Cast Inversion™

for FastSCAN II™

March 2014

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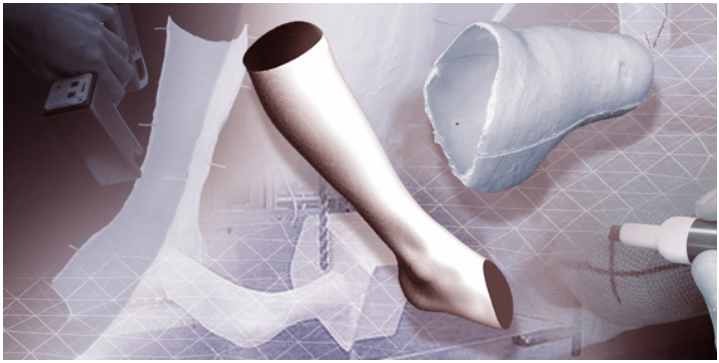
Contents



1 Introduction

The Cast Inversion™ feature for FastSCAN II™ has been developed to enable Orthotics and Prosthetics (O&P) practitioners to scan the inside surface of plaster casts, enabling the direct creation of a CAD model from the cast. The file can then be loaded into suitable O&P CAD software to facilitate modifications and/or fabrication of a pattern or prosthetic, as well as easily archived.

2 Overview

To scan the inside surface of a plaster cast (using a Cobra or Scorpion handheld laser scanner) it is first necessary to split the cast in two, to provide access to the inside surfaces of the cast. The Cast Inversion™ feature of FastSCAN II™ is then used to invert and seamlessly re-join the two scans of the split cast, creating a complete CAD model.

The procedure is broken down into a series of steps in Figure 1:

1. Decide on a suitable strategy for marking up reference points (these points are used in the re-joining process) and splitting the cast into two pieces.

