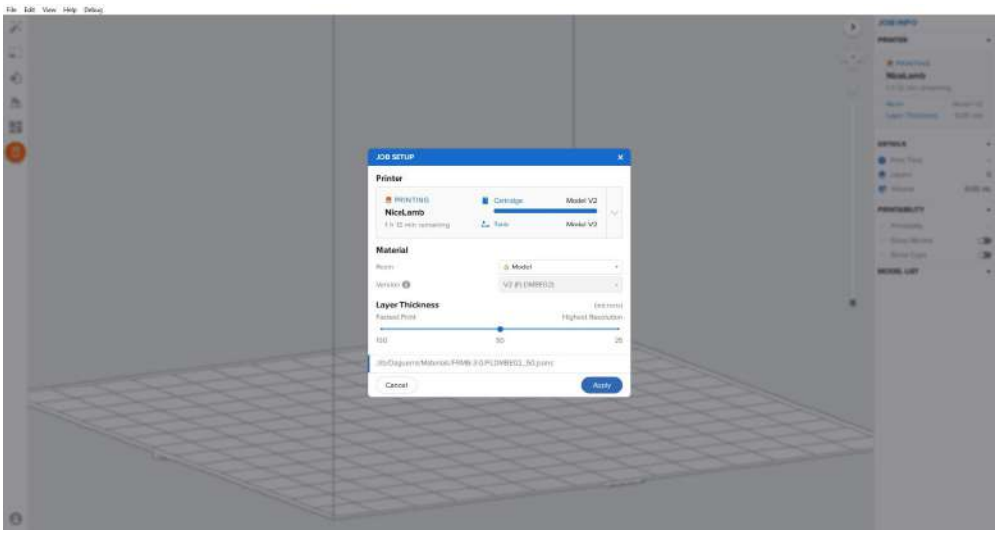
Open Preform



The three main buttons that will be used in this guide are

1. Orientation
2. Support Generation
3. Printer

Click the “Printer” button
This opens the “Job Setup” menu



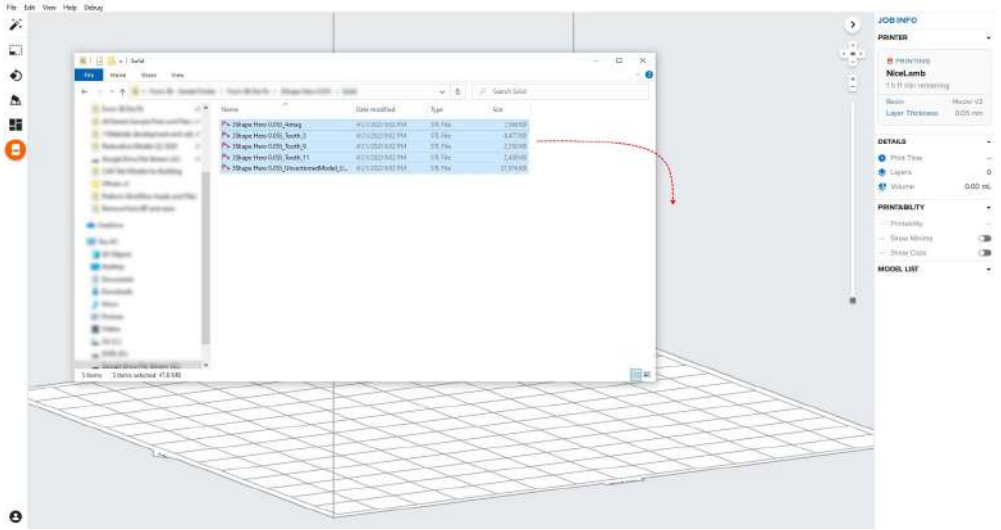
Once in the “Job Setup” menu

Select “Model” from the “Resin” pulldown

Select “100” or “50” using the “Layer Thickness” slider

Select the printer you want to send the job to by clicking the “v” next to the printer details

Importing model files

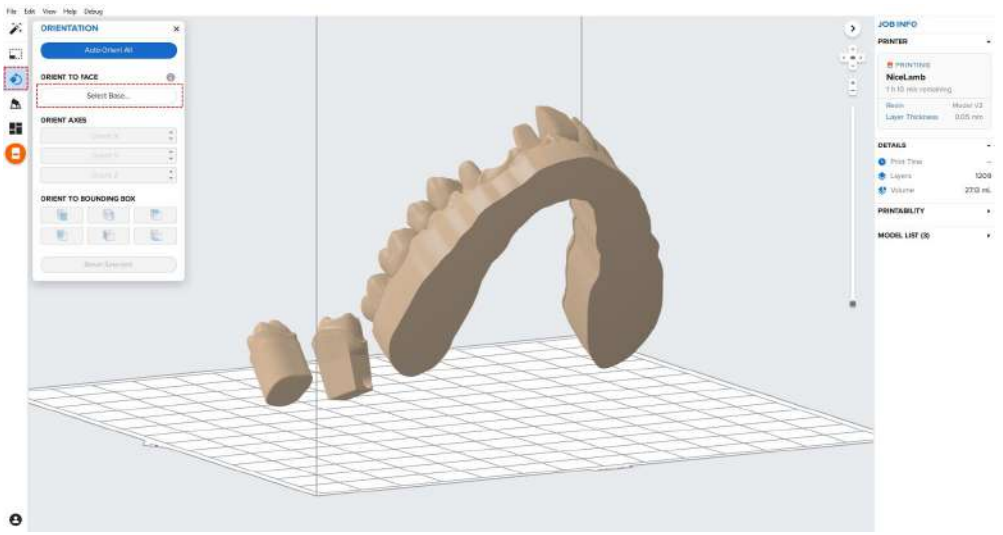


Locate your dental CAD software manufacturing output if using 3Shape or ExoCAD refer back to the last step of those guides

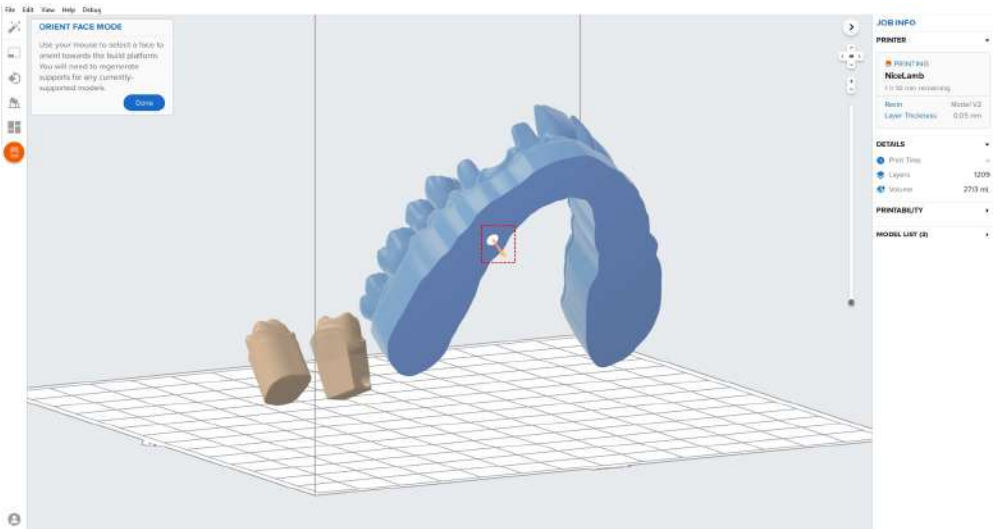
Drag your files into Preform directly or under the “File” menu select “Open” locate and open the files

Snap the parts down to the build plate by clicking on the “Orientation” button on the left side panel

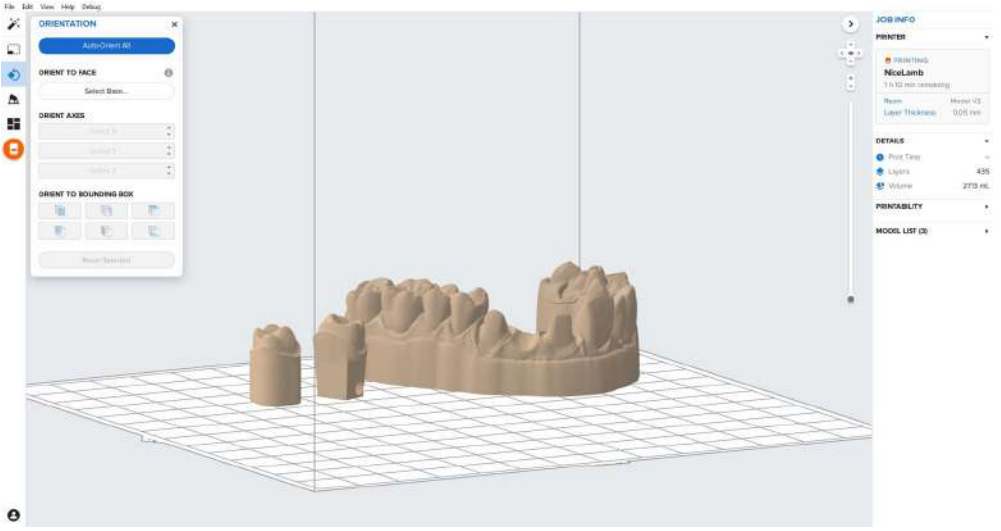
Once the “Orientation” menu opens click “Select Base”



Left click on the bottom surface of the models and dies



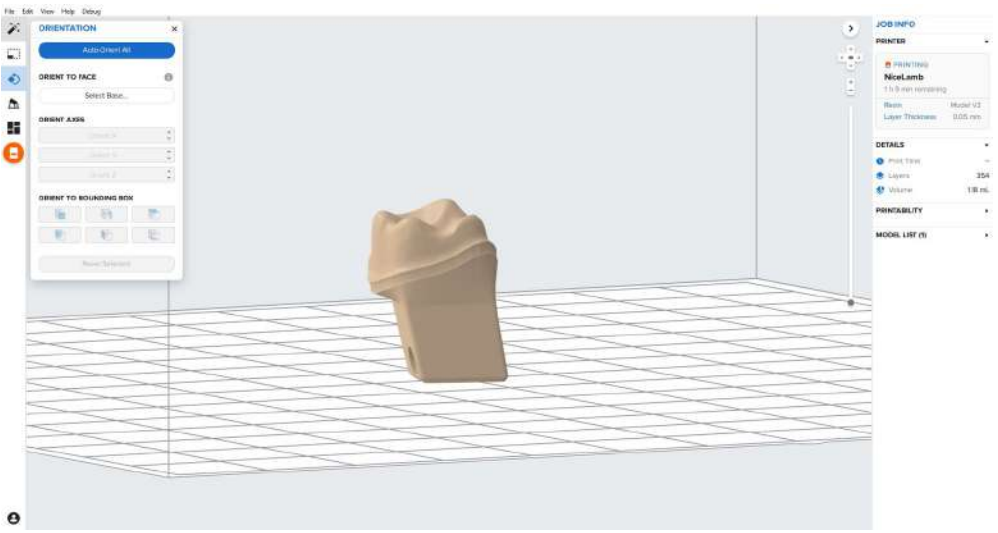
Repeat this process until all dies and models are snapped down to the build platform



Angled dies are not recommended

Straight insertion directions produce better and more consistent fits

This can be controlled in the CAD part of the workflow, click here for more information



If angulation is needed it is ideal to have the socket walls be straight up, perpendicular to the build platform

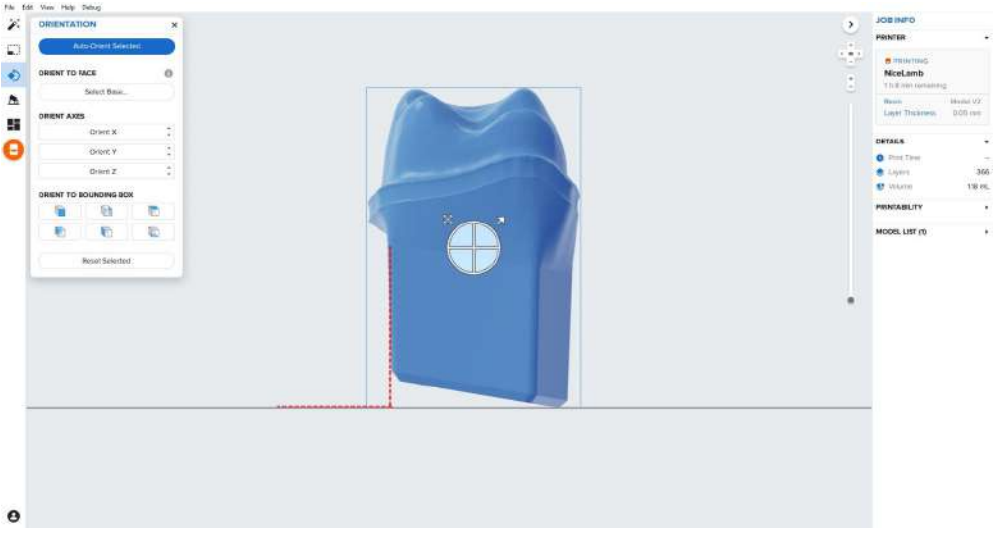
Click the view arrows on the top right of the screen to move to the front, left, and back sides of the print volume

Click on the die to bring up the rotation sphere

Rotate the view to multiple angles to confirm die is as vertical as possible

Click and drag the outer edge of the rotation sphere while view the die from the side

Here is an idealized angled die



Adding Supports (or not) to Models

There are two support methods for restorative models

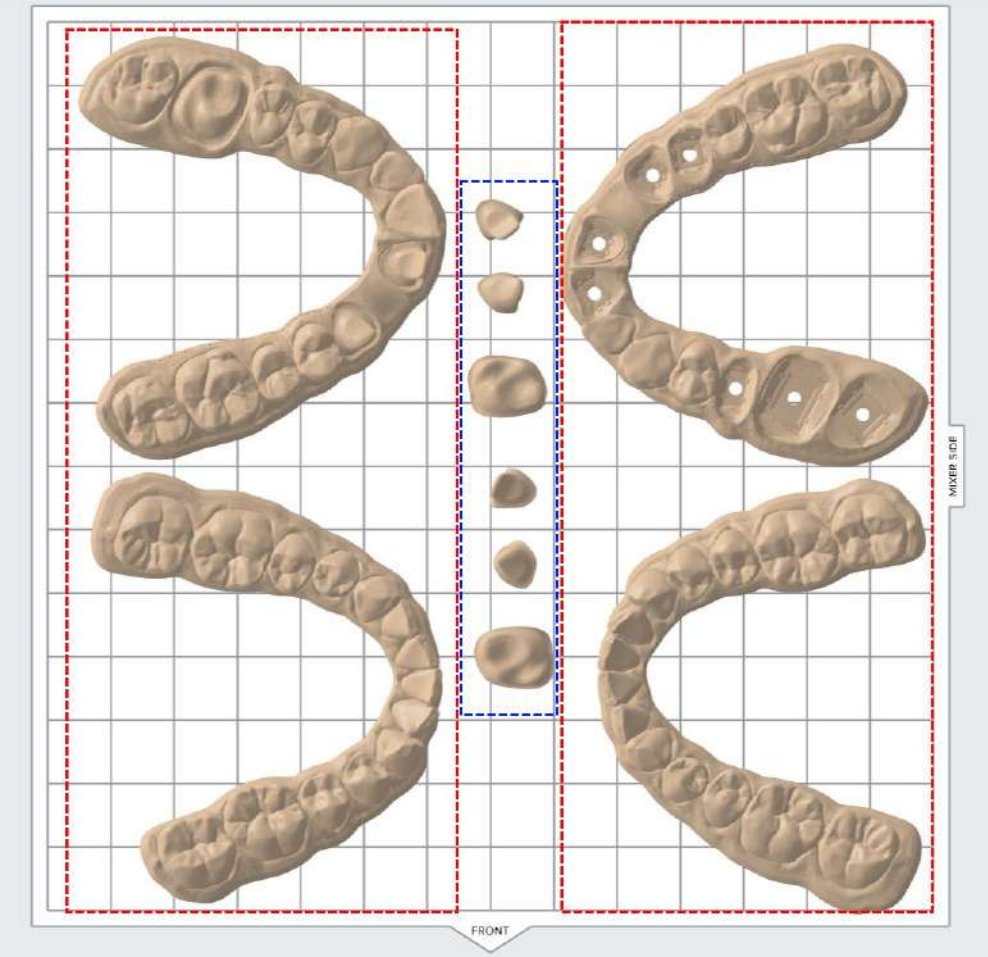
Support Method One: Operative and antagonist models (**outlined in red**)

