

FastSCAN[™]

Cobra C1[™]

Handheld Laser Scanner
User Manual

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110 Papanui Road
Merivale, Christchurch, 8014
New Zealand

PO Box 3894
Christchurch, 8140
New Zealand

www.aranz.com
www.fastscan.com

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Before You Begin...

Please read and fully understand **Section 12: Safety Guidelines** before using the *FastSCAN*[™] Scanning equipment. This section contains important safety information.

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1 Introduction

Thank you for purchasing a *FastSCAN*[™] 3D laser scanner. Your scanner will quickly and conveniently digitize the surface of any object into a series of points that fit together in 3D space. The *FastSCAN*[™] software then transforms this data into a detailed 3D object, in a file format that suits your needs.

The *FastSCAN*[™] software combines overlapping sweeps and eliminates redundant data to create a complete surface. This can then be further processed using mathematical functions called RBFs (Radial Basis Functions) to create a smooth watertight surface in the form of your scanned object. The resulting 3D object can be exported in a range of industry standard formats for use in other applications.

Please ensure you have read **Section 12: Safety Guidelines** before using this product.



2 Hardware and Software Setup

2.1 Components

You should have received the following components with your *FastSCAN™* package:

- Wand (1)
- Processing Unit (PU) (2)
- Transmitter (3), options are:
 - 4 inch
 - 2 inch (standard)
 - 1/2 inch (short ranger)
- 1/2-inch Reference receiver (small cube) (4)
- Wand cable (color coded) (5)
- PU's power supply and power cable (6)
- Wand pad
- USB cable
- *FastSCAN™* software install CD
- This manual.

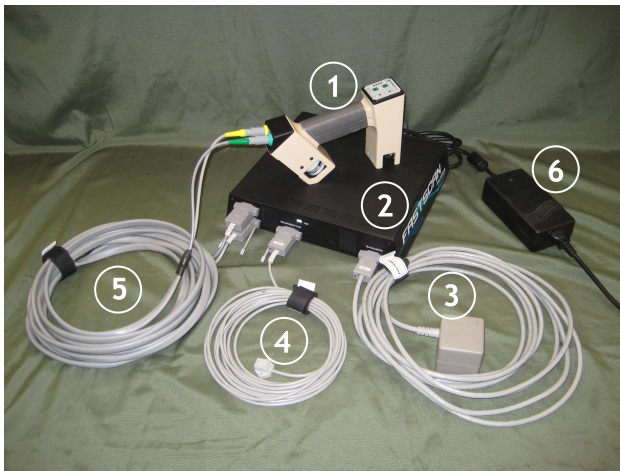


Figure 1: The FastSCAN™ Cobra system with numbered components.

Optional Items

- Mechanical Stylus
- Optical Stylus

2.2 Computer Requirements

- Windows Vista or XP (SP2) 32 or 64 bit OS, or Windows 2000 SP4.
 - 1 GHz Intel Pentium III or greater
(2 GHz Intel Pentium IV or greater recommended for RBF processing)
 - 512 MB RAM or greater.
 - USB port.
- OpenGL compatible hardware accelerated graphics adapter in 32-bit (true color) mode (minimum resolution 1024 x 768).

2.3 Installing the Software

Important: In order to install *FastSCAN*[™] ensure you have administrator privileges on the computer.

Note to Windows Vista users: Before installing the *FastSCAN*[™] software do the following:

- Go to **Start/Settings/Control Panel/User Accounts**.
- Uncheck the box **Turn user account On/Off**.
- Click **OK**.

The installation procedure is as follows:

1. Insert the *FastSCAN*[™] CD. The set-up program should start automatically. If it doesn't, open the *FastSCAN*[™] CD folder manually and double-click on the **FastSCAN Setup.exe** file to run the wizard.
2. You will be guided through the installation of the *FastSCAN*[™] software. Install the *FastSCAN*[™] files in the default directory. The setup program will also install the USB drivers automatically. During the process you may be alerted that the *FastSCAN*[™] USB software has not passed Windows Logo Testing—if this happens click the **Continue Anyway** button. You will be prompted to restart your computer if necessary.
3. When the software has finished installing open the CD folder, double-click on the license file **FastSCAN.lic.exe** and follow the instructions.
4. After the license file has installed double-click on the **wand_(serial#).exe** file to install the calibration data for your particular Wand.

