

**Matter and Form**

**3D Scanner**

**V2 User Manual**

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## Legal & Safety Stuff

These instructions provide important information concerning the proper operation of the product. Only use this product after carefully reading the operating instructions included with the product and all warnings and labels on the product packaging, including the manual and any separately included sheets. Only use this product with the included accessories and the included power adapter. Do not use this product or any Matter and Form Inc. online services for purposes that could infringe on the intellectual property of a third party. Matter and Form Inc. assumes no responsibility whatsoever with regard to the infringement of intellectual property through use of the Matter and Form 3D Scanner or Matter and Form Inc. online services. The Matter and Form 3D Scanner comes with a limited warranty, in addition to any warranties mandated by local laws. Details of the warranty can be found at <https://matterandform.net/legal>

Matter and Form Inc.  
243 College St., Suite 401  
Toronto, Ontario  
Canada, M5T 1R5

Please note the following important safety instructions:

- Do not operate this product if it is damaged, or if the power cable or USB cable are damaged or if any of its internal features are exposed.
- Only use the cables and power adapters provided with the scanner. If you require a replacement, please contact Matter and Form Inc. at [support@matterandform.net](mailto:support@matterandform.net)
- Do not operate the product when wet. If it should become wet, do not turn it on. Disconnect it from its power source and do not operate it until completely dry.
- Do not touch the camera lens, laser lenses or laser housing.
- If your product requires maintenance or repair, contact Matter and Form Inc. at [support@matterandform.net](mailto:support@matterandform.net). Do not attempt to open or repair the product on your own, as it may be hazardous and will void your warranty.

## FCC Class B Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

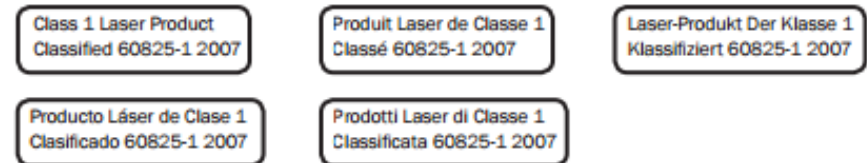
You may also find helpful the following booklet, prepared by the FCC: “How to Identify and Resolve Radio-TV Interference Problems.” This booklet is available from the U.S. Government Printing Office, Washington D.C. 20402.

Modifications: Any modifications made to this device that are not approved by Matter and Form Inc. may void the authority granted to the user by the FCC to operate this equipment.

## Laser Stuff

“Complies with FDA performance standards for laser products except for deviations to Laser Notice NO-50, dated June 24

2007. Class 1 laser product classified under IEC60825-1:2007.”



## Inside the Box

Thank you for purchasing the Matter and Form 3D Scanner.

Included in your box, you'll find:

1. One (1) Matter and Form 3D Scanner
2. One (1) AC Power Adapter
3. Four (4) Interchangeable Power Adapter Plugs  
(set of 4 international)
4. One (1) USB B Cable
5. One (1) Plastic toy for first time scans
6. One (1) Calibration Box or Card and stand
7. Set-up Manual
8. Electronics Documentation

The scanner also features a removable plug in the center of the turntable bed. Removing the plug reveals a standard camera threaded socket that users can use to attach a tripod mount for holding objects in place.

# Before You Begin

## The Importance of Lighting

Scanning should be done in well-lit conditions. Diffuse, white light from fluorescent tubes, incandescent or halogen bulbs, or a natural light source is best. Be aware that incandescent bulbs can add a yellowish tone to your final scan texture.

Lighting situations to avoid include:

- Spotlights or shining light directly on the object can cause hot spots in some areas and shadows in others, making it difficult for your scanner to see the lasers.
- Uneven lighting can cause uneven textures, especially when aligning scans together.
- Bright direct sunlight can overpower and wash out the scanning lasers, leaving fewer points recorded by the scanner.
- No lights at all will cause missing and inaccurate data, and textures will appear black.
- Variable lighting (lighting that fluctuates between bright and dark during the scan) will affect the color information that is gathered, making the textures look striped.

For more up-to-date tips and tricks, visit our website.

[www.matterandform.net/help](http://www.matterandform.net/help)

## Problem Materials and Surfaces

There are some materials that laser scanners have trouble scanning. Because the scanner works by capturing the data that is made by the laser hitting the surface of the object, any material that makes the lasers difficult to see will not scan well.

Here are some materials you cannot scan without prepping first:

- Objects with surfaces that are too shiny (i.e. metal, jewels, mirrors etc.) will reflect or bounce the laser away from the object. This can cause noisy looking scans.
- Objects that are clear or translucent (i.e. glass, clear plastic, flower petals, jello etc.) will let the laser light pass right through the surface of the object. This can cause scans that appear to have two layers.
- Objects that are too dark and absorb too much light (i.e. black velvet, fur) will also absorb the laser light causing an inaccurate scan. This can cause your scan to appear empty.

## Preparing Your Object for Scanning

Some objects (as listed above) will require a bit of prep work to allow them to scan properly, or at all. Pre-treating your objects with matte paint, foot sprays or baby powder will give the best results. If using paint, a light grey color is best.

If you want to capture color data, be aware that any treatment may alter the color as it appears in the final scan.

## Download and Install

Download the MFStudio software from [www.matterandform.net/download](http://www.matterandform.net/download).

If you don't already have an account you'll be prompted to register your email.

Make sure to download the appropriate software for your computer!

Follow the setup wizard and complete the install process.

## Setting Up Your Scanner

Choose a location close to your computer that has even, ambient light and a stable, level surface. The first step is to connect the scanner:

1. Plug the USB Type A connector end into the computer;
2. Plug the USB Type B connector end into the scanner;
3. Connect the power cable to the scanner and plug the power cable into a surge protector;
4. Open the scanner on by gently depressing the release button on the top of the scanner and swing it open, revealing the scanner head and the turntable. Turn the handle 90° until it locks in place as the scanner leg.
5. Power the scanner on. To do so, push the MF logo on the lower front of the scanner until it lights up; Open the software. The software will search and detect the scanner. Once it does, you're ready to start

Before you perform your first scan, you must calibrate your scanner. Go to [Calibrating the Scanner](#) for step-by-step instructions.