Printed directly to the build platform and adding supports where needed

---

Support Method Two: Removable and working dies (**outlined in blue**)

Printed on a “Full Raft” and adding supports



Support Method One

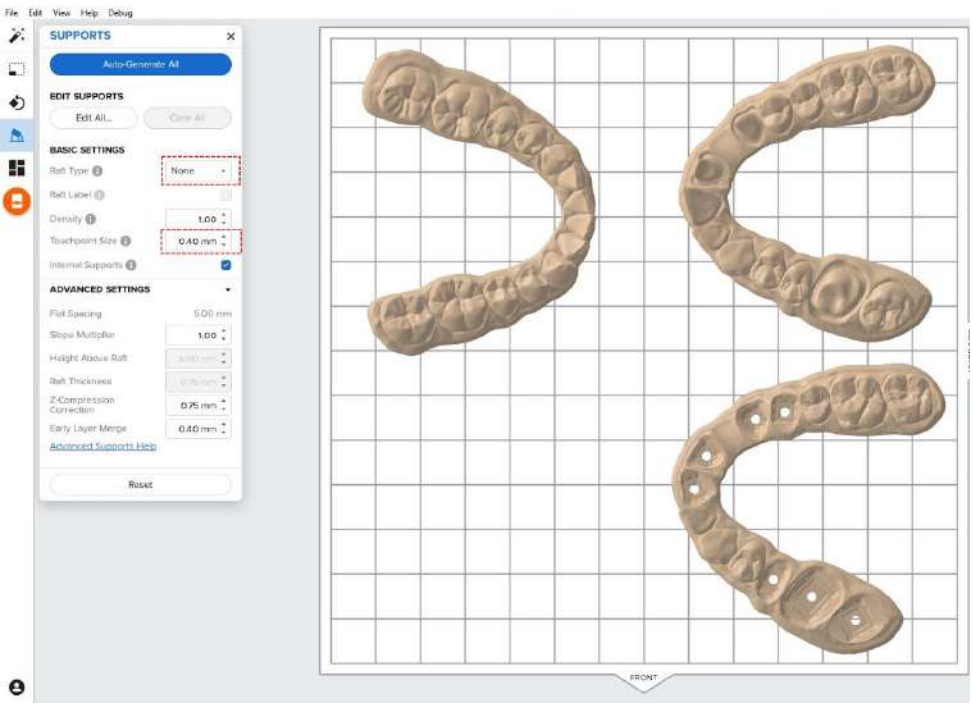
Operative and antagonist models should be snapped down and printed directly to the build platform

Solid models and antagonist models typically do not need any support structures

Operative models require supports on the side hole

Raft Type: None

Touchpoint Size: 0.40 mm



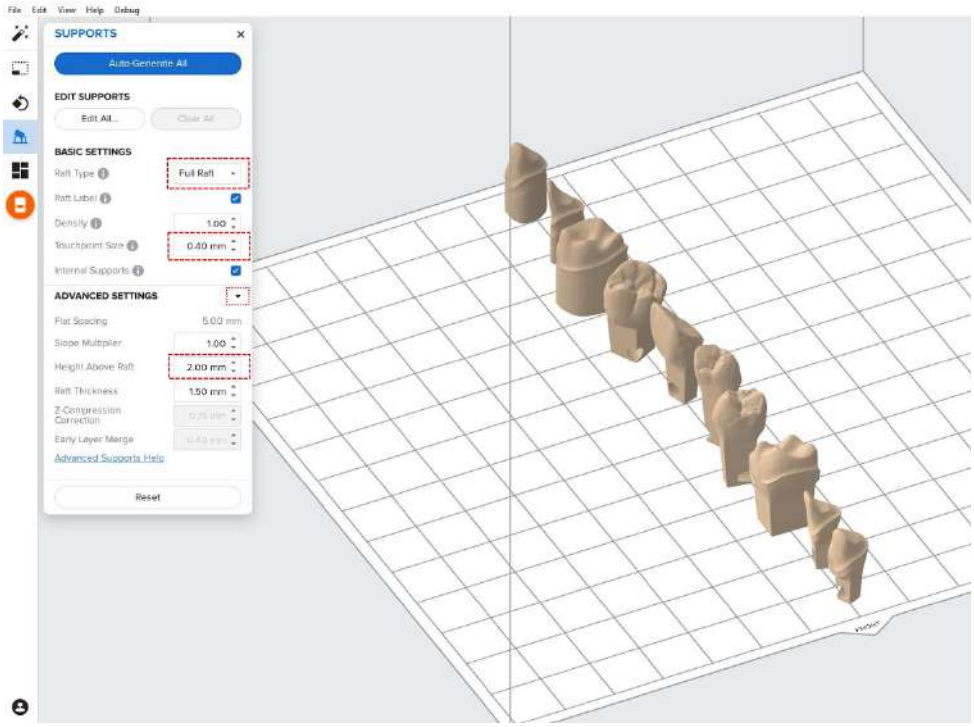
Support Method Two

Removable or working dies should be fully supported on a raft

Raft Type: Full Raft

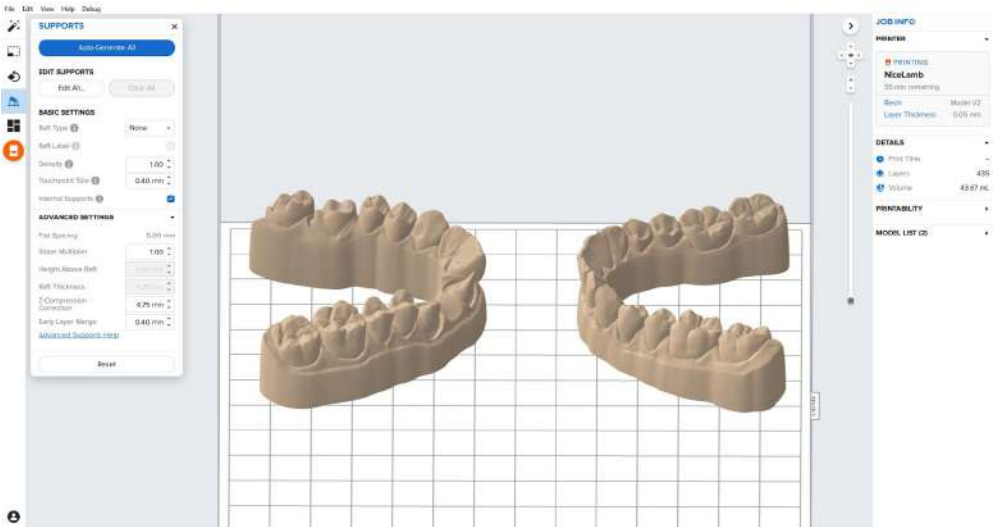
Touchpoint Size: 0.40 mm

Height Above Raft: 2.00 mm



Antagonist and solid models typically do not need supports

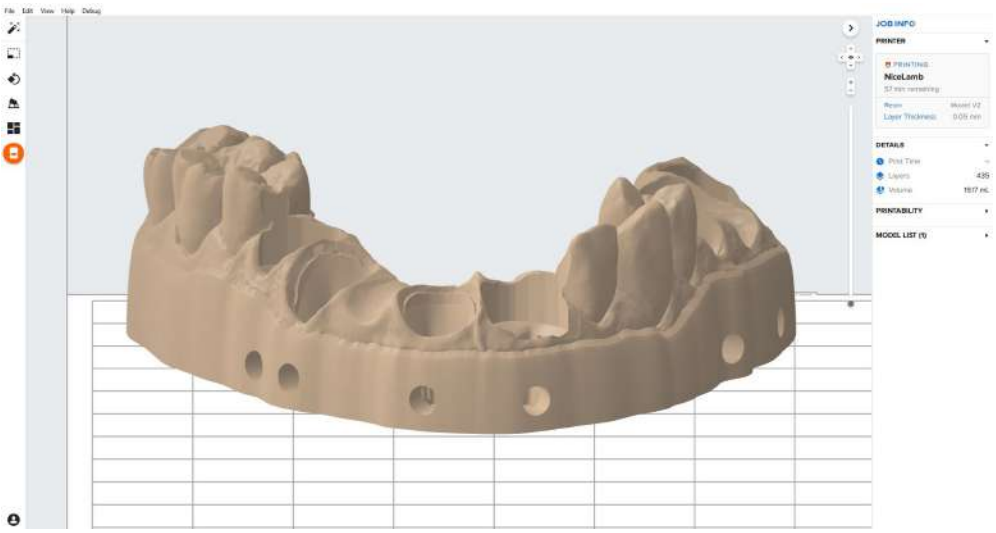
If one of these models do need support structures because of a angled wall or articulator add supports where needed using “**Support Method One”**



Removable die models have a side hole that allows technicians to confirm the seating of the die

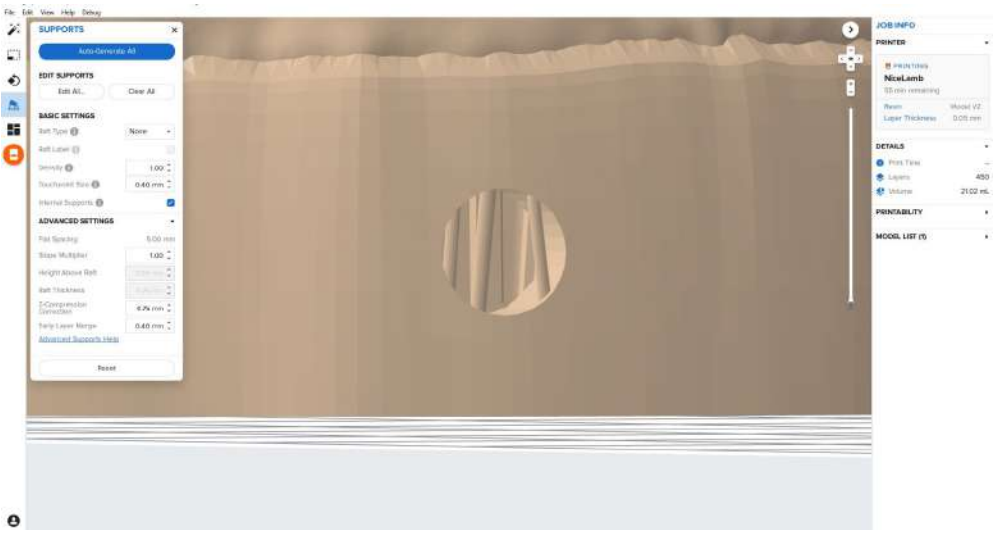
To properly 3D print the hole geometry a few supports are needed to be added using “**Support Method One”**

This is not needed for solid model kits



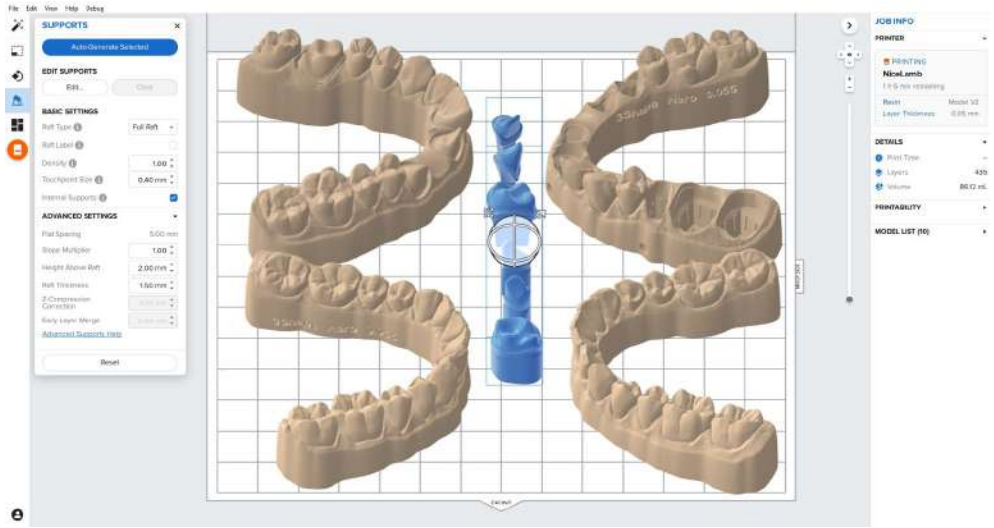
Working around the top of the side hole add supports from the transition of the holes top surfaces like pictured in the example

Here is the final supports generated

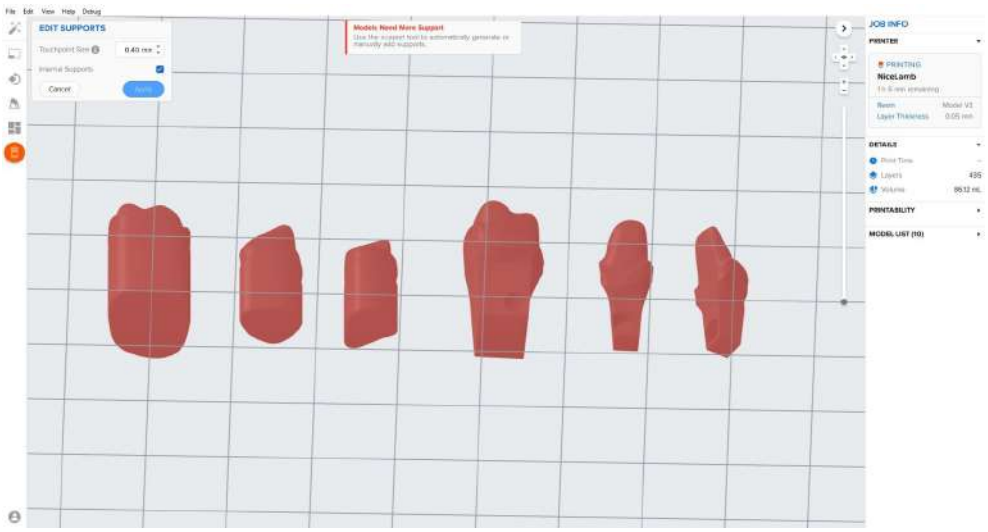


Adding Supports to Dies

To removable or working dies they should be supported and rafte using "**Support Method Two**"

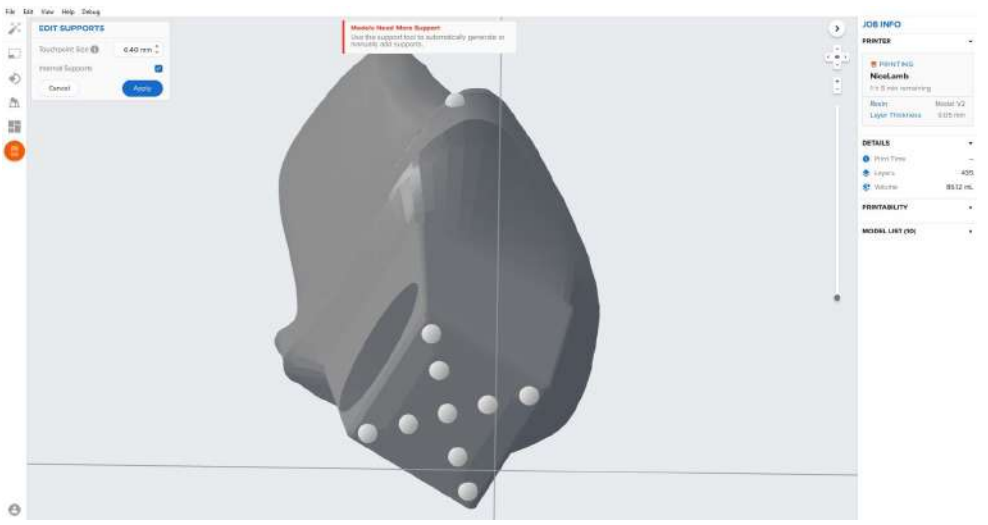


After clicking on the dies and editing those parts specifically



3Shape anterior die example

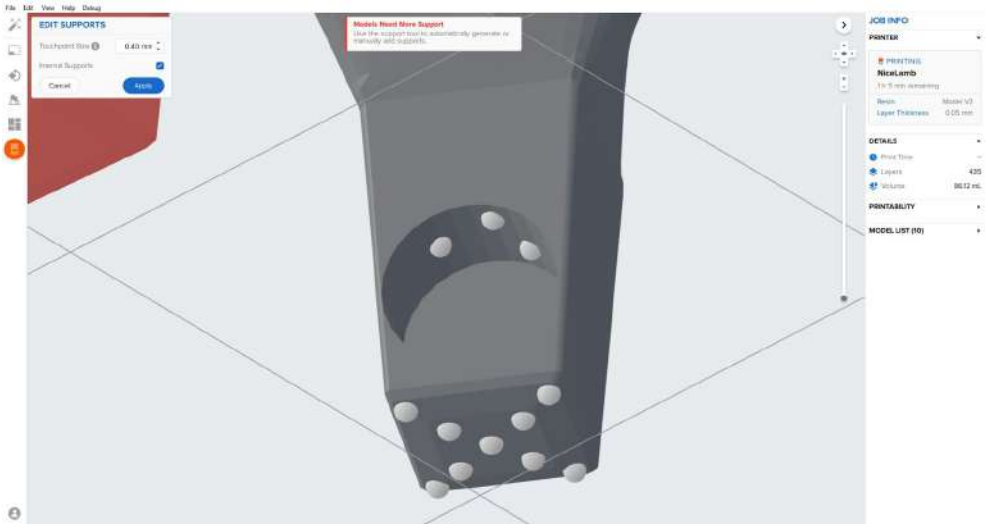
Add supports to the corners of the bottom most part of the die and add as many supports as possible to the bottom most surface like in the example shown