2.4 Connecting It All Together

Note: Ensure that the PU is switched off before any of the front panel leads are connected or disconnected, or the Wand is detached from its cable.

1. Place the PU near the computer and plug it into a power source using the power pack and cable. Connect the USB cable to the front of the PU and to the computer. Allow room for air circulation at the back of the PU.
2. Plug the appropriate color coded plugs of the Wand cable into their respective sockets on the Wand. Plug the two connectors at the other end of the Wand cable into the sockets at the front of the PU, labeled 'Wand'. The two plugs/sockets have different polarization and cannot be connected incorrectly.
3. Plug the Transmitter connector into the socket labeled 'Transmitter'.



Figure 2: Front view of the Processing Unit.

2.4.1 Installing the Drivers

Ensure you have run **FastSCANsetup.exe**. The *FastSCAN*[™] installation process provides your computer with the necessary drivers. They will become available for loading when the hardware is plugged in and powered on for the first time.

For Windows XP:

1. When the scanner is first plugged in the **Found New Hardware** wizard window will display. If you are requested to allow Windows to connect to the Windows Update Web site select **No, not this time** and click **Next**.
2. Choose **Install from a list or specific location (Advanced)** and click **Next**.
3. Then choose **Don't search. I will choose the driver to install.** and click **Next**.
4. Select **FastSCAN USB Laser Scanner** and click **Next**. If the list contains no item for **FastSCAN USB Laser Scanner** choose **Have Disk** and browse to the location of the driver files located on the install CD, typically:
C:\Program Files\Polhemus\FastSCAN\USB Driver and click **Open**.

5. It is normal for Windows to report that *FastSCAN*[™] drivers have not passed Windows Logo testing/are not digitally signed by Microsoft. Click **Continue Anyway** each time when prompted until the drivers are installed.

Note: This procedure needs to be repeated when plugging the scanner into a different USB port.

For Windows Vista:

1. Before powering up the PU connected to your computer click: **Start/Settings/Control Panel** to open the **Control Panel** window.
2. Double-click on **System**.
3. In the **System** window click on **Advanced System Settings**.
4. In the **Advanced System Settings** window choose the **Windows Update Driver Settings** button.
5. Select the middle option: **Ask me each time I connect a new device before checking for drivers**.
6. The drivers should now automatically install when you power up the *FastSCAN*[™] system connected to your computer.

2.5 Running *FastSCAN*[™]

1. Ensure the system is fully connected and the scanning environment set up as desired.
2. Turn on the PU. The green light on the front of the PU should flash for approximately 10 seconds and then stay on. If it doesn't, check that the Wand cable and power supply are correctly connected.
3. Start *FastSCAN*[™] by double clicking on its desktop icon. The *FastSCAN*[™] startup screen (Figure 3) will appear.

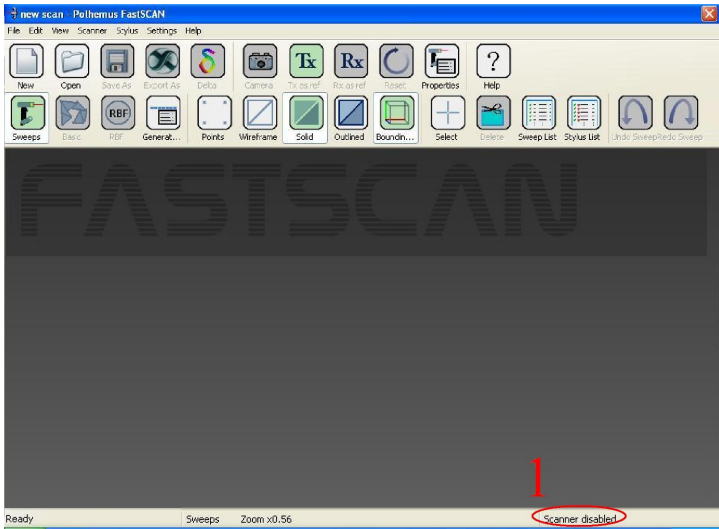


Figure 3: The *FastSCAN* startup screen.