2. Scan the two halves and identify the previously marked reference points.

3. Use the Cast Inversion™ feature to invert and re-join the scans.

4. Create the final model, using the standard FastSCAN II™ surfacing options.

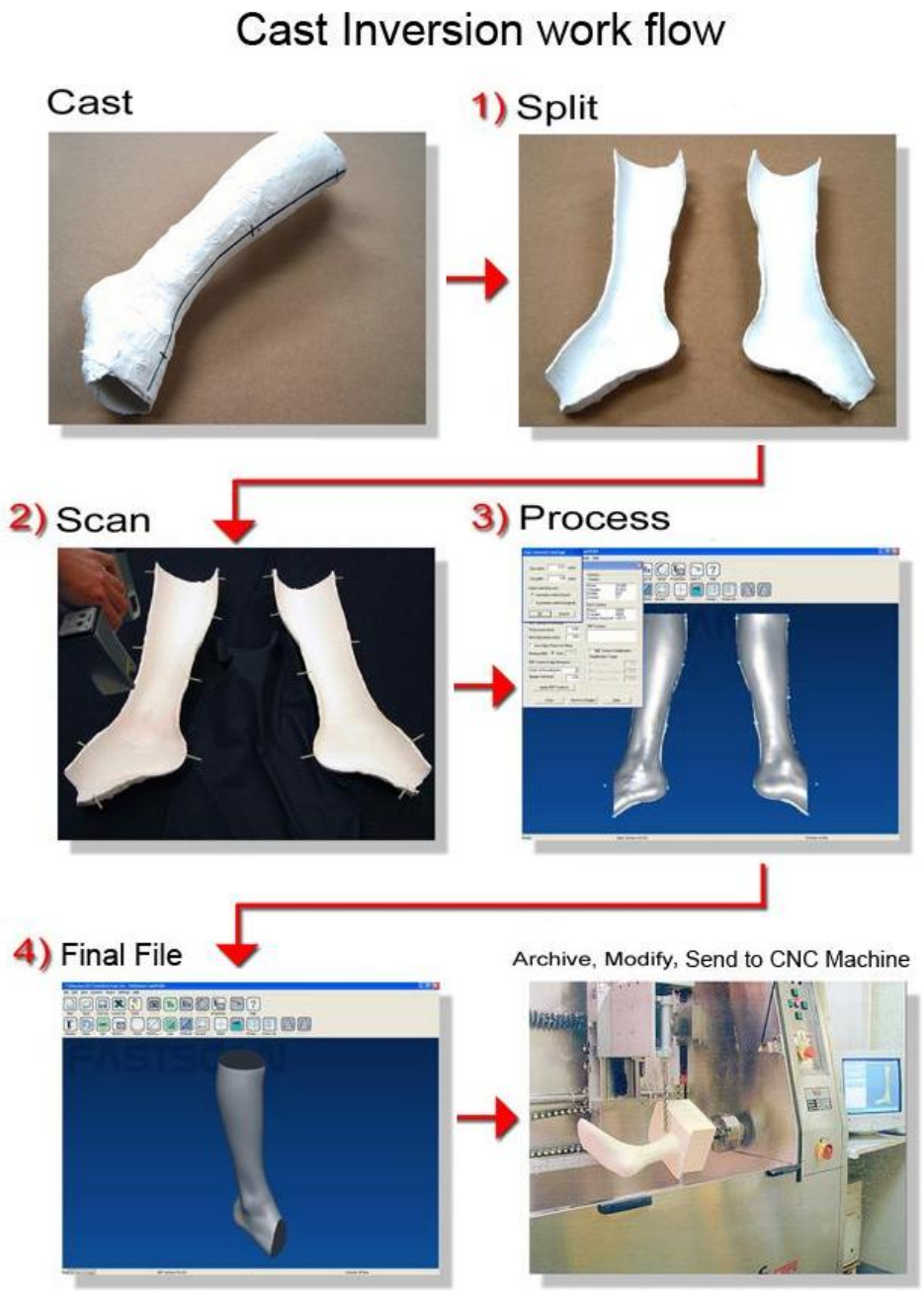


Figure 1: The process of scanning a plaster cast

3 The Process

3.1 Preparation For Scanning

1. Decide where best to split the cast and mark the path where the cut is to be made. Generally the best results will be obtained by cutting the cast into two approximately equal pieces, in such a way as to allow maximum unimpeded visual access to the inside surfaces.

Figure 2: Vertical lines on the front of the cast.

2. Place a number of reference marks along the cutting path—these marks will be used later by the Cast Inversion™ feature to assist in rejoining the two scanned surfaces. The reference marks can easily be placed by drawing a number of short (20-50 mm long) lines perpendicular to the cutting path, with a part of each line remaining on either side of the cast after it is split in two. Typically six to eight lines spaced around the full perimeter are sufficient (see Figures 2 & 3).

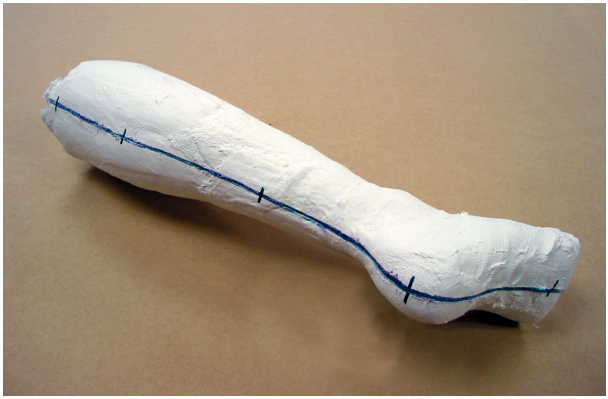


Figure 3: Vertical lines on the back of the cast.

3. The cast can now be cut (as cleanly as possible) along the previously defined cutting line. Any reduction in the cross section of the cast (due to saw blade thickness) can be compensated for later in the Cast Inversion™ process. To ensure a high quality scan clean away any loose material from around the edges of the cast.

Figure 4: The split cast.