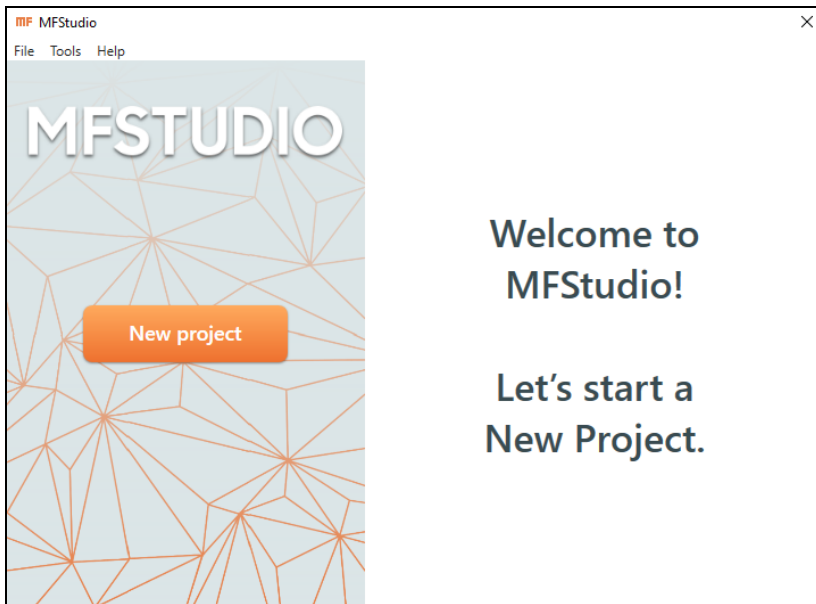


# MFStudio

## Starting a New Project

To start a new project, click **New Project** on the MFStudio homepage. Enter a **Filename**, select a **Save to:** location, then click **Continue**.

To open a project, click the thumbnail of a recent project on the MFStudio homepage, or navigate to **Open** from the File menu.



# Calibration

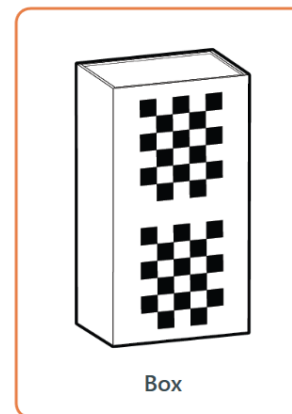
## Calibrating the Scanner

Calibration is very important to getting the best out of your scanner. From time-to-time or with brand new scanners, MFStudio will remind you when it's time to calibrate, but you can calibrate whenever you need to by selecting **Calibrate** from the File menu.

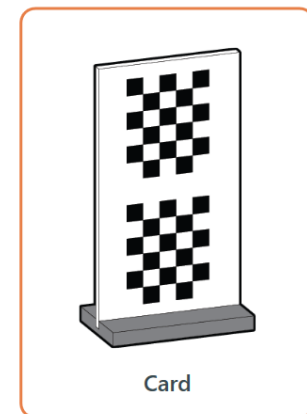


Calibrate your scanner when it gets moved or your lighting changes drastically! The turntable can shift when moved, causing the scanner to scan incorrectly.

Click to select the calibration device, card or box, that came with your scanner. Follow the instructions to assemble the card, if needed.

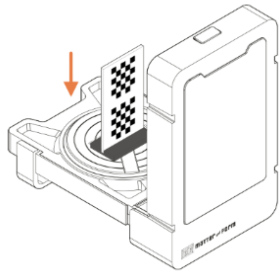


Box



Card

Follow the instructions for Calibration Steps 1 and 2 in the software to calibrate your scanner.



#### Calibration step 1

Please place the calibration card in the centre of the turntable with the checkers facing the camera (as shown), and click "Calibrate."

Note: there may be a short grinding noise. This is normal!



The scanner turntable will rotate left and right, firing its lasers and collecting a range of data. Be patient and do not move the calibration card or scanner.

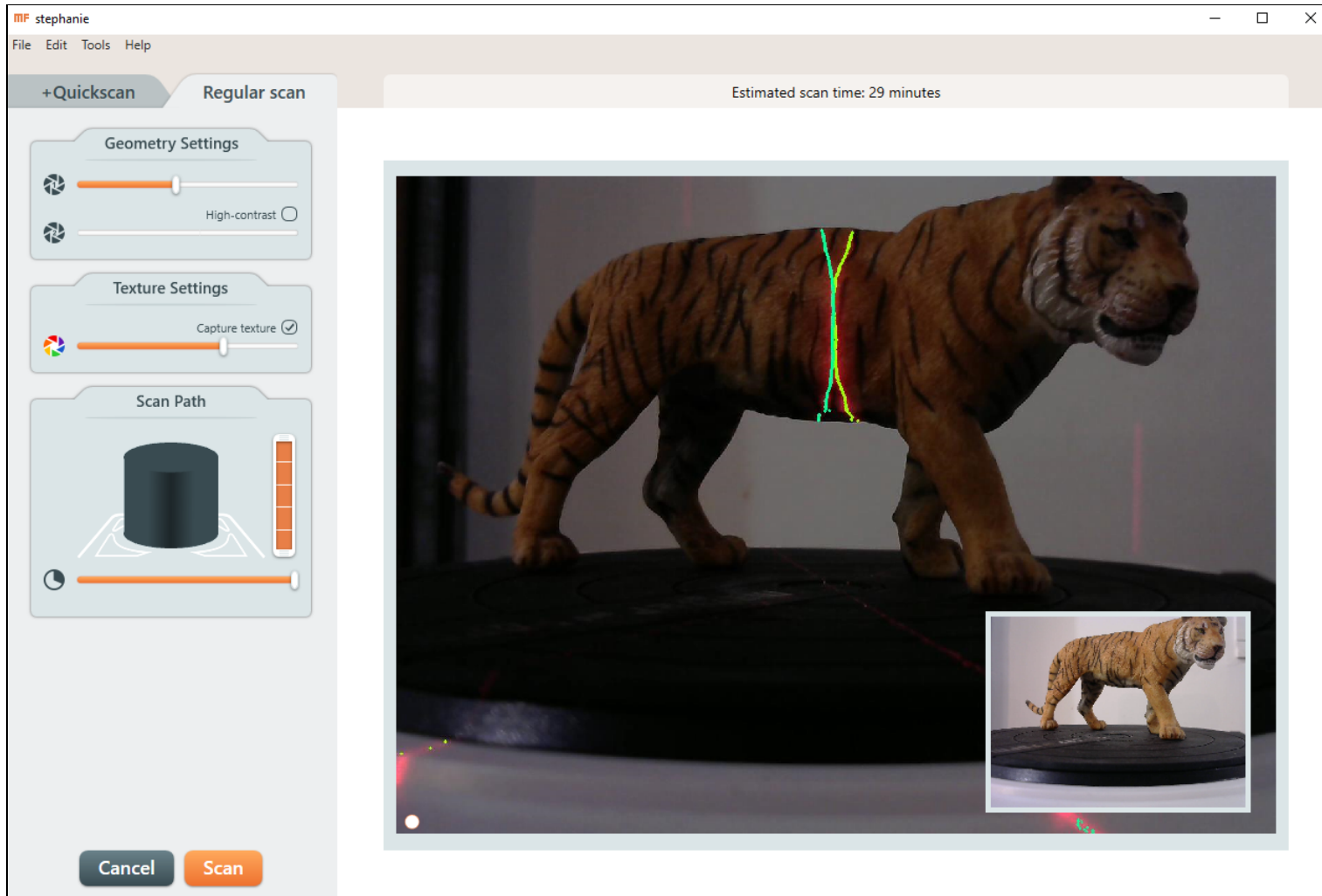
Step 2 will take slightly longer than Step 1 as the software compares the data between Step 1 and Step 2.



