3DXpert™

3DXpert Guide

3DXpert for ProX SLS 6100

Tutorial_V7- Updated: 15,0100,1774,705(Official)

3D SYSTEMS

Table of Contents

Contents

Introduction

Using SLS printing technology you can produce functional products with complex geometries. 3DSystem's 3DXpert software has various features to design and prepare parts for SLS machines. This guide includes an overview of the design to print for SLS with 3DSystem's 3DXpert software and focuses on how to prepare (or setup) to work with the 3D Systems ProX SLS 6100 printer.
3D Systems ProX SLS 6100 is a production-grade nylon 3D printer delivering best in class part quality, fast build times and automated production tools.

The 3DXpert Offering for 3D Systems ProX SLS 6100

3DXpert is the most advanced and complete software solution for Additive Manufacturing. It supports part preparation: positioning, supports, analysis, printability checks, tray management and much more.

3DXpert also enables the creation of printable lightweight and surface texture lattice structures.

In 3Dxpert, it is now possible to select and use Validated Materials and privately developed materials* for direct printing on the ProX SLS 6100 printer and to export (Send To Print) the job to ProX SLS 6100's native format (BPZ). Privately developed materials are defined via 3D Systems 3D Sprint software.

To use the 3DXpert slicer for 3D Systems ProX SLS 6100, a dedicated 3DXpert license option is required. The output to ProX SLS 6100 is a direct format.

3DXpert prepares the geometry and parameters for the part and writes it to a 3D Systems native BPZ file. 3D Sprint can then read the BPZ files that 3DXpert writes, and send the data to the printer. Slicing is then performed on the printer itself.

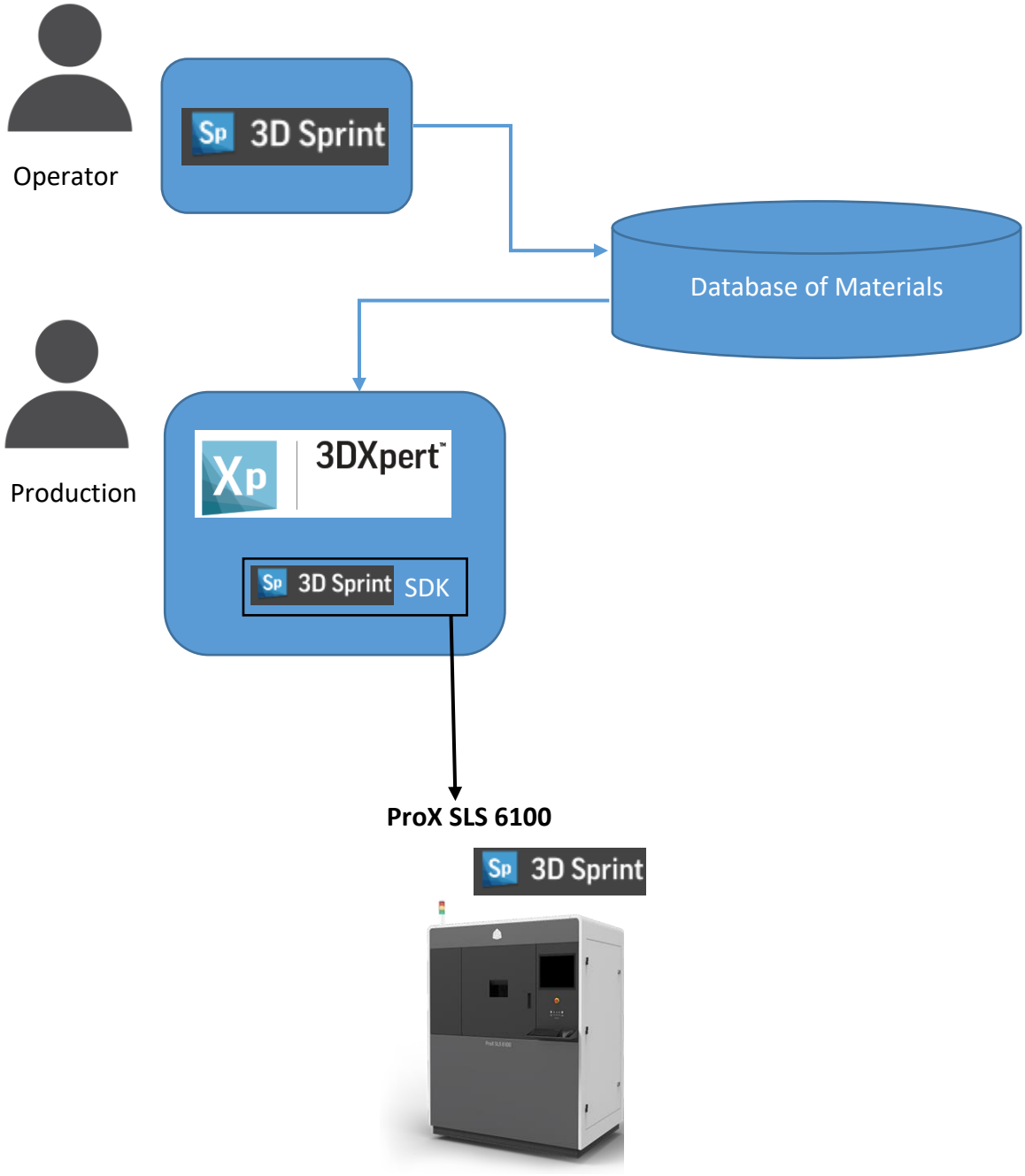
For this to work, a **3D Systems 3D Sprint** database should be available to 3DXpert.

This is possible if the database can be reached through the network or in case that 3D Sprint is installed on the same PC where 3DXpert is installed. In this case, the local 3D Sprint database will be found automatically by 3DXpert.

*Practically, this refers to private materials developed with 3D Sprint

ProX SLS 6100 Process Flow (Software)

Here is a typical process flow at a glance:



Part Preparation for SLS Printers with 3DXpert

The design work for SLS printers is generally similar to that of any other printing technology.

However, when using SLS technology, there is no need to use any kind of support structures. The un-sintered powder (which surrounds the part during the printing process) removes the need for any additional support of the sintered material. This enables to produce highly complex designs to be printed.

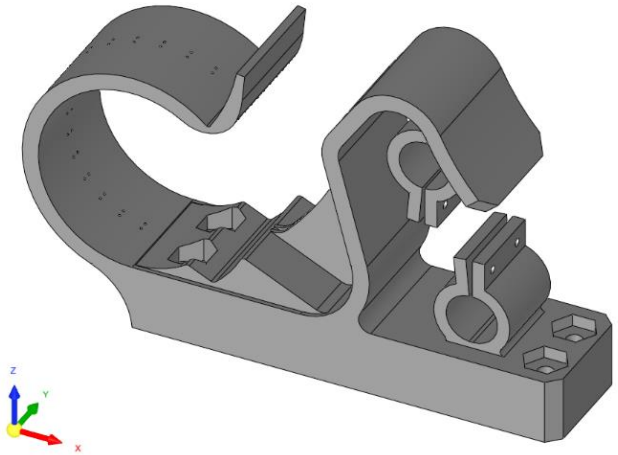
There are still several design considerations for improving the quality, surface finish and functionality of SLS parts. So first, the designer should be aware of the manufacturing tolerance of SLS technology. In addition, a minimum wall thickness is important to ensure a successful print (this value varies according to the material). There is also a minimal value the diameter of holes in the part.

Usually, SLS parts are printed hollow. This saves weight, time and cost. Therefore, it is required to remove the un-sintered material away from the final part. For this, dedicated drain holes should be designed on the part and these also have a minimum diameter, otherwise the powder may stay trapped.

Many designs include embossed and engraved details, or text. In order for these details to clearly show on the printer part, they also need to have minimal depth or height.

3DXpert includes a full design suite to enable the designer to add any of the above mentioned features on the part and/or adapt it for printing, and also analysis tools to make sure that the design can be printed successfully.

With 3DXpert you can work on with any input geometry, whether it is a generic format such as STEP, IGES, Parasolid etc… the common mesh formats such as STL, OBJ, PLY, VRML, 3MF, or a native format such as CATIA, Creo, SOLIDWORKS, NX and more. In addition, 3DXpert is a full CAD solution which provides full 3D design and hybrid modeling capabilities (working with solid & surfaces or mesh), as well as fully-associative 2D drawing and sketching functions.

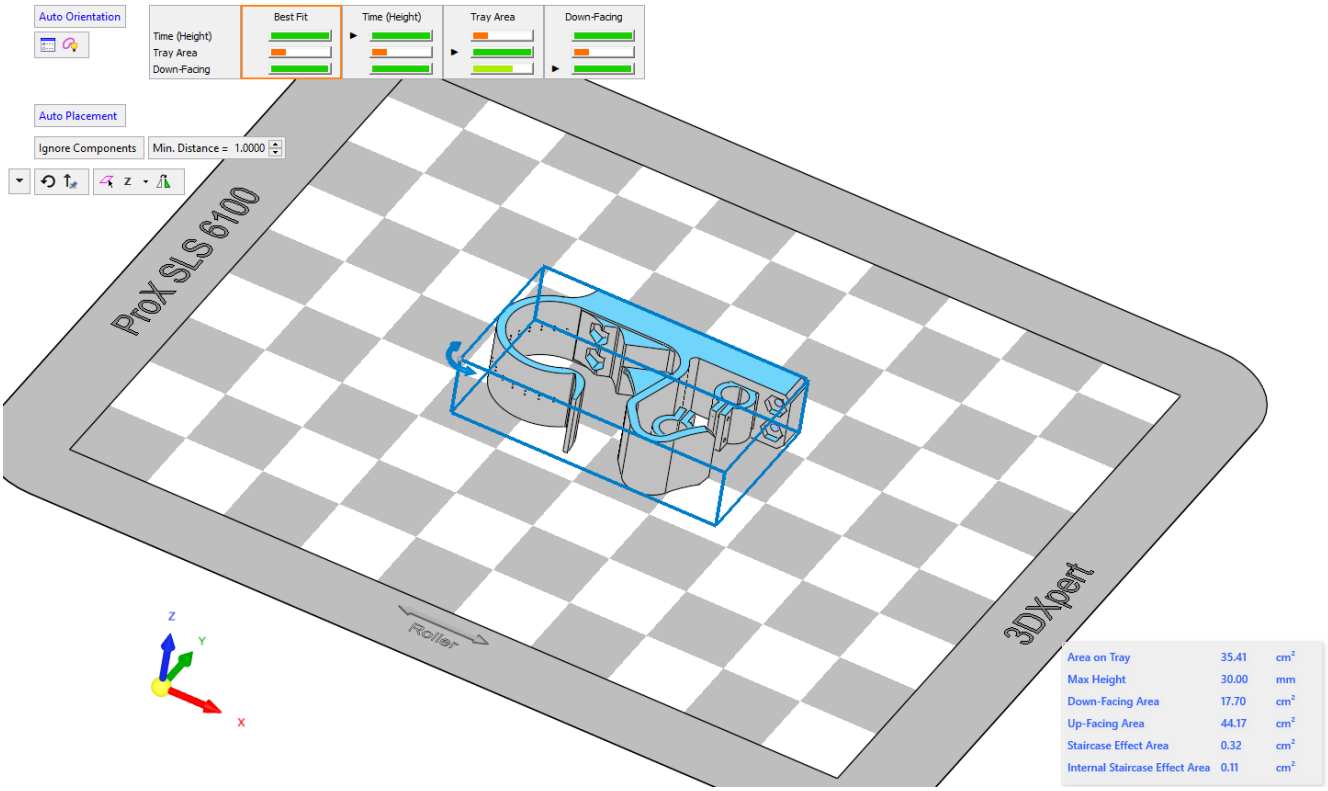


A typical model, imported into 3DXpert retains its Brep (Solid & Surface) qualities.

This is a unique capability of 3DXpert that saves precious time that may be spent (in other systems) on fixing mesh data, allows higher data integrity and uses history based parametric features.