Removable dies have a side hole that allows technicians to confirm the seating of the die

To properly 3D print the hole geometry a few supports are needed to be added using

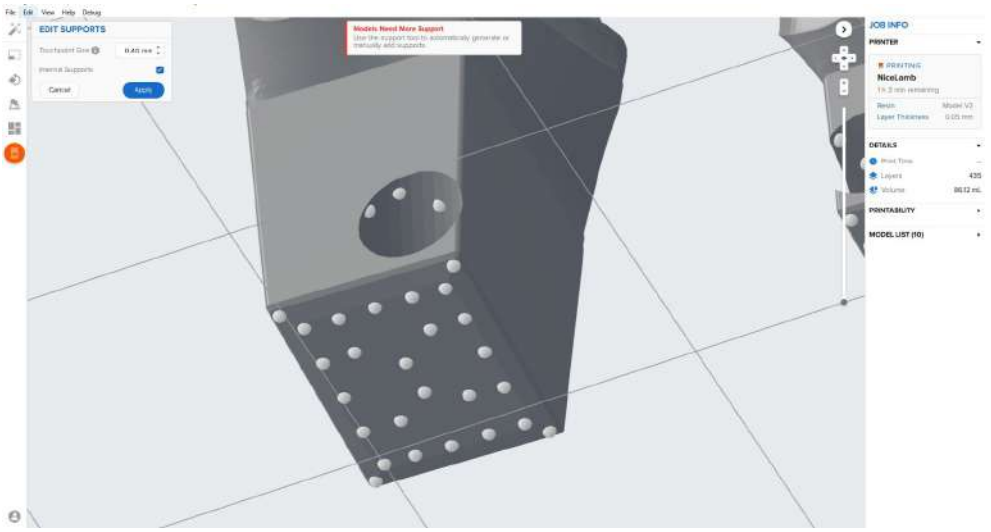
Working around the top of the side hole add supports from the transition of the holes top surfaces like pictured in the example



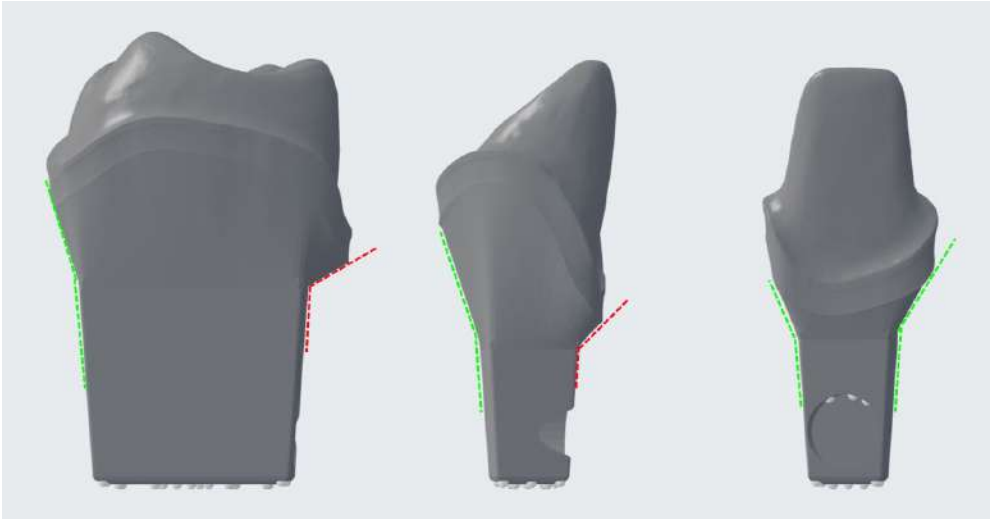
3Shape posterior die example

Here is a larger posterior die support example

Note: If you are concerned with the amount of supports added, the reduction of the touch point to 0.40 mm will allow the technician to easily remove and finish support touch points

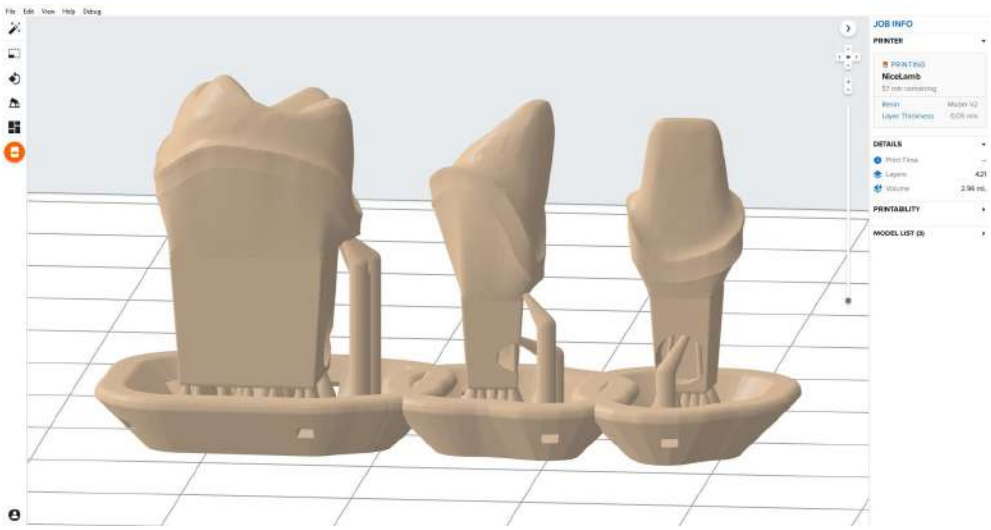


Wall angulation can occur, if you see the die has a angle that is almost parallel with the build platform it will need support structures



A lot of supports are not needed for these situation, use the example as guidance

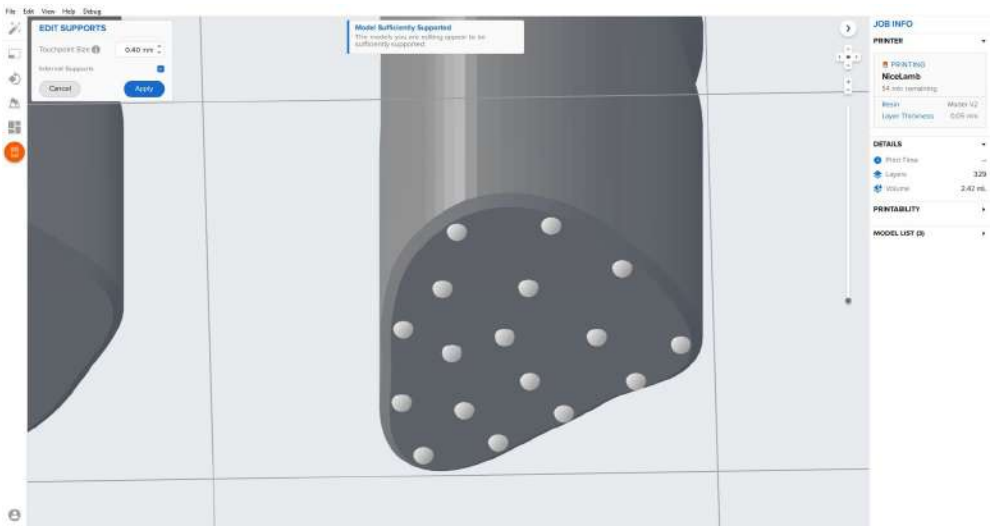
Here is the final result



ExoCAD anterior die example

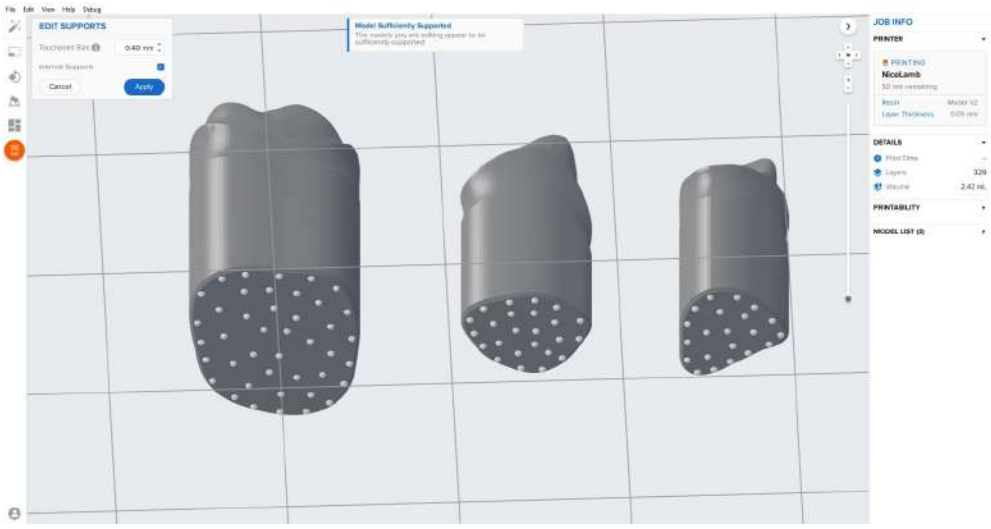
Follow the same procedure as outlined above for 3Shape for ExoCAD generated dies

Ensure the edge is properly supported but not touching directly onto the edge



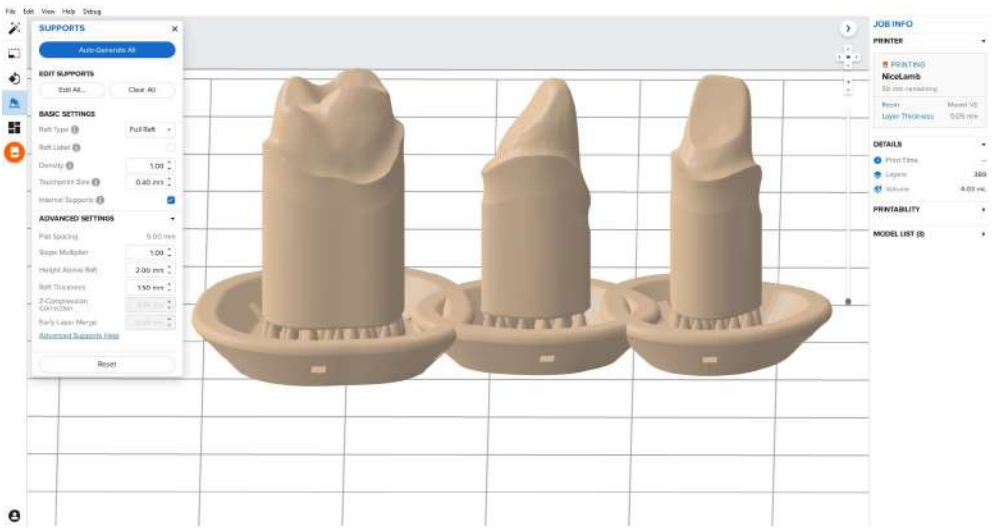
ExoCAD die example overall

Here is an example of a few different size supported ExoCAD dies



Note: If you are concerned with the amount of supports added, the reduction of the touch point to 0.40 mm will allow the technician to easily remove and finish support touch points

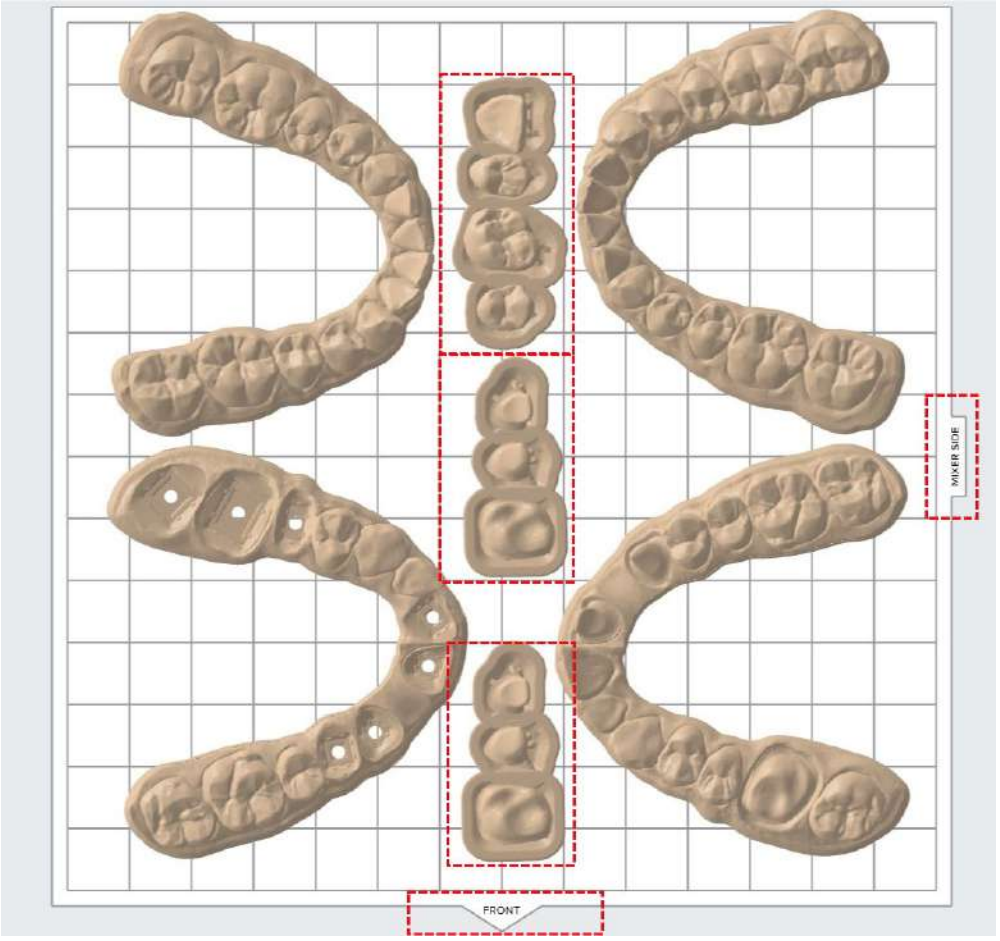
The final result for ExoCAD



Print Layout and Part Positioning

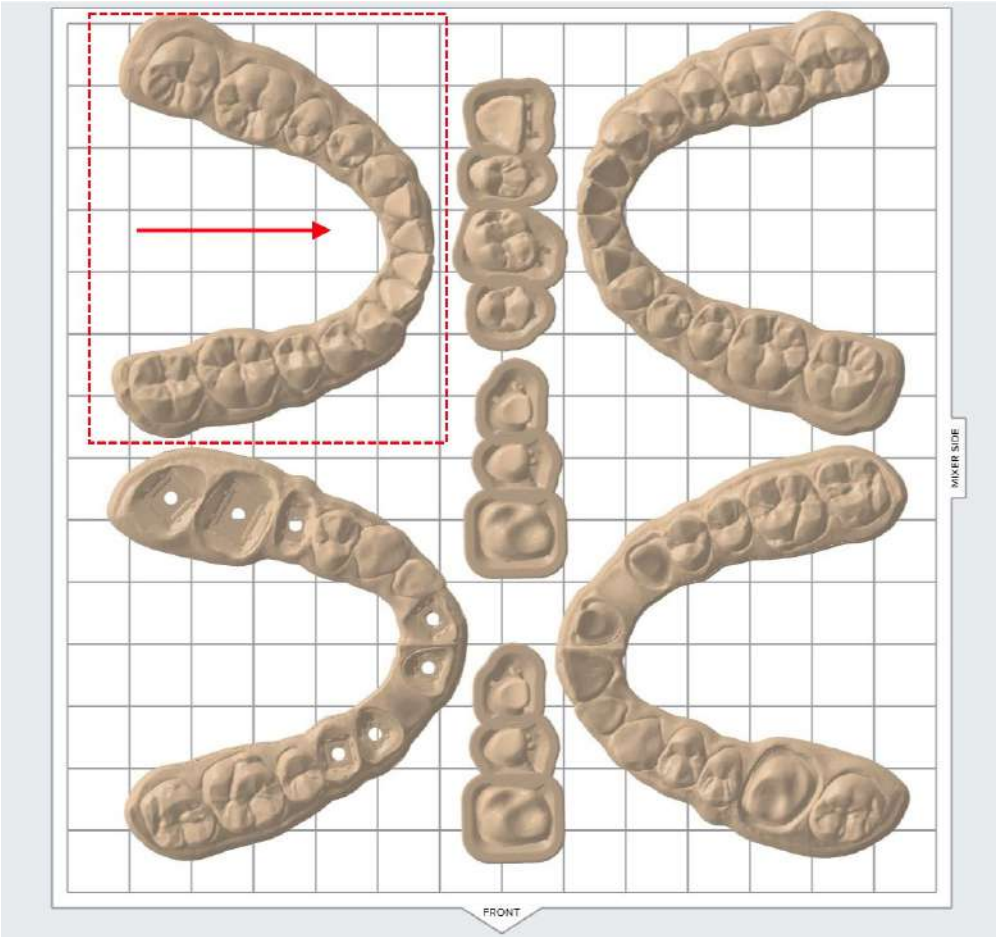
Line dies up perpendicular to the front of the build platform