4. The previously applied reference marks need to be highlighted so that they will appear on the scanned surface. This can be done in several ways:

   - **Method 1:** Place thin strips of tape (2–3 mm wide and at least 15 mm long) on the edges of the split cast, directly above the reference marks, so that the tape sticks out (shown in Figure 5). The tape strips will be picked up during the scanning process and are easy to identify when processing the scans.
   - **Method 2:** With thick walled casts simply continue the marker lines onto the top surface of the walls of the split cast with a dark marker pen. The lines will appear on the scan as a darkened area when **Pseudo-Grayscale** is enabled (by clicking **View/Color Mapping/Pseudo-Grayscale**).

     Note: Some experimentation may by required to perfect this technique as data must still be collected under the darkened areas.
   - **Method 3:** Apply electronic markers using the Optical Stylus™ (if available).

Figure 5: Shows the split cast with tape markers placed on edges.

3.2 Scanning

1. Place the two halves of the cast side by side on a matte black cloth with the Transmitter placed between them, as shown in Figure 6.

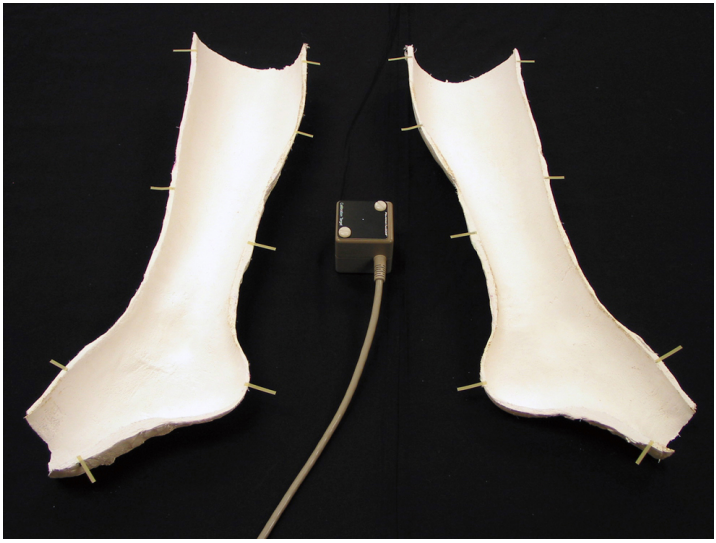


Figure 6: The Transmitter between the two halves of the cast.

Note:

- The (matte) black cloth ensures that the surface of the table is not picked up during the scanning process.
- It is useful to cover the Transmitter and cable with another black cloth or place it directly under the main cloth (Figure 7).
- It is very important that neither the two parts of the cast or the Transmitter move during the scanning process (the cast halves may require some form of support to stop them rocking).
- Ensure that the table or surface on which the scanning takes place is non-metallic—a small wooden table is recommended.

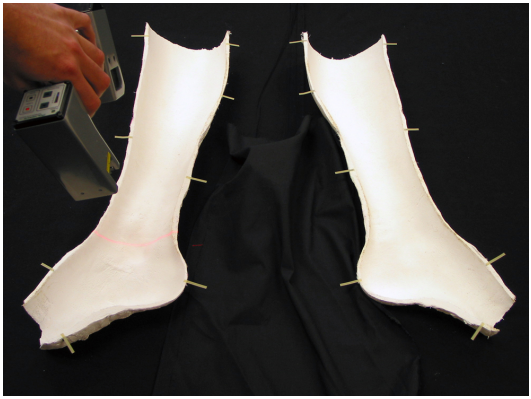


Figure 7: Scanning the cast with the Transmitter covered.

2. Carefully scan the inside surface of both halves of the cast, including the top surface of the rim and the markers. Take care not to scan the outside surfaces of the cast or any other unwanted objects within the scanner's range (Figure 7).