Orientating the parts on the tray is always important in 3D Printing, either for a successful build, for better results or for largest number of parts.

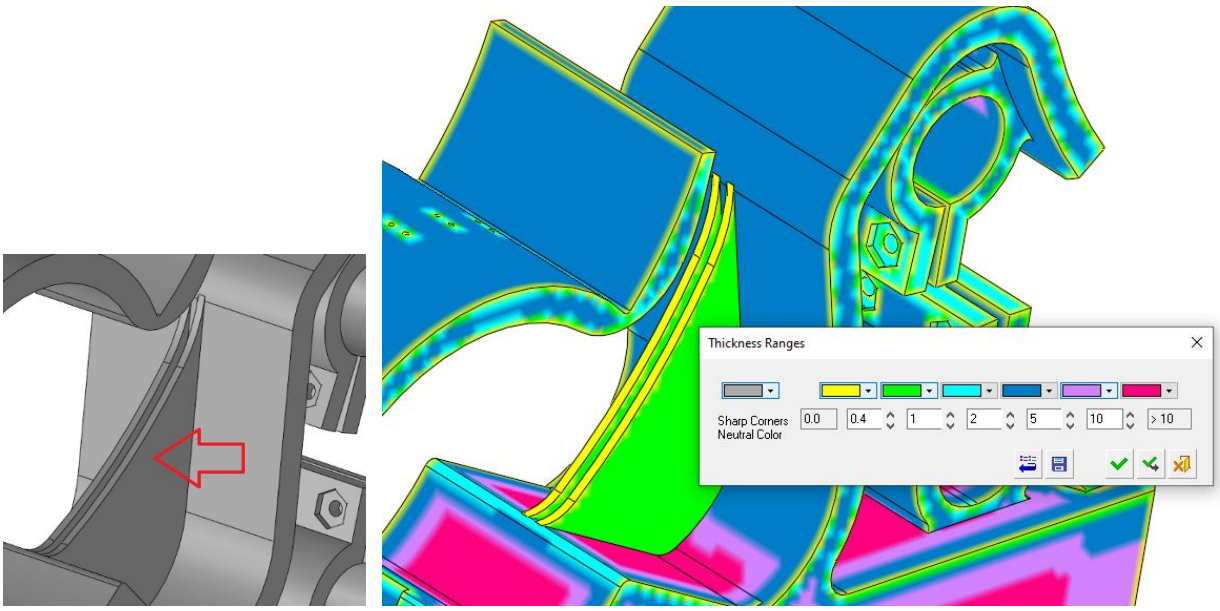
Since SLS does not require supports, there is no need for positioning to consider supports and hence it favors down-facing area analysis and optimization.



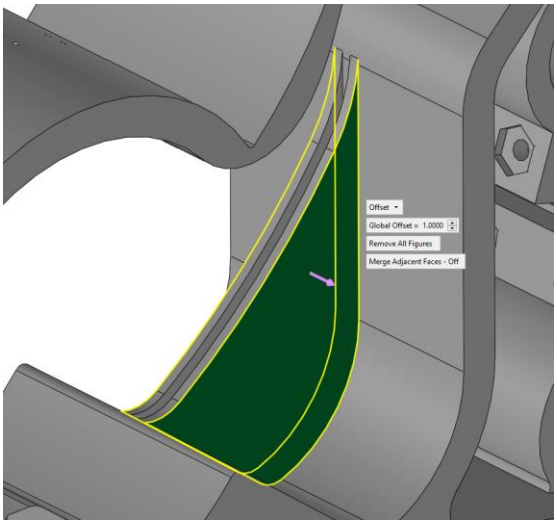
As mentioned above, the design for SLS must consider this technology for wall thickness, holes size, channels, engraving and so on.
3DXpert includes various analysis and CAD modeling tools to analyze the design, see where changes are required and modify the part accordingly. For example, it is possible to modify diameters of holes, round sharp corners, create a shell to hollow the part, change rib thickness, or add spacing.

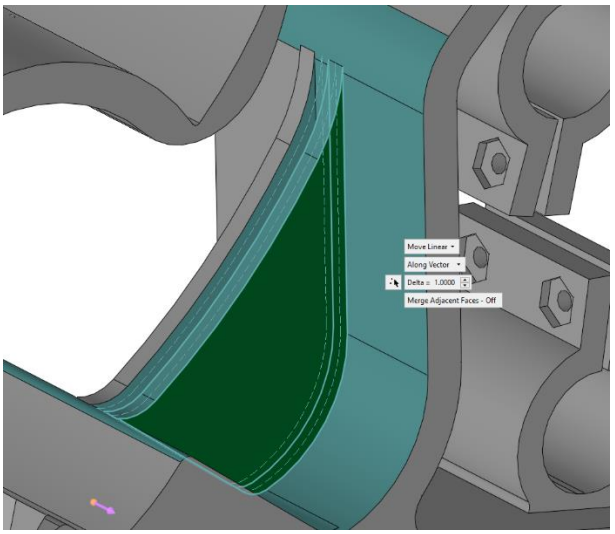
Running a Thickness Analysis on this part to evaluate whether the design is compatible with SLS printing yields various issues that should be attended to.

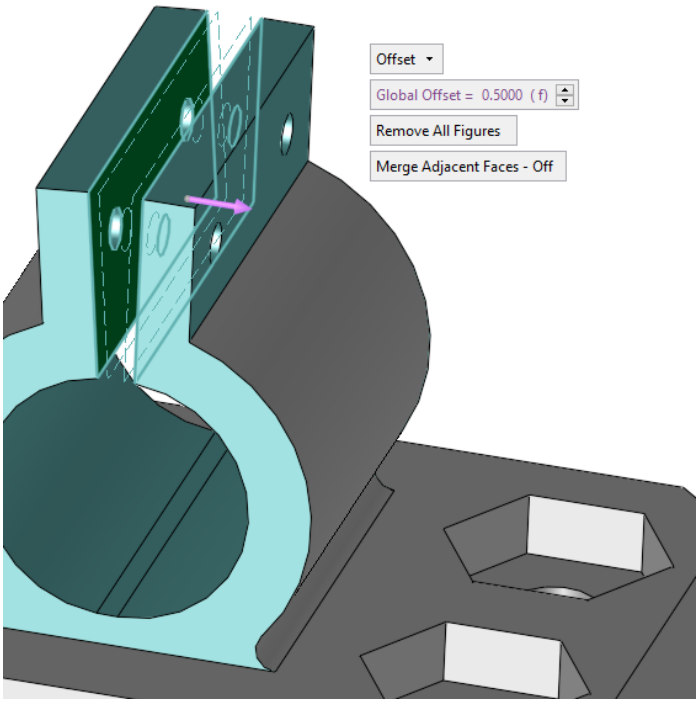
These ribs are set to close apart and each is too thin.



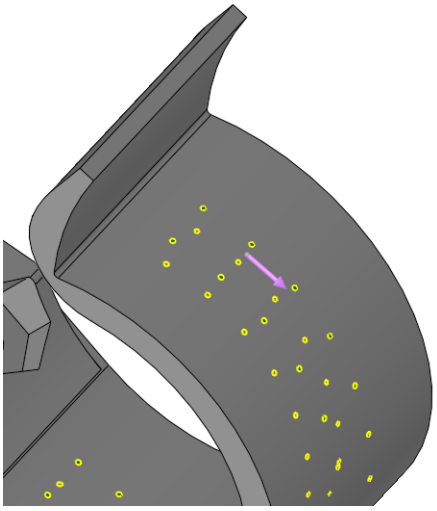
3DXpert's has all the modeling tool to modify the part accordingly, such as to offset faces in order to thicken the ribs or move the ribs further apart.

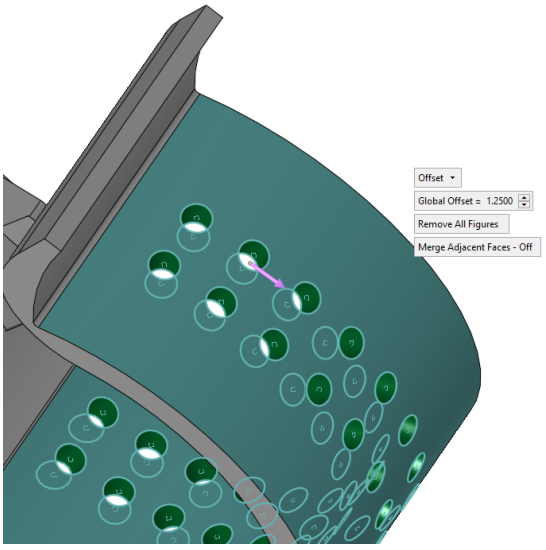




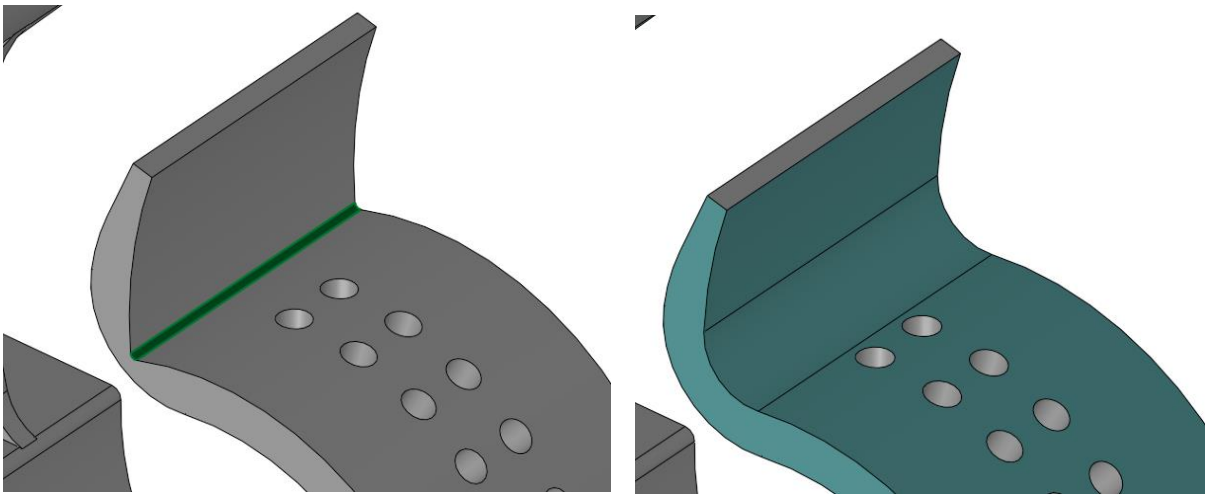


Powder inside holes with a small diameter are exposed to a lot of heat during the sintering process. This can cause the powder inside the holes to become fused. To make sure that holes in your parts remain clear, a minimal diameter size is required.
The holes on the left were too close to each other and too thin for SLS and are therefore, they were moved further apart and resized.



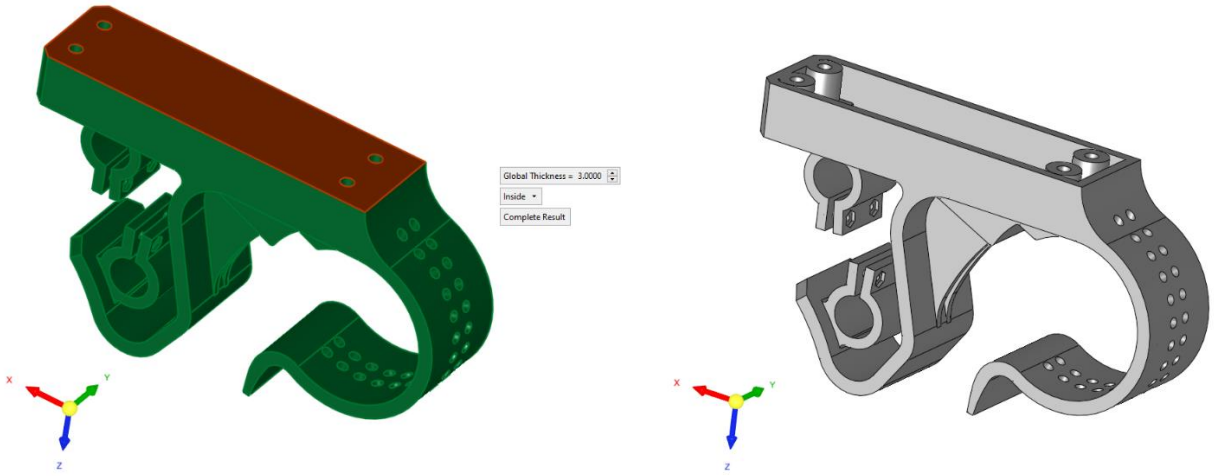


Other features to modify are adding or resizing rounds. In the following images the round on the left is too small and therefore it is resized.