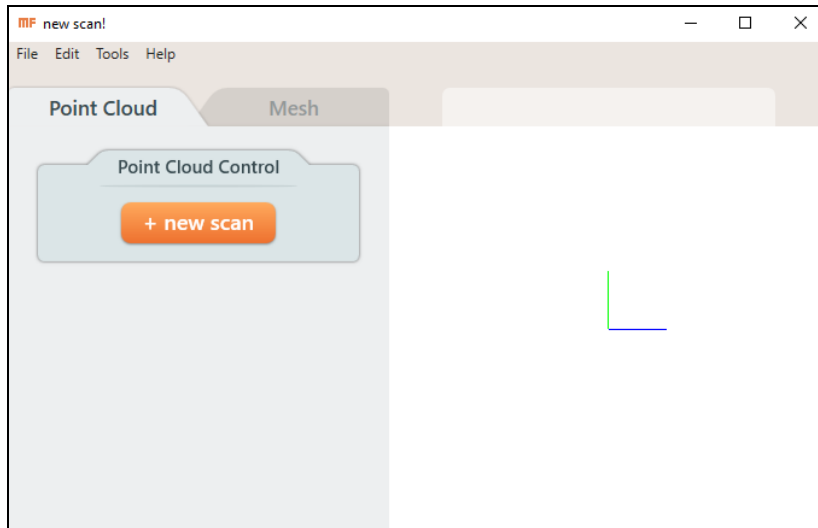
If your calibration is interrupted or fails, an error message should appear. Make sure your lighting environment is ideal and the scanner is properly setup before trying calibration again.

If a step in calibration takes longer than 30 minutes, stop the calibration and try again or contact [support@matterandform.net](mailto:support@matterandform.net) for tips and assistance.

# Scanning



## Starting a New Scan



Click **+new scan** to start a new scan. Clicking the tabs from the top of the sidebar on the Scan Setup page will let you choose between scanning modes:



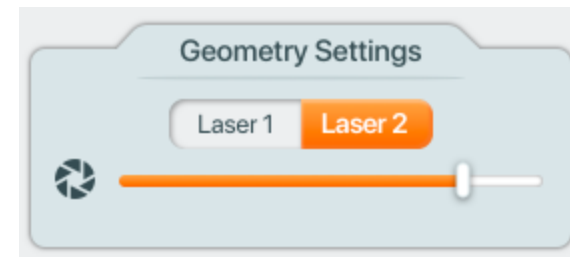
## Regular Scan

**Regular Scan** (10-15 minutes per pass) uses two lasers to capture geometry with optional textures.

Regular scan uses a process called “Adaptive Scanning”, in which the bed will rotate forward, but will also rotate back. This is to capture extra data when the distance between new and previously captured points is determined to be too great.

### +Quickscan

**+Quickscan** (1-2 min per pass) uses one laser to capture geometry. Click the Laser 1 and Laser 2 buttons under Geometry Settings to choose which laser to scan with.

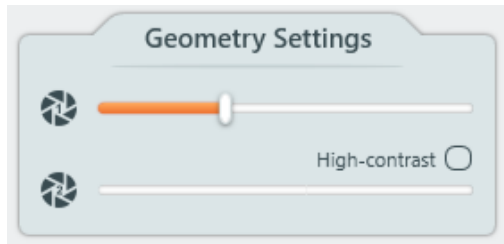


Laser 1 is farther from the camera than Laser 2. Choosing Laser 1 may result in greater accuracy, but capture less of the object (due to the shadow the laser will cast), while choosing Laser 2 may result in less accuracy, but more coverage.

See the following sections for information about [Geometry Settings](#) and [Texture Settings](#).

+Quickscan is only available for purchase through MFStudio, or at the time you bought your scanner. See [+Quickscan Purchasing and Activation](#) for more info.

## Geometry Settings



The Geometry Settings can be found at the top of the Scan Setup sidebar. The slider controls the camera's exposure, making the laser lines visible for capturing an object. Laser lines will bounce off different colours and object materials differently, influencing how well it will capture information. Changing the camera's exposure can make the lasers more or less visible.

One or two red lasers will be visible in the camera view. The additional green overlay represents how the scanner sees the lasers, ie. where your object is being detected. Adjusting the Geometry Settings slider will change how easy it is for the scanner to see the lasers.

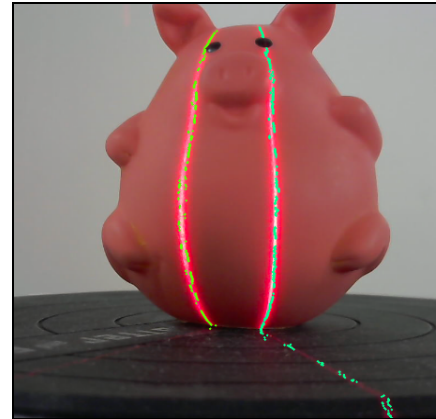
**To find the best exposure for your object,** choose an exposure where the green overlay is a sharp line, meaning that it doesn't have a lot of noise. Noise appears as fuzzy static rather than a straight solid or nearly solid line. The more defined and filled in the laser line the better the results.