3. The **mechanical/optical stylus** can now be used to digitize the reference markers (the cast halves and reference transmitter must not be moved from their original positions). To use **Mark With Mouse**™ to perform this function, see Section 3.2.1

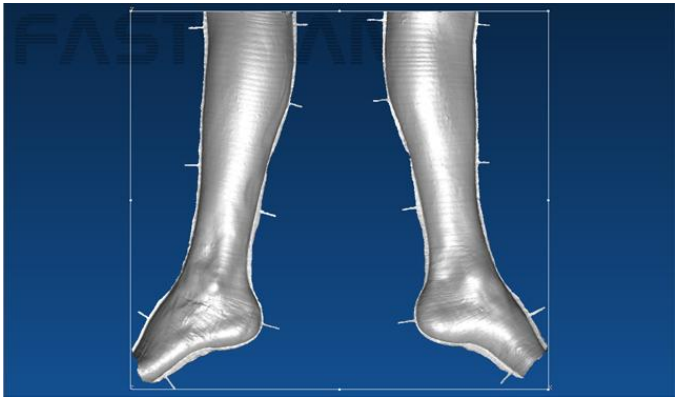


Figure 8: Scan aligned with the bounding box set to view.

3.2.1 Digitizing the Scanned Reference Marks

Digital reference points need to be defined based on the position of the tape or drawn markers.

Note: If the **mechanical/optical stylus** was used to locate the reference markers then this section can be skipped.

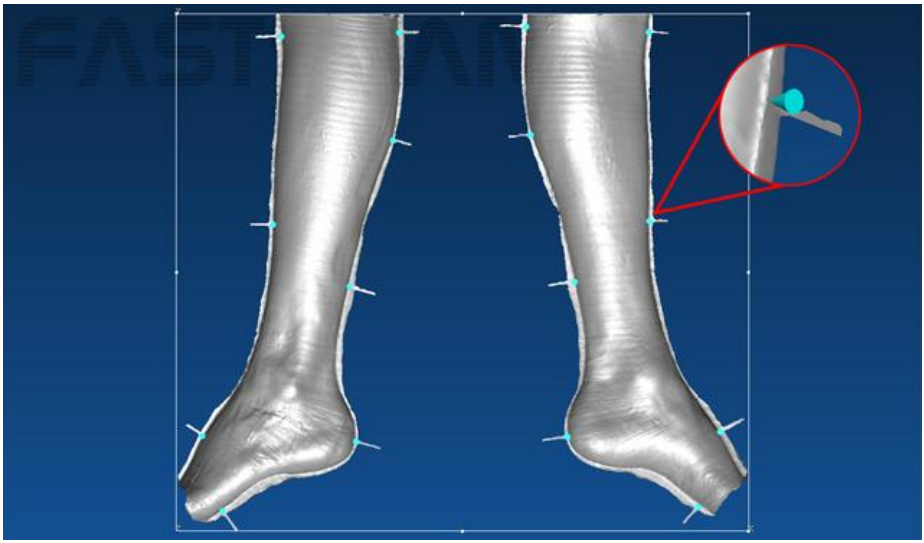


Figure 9: The placed stylus points.

Use the **Mark with Mouse**™ function to place reference points on the edges/rim of the scanned cast halves (directly over the previously applied tape or drawn markers). Align the scanned image on screen as shown in Figure 8, then click on **View/Set Bounding Box To View**. Zoom in on the tape or drawn markers and place a marker on each point (Figure 9).

Note: If drawn markers were used then **Pseudo-Gray Scale** should be selected to make the locating of these easier (turn this off again after all the points have been found). Whether using the **mechanical/optical stylus** or the **Mark with Mouse**™ mode to define the reference points, it is important that the location of these points be accurately identified to successfully recombine the two halves of the cast into a single image.

3.3 Applying Cast Inversion

1. Select **Edit/Cast Inversion Mode** to activate Cast Inversion™ mode (a tick will appear next to it).

2. Select the **Form Surface** tab and click on **Advanced** (or Ctrl+G) to bring up the **Generate Surface** dialog box (Figure 10). Enter the desired settings and click **Apply (Basic Surface)**.

   Note: The default parameters can be used as a starting point, however more suitable settings to enter in the **Generate Surface** dialog for a typical **Ankle-Foot Orthosis** (AFO) might be:

	Small Highly Detailed AFO	**Large AFO**
Smoothing	4.0 mm	10.0 mm
Decimation	3.0 mm	6.0 mm

   Limit Objects to: must remain on **2** and **Surface Simplification** is not required.