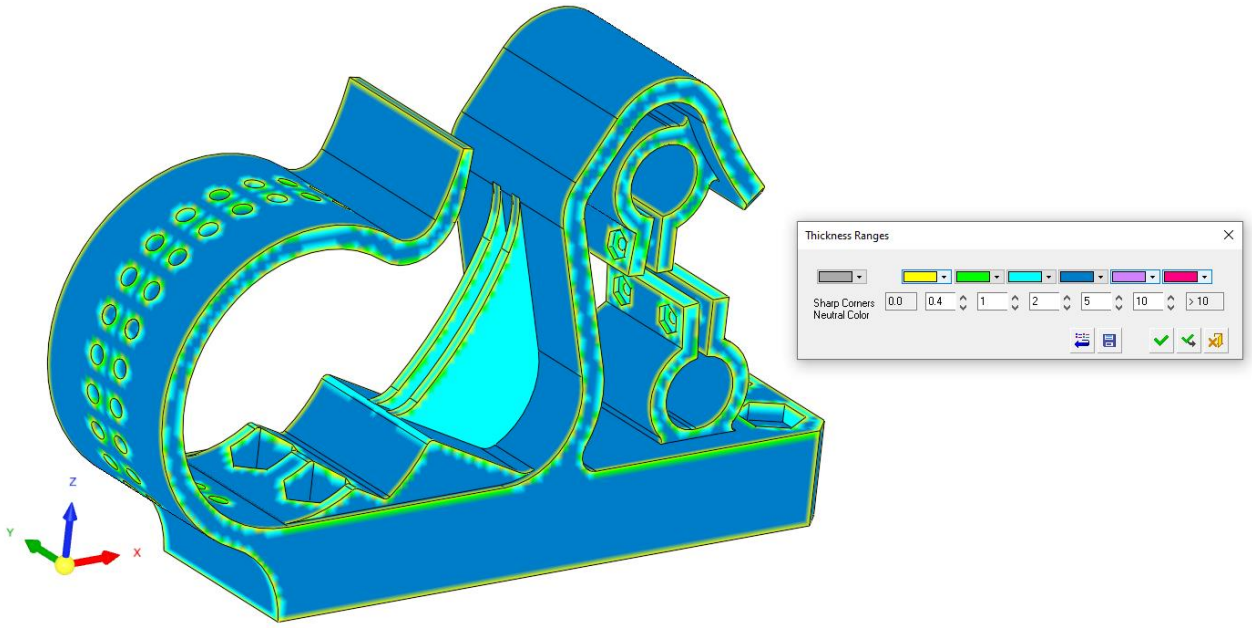
With SLS it is common also to hollow the part, in order to avoid deformation during the printing process.

This is possible using a Shell operation.



You can also can add drain (or escape) holes so that the unsintered powder can be easily removed after printing.
Such modifications are all essential for a successful print.

The part's mending results are reviewed again through the Thickness Analysis.



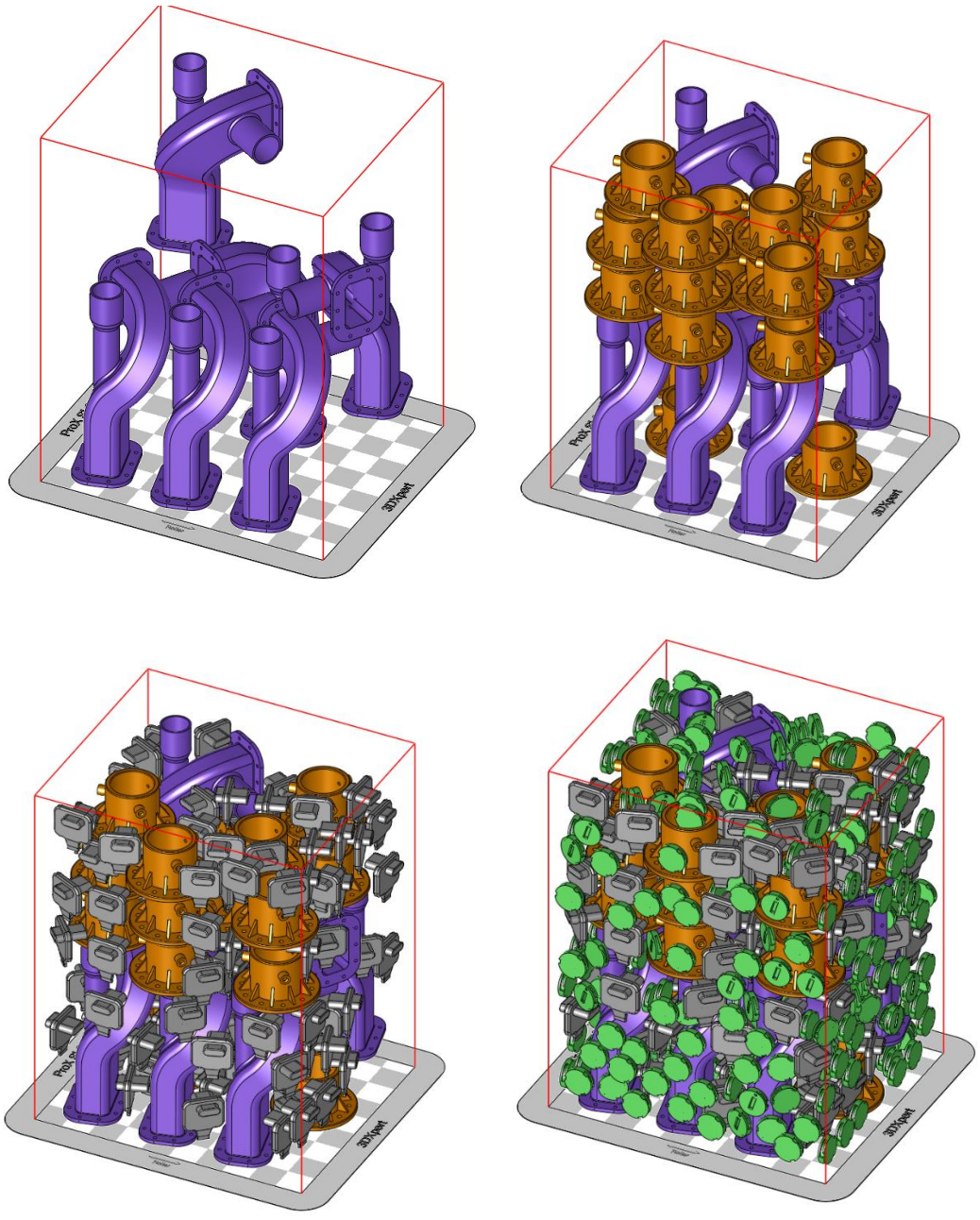
All the modeling features created in 3DXpert are history based and are always available for review of the part preparation process or editing.

There are in addition some specific software features, which are commonly required for SLS printing, notably 3D Nesting, Sinter Box, Joint Cut, Labeling & Infills.

3D Nesting

3D Nesting enables efficient nesting of parts in the entire printing space of the tray.

This example has 4 different model on the tray. The goal in this case is to fill the tray as much as possible (this is a common task, as it optimizes printer time, material and resources).

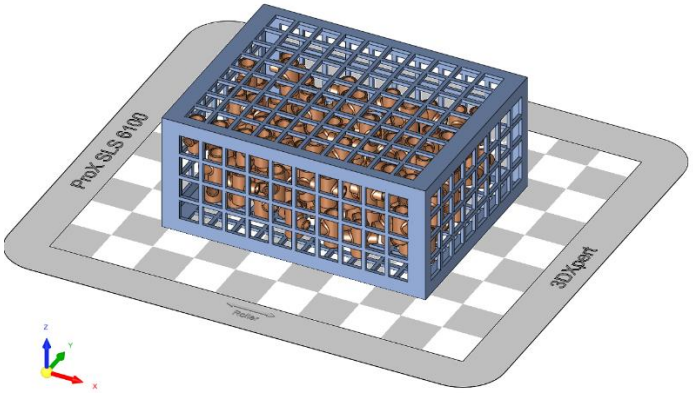


In this example, the largest part, a manifold (purple) is placed 6 times, the pipe bracket (orange) 19 times, the key (grey) 107 times and the cover (green) is placed 432 times.

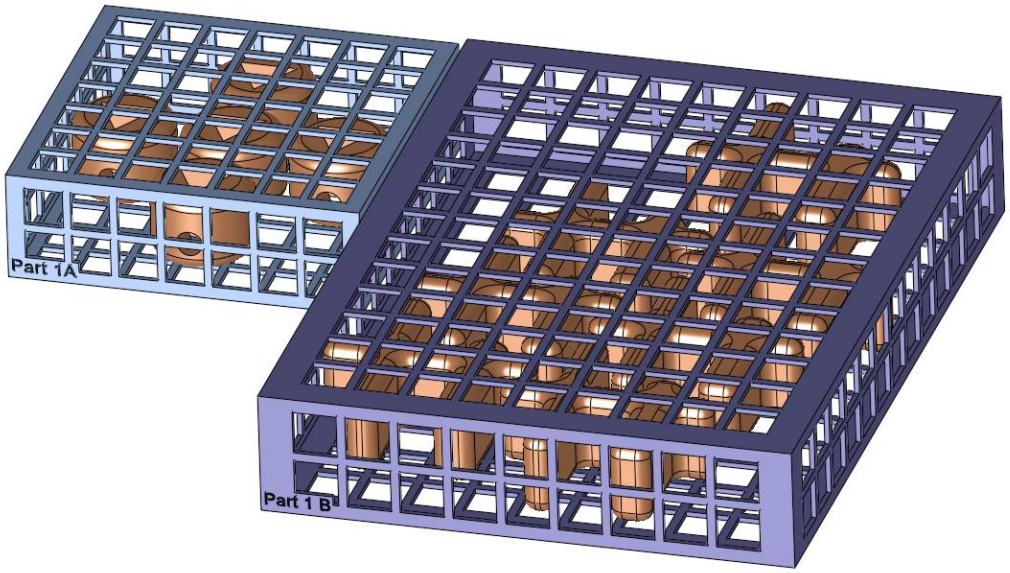
3D Nesting has various option, such as the minimum distance between the nested parts (critical for SLS), minimum Z distance (i.e., layers) between the parts rotated around the Z axis to optimize volume efficiency by finding the best nesting orientation fit and set build platform margins. It is possible to set a specific quantity of each part or let the system calculate the maximal amount of parts depending on the available build volume and the placement conditions. Note that in 3DXpert, there is no need to duplicate the parts before nesting. You can change the amount of instances of each part dynamically without really adding or subtracting parts.

Sinter Box

This feature enables the creation of a box around parts. The parts collected in the box may belong to a specific project or customer, so that the printed parts do not get lost in the printed “cake”. This box is also referred to as a cage (also in 3D Sprint). The box may be created around the parts as they are positioned on the tray, but a unique benefit of 3DXpert is the ability to 3D nest parts within the cage, optimizing the size of the cage.