Overlap rafts to improve print reliability



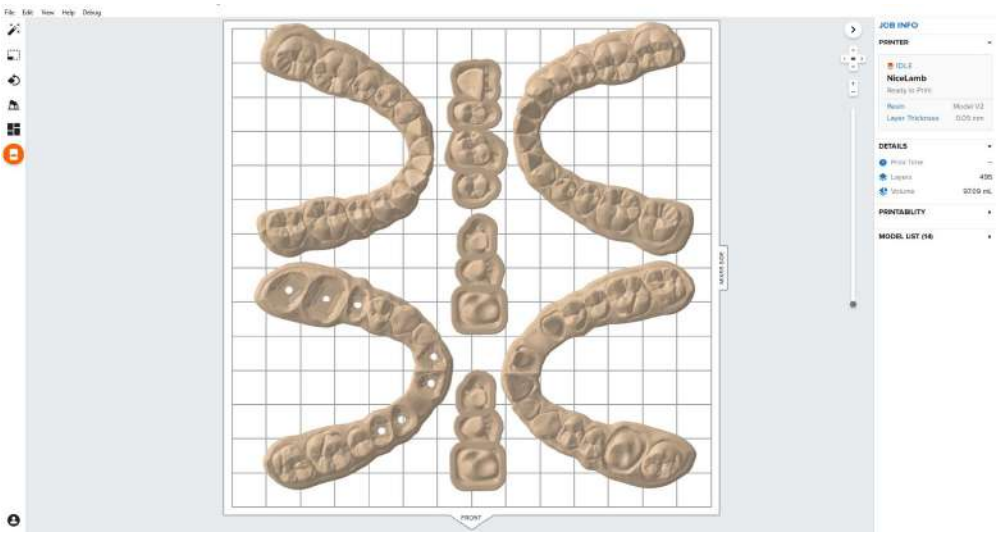
Rotate the anterior part of the model towards the middle of the build platform

Move the models as close to the dies as possible

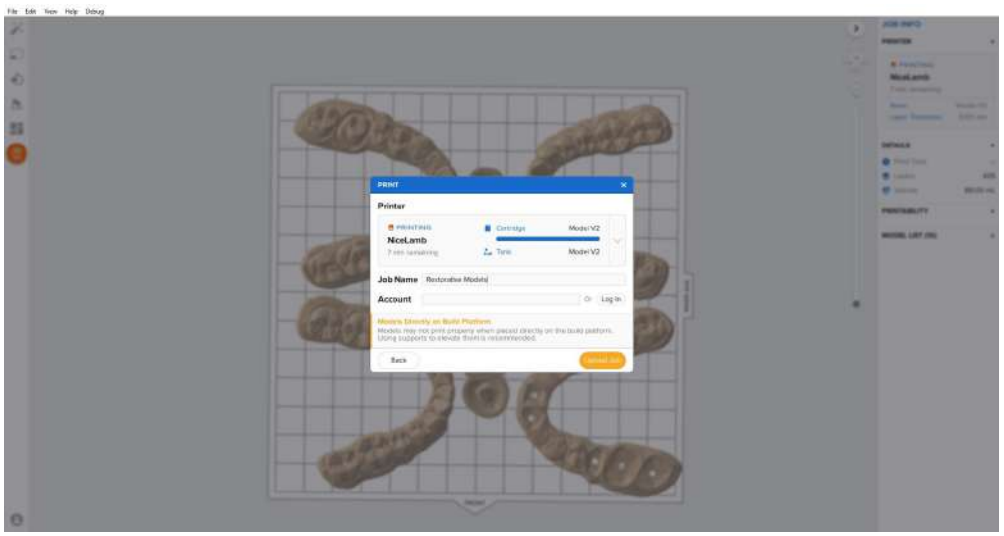


Positioning and layout finished ready for printing

Click the orange printer bottom on the left



Select your printer and upload your job to the printer



Note: Always shake and mix your resin cartridge before each print
Optional: Use a gloved hand to hand-mix the tank by moving the wiper (helpful when tank has been sitting)

Next Step: Post Processing

One printing has completed post processing the parts is the next step of the process

[Post Processing and Finishing Restorative Models]

formlabs | dental

Post Processing and Finishing Restorative Models

Formlabs Form 3B

formlabs | dental

Proper post processing is critical to consistent restorative models.

Always use gloves! Do not touch raw resin with bare hands, if you get resin on your hands or body use soap and water to wash the area.

1. Removing Models and Dies from the Build Platform

Note: You can wash parts directly on the build platform but isn't recommended

a. Most of excess resin is left on the build platform and will rapidly degrade the purity of the isopropyl alcohol reducing its life
b. Doesn't allow it to flow properly into certain areas like die sockets
c. Reduces the life of the build platform (IPA can degrade seals over time)

Since the models are printed directly to the build platform it can be difficult to remove the part

Using a razor blade around the edge of the part breaks the seal between the part and the build platform

Two options for recommended tools

- Long Scraper Razor Blade Scraper (Use this tool upside down, it gives a great scraping angle)
- Mini Scraper
- Extra Blades (10 cents per)

Always use a sharp, straight, blade

Replace if the edge becomes dull or deformed

Replace the blade weekly at least

Hold the bottom of the build platform firmly

Push against a table or wall

Do not cut toward the hand holding the build platform!

Apply even pressure to the scraper and push into the model (don't push too hard)

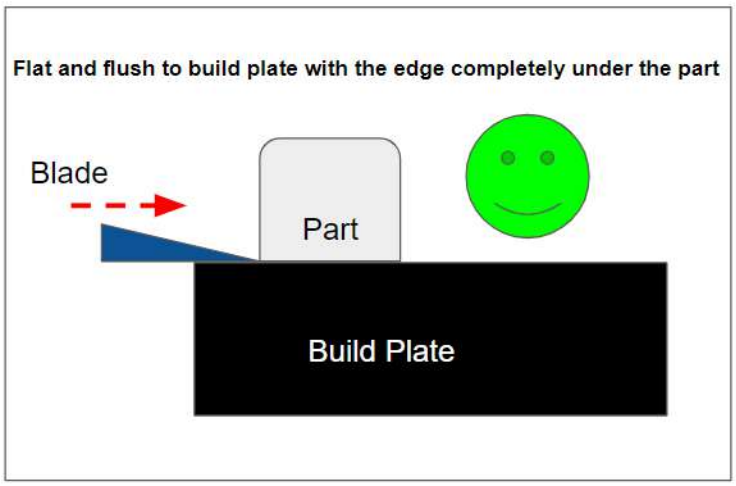
Work around the part in as many spots as possible

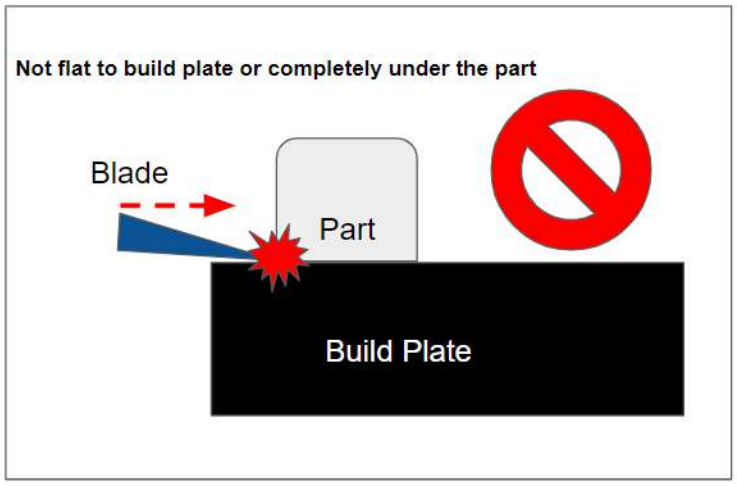
If the blade, build platform, or part gets damaged:

The blade edge is not completely under the model

Too much force is being applied to that specific area

Blade should be replaced





Once you get under the model, even if only slightly, the part will pop off

Tip: After removing the parts from the build platform use a squeeze or spray bottle and paper towels to quickly clean its surfaces, preparing it for the next job

2. Remove Flashing From Die Ejection Hole

Note: Only a requirement for removable die models

To punch out the hole and for easy die removal we recommend having a ⅛ inch (~3.175 mm) “Scratch Awl” or something similar. You can find the tool online here

In the image you can see the die ejection hole has a very thin layer of material closing it off

This process can be done right after removing the model from the build plate or after a quick rinse in “dirty” IPA

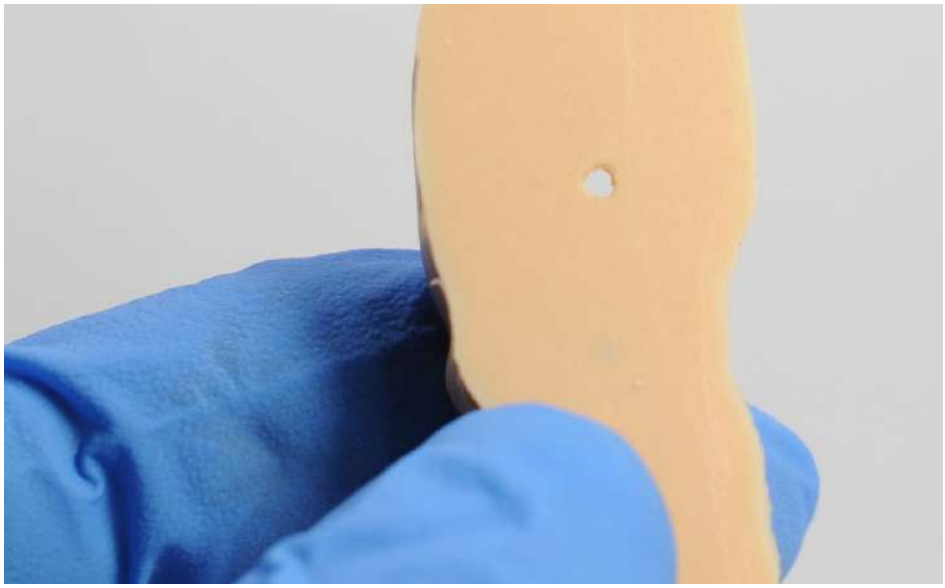
We recommend doing it at this stage because the hole allows the flow of solvent through the socket during the washing process

Insert the awl from the top, ensuring the location of the hole

Push through completely until it stops, repeat if necessary

With the edge of the tool remove and finish the bottom of the models die ejection hole

Here is an example of what it should look like after this process and finally with all of the die ejection holes finished.



3. Washing Parts in Isopropyl Alcohol

Note: Having completely clean parts is critical to ensure fitment of dies and restorations.

It is best to have a two bucket and/or step washing workflow for properly cleaning models and parts. The first wash is an initial wash to remove the majority of resin from the part and typically dirties very quickly, the second wash should be almost completely clean. This can be achieved in a variety of equipment and setups as outlined below.

Tips:

- The higher percentage of isopropyl alcohol does a better job of cleaning parts and lasts longer (ie 96 vs 99% IPA)
- As the “clean” wash dirties it should be used in the “dirty” wash, the “dirty” wash should be recycled according to local regulation, and finally fresh IPA should used for a new “clean” wash station
- The Form Wash comes with a “**hydrometer**” that can test the purity of a wash or finishing bucket you can find

instructions here
- Biocompatible resins should have their own washing system

3.a Finishing kit only

1. 2 to 5 minutes of agitation in the first bucket or “dirty” IPA
2. 5 or more minutes of agitation in the second bucket or “clean” IPA

3.b Finishing kit and Form Wash

1. 10 to 15 minutes (depending how dirty) of washing in “dirty” IPA in the Form Wash
2. 2 to 5 minutes of agitation in a finishing kit bucket or “clean” IPA

3.c Two Form Wash

1. 10 to 15 minutes (depending how dirty) of washing in “dirty” IPA in the Form Wash
2. 5 min of washing in “clean” IPA using a Form Wash

Optional: Having a final clean rinse bucket of IPA can be helpful for secondary clean washes

4. Drying Washed Parts

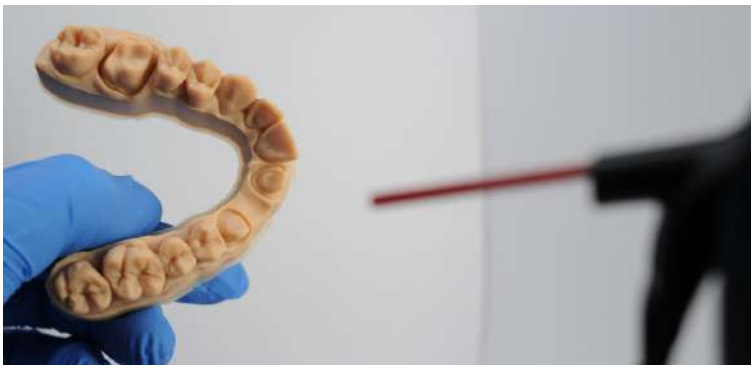
Note: Be sure to use ventilation, safety glasses, and other safety equipment when using compressed air with IPA

To ensure resin has been removed from holes, sockets, and ditching it is ideal to use compressed air on those areas right after the part is removed from its final “clean” wash

For absolutely flawless parts repeat this process a few times

Allow parts to completely dry for 30 mins or a few minutes of (clean & dry) compressed air combined with a few minutes of open air drying

If using compressed air hold the part 6 to 12 inches (15 to 30 cm) away from the nozzle

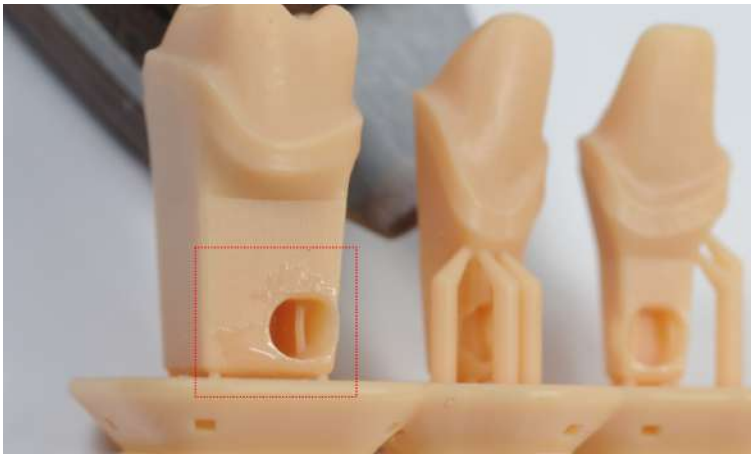


If parts still have uncured resin on them (it will look shiny, be sticky, and not dry) wash in clean IPA for another minute (blowing with compressed air helps)

See the image as an example of a part with resin left on the part after washing

If absolutely necessary you can use a soft brush to remove resin while the area is wet with resin (dunking or spraying the area with clean IPA)