If your laser line detection is poor at every exposure, adjust your lighting environment.

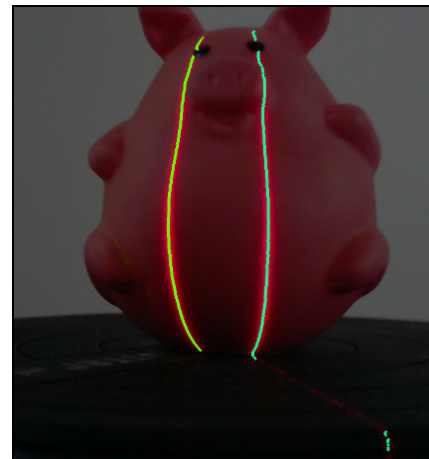


Dark-colored areas need a bright camera exposure and light-colored areas need a darker camera exposure for the best laser line detection.

## Picking the Best Laser Exposure



Here is an example of noisy laser lines with gaps.



Here the gaps are closed. This is a good set of laser lines.



When more than one exposure gives good results, choose the lowest value, as this reduces total scanning time and the capturing of noise points from the scan bed.

## High Contrast Scanning (Regular scan)

High Contrast Scanning is a method for capturing the best data possible when scanning objects with more than one color, particularly contrasting colors, like black and white. High contrast scanning allows for improved laser detection by tuning two different exposures, one for each contrasting color.

Click the **High-Contrast** checkbox in the Geometry Settings toolbox to turn on high-contrast scanning.

### How Do I Identify High Contrast Objects?



Use high contrast if your object has colors from both of these categories:

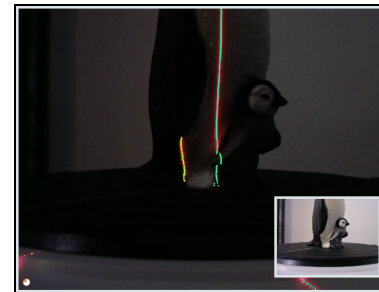
- 1) Blue, Purple, Dark Green, Black
- 2) Yellow, Orange, Red, Grey, White (and pastel colors)

Try High-Contrast, if the green visualization overlay for the lasers in the Geometry camera feed does not achieve a complete line when adjusting the Geometry Settings slider.

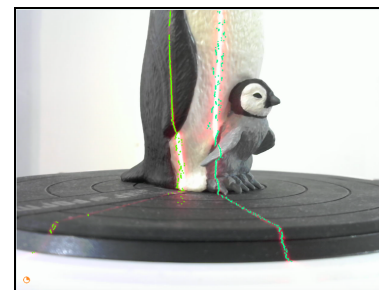
## Setting High Contrast Laser Exposures



Some models cannot be scanned with only one laser exposure due to their high contrast colors: grey and white both contrast with black.



Here you can see the laser lines when a darker exposure is selected. One color shows well, but the other doesn't.

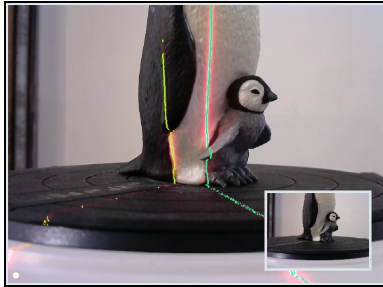


Here you can see the laser line shows up well on the black, but is spotty on the white.

To set a different exposure for each colour, first adjust the top Geometry Settings slider for **Exposure 1** to capture clean laser lines on the light areas of the object.

Check the **High-Contrast** checkbox, which enables the second exposure slider.

Then, adjust the bottom slider for **Exposure 2** until the dark areas of the model fill in with a clean laser line.



Here you can see the two laser lines showing clearly on both colors.

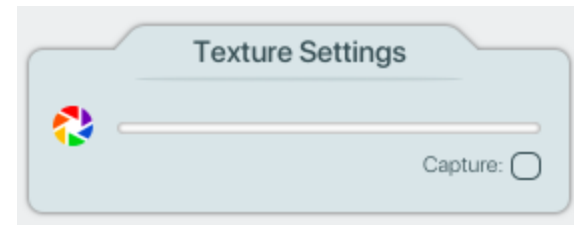


Changing exposures may take time to reflect in the Geometry camera feed, so you may need to wait a moment to see the results.

## Texture Settings

Texturing captures color information from photos taken during scanning and applies them to the generated point cloud. Textures can be enabled for meshed scan projects, and included when exporting/saving to MFPROJ or OBJ file formats.

To capture textures, check **Capture** in the Texture Settings toolbox. The Texture camera feed (displayed in color as a thumbnail within the Geometry camera feed) shows the exposure that will be used for texturing. Look at this feed when adjusting the Texture Settings slider.



Adjust the slider until you find an exposure where an object's colors appear realistically. You want an exposure that shows the colors on the object in a bright but not overexposed manner.

Textures for a **Regular Scan** are captured during the same bed rotations as the scanning operation.

Textures for a **+Quickscan** are captured during an additional bed rotation after geometry is captured.

## Picking the best exposure for color

Here are three examples for Texture Settings exposures:



This is underexposed. Capturing textures with this exposure will result in a fairly dark object.



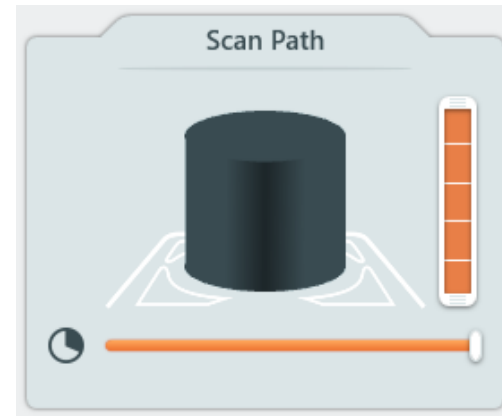
This is a good choice for capturing color because the object is evenly lit with minimal shadows and hot spots.




This is overexposed. Capturing textures with this exposure will result in hot spots and uneven colors.