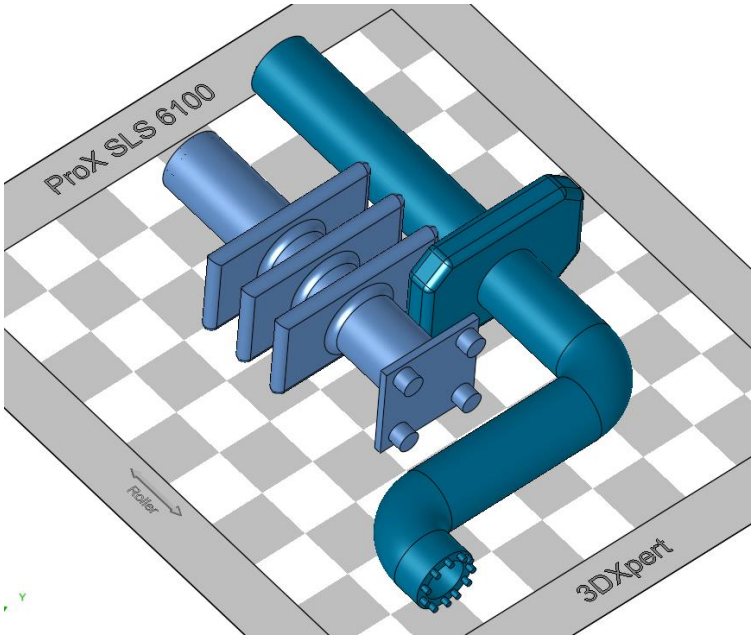


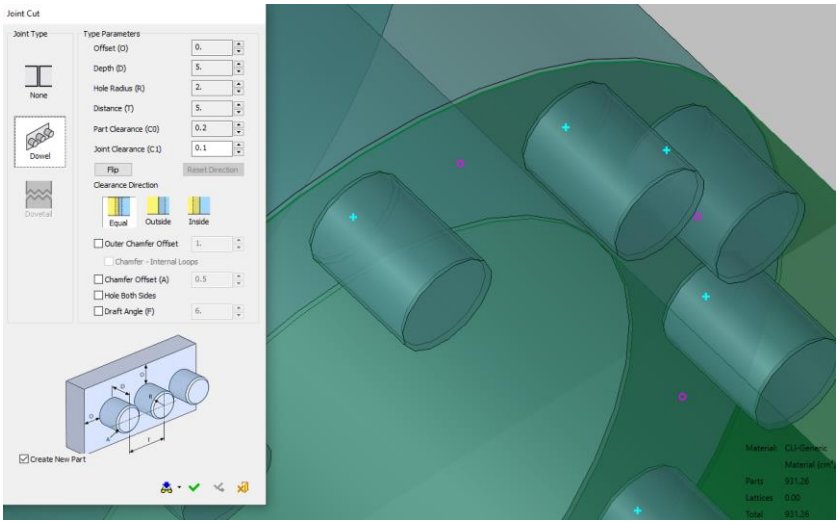
Sinter Box includes various options, such as creating a totally sealed cage or a perforated cage, setting for the thickness of the cage and margins from the tray boundaries, adding text to the cage and more.


Part 1A
Part 1 B

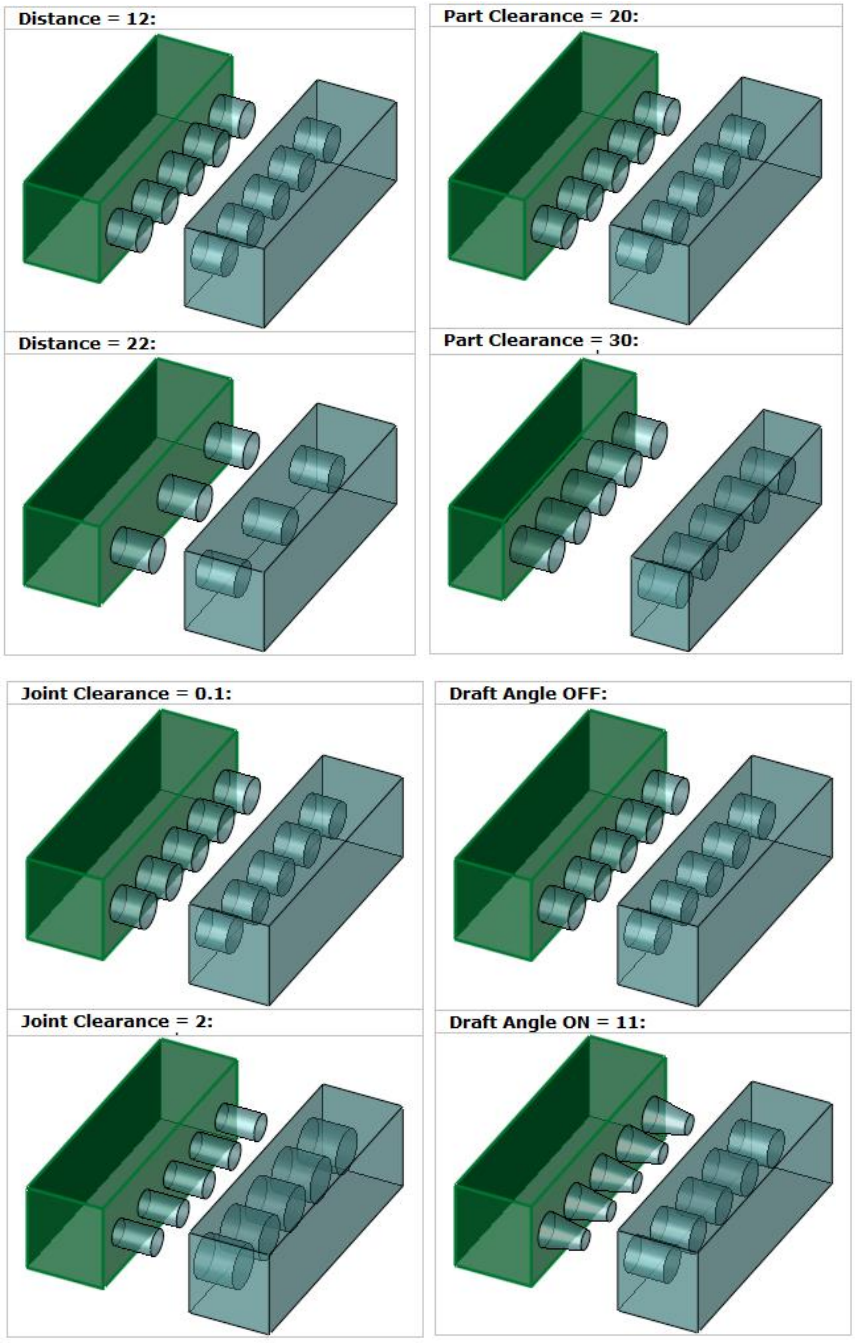
Joint Cut

Parts printed in SLS may be very large. In case that the part size is greater than the tray size, the Joint Cut tool allows cutting them into smaller pieces, so that each of the separate parts has joint points to assemble them back together after printing.





The part can be split along any plane or along a contour. There is full control over the connecting dowel's parameters (such as radius, depth, chamfering and clearance). Here are some examples for Joint Cut parameters:



Examples for Joint Cut Parameters

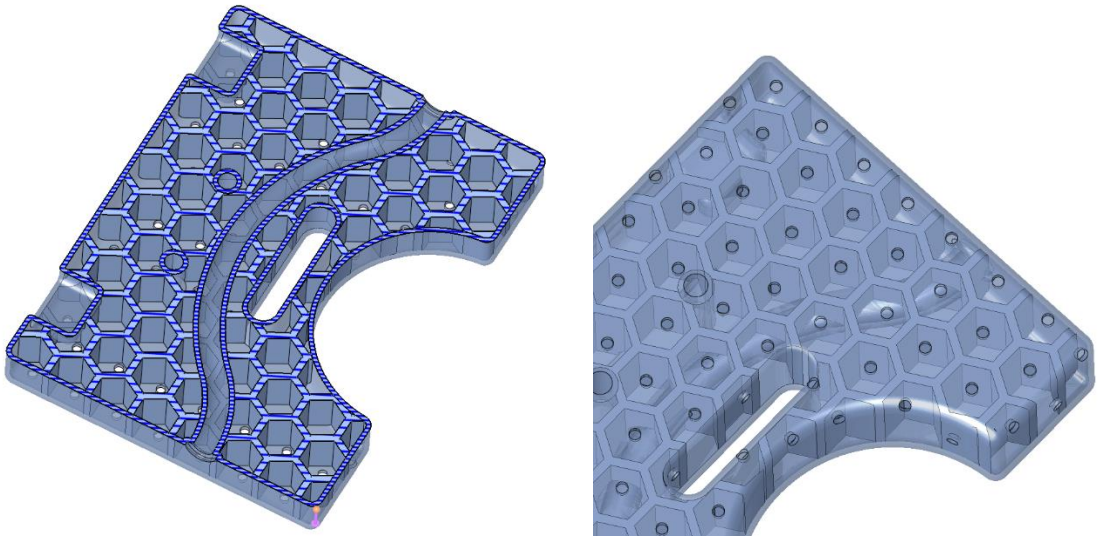
Distance – the spaces between hole/pin centers

Clearance - the clearance value between the faces of the two parts

Joint Clearance - the clearance value between the faces of the joints (pins)

Infills

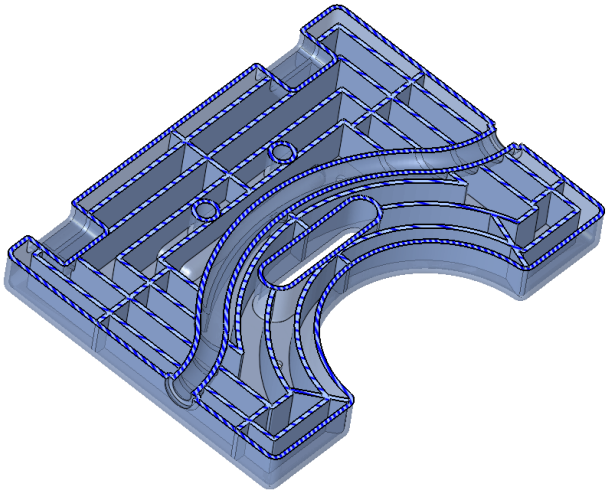
Infills are used for creating structures that support the inner volume, reduces part thickness (and therefore deformation), reduces the part's weight and save sintering time.
3DXpert includes various options for Infills, either by a pattern or a Conformal Infill that follows the shape of the model. Drain holes can be added, manually or automatically, to enable remove the unsintered powder.

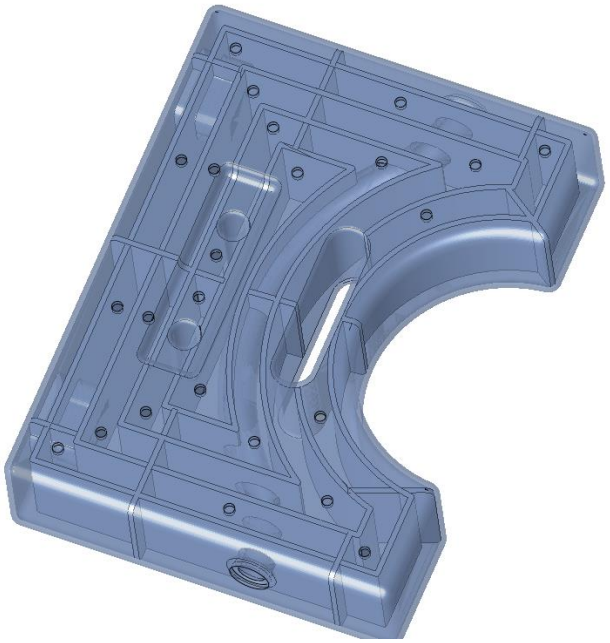


The above images show an internal honeycomb Infill structure. Such walls inside the volume also increase the stiffness of the component. Hollowing a part this way may also reduce warping.

Conformal Infill

The Conformal Infill creates similar walls, but instead of being based on a pattern, this infill uses by default the shape (silhouette) of the object. Web lines can be added for increased stiffness.





Conformal Infill - Notice the way that the walls follows the different areas of the volume.