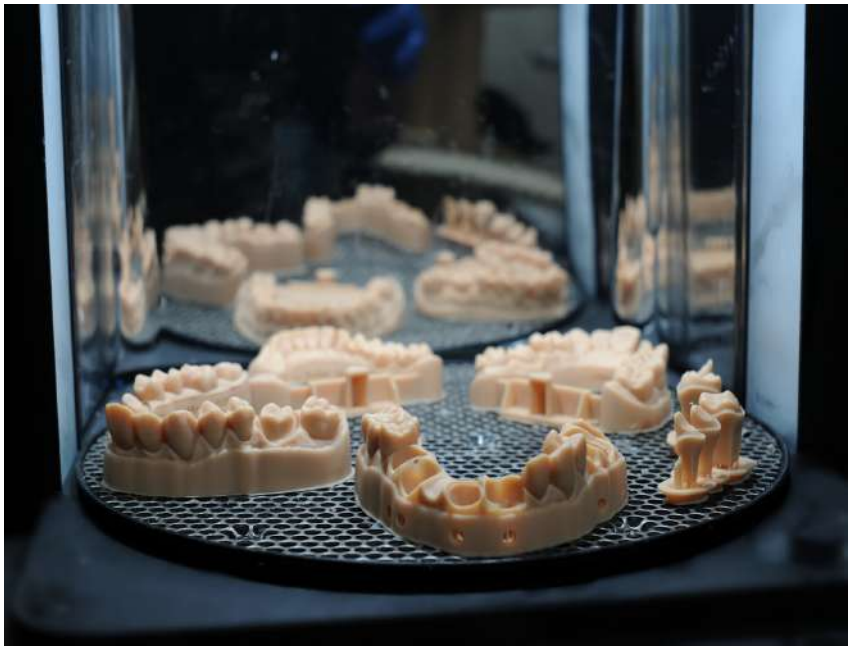
Be very careful not to abrade the area too aggressively
Do not use the brush on the abutment or preperation



The Curapox Ultra Soft brush is what we'd recommend:
[Link]

5. UV Curing

Note:
1. Do not overload your cure unit with models or parts, it will produce parts that are not completely UV cured (see ideal example)
2. Make sure parts are completely dry before UV curing
3. Do not use a steamer or wash parts in water before UV curing (completely fine after UV curing)



Model Resin should be cured in a Form Cure for 30 min at 60 c

After UV curing allow models to cool for 5 to 10 minutes inside cure chamber or on a table

Note: For 3rd party UV curing units ask the manufacturer what the standard UV cure time should be used for opaque 405 nm (nanometer) photopolymers (not recommended)

6. Removing the Flashing from the Bottom of the Model (optional)

Note: Formlabs is working on reducing the amount of flashing that occurs on Model Resin and the Form 3B to remove the need to finish models. Always update Preform and firmware for the latest improvements and features.

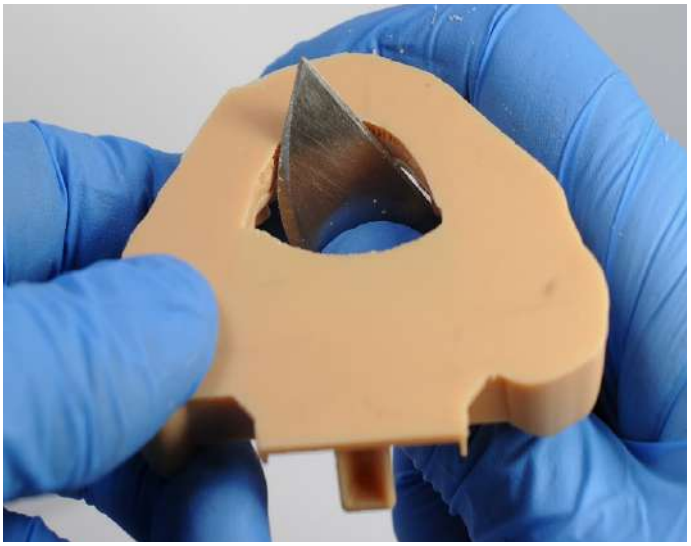
To make your models look even better an optional step is trimming the flashing off of the base of the model

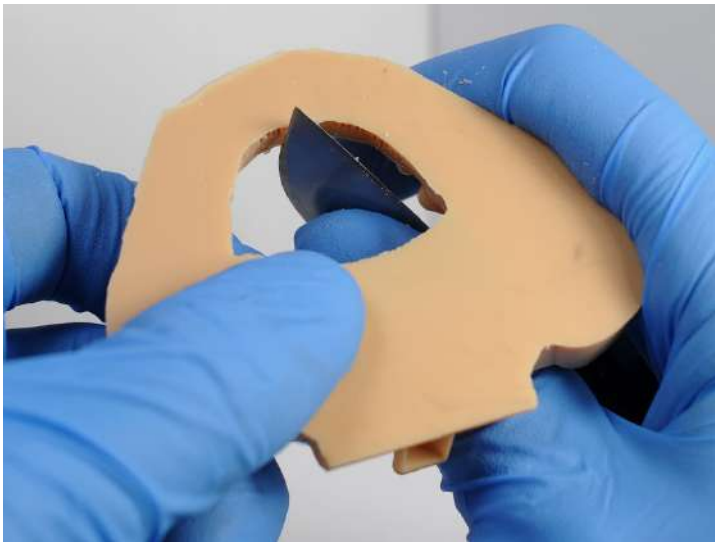
- Buffalo Dental No. 12 Knife or something similar - Link
- Dental handpiece with cylindrical or football rotary

The easiest and quickest way to remove flashing is using the back of a knife, like pictured

Any rounded, straight, metal tool that you can hold will work

Run the edge of the tool flush to the vertical wall to quickly work the edge off



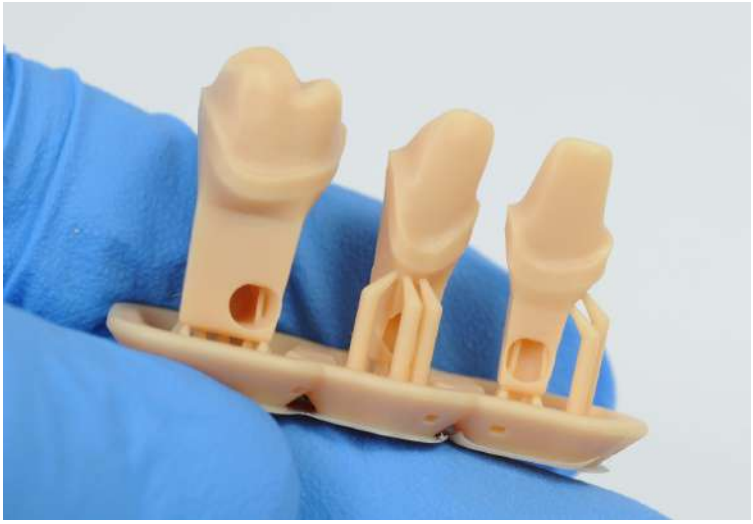


If a bevel is desired use a cylindrical, barrel, or football grinding tool and work quickly and evenly around the models edge

Blow the dust off with compressed air

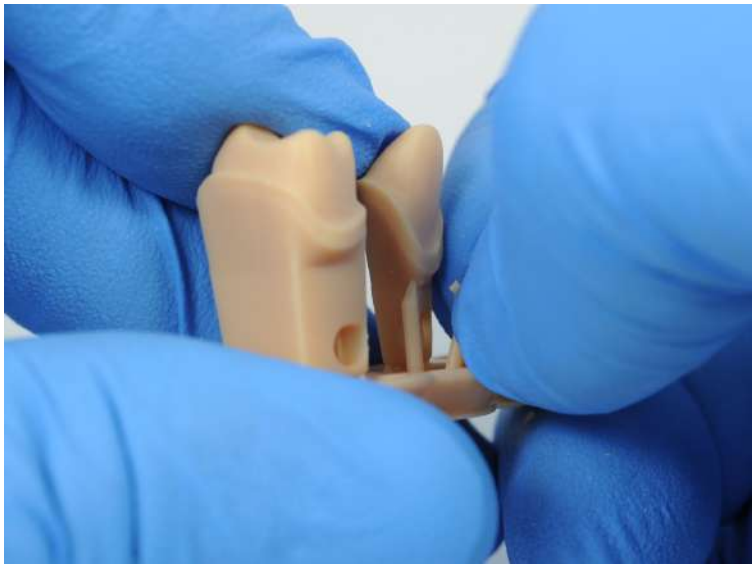
7. Removing Supports from Dies

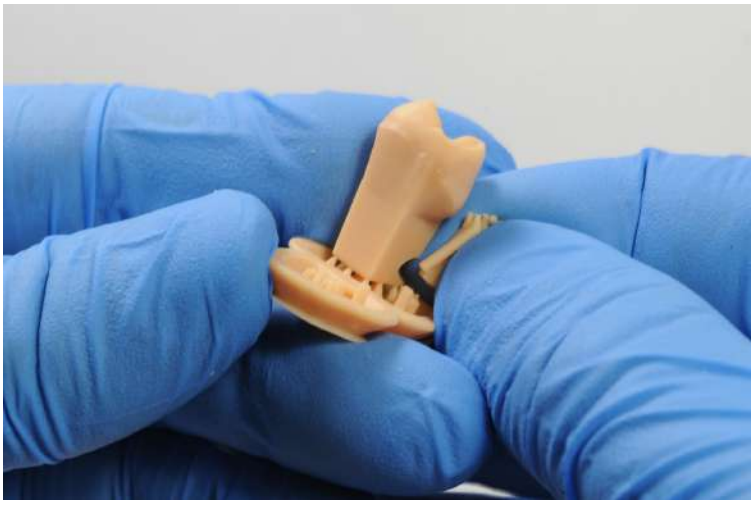
3Shape die example



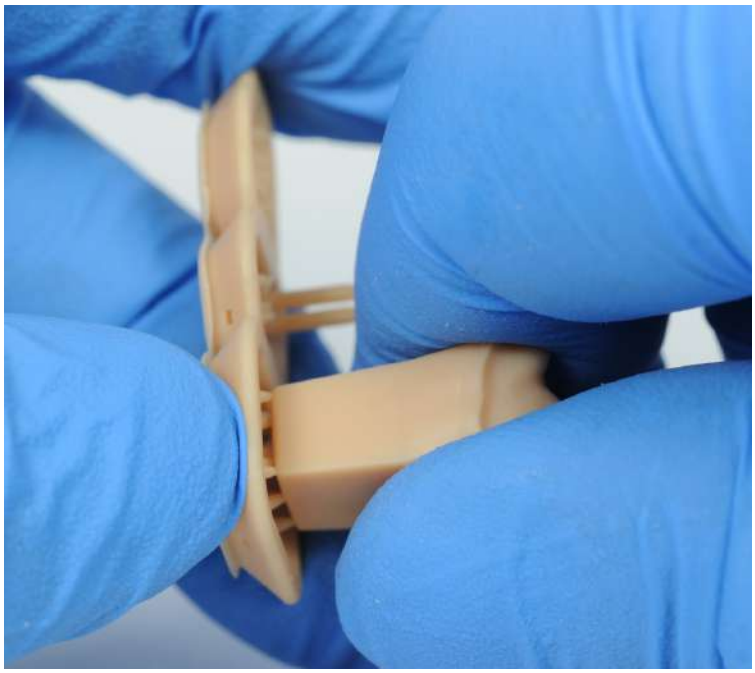
ExoCAD die example

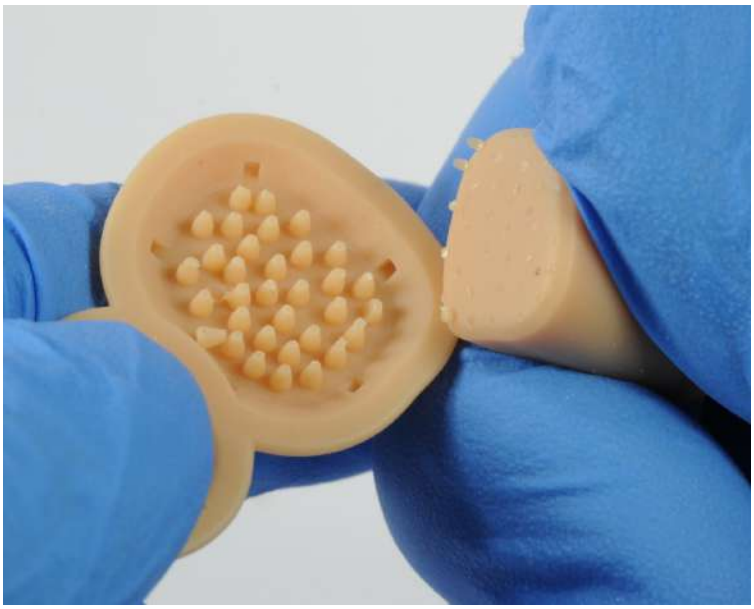
Snap the supports attached outside of the base surface first

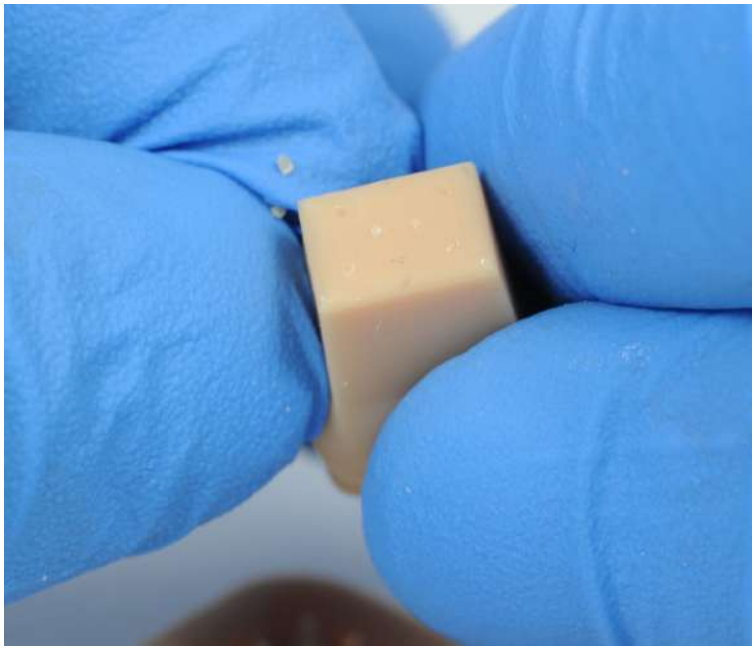




Holding the base with one hand and the die with the other snap the die from the raft
If it is too difficult or for very small anterior dies use the flush cutters to snip the raft