## Scan Path

Adjusting the sliders in the Scan Path toolbox will restrict scanning to only a portion of the object.



- Height: The vertical slider sets how high the camera head will move - each block of the slider represents another height at which the camera head will stop to complete a bed rotation (or pass) to capture points.

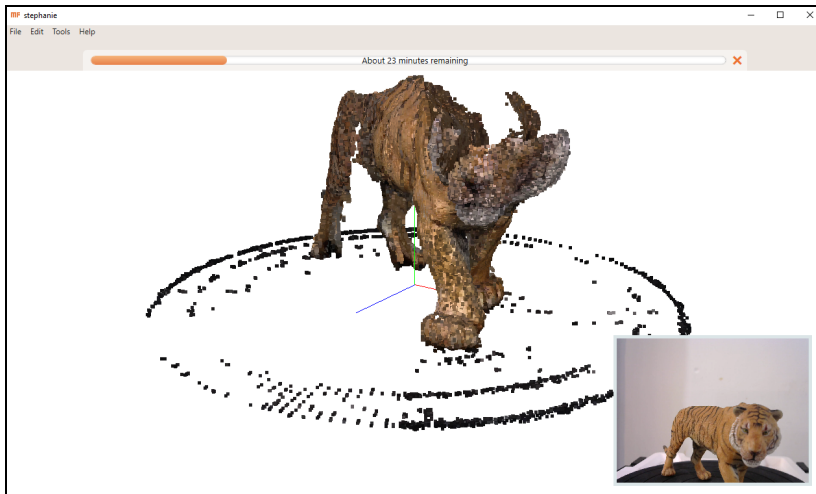
 If unsure of the appropriate scan path height for your object, leave the slider full and cancel the scan's progress when your object is completely scanned. It will load in the Project Editor as is.

- Degree: The horizontal slider sets the degree of bed rotation for each pass (45° minimum). Moving this slider will restrict the scan bed's rotation in order to scan only a portion of an object.

Click **Scan** when you're happy with your settings.

## Scan Progress

The Scan Progress window displays points as they are captured during scanning.



Click the **X** icon by the progress bar to finish scanning at any time. The scan will load into the Project Editor as-is.

You can interact with the point cloud while scanning:

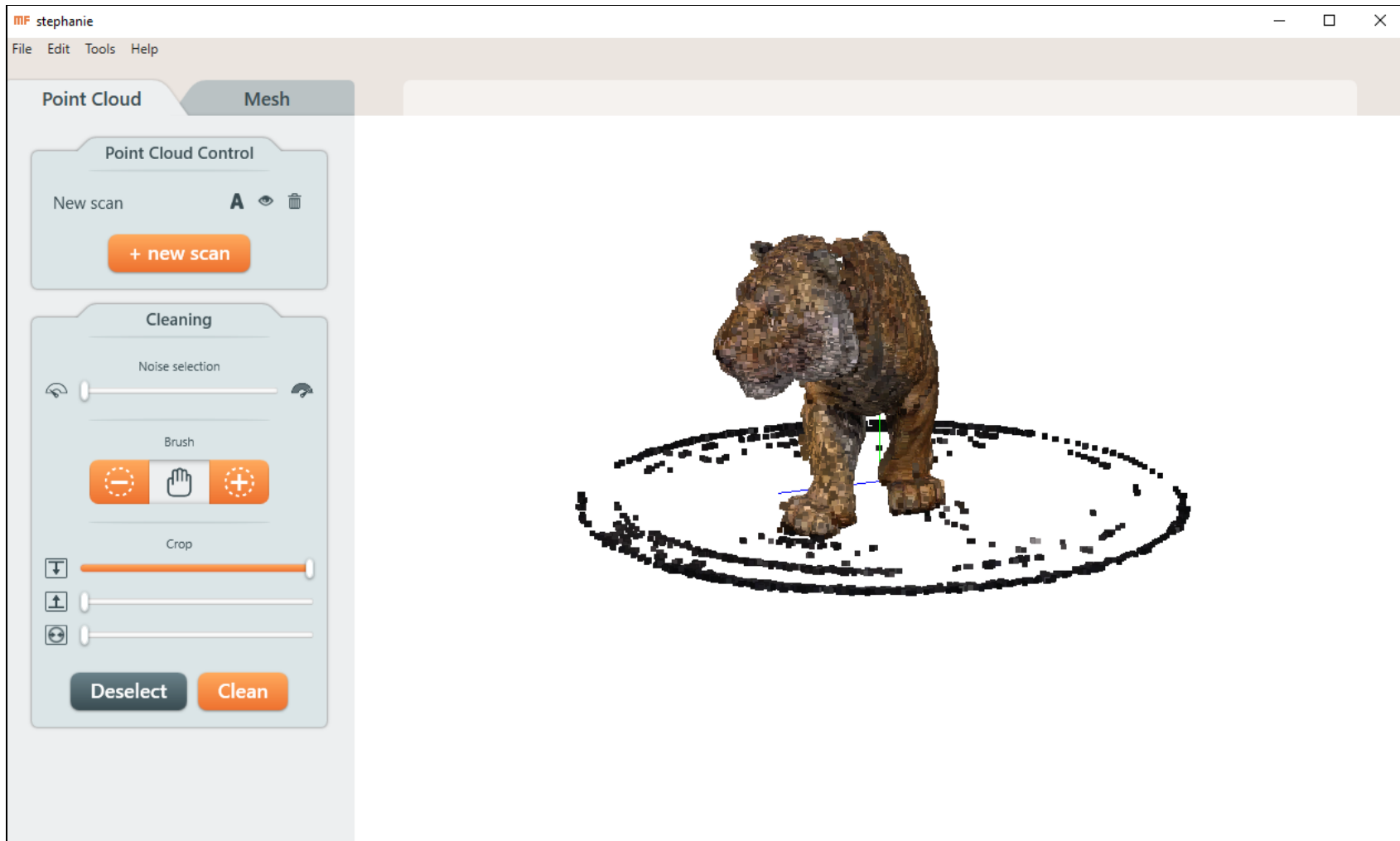
To SPIN: Click and drag anywhere in the view window.

To ZOOM: Use the mouse wheel, or scroll, to zoom in and out.

To PAN: Right click and drag.