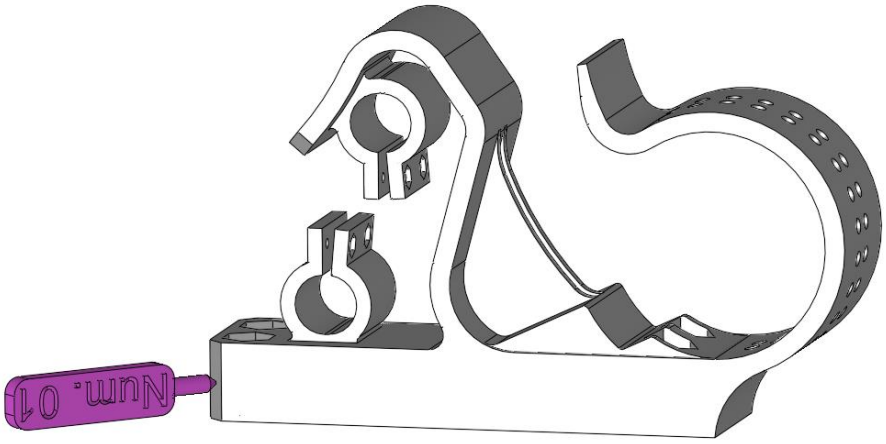
Clearly for SLS these walls must have enough thickness and be and enough spacing should be left between them. When creating an Infill, the number of walls, the distance between them and their thickness can be set to ensure that the Infill will conform to SLS requirements.
All of these parameters can be preset and saved into templates that can later be reused for other parts.

Text & Labeling

Labels are commonly used to designate the part's serial number, customer name and so on. Such labels may be also added for production purposes only and are not part of the original design. You can create these volumetric text and labels either on the part as detachable labels.

In addition, you can create and place any QRCode or Barcode.

The text can be created on mesh and solid objects and are editable as any other 3DXpert feature. Remember that since this is printed with SLS technology, SLS requirements stand here as well and therefore when creating text objects, set the appropriate font size and depth.



A detachable label, connected to the part, to be removed after printing.

The 3DXpert workflow for ProX SLS 6100 printer

3D System's ProX SLS 6100 has a unique workflow, since it does all scaling and offsetting work associated with Shrinkage Compensation on the printer itself. This means that the parts sent to the printer are not scaled and hence, they keep their original size.

Therefore, unlike other workflows, this one does not involve shrinkage compensation scaling at any point.

The system does emulate shrinkage compensation when using the 3D Nesting tool.

The parts will be temporarily scaled in the background before the nesting and will be nested with the scaling in mind, to ensure parts are positioned correctly in the space of the tray.

After the 3D Nesting is done, parts will retain their original size but will still be placed correctly, as the systems does consider their scaling.

The scaling factors and formulas for this operation are retrieved from the build style definitions, based on the technology or build style attached to each object. Note that when running slicing, you may choose to use also a different build style for specific technologies, if available. See later in this document on how to setup the buildstyles.

Note that if you do select a buildstyle that is not the default one after 3D Nesting has been executed, and that build style has different scaling parameters, it is recommended to re-run the 3D Nesting.

Note that Export, Position Body, Printability Check & 2D Nesting do not consider scaling.

Another important note is that parts sliced for the ProX SLS 6100 cannot be loaded into the 3DXpert Operator environment, as also after slicing calculation, these 3Dxpert files do not contain actual scan path data (slicing is practically executed on the printer itself, as will be discussed here).

3D Sprint Printer and Material Settings

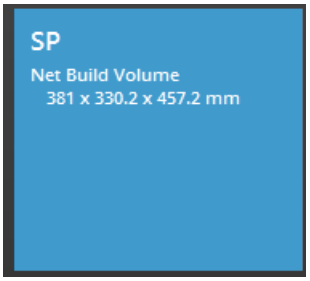
3D Sprint is used to manage the different jobs in different printers and to examine the printing process while it is running.

This is a quick overview of 3D Sprint build and material definitions. When creating a job in 3D Sprint, the user selects the printer, the material, a Print Mode (Standard or High Production modes) and finally a Build Style.

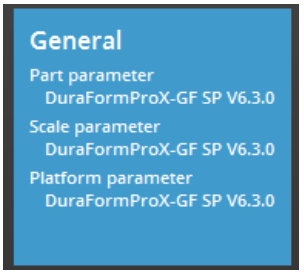
Printer

Material

Print Mode



Build Style



There are three categories of parameter sets in 3D Sprint, that are used as the default but can be altered:

- Platform parameters, called ‘Build Profile’, applies to the whole print build.
- Part parameters, called ‘Part Profile’, applies to each Component individually.
- Scaling and offset parameters, called ‘Scale & Offset’, applies to each Component individually.

Build Profiles

Build Profiles can be applied to an entire build using the Build Profile Editor.

By default, the Build Profile assigned is defined during the configuration of printer and materials when setting up printer via the Printer function. The Build Profile Editor allows to create a new profile or modify an existing one to assign specific build parameters to a job, it will define the behavior of the build at various Z levels during the print. Build Profiles are assigned to an entire print build.

Part Profile

Part Profiles can be applied separately to parts using the Part Profile Editor. By default, the Part Profile assigned is defined during the configuration of printer and materials when setting up printer in the Printer function. The Part Profile Editor allows you to create a new profile or modify an existing one to assign specific part build parameters to parts to define the behavior of the build at various Z

levels during the print. Part Profiles can be assigned to selected parts of a print build. You set part parameters and create part profiles with the Part Profile Editor, launched from the Print tab.

Scale and Offset

3D Sprint provides tools for scaling and offsetting parts with simple and advanced options: simple changes where dimensions are multiplied by constants, and more complex ones where dimensions can vary non-linearly and use tables of values or formulas.

You will typically want to increase the size of a part slightly to compensate for shrinkage during the SLS process; this is called scaling the part. You can apply a different scale factor in each direction (X, Y, and Z). To scale parts, select the Scale & Offset option from the Print tab.

You can determine scale values by measuring parts and hand-calculating their variance from the desired dimensions, or use 3D Sprints Scale & Offset Wizard to perform the calculations.

3D Sprint to 3DXpert

So as explained above, in 3D Sprint there are two categories: the first category includes all the items or parameters that influence the whole build, and the second category includes all the items or parameters, which influence each component individually.

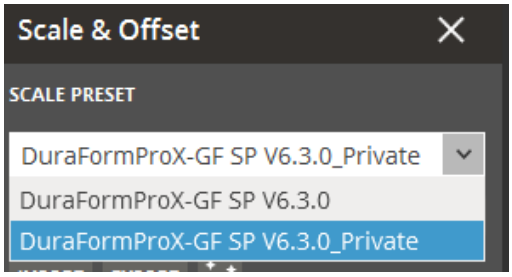
For use in 3DXpert, each one of these category is grouped and the result is

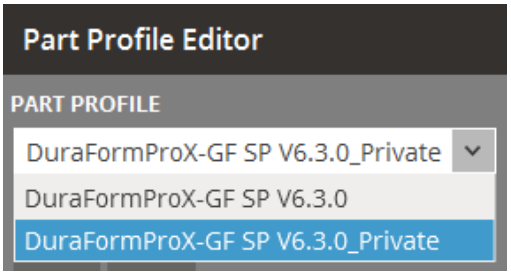
A group for each one of the combinations of the following items:

- Printer
- Material (physical powder)
- Print Mode
- Default parameter set values (Build Style)
- Platform parameters (Build Profile)

A group for each one of the combinations of the following items:

- Part parameters, as defined in 3D Sprint's 'Part Profile'
- Scaling and offset parameters, as defined in 3D Sprint's 'Scale & Offset'





The result is that any 3DXpert build style for ProX SLS 6100 is a combination of Scale & Offset and Part Profile.

Working with ProX 6100 SLS Validated Materials (via 3D Sprint SDK)

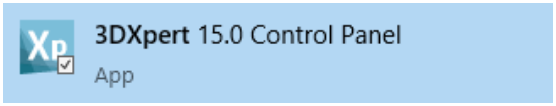
Downloading Materials Databases

Generally, creating a 3D Printing project in 3DXpert requires the definition of the printer and the specific material (i.e., in the case of a metal printer, the metal powder) as the mandatory first steps of the project. The printer and materials are defined by a set of files, a database, which includes the exact technology parameters for each different printer and material.

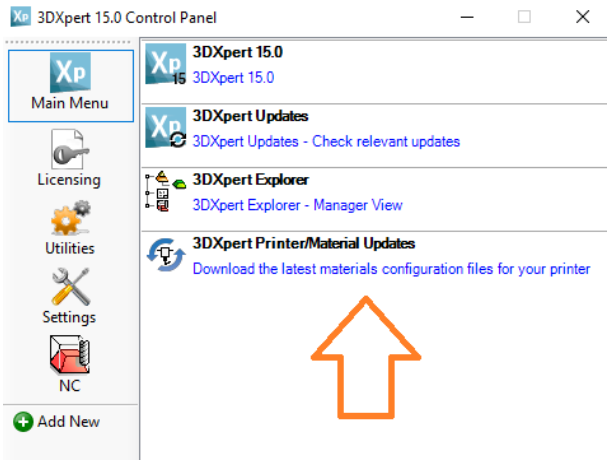
Each method requires the download of a dedicated printer database files from the web server.

Pre-configured 3DXpert databases are available for download from 3D Systems. The first step is to download the ProX SLS 6100 Family printer and the specific material from the 3D Systems online web server. This is in general a one time operation.

1. Launch the 3DXpert Control Panel.



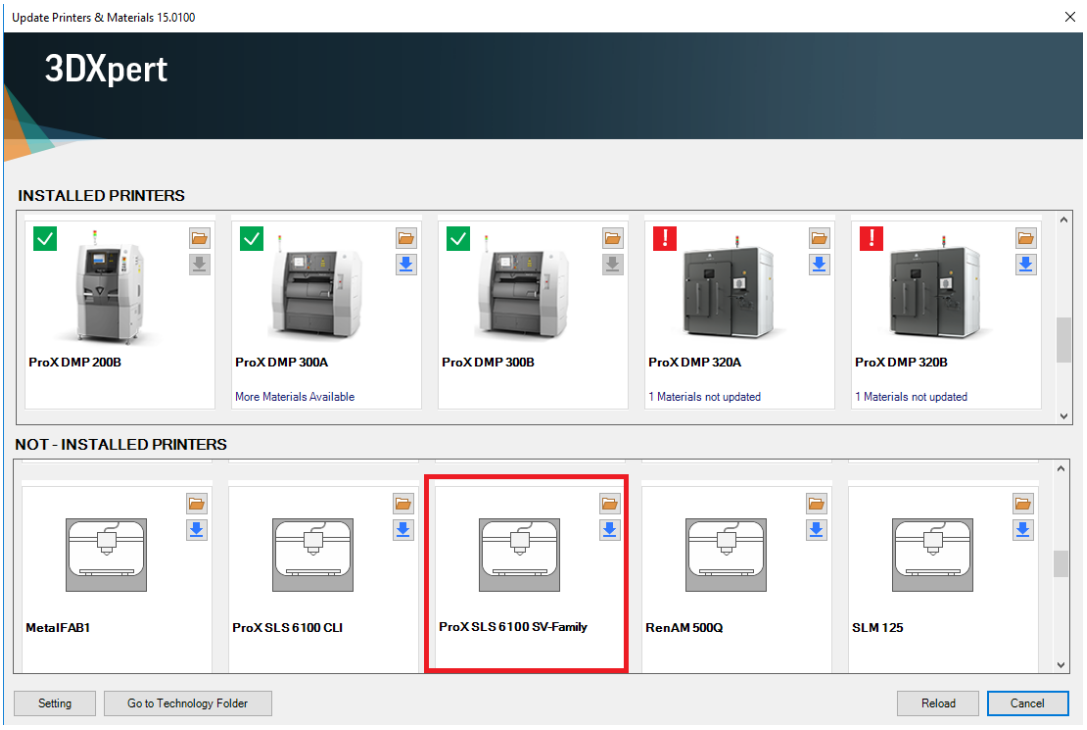
2. From the Main Menu click the **3DXpert Printer/Material Updates**.