8. Solid Model with Working Die Workflow Complete

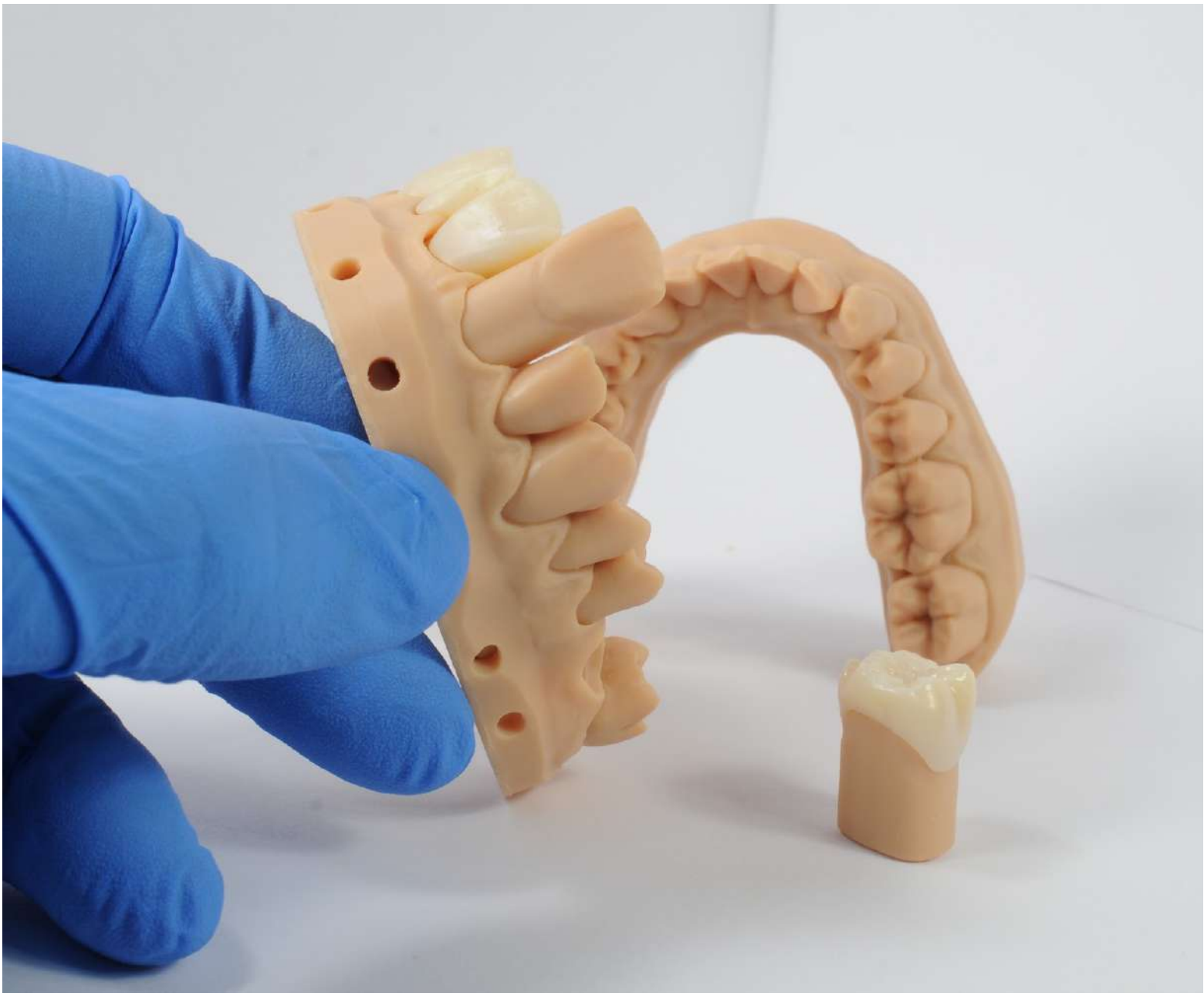
This concludes the guide on how to make solid models with working dies on the Formlabs Form 3B
Any questions or concerns feel free to email dental@formlabs.com and be sure to visit dental.formlabs.com

Thank you

If you are looking to produce removable die models continue to the next step

9. Next Step: Finishing and Using Removable Die Models (Not needed for solid models)

Proceed to the next step and guide: Finishing, Using, and Testing for Removable Die Models



formlabs | dental

Finishing, Using, and Testing for Removable Die Models

Formlabs Form 3B

formlabs | dental

This guide starts with the normal workflow working with 3D printed removable die models but users should start by testing for what 3Shape or ExoCAD offsets are best for you and your Form 3B. The test, tools, and workflow outlined in this guide will ensure repeatable fitment of removable die models.

Tools and Materials Needed

Cleaning Tools

- Buffalo Dental No. 12 Knife or something similar - Link
- Die removal and socket cleaning a ⅛” “Scratch Awl” or something similar - Link

Dry Lubricant for Die Insertion

Option One

- “Super Lube” - Spray PTFE - Link

The best spray dry lubricant, works very well and **recommended**

Goes on completely clear

Food grade

Option Two

- Talcum Powder - Link
- Flat brush for application

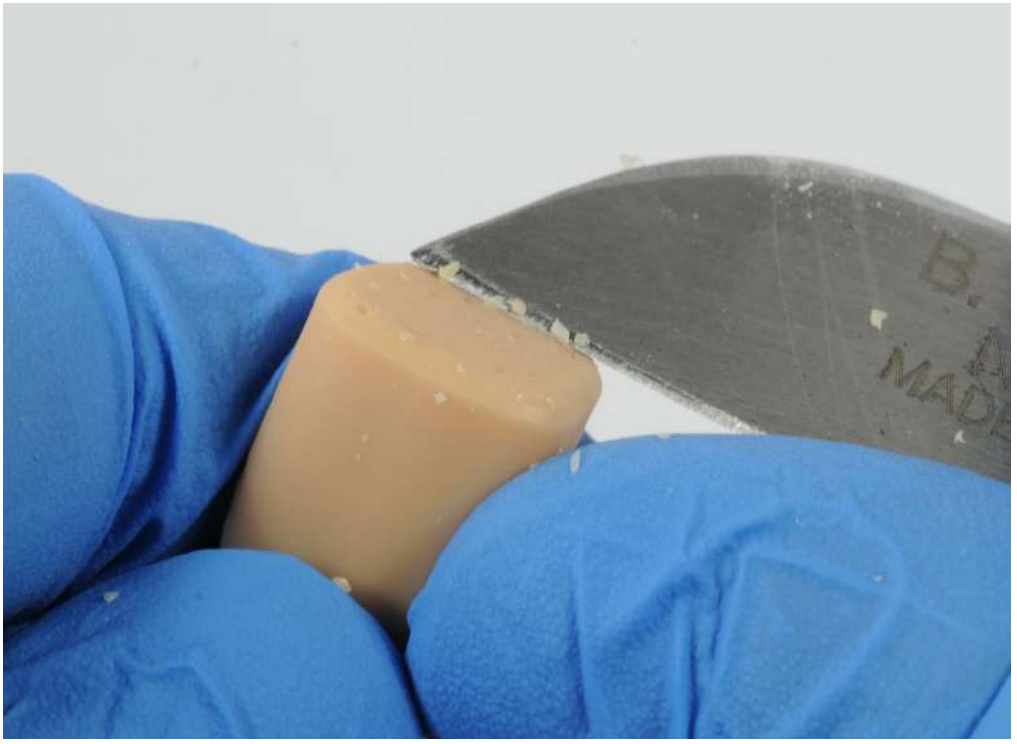
Very easy to use, does require reapplication after a few seatings

Preparing the Die for Seatment

Trim and flatten bottom of die

Helps prevent unwanted interference with fitting


MADE IN U.S.A.

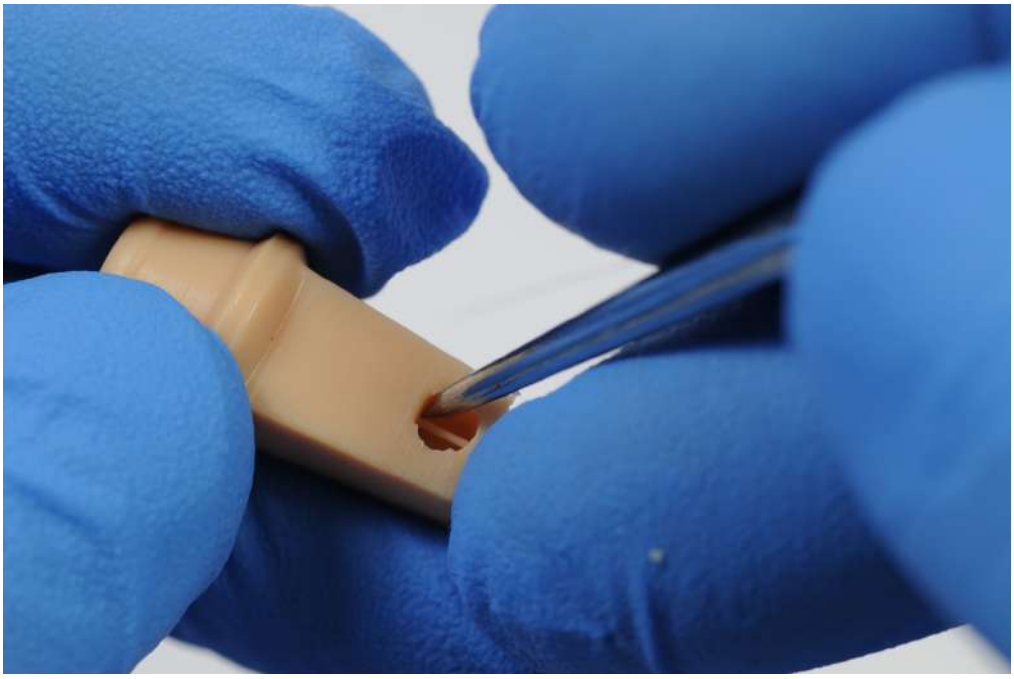


Trim the corners and edges of the bottom of the die

The bottom of the dies should look something similar to the example shown

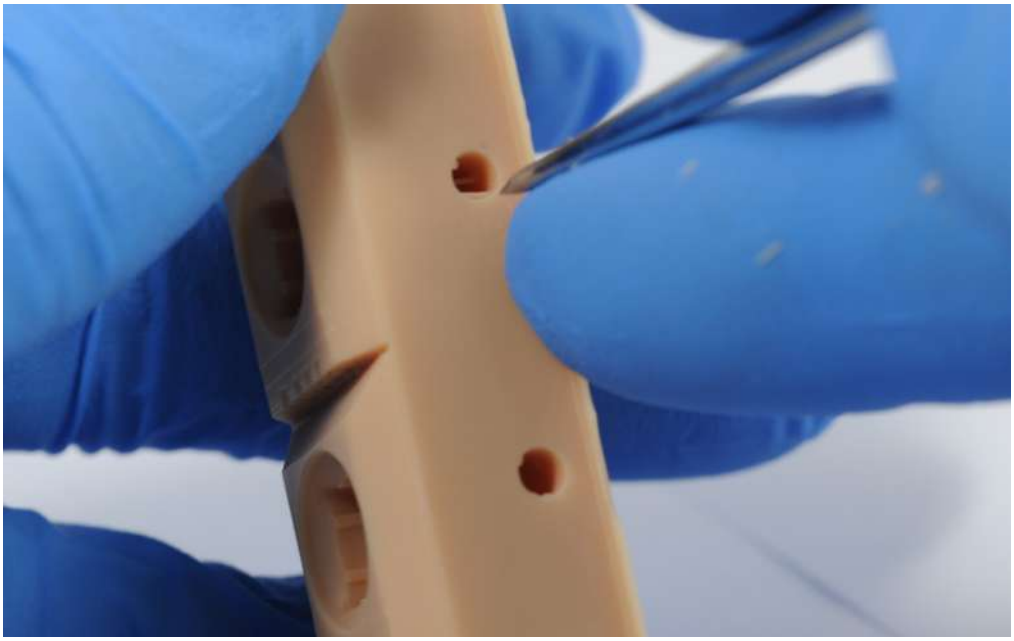
Optional

Using the awl, punch out the supports at the top and base of the structure



Use the same technique for the seating holes

Allows for seating of the die to be seen completely



Die Insertion and Fitment

Apply dry lubricant

Option One

- “Super Lube” - Spray PTFE - Link

After shaking the can of “Super Lube” spray the material into the sockets

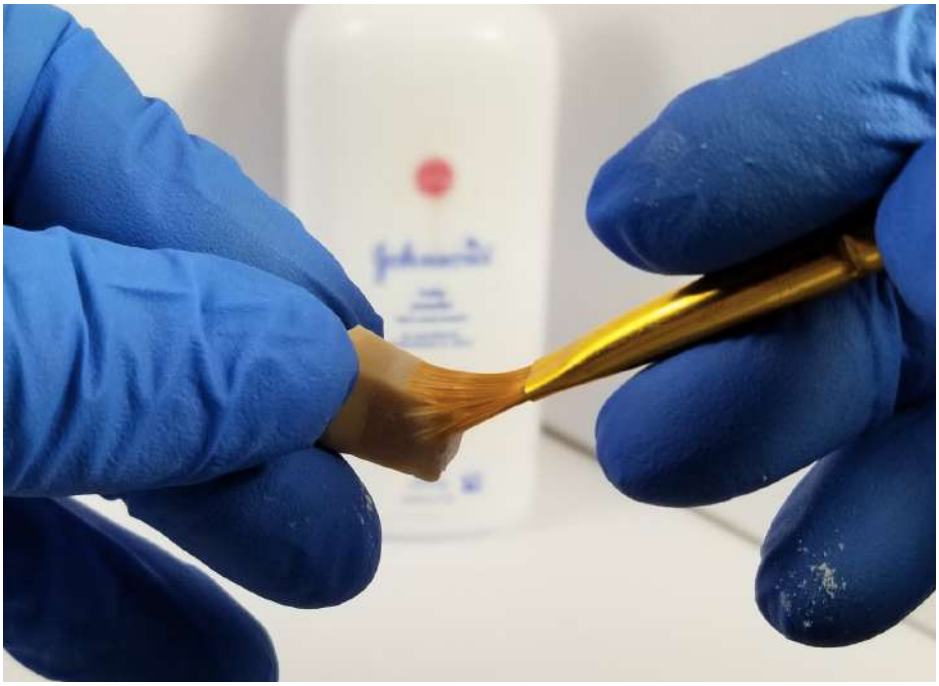
Allow propellant to dry before seatment

Option Two

- Talcum Powder - Link
- Flat brush for application

Brush the shaft of the die with powder on all sides

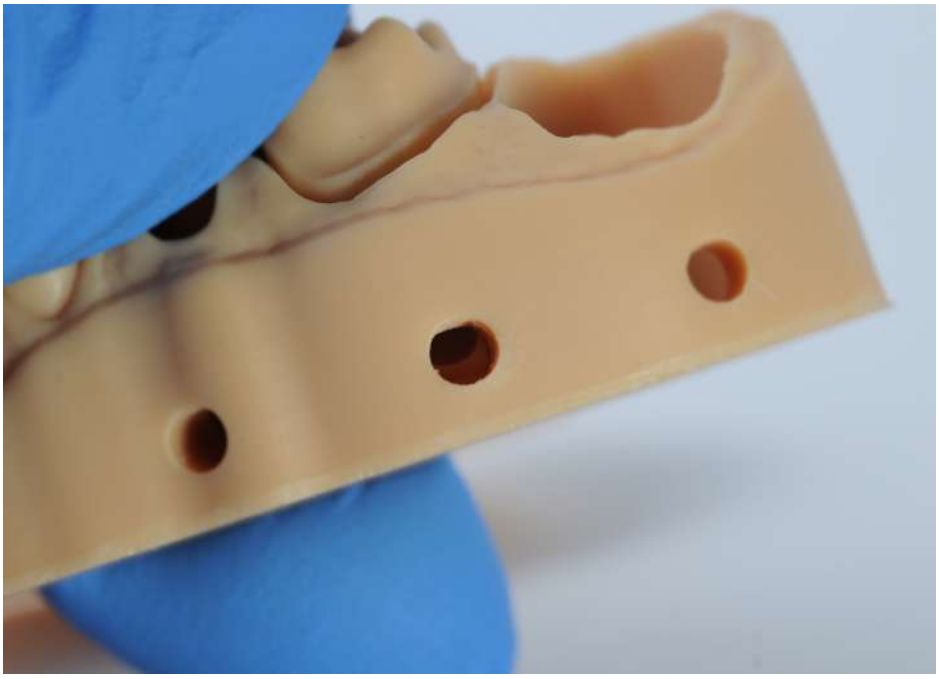
Reapply if needed



3Shape only

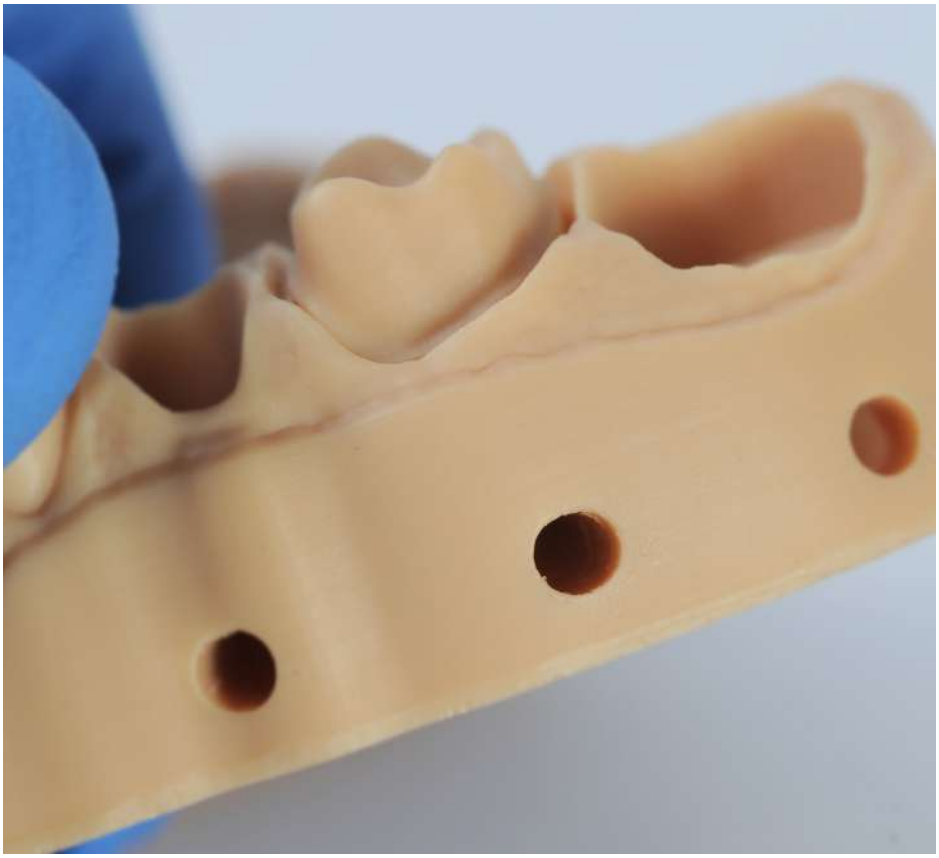
Check die fitment with die seatment or alignment hole

In the example you can see a “crescent moon” shape, indicating its not in the correct vertical position



3Shape only

The die and model hole edges should line up once completely seating



After a firm insertion of the die if the alignment hole does not match:

Check the bottom die pin hole to see if the base of the die is down flush (see image)

For ExoCAD seatment of the die should also be check from the bottom hole as shown

To ensure proper vertical seating print and complete the [ExoCAD test block]

Die Seatment Troubleshooting

Is the base of the die flush to the bottom hole of the model?