To RESET VIEW: After clicking the view window, press the "c" on your keyboard.

# Editing



## Project Editor

The Project Editor is designed for working on multiple scans of the same object simultaneously (though it functions the same with a single scan).

Sometimes a single scan can miss a feature of an object, like the bottom or top, that can be captured by performing another scan at a different angle (i.e. with the object on its side).

To add an additional scan to your project, click **+new scan**.

From the Point Cloud Control toolbox you can:



Click to turn on/off visibility. Scans must be visible to clean or align them.



Click to delete a scan from the project.



Click to turn on/off alignment. Scans will align to the first scan selected.

## Aligning Scans

The most effective way to get complete geometry of an object is to scan it from different angles and align the resulting point clouds together in the Project Editor.

It's a good idea to clean your point clouds before aligning them.

Choose the point cloud in the desired orientation.

To begin the alignment process, click **A** on a point cloud in your desired orientation. This scan will be used as the reference for the next scan's alignment. Subsequent scans chosen for alignment will use all the previously aligned scans as their reference.

Alignment may take a few minutes depending on the size and complexity of the point clouds.



Occasionally the alignment algorithm identifies the wrong key points for aligning scans together, particularly with symmetrical objects. When alignment fails in this way, try aligning your scans in a different order.

## Cleaning Scans

The scanner can pick up unintended points caused by reflections off the surface of the object or captured background movement. The turntable can also be captured, especially if the object's color is similar to that of the bed.

There are three options for cleaning tools in the sidebar of the Project Editor: Noise, Brush, and Crop. Points selected by any of these methods will be highlighted in red. Click **Clean** to delete the highlighted points, or **Deselect** to keep them.

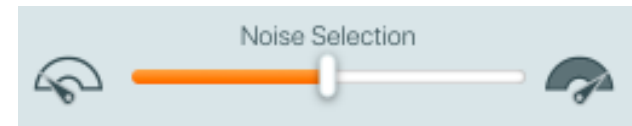
**Undo**, in the Edit menu, restores points that have been cleaned.



All points can be removed, including good points. Rotate the model to make sure only unwanted points are highlighted. You can use the mouse wheel, or scroll, to zoom in for a closer look.

## Noise Tool

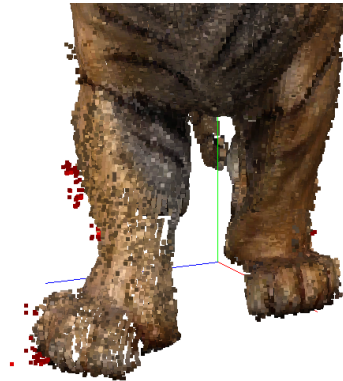
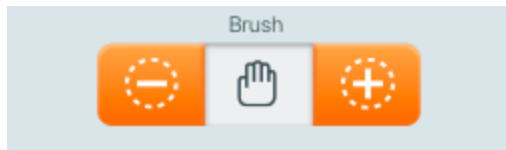
The Noise Selection tool automatically highlights points for cleaning. Move the slider to choose how aggressive the selection will be.



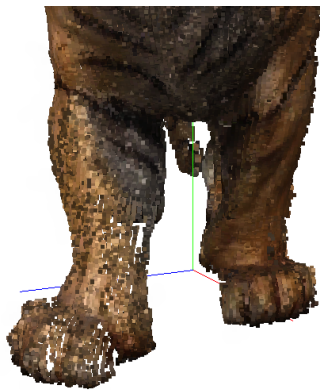
*Points selected with the Noise Selection slider set in the middle.*

## Brush Tool

The **Brush** tool manually selects (+) or deselects (-) points. Control the brush size using the square bracket tools ] and [. The hand button returns regular mouse functionality.



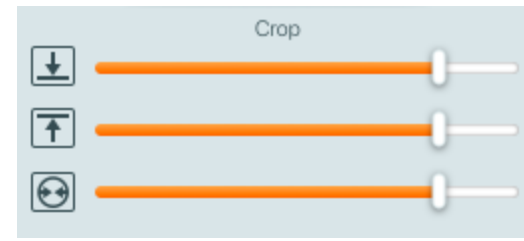
*Before: Unwanted points individually highlighted*



*After: Unwanted points deleted*

## Crop Tool

The **Crop** tool removes all points outside an area you specify. Use the sliders to choose points from the top down, the bottom up, or moving towards the center.



*Points to be removed are highlighted in red.*



*Result after clicking "Clean"*

# Meshing

To mesh a project for export, navigate to the Mesh tab within the Project Editor.

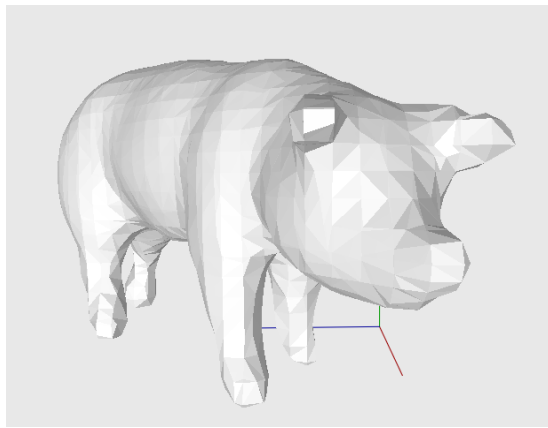
The Mesh Options slider controls the level of detail in the mesh: to the right for lots of detail, to the left for low detail.

If textures have been captured for the project, check **Enable texture** to texturize your mesh .

Click **Mesh**.

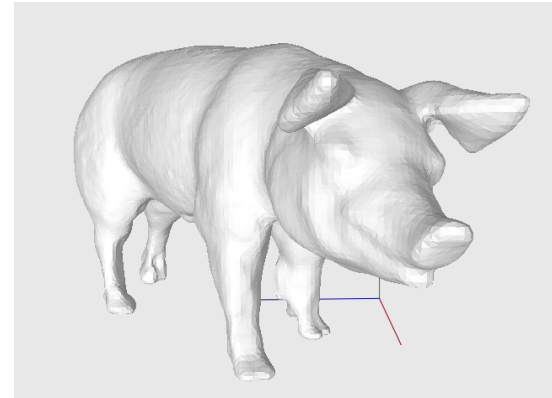


The ideal level of detail for meshing may vary by object and project. Further changes made to point clouds in the Point Cloud tab will not be reflected in the Mesh tab until **Mesh** is clicked again.