Note: if you do not have the license for 3DXpert's license for ProX SLS 6100 printer, the printer will not be available to you through the Update tool. Contact your 3DXpert vendor regarding licensing.

Download the 3D Systems ProX SLS 6100 Printer Family

In the Printers Update tool, click the download button  of the relevant ProX SLS 6100 printer in the NOT-INSTALLED PRINTERS section of the dialog.
You should download the one shown here **– ProX SLS 6100 SV-Family**:



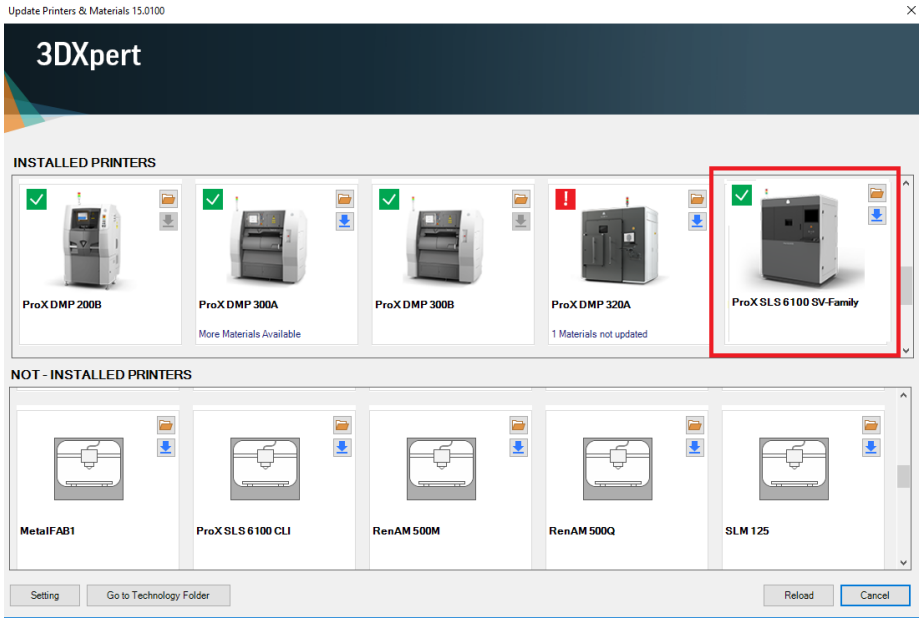
This is a ‘template’ that will be the source for integrating ProX SLS 6100 Validated data with 3DXpert’s material database.

This solution generates a BPZ file. The BPZ file is an 3D Sprint pre-slicing format, containing instruction for the SLS printer how to slice and with which parameters (actual slice with the parameters is executed by the printer software).

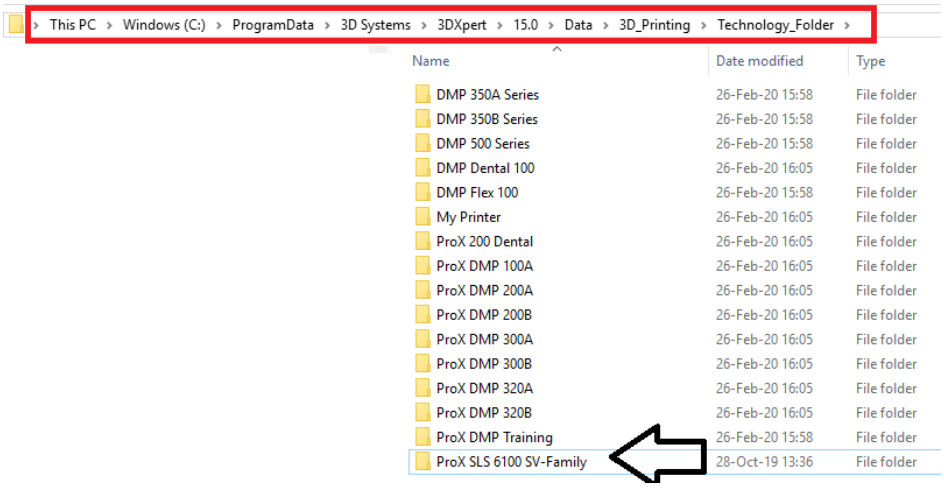
This allows using the 3D Systems validated material database and the user can apply them by assigning technologies to volume in the same way that 3DXpert works for other printers.

The ‘SV-Family’ template can be used on any ProX SLS 6100 printer.

Once installed, the printer will show up in the INSTALLED PRINTERS section of the dialog.



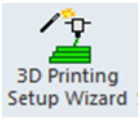
The 'Family' printer template has been added to the Technology Folder of 3DXpert.



To use the template, it is required to have 3D Sprint installed as well, or to have access to the 3D Sprint database.

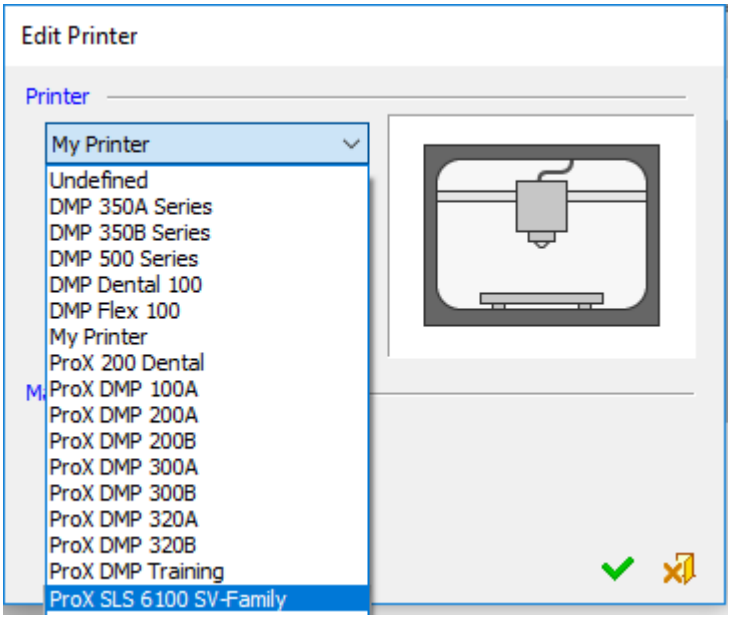
Setup of ProX SLS 6100 Validated Materials

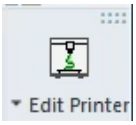
Launch 3DXpert and open/create a 3D Printing project.



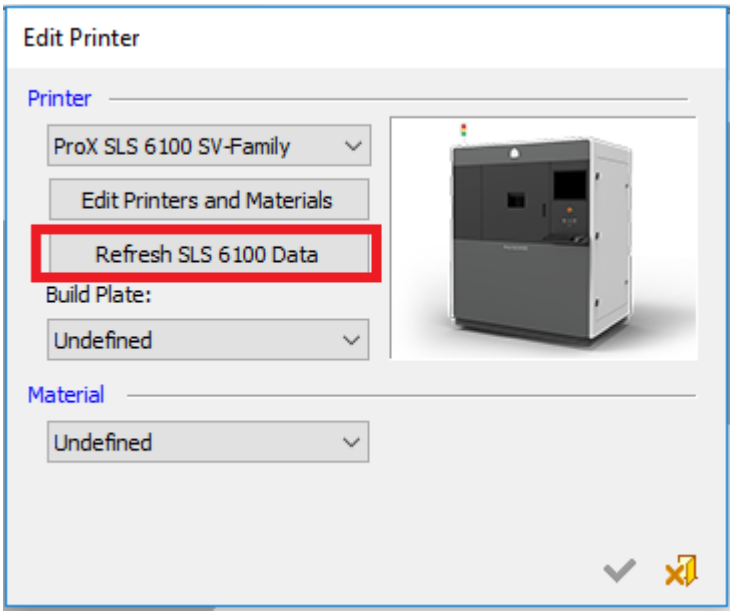
Click the Edit Printer icon from the Guide Bar

Open the Printers' list and from the drop down select the 'ProX SLS 6100 SV-Family' printer.





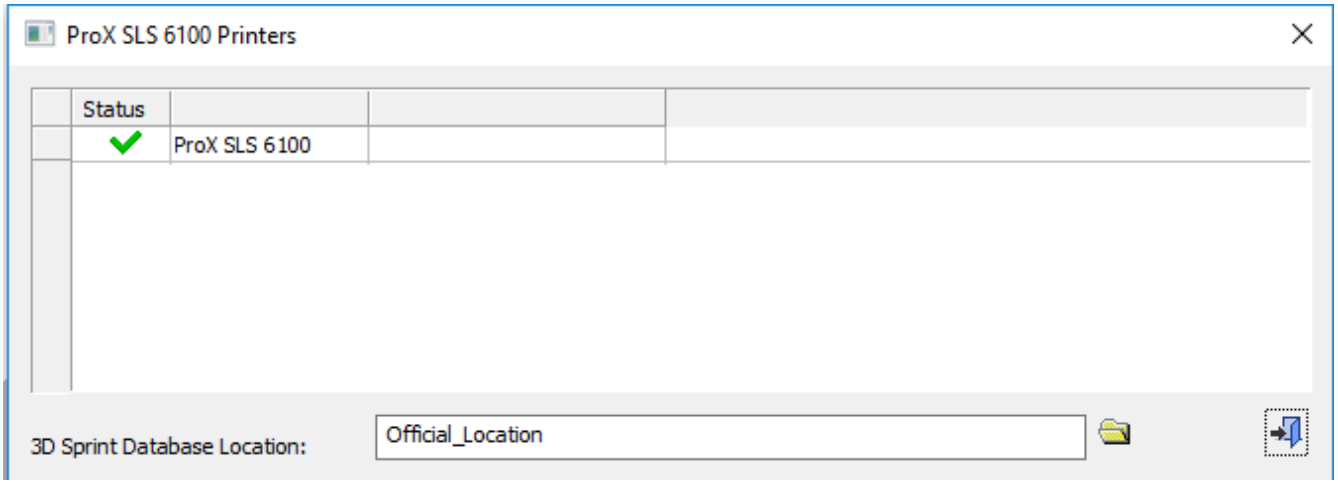
Once selected, note the additional button the Edit Printer dialog – Refresh SLS 6100 Data.



Click Refresh SLS 6100 Data.

At this stage 3DXpert communicates with the 3D Sprint database (again, either it is local or in the network) and checks which specific ProX SLS 6100 databases are available.

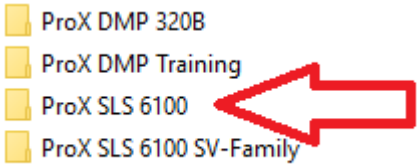
A single line is presented in the table on a ProX SLS 6100 Printers Dialog:



The location of the 3D Sprint database is automatically recognized, in case that 3D Sprint is installed on same PC. However if the system does not automatically find this location, or if the database is located on the network, you can navigate to it and pick it manually.