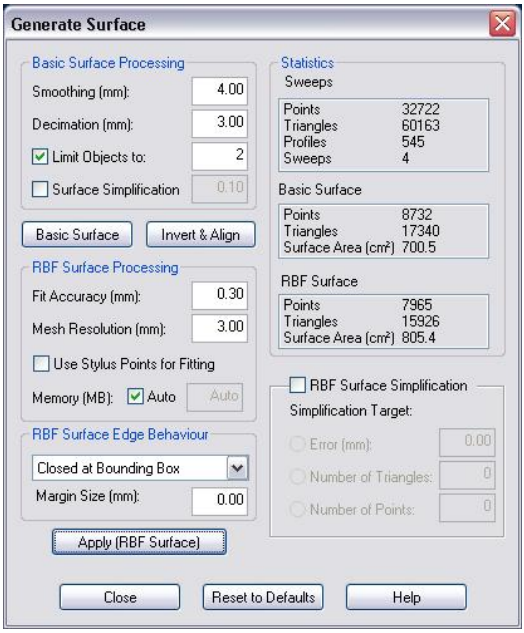


Figure 10: The Generate Surface dialog box with the **Invert & Align** button active.

3. If the Basic Surface looks satisfactory then save the file. The **Invert & Align** button will become active (within the **Generate Surface** dialog).

   Click on the **Invert & Align** button to bring up the **Cast Inversion** dialog box (Figure 11).

   Note: The **Invert & Align** button will not be available unless **Cast Inversion Mode** has been selected.

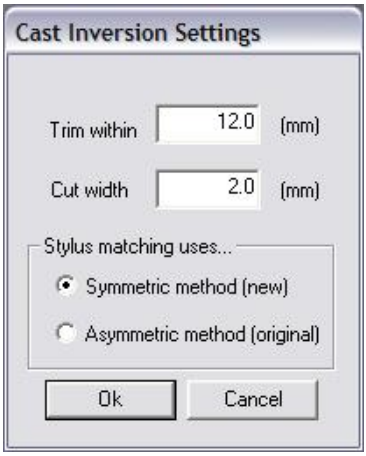


Figure 11: Cast Inversion Settings.

Three parameters must now be set:

(a) **Trim within:** This is used to remove noisy data that may have appeared around the edges of the scans (due to cutting debris, etc.), ensuring that when the scans are rejoined the resulting RBF surface has a clean fit.

Note: The number entered is the total width of the noisy data region from which the data is removed: i.e. a **10 mm Trim within** value will remove **5 mm from the edge of each half** of the scanned object.

(b) **Cut width:** This is used to compensate for the loss of cast material that will have occurred if the cast was cut with a saw blade—it is generally set to the width of the blade.

(c) **Stylus matching uses...:** Stylus matching should usually be set to **Symmetric method (new)**. This tells the Cast Inversion™ software that there are equal numbers of reference points on each half of the cast scan.

If, for some reason, there are unequal numbers of reference points on the cast scan halves, then use **Asymmetric method (original)**.

4. Click the **OK** button to continue.

   Any data in the set back area will now be removed and the scan adjusted for the thickness of the saw blade (if required). Now orientate the scans as shown in Figure 12.

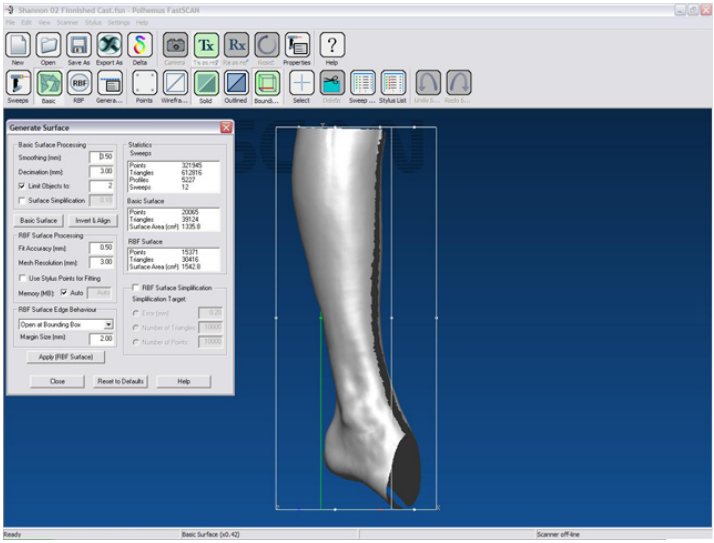


Figure 12: The object after Cast Inversion.