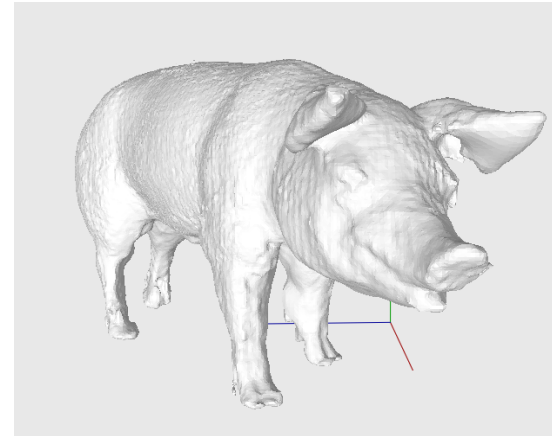
Detail level 6

*Meshing with a low level of detail results in fewer, larger polygons and create a very smooth surface.*



Detail level 8

*Surface is smooth and detail is accurate.*



Detail level 9

*Meshing with a high level of detail results in a dense polygon count that may make surfaces appear rough depending on your object.*

# Save and Export

## Saving Your Project

To save the project file, select **Save** from the File menu. Files are saved with the **.mfproj** file extension. **.mfproj** files can only be opened with MFStudio. The **.mfproj** file format is proprietary to Matter and Form and is the quickest and easiest file format for the software to use.

## Exporting

To export your project in a different file format, select **Export** from the File menu.

- Exporting with the Point Cloud tab open in the Project Editor will allow exporting point cloud file formats, like PLY or XYZ.
- Exporting with the Mesh tab open will allow exporting in other file formats requiring meshed models, like OBJ or STL.

All file format units are in millimeters. Exported files cannot be re-imported.

Export file formats include:

FILE TYPE	DESCRIPTION
XYZ (point cloud)	Use XYZ when working with CAD modeling programs. XYZ is the most basic point cloud format, and stores points on a Cartesian coordinate system with X, Y, and Z axes. XYZ does not save colour information.
PLY (point cloud)	Use PLY when working with programs like Meshlab. Like XYZ, PLY exports the point cloud as individual points. Unlike XYZ, PLY will store the point colors that were captured when scanning with regular scan.
OBJ (meshed)	Use OBJ when working with animation or 3D printing programs. OBJ will only store your final mesh. OBJ exports contain multiple files, so be sure to export to an empty folder. OBJ is the only file format that will export textures.
STL (meshed)	Use STL when working with CAM or 3D printing programs. STL exports are watertight and printable in most cases. Some editing may be required to flatten or hollow your mesh before printing.

# Pro Tips

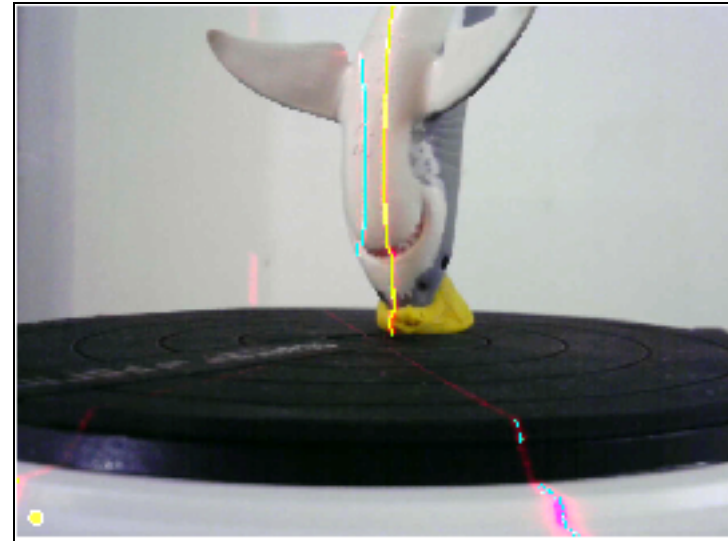
## Positioning your laser

Laser scanning operates on a sight-line principal: whatever the lasers cannot touch and the camera cannot see, the scanner cannot capture. For example, it would be able to scan the outside of a straw but not the inside. Like a photo camera, the scanner can only capture what is in its field of view.

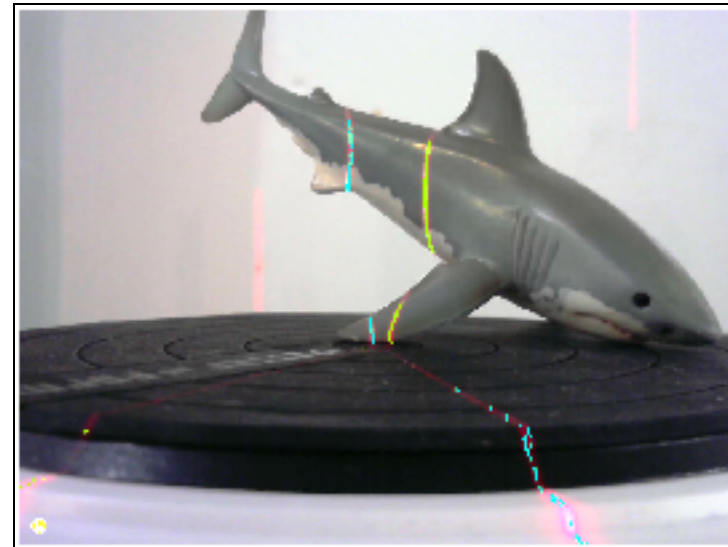
Organic shapes: curves, surface detail, outer geometry is easier to capture. Deep depressions and overlapping features, however, are difficult for the scanner to capture accurately.

Use the Geometry Settings camera feed on the Scan Setup page to preview how the laser lines are hitting your object -- this will change depending on where it's positioned on the bed (center or off-center) and how it is angled. Tilt, pan or rotate your object on the scan bed using your hand while looking at the camera feed to check where your object is being seen by the laser.

Use some plasticine or tack to stabilize your object at the angle and position with the best laser coverage (for longer, thinner objects try standing them upright with plasticine) . You can clean the scanned plasticine with the brush tool.