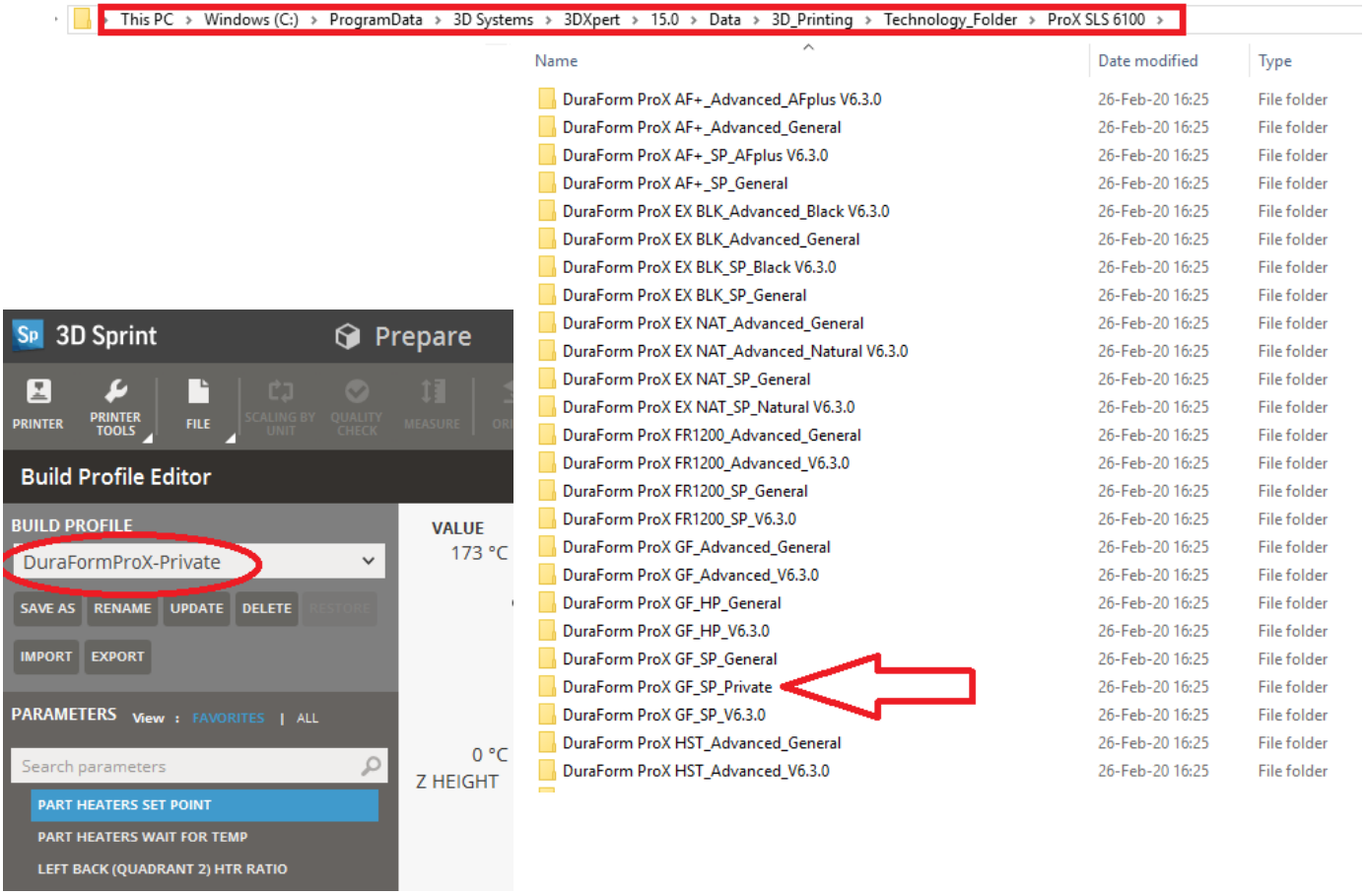
Close the SLS Printers dialog by clicking the Close icon.

At this point, the system creates local 3DXpert printer database for the printer.
Note the new, dedicated printer folder in the Technology folder, called ProX SLS 6100:



In this folder, all the validated material folders, as found in 3D Sprint, are created using official 3D Systems material names.
If the user create private databases in 3D Sprint, they will be available as well.

The image below shows the material folders created in 3DXpert's Technology folder, for ProX SLS 6100. All the material names which are provided from 3D Systems end with the "General" postfix. Note also the folder called "DuraForm ProX GF_SP_Private". This is a material name, which the user defined in 3D Sprint, after updating a database and saving it as a separate, private, material.



The above image shown the private build profile in 3D Sprint. It has been converted as well to a 3DXpert database.

3DXpert SLS Material and Build Style Naming Convention

A 3DXpert **Material** name of any material database derived from 3D Sprint includes the items relevant for this material, separated by an underscore character:
<Short powder name> _ <PRINT MODE> _ <BUILD STYLE> _ <BUILD PROFILE>.

For example: DuraForm ProX EX BLK_Advanced_General

In case that the BUILD PROFILE is exactly the same one that is defined in the BUILD STYLE, they will not be dupicated.

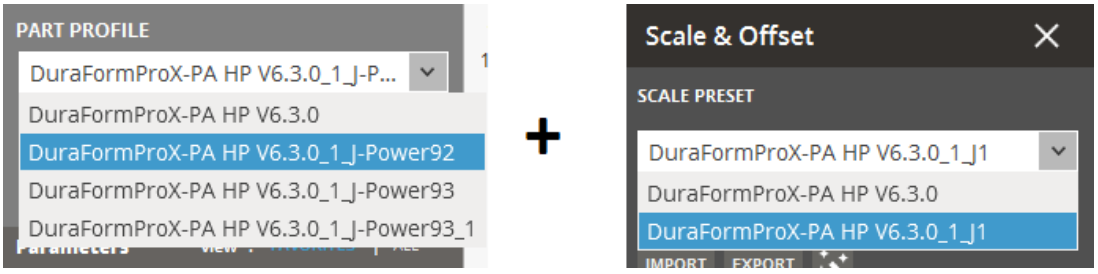
A 3DXpert **Build Style** name includes each one of the 3D-Sprint items that are in it separated by an underscore character, and without repetitions:

<PART PROFILE> _ <SCALE&OFFSET>

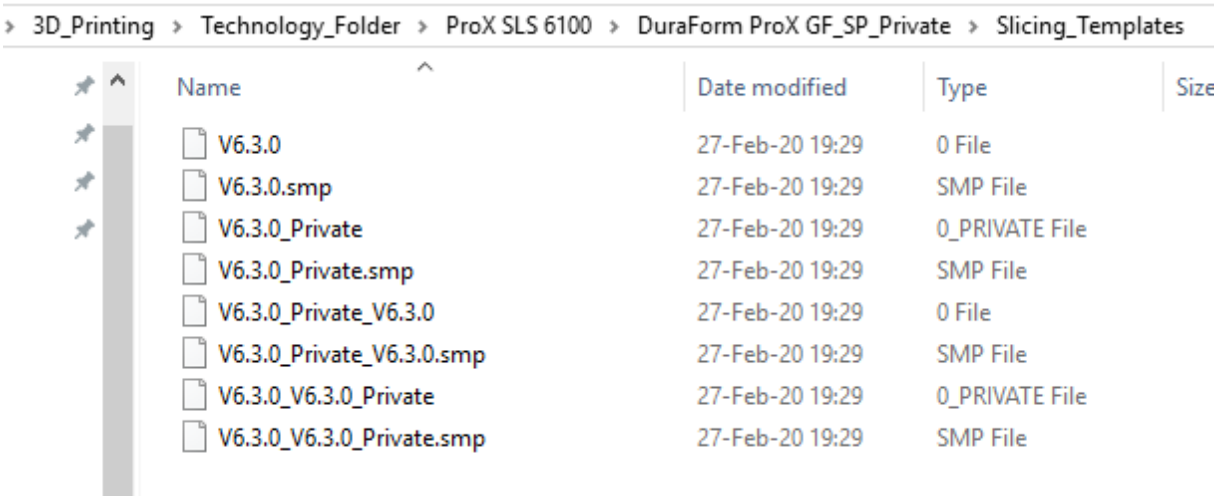
Examples:

1) DuraFormProx-PA HP V6.3.0

2) DuraFormProx-PA HP V6.3.0_1_J-Power92_1_J1



Inside 3DXpert's Material folder, the Slicing_Templates folder contains the created build styles:



Any combination of a 3D Sprint Part Profile and Scale & Offset will get its own 3DXpert build style.
The printer database is almost ready.
Next, we will select the printer and material to work with.

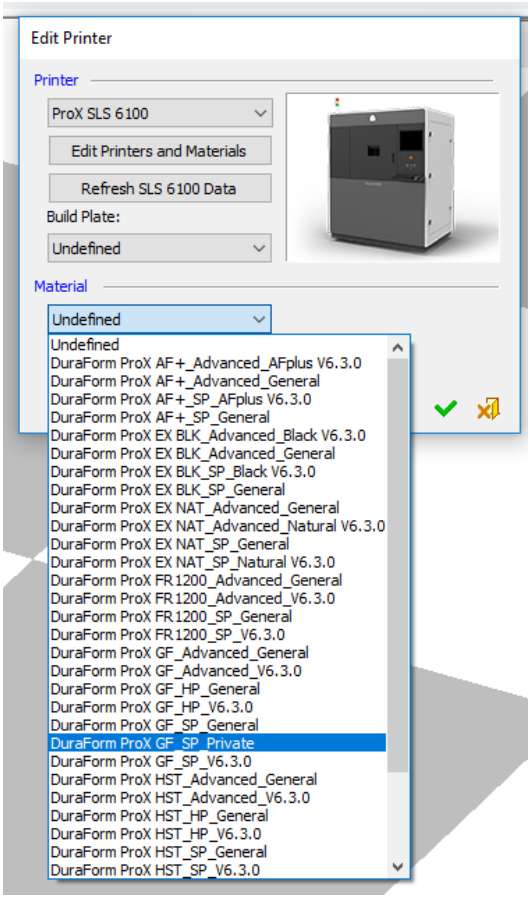
Setting up the Technologies

Once the material folders were created and the relevant build styles were placed in them, you can set which build styles will be the defaults.

Any of the created build styles is a combination of Scale & Offset and Part Profile. Such a build style can be assigned in 3D Sprint and 3DXpert for each component (in 3DXpert by the Technology Assignments tool).

Note that it is not possible to change the build style parameters in 3DXpert, only read from 3D Sprint.

Launch the Edit Printer dialog, note the printer ProX SLS 6100 showing up in the list and select a material"



Build Plate information is not relevant for SLS printers. Keep it as Undefined.

Press OK.

The 'Refresh SLS 6100 Data' button remains available for each of the physical printers, as whenever an update comes along (for example, a new version of the SLS validated material, printer maintenance etc…), you can use this button to refresh (recreate) the database also for 3DXpert.

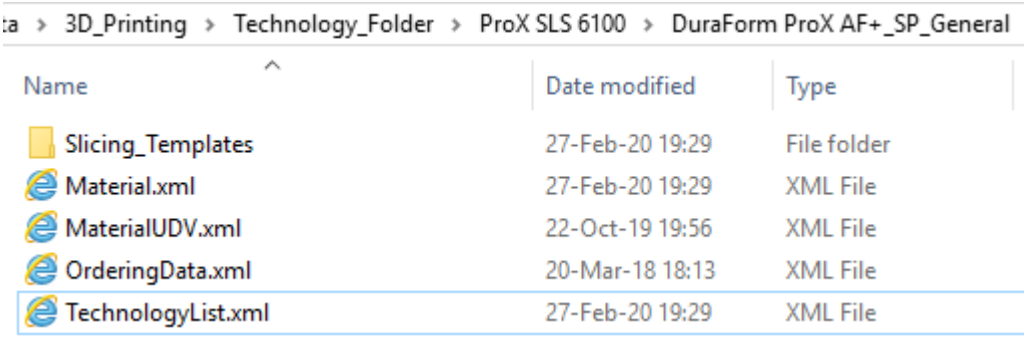
Manage Technology List

The next step of the setup stage (usually done once) is to connect the SLS technologies to the 3DXpert technology lists.
Click the Technology Settings icon.