If...

No

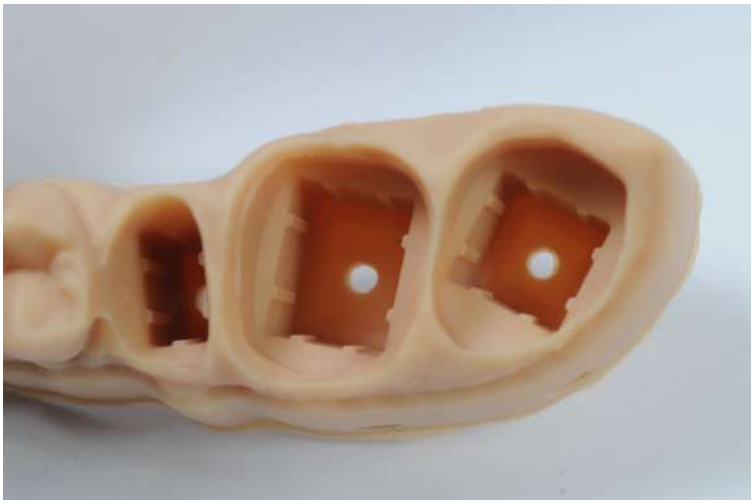
The die is not inserted completely

1. Check the socket for obstructions
2. Trim the edges and corners of the die base (not the base)
3. Apply more dry lubricant to the socket(s)
4. If after all those steps the die still doesn't seat, use a wood tool to push the die with more force

Yes, but the holes are not aligned (3Shape)

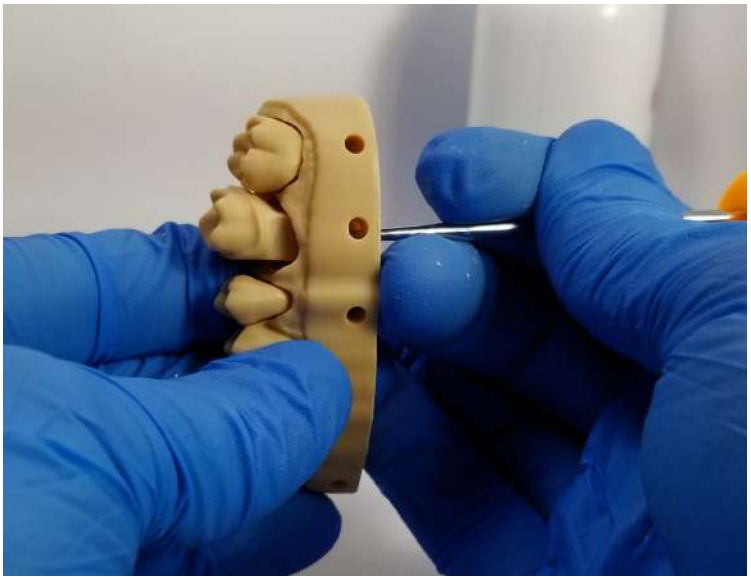
The base of the die needs to be trimmed further with a knife

Cut a small, even, amount of material from the base of the die, reseat, and repeat if necessary



Die Ejection

Using the awl you can push the dies out of their sockets easily



CAD Offset Testing Block and Workflow

Testing Block Introduction and Print Files

ExoCAD Test Block for Die Fit

Download the ExoCAD test file: here

Video version of this guide: here

3Shape Test Block for Die Fit

Download the 3Shape test file: here

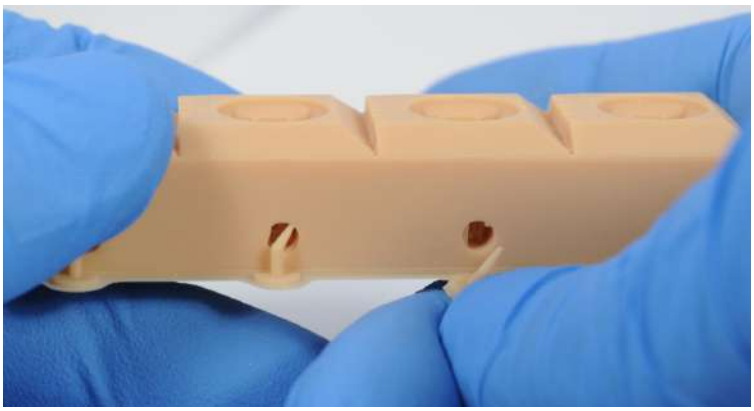
Video version of this guide: here

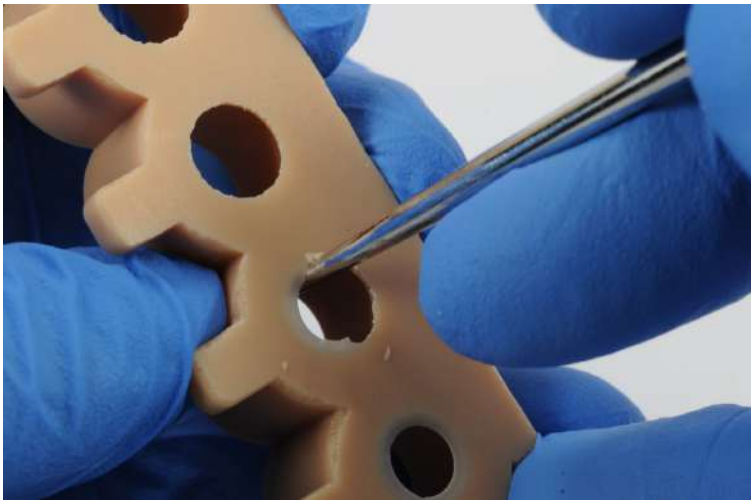
Load the appropriate test file into Preform and 3D print the job on your Form 3B using Model Resin at 50 micron layer height (it should be default when loaded)

Follow the post processing and finishing procedures outlined previously in this guide

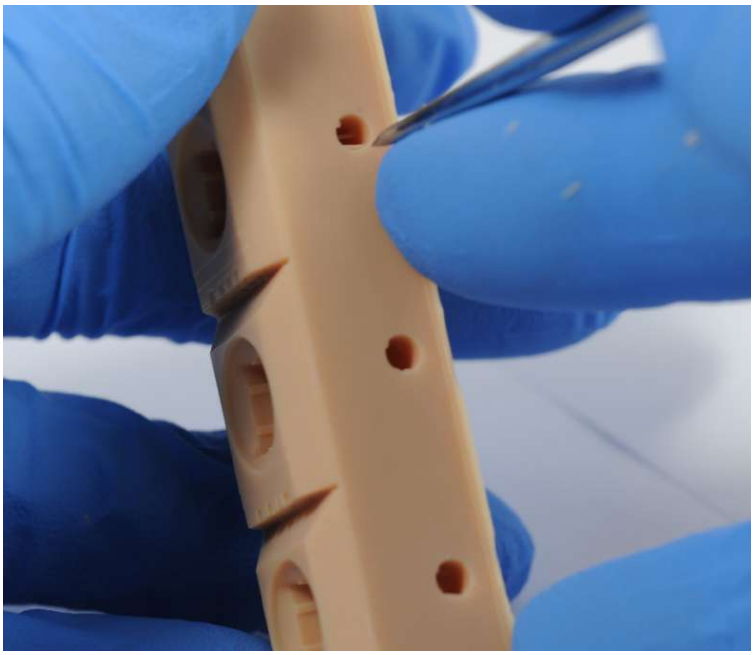
Preparing the Testing Die and Block

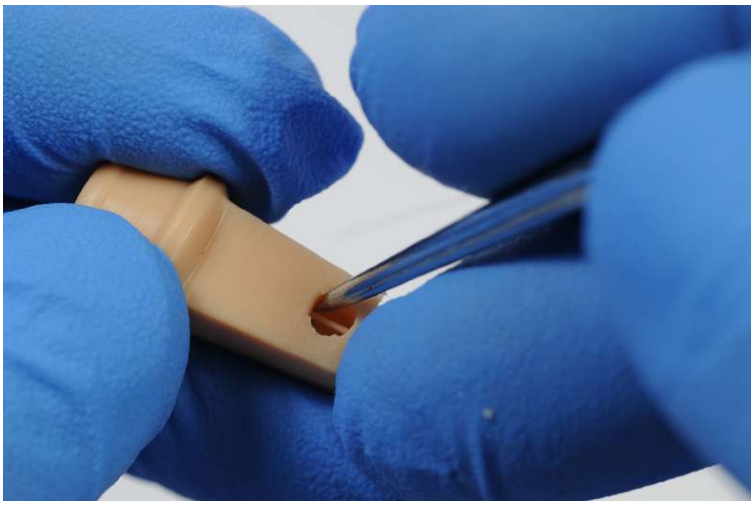
Remove supports like normal





3Shape only: Remove supports inside insertion holes





Trim and prepare die and apply dry lubricant as outlined above

Test Block Fitment - 3Shape

The numbers engraved on the side are the value set within the Form 3B 3Shape library that should have been imported into your system

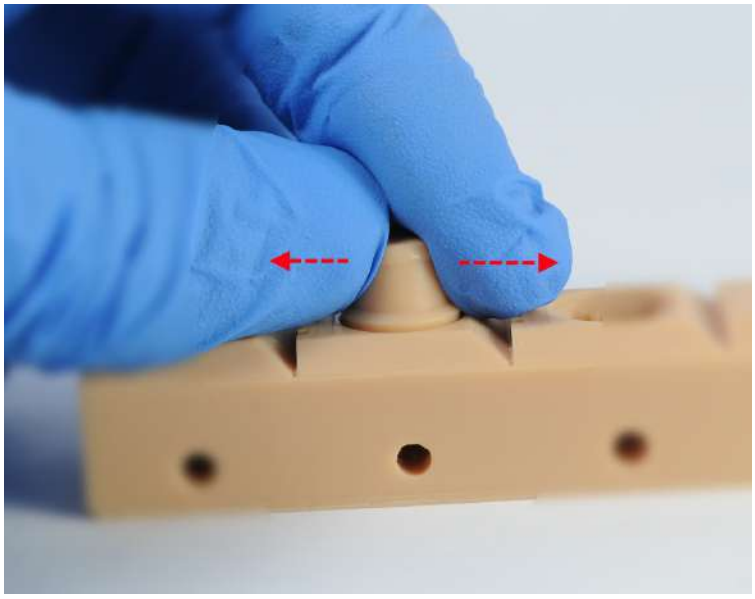
Loosest
0.035 mm
0.045 mm
0.055 mm
0.065 mm
Tightest

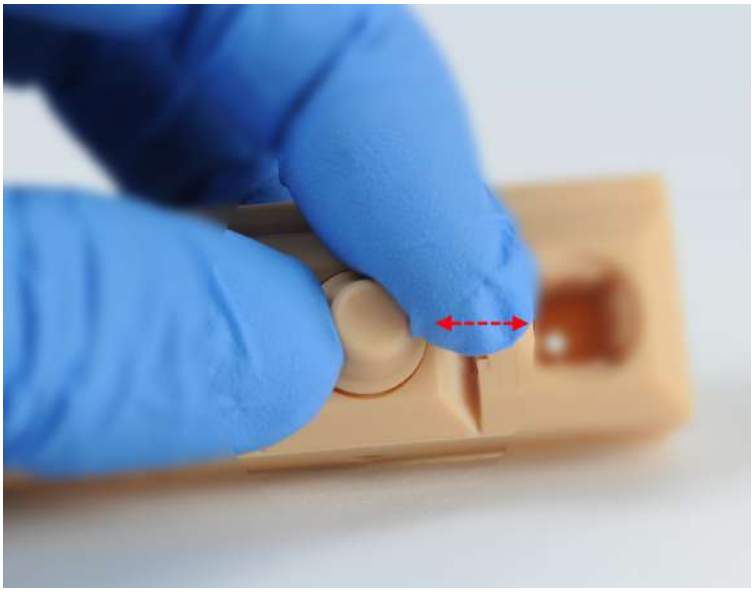
Video version of this guide (Extremely helpful): here

Work from the loosest hole to the tightest
Note: Spray “super lube” on the shaft of the die before testing fit, refer to this section

In each hole as you move tighter judge the die based on snugness of fit and movement in the socket

It is best to go with the tightest possible size in the block test without being difficult to eject the die

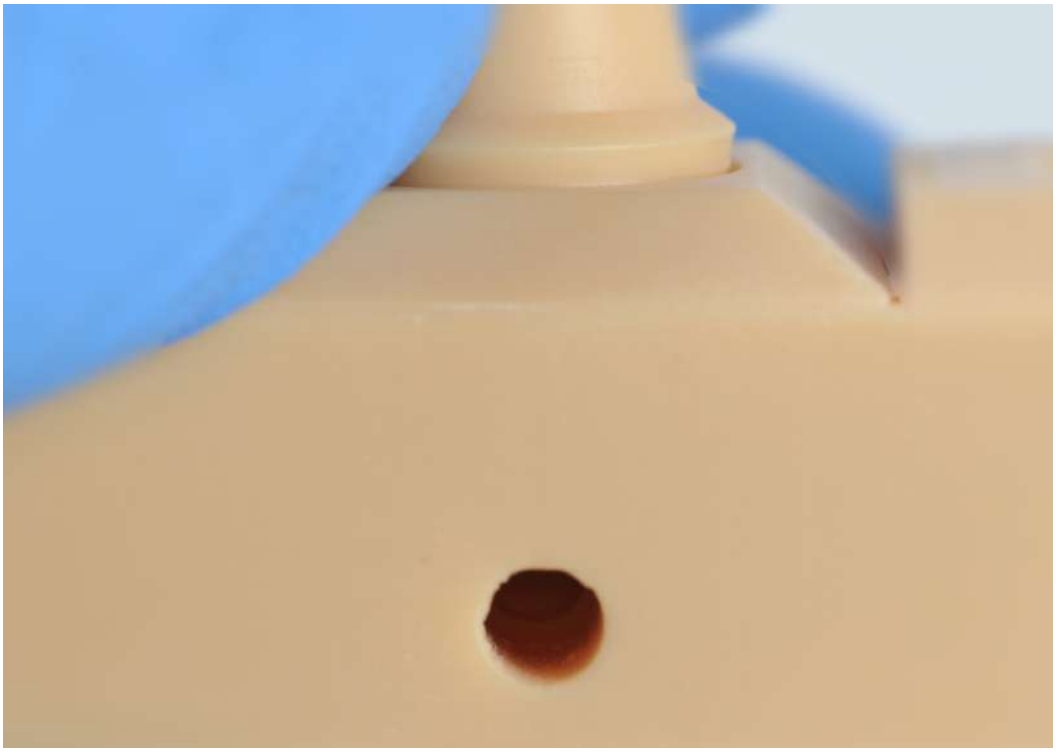




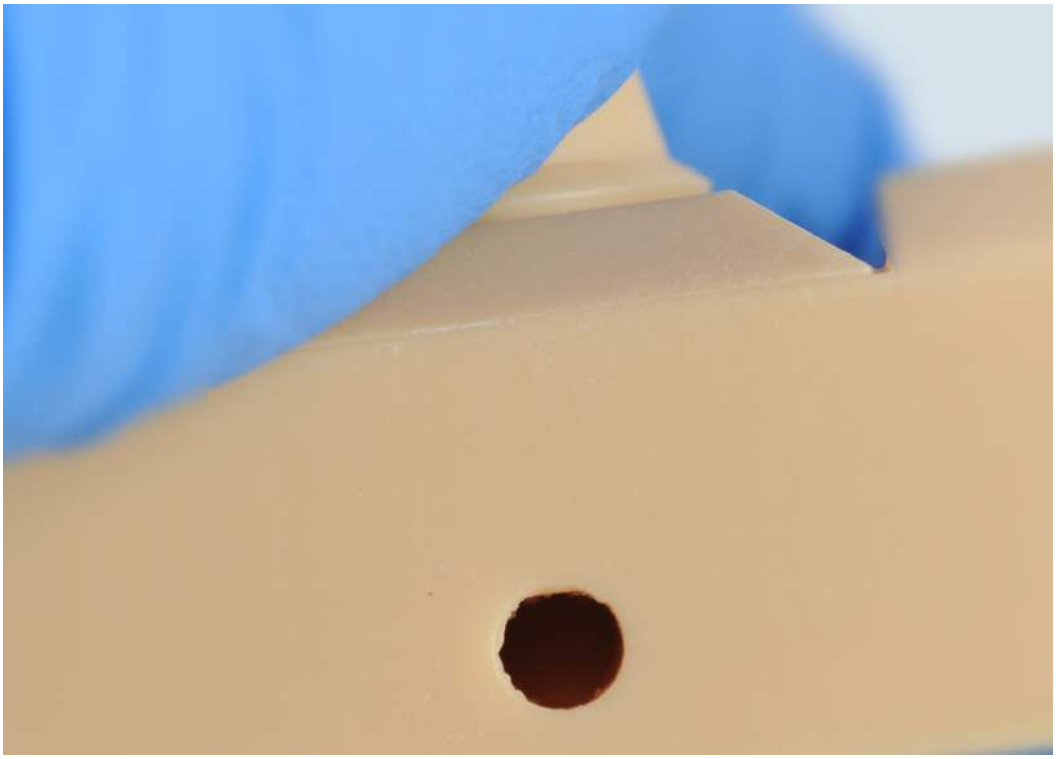
Confirm Seating of Test Die and Block - 3Shape