Try positioning your object off center or on a diagonal across the scanner bed for longer objects. The lasers will sweep across your object and add more coverage.



## Symmetrical Objects

Some objects are too symmetrical for the software to correctly align them.

One solution is to use tack, plasticine or anything that can create a geometric marker on your object, making it easier for the software to correctly align the scans. Then after aligning, use the brush tool to remove those points.

## +Quickscan, then Regular Scan

An efficient workflow worth trying is to initially scan with +Quickscan to generate point clouds of an object's basic geometry, then, with the knowledge gained from your recent scanning experience with that object, set up a Regular scan in the optimum position to generate any extra detail and hole-filling that's needed.

## Using other software with your scanner

For some purposes, scan projects may require some extra clean-up or geometric sculpting beyond what MFStudio can provide. MFStudio exports point clouds and meshes in a variety of file formats compatible with other software programs (see [Saving and Exporting Scans](#)).

Check the import settings within the software program you'd like to use and choose a compatible export format. You can control the size and number of faces of your mesh by lowering and raising the level of detail using the slider in the Mesh toolbox.

## 3D printing

To 3D print a scan you'll first need to mesh the point cloud (see [Meshing](#)) and export the project as either an OBJ or STL file. Both these file formats create watertight meshes capable of being 3D printed.


Check the file format restrictions of your 3D printer software. You can adjust the spatial size of the mesh once it's opened in the 3D printer software.

## 3D Lingo

A point cloud is a set of data points in a coordinate system. In a three-dimensional coordinate system, these points represent the external surface of an object and are usually defined by X, Y, and Z coordinates.


There are five essential terms that are used to describe elements of a given point cloud: vertices, edges, faces, polygons and surfaces.

**Vertices**




A vertex is a position. It includes additional information such as color, normal vector, and texture coordinates.

**Edges**



A connection (i.e. a line) between two vertices is an edge.

**Faces**



A face is a closed set of edges. It can be categorized as a triangle face (three edges) or a quad face (four edges).

**Polygons**



If a collection of faces all exist on a single geometric plane, this one collection of faces is labeled as a polygon.

Note: Polygons and faces are equivalent in software platforms that support multi-sided faces. However, most rendering systems support only 3- or 4-sided faces. So polygons are represented as multiple faces.

**Surfaces**



Surfaces connect neighbouring polygons together. Also called smoothing groups.

# +Quickscan Purchasing and Activation

## Purchase +Quickscan

On the +Quickscan tab in the Scan Setup page, click the **Upgrade to +Quickscan** button.

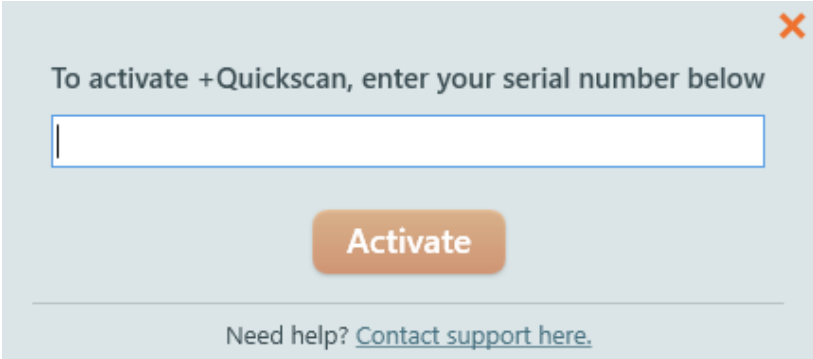
Fill in the information requested in the purchase dialog box, including payment option.

Once payment is received, a dialog box will open with a thank you message where you can click to **Start using +Quickscan!**

## Activate / Deactivate +Quickscan

Go to the +Quickscan tab in the Scan Setup page and click the **Activate +Quickscan** button.

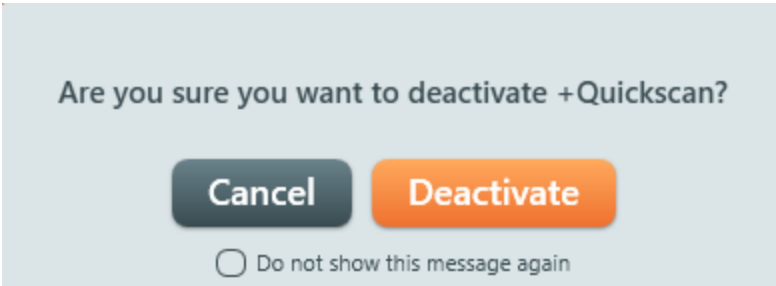
Enter the 12 digit serial number on the bottom of your scanner, or the 24 digit serial number emailed to you after purchasing quickscan, and click **Activate**.



The screenshot shows a light blue dialog box with a close button (X) in the top right corner. The text inside reads: "To activate +Quickscan, enter your serial number below". Below this text is a white text input field with a blue border. Underneath the input field is a prominent orange button labeled "Activate". At the bottom of the dialog box, there is a link: "Need help? [Contact support here.](#)"

Your +Quickscan license can only be active on one computer at a time. To use +Quickscan on a different computer you must first deactivate the feature on the first computer.

Deactivate +Quickscan by selecting 'Deactivate / Activate +Quickscan' from the MFStudio program menu and click **Deactivate** in the dialog box that appears.



The screenshot shows a light blue dialog box with the text: "Are you sure you want to deactivate +Quickscan?". Below the text are two buttons: a dark grey button labeled "Cancel" and an orange button labeled "Deactivate". At the bottom of the dialog box, there is a checkbox with the text "Do not show this message again".

Once MFStudio has been installed on the new computer, activate +Quickscan by following the activation steps as outlined above.



## Our Roots

We are designers and programmers from Toronto who needed a high-res 3D scanner but couldn't afford one, so we built our own. Determined to help others enhance their creative, professional and recreational lives, we launched a record-breaking Indiegogo campaign backed by designers, architects, hobbyists, gamers, teachers and creative families.

At the heart of our scanner's technology is a high-definition camera that produces accurate, detailed color scans at resolution qualities that match or top what more expensive scanners can achieve. It works with almost any 3D printer or online printing service, supports Windows and Mac OS, and allows users to scan solid items to create basic scans quickly and with little effort. It is also capable of exporting intricate, high-resolution, 3D representations for use in any number of digital 3D applications.

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