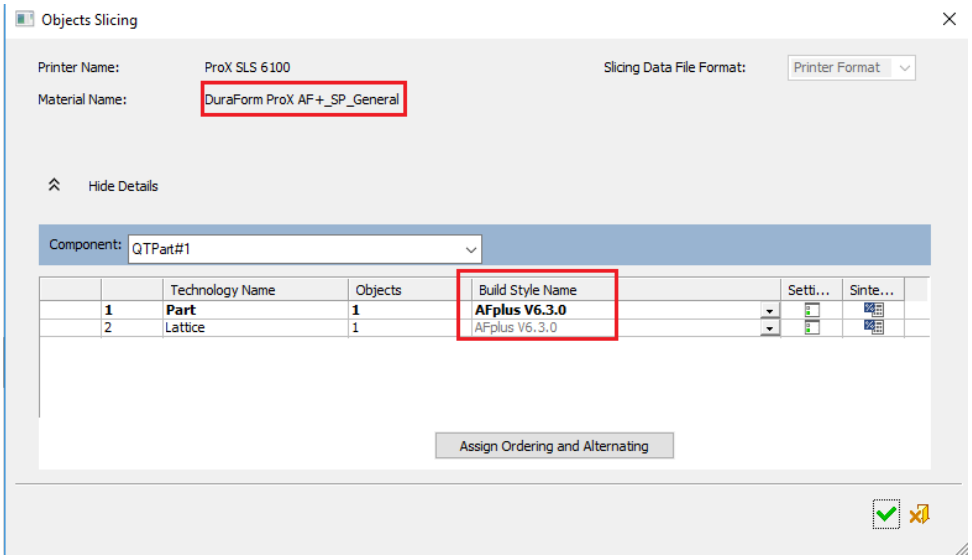
3D Systems creates material databases for ProXSLS 6100 users. Each of these databases is fully defined.

Thus, when such a database is migrated from 3D Sprint to 3DXpert, it becomes a specific material database and the postfix ‘General’ is added to its name. The Technology List of such materials is automatically set.

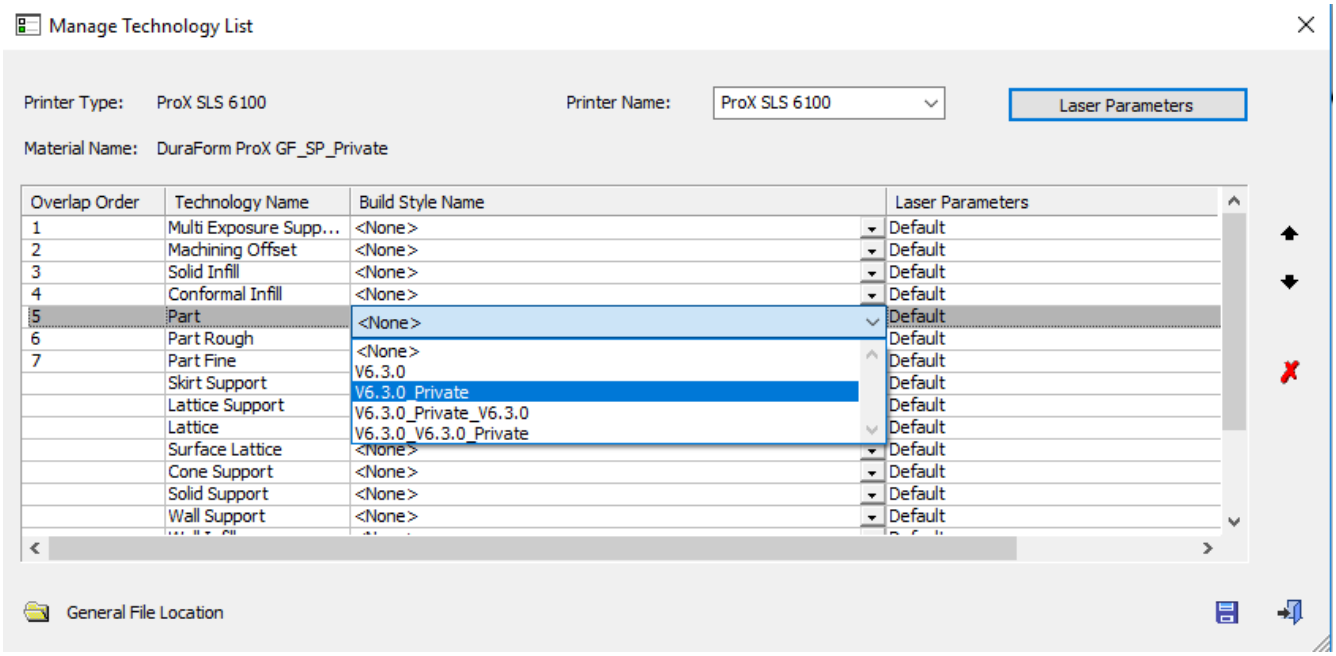
In this example, the database for DuraForm ProX AF+_SP gets the postfix ‘Generel’:



The Technology list file of this material is set. Clicking Calculate Slices, the build styles are already attached to the technologies:



In other materials databases migrated from 3D Sprint, this connection is not achieved automatically. Connect the relevant Technology Name of 3DXpert with the suitable Build Style Names coming from the specific SLS Material and showing up in the list (the list of available build styles may vary depending on the material).



Press the Save icon at the bottom of the dialog.
Now the material database is ready. Remember that this setup is carried out once so from now on (or until a next material update from SLS), there is no need to run any of the above again.

NOTE for 3DXpert 15:
1. In order to update correctly the SLS 6100 database it is required to

   1.1. Close all open 3DXpert sessions

   1.2. Launch 3DXpert again

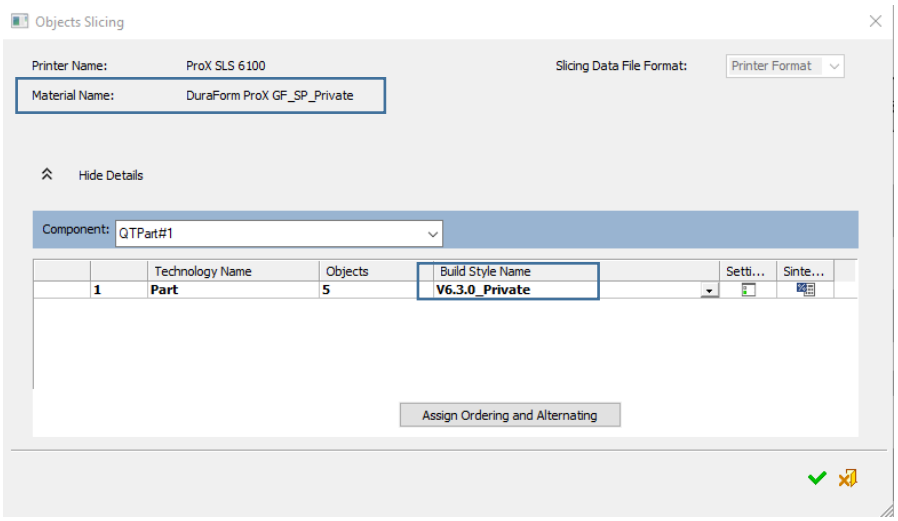
2. Refresh the database. After the material database migration from 3D Sprint to 3DXpert has been completed, and again, all the material names which are provided from 3D Systems end with the "General" postfix.

   2.1. The Technology List of these materials is updated automatically (see above).

   2.2. The Technology List of other materials should be updated by the user (as described above).

Slicing

In the following example, parts are sliced in 3DXpert. Note that the SLS technology names now show as the Build Style Names in the Object Slicing dialog:

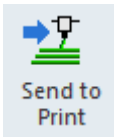


It is not possible to assign different Technologies (build styles) to different objects of a single part (component).

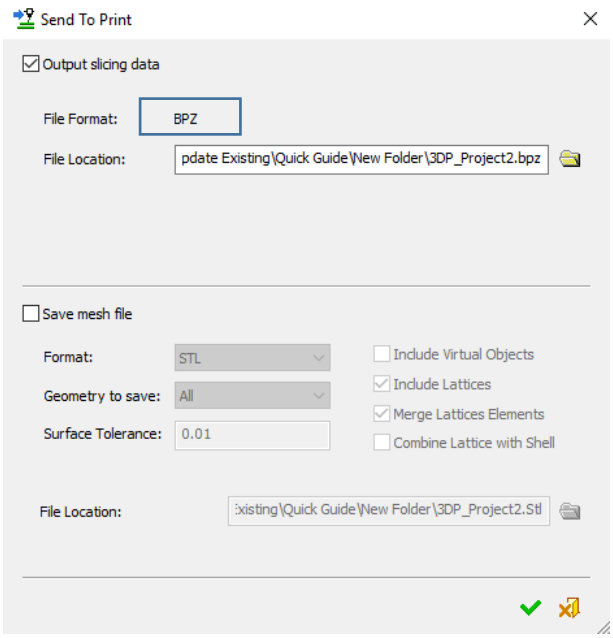
Click OK to calculate.

After calculation, there is no scan path to show (the scan path itself is calculated by the printer) therefore, the Scan Path Viewer is not available when working with this printer.

Creating the Build File

After slice calculation, press Send to Print. 

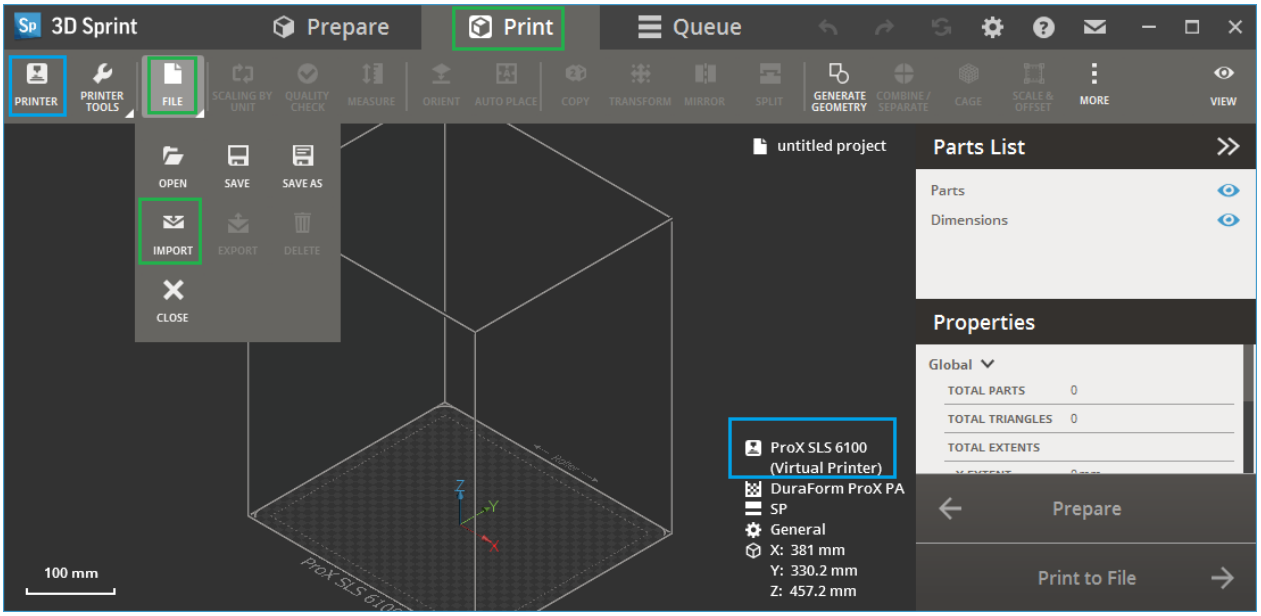
Note that the file format is BPZ, this is the format of the Build File. After OK, browse to the folder set as File Location and check for the relevant BPZ file.



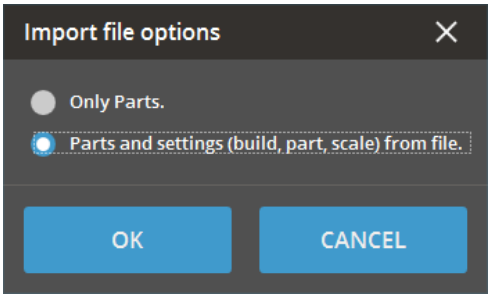
Load the BPZ on the printer, or on 3D Sprint, to manage it alongside the any other running printing jobs.

Load a BPZ file on 3D Sprint

Launch 3D Sprint and verify that the printer family to use is Prox SLS 6100 printer, if not change to it via the PRINTER button.
Click the Print tab and press the File icon. Click Import



Select the BPZ file created by 3DXpert, and in the Import file options dialog set “Parts and settings (build, part, scale)from file.”



Press OK.

End of 3DXpert SLS Guide