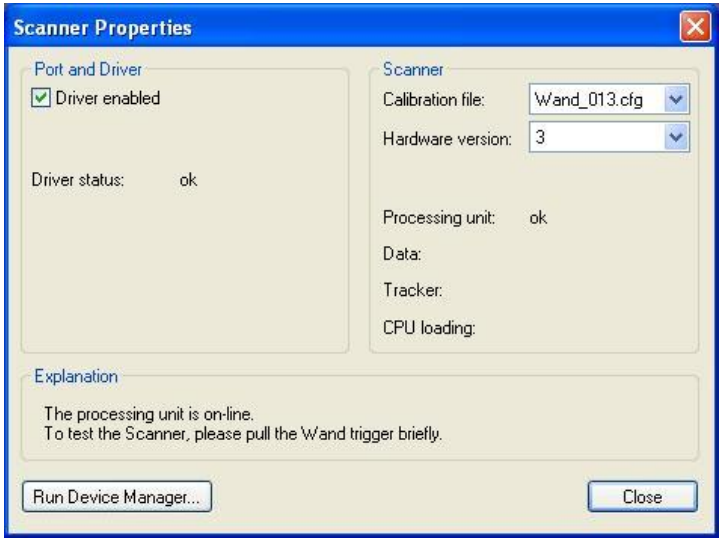


Figure 4: The **Scanner Properties** dialog box.

4. The status indicator at the bottom right of the screen (labeled **1** in Figure 3) should change from **Scanner disabled** to **Scanner initializing...** After approximately 10 seconds this should change to **Scanner on-line**, indicating that the system has initialized.

Note: Do not depress the trigger while the Wand is initializing.

5. When setting up the system for the first time or changing Wands open the **Scanner Properties** box (Figure 4) via **Scanner/Properties...**
6. Confirm that the **Calibration file** corresponds with the Wand you are using (if not you may need to select the appropriate configuration file) and that the **Hardware version** is set correctly. For current systems the correct setting is 3. If the scanner has not come online ensure that **Driver enabled** is checked. If the Wand has not been used with the system before, you may also have to install the configuration file.



Figure 5: The **Wand Hemisphere Setup** dialog box.

7. When the system has initialized, and the status bar indicates that the scanner is on-line, pull the trigger on the Wand. The **Wand Hemisphere Setup** dialog box (Figure 5) will prompt you to define the hemisphere of operation—follow the instructions in the dialog box.
8. Once the hemisphere has been defined *FastSCAN* is ready for use.

3 Scanning



3.1 The Scanning Environment

An area of subdued lighting is ideal for scanning, with no external light entering from windows. Scanning errors can arise when the scanner's camera views direct sources of strong, bright light, such as the sun or a powerful incandescent light.

Keep the scanning area at least one meter away from the Processing Unit, computer, and any other significant metal objects. A wooden table is an ideal surface on which to place objects for scanning.

For best results always position the Transmitter as close as possible to the object that you are scanning. It is usually most convenient to place it behind or under the object.

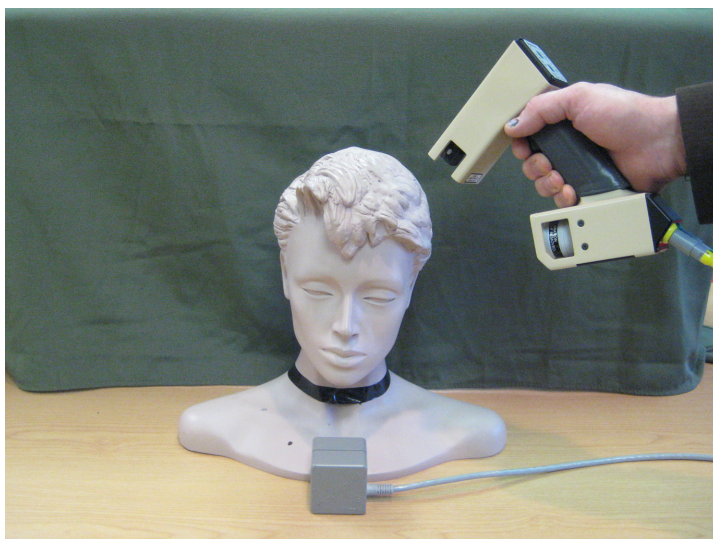