4 The Final Surface

Process the data using the RBF Surface Processing function within the **Generate Surface** dialog box (this should still be open) to produce the final surface.

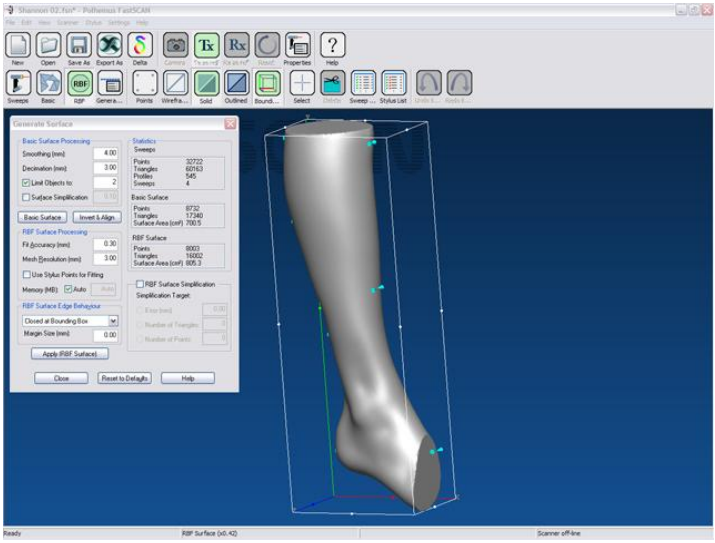


Figure 13: The final RBF surface ready for exporting.

Note:

- Fit Accuracy should be between 0.3 mm (Small Highly Detailed AFO) and 0.5 mm (Large AFO).
- Mesh Resolution should be consistent with that of the Basic Surface: i.e. the decimation value should be the same as that used in the Basic Surface.
- If Trim to Edges is selected the Margin Size must be set to a larger value than the gap between the scans.
- The stylus points may be turned off to view a clean image. Click on **Edit/Stylus Marks List...** (Ctrl+T) to bring up the **Stylus Marks List** dialog box (Figure 14). Select **None** or uncheck individual boxes in the list to view the object without the (selected) points.

  Clicking on **Invert** will uncheck all checked stylus point boxes and check those previously unchecked.

  Left-clicking the mouse on a stylus number in the **Stylus Marks List** will turn the selected point red. Choose more than one point by holding down **Shift** or

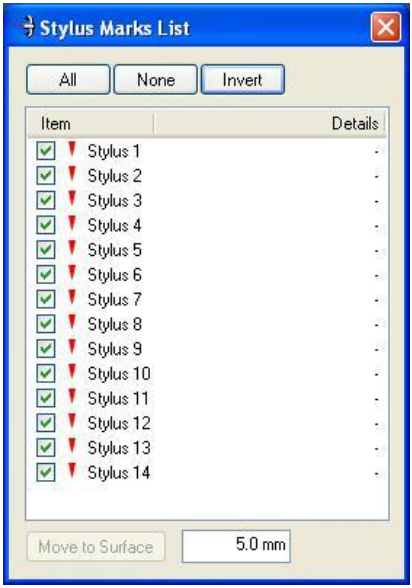


Figure 14: The **Stylus Marks List** dialog box.

Control while selecting points.

Note: Cast Inversion™ is an optional feature of FastSCAN II™ and requires a separate license. The Cast Inversion™ software also requires support from other licensed features of FastSCAN II™: the optical/mechanical stylus (with the Mark with Mouse™ feature).

5 Getting Help

For help on any aspect of Cast Inversion™ please email scanning@aranz.com