Be sure to confirm the die is fully seating in the socket

As described above align the two holes flush to each other



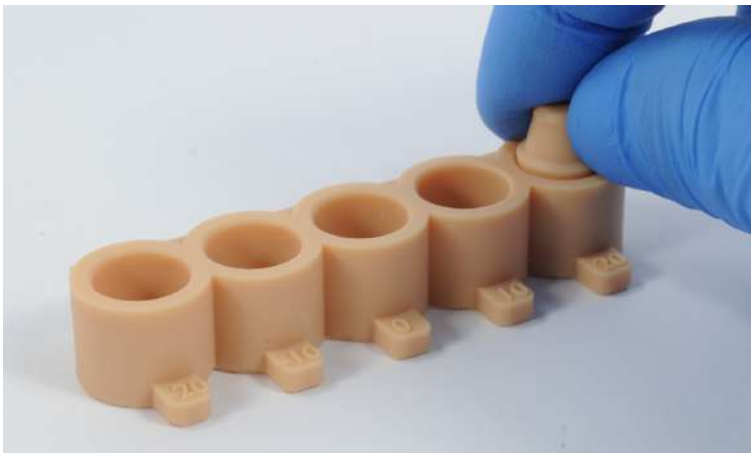
Here is an example of the die seating properly



Refer to the instructions previously in this guide, ensure proper fit to the bottom hole

Test Block Fitment - ExoCAD

The numbers engraved on the tabs of the ExoCAD test model are the offset value set in ExoCAD and are selected during model creation



Loosest
 0.020 mm
 0.010 mm
 0.000 mm
-0.10 mm
-0.20 mm
Tightest

Video version of this guide (Extremely helpful): here

Confirm Seating of Test Die and Block - ExoCAD

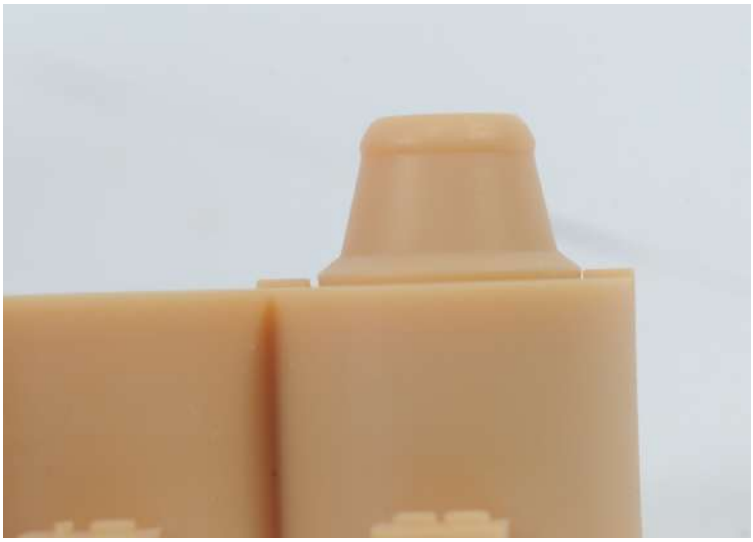
Be certain to confirm complete seating of the die into the socket, use the bottom hole as reference

Be sure to trim the bottom of the die flush, here is an example of what it should look like

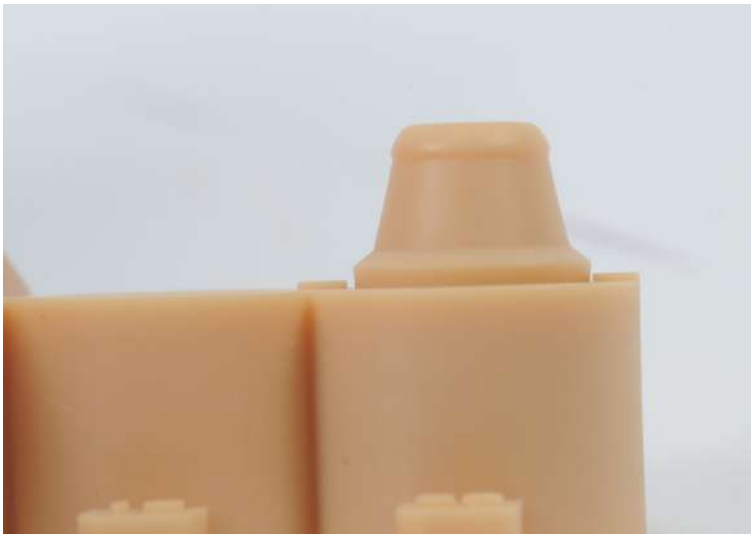
On the loosest die socket there are two raised areas, these raised areas should be completely even with the dies margin

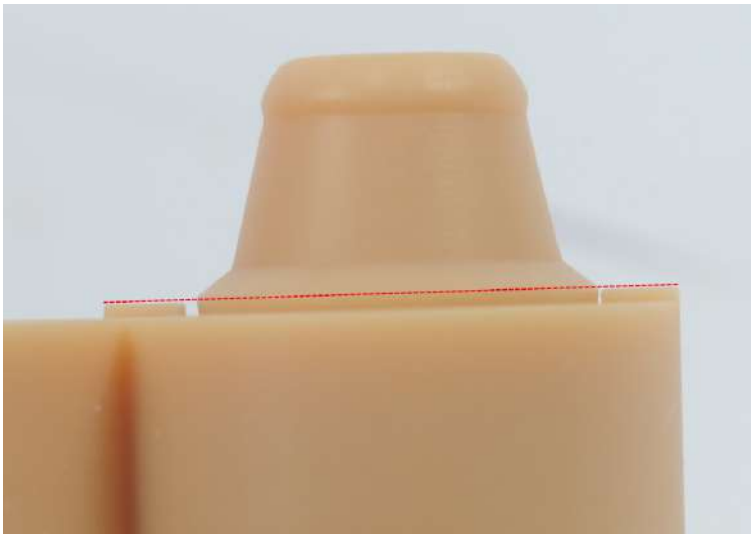
Here is an example of what seating should look like in relation to those raised areas

Good vertical fitment



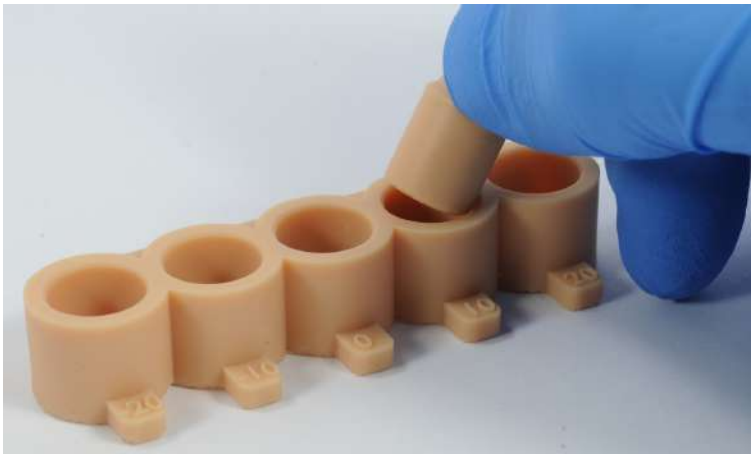
Bad vertical fitment, additional relief is needed





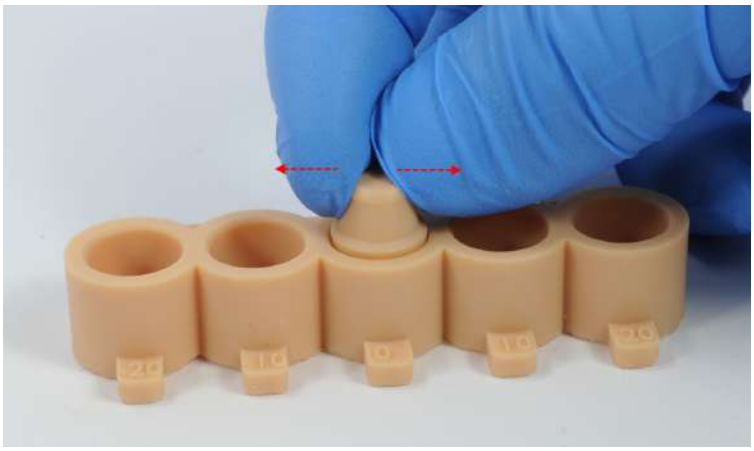
Once your vertical height is correct and bottom of the die seating completely work from the loosest hole to the tightest

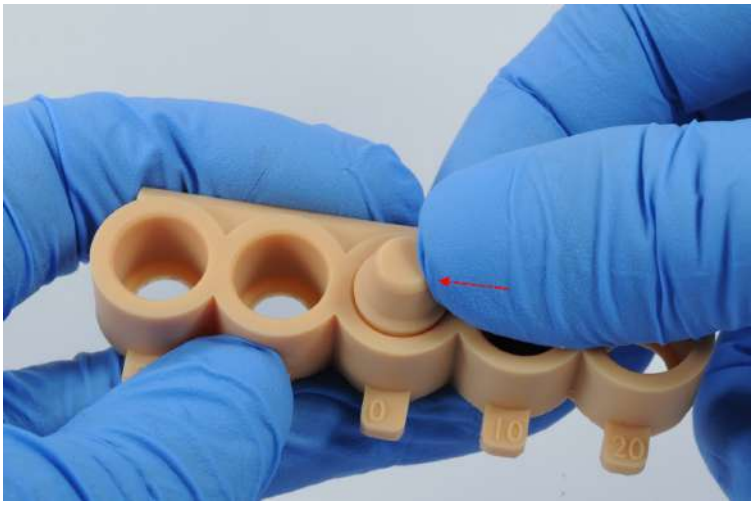
Note: Spray “super lube” on the shaft of the die before testing fit, refer to this section



In each hole as you move tighter judge the die based on snugness of fit and movement in the socket

It is best to go with the tightest possible size in the block test without being difficult to eject the die

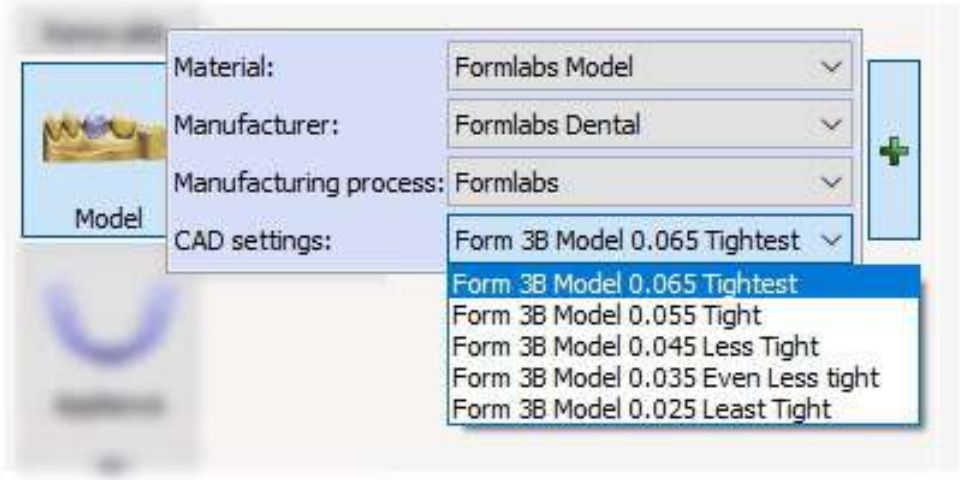




Based on Test Results Pick CAD Setting

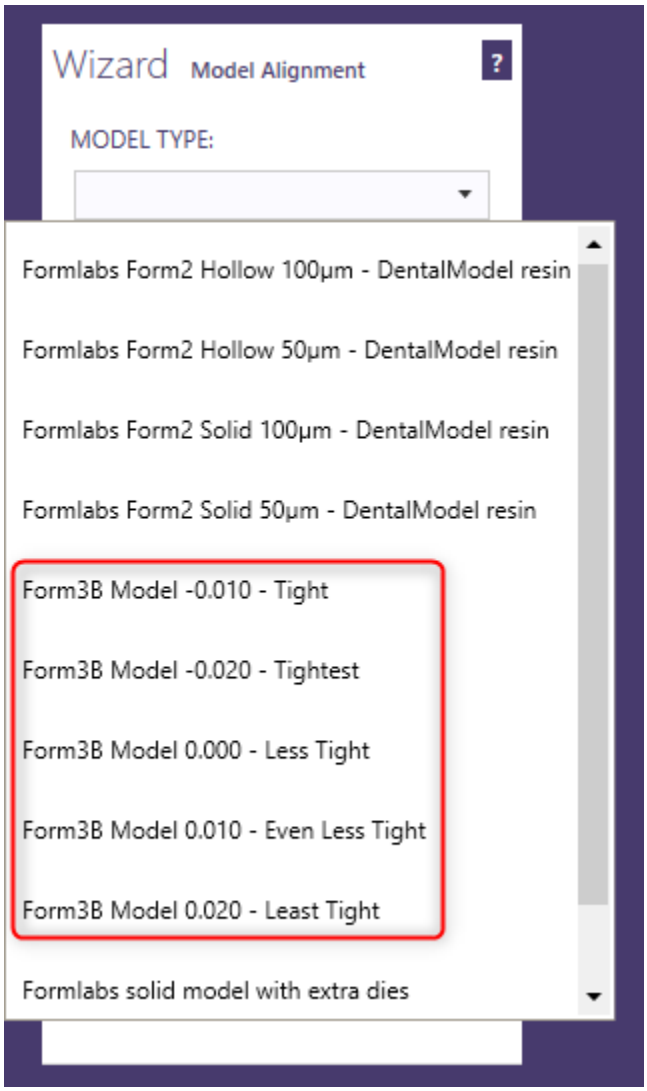
Based on your testing results, set up your 3Shape order using that value

[Refer back to the 3Shape workflow]



Based on your testing results, during ExoCAD design to use that value

[Refer back to the ExoCAD workflow]



Finished - Removable Die Model Guide

That concludes the guide for restorative models with removable dies 3D printed on the Formlabs Form 3B
Any questions or concerns feel free to email dental@formlabs.com and be sure to visit dental.formlabs.com

Thank you

formlabs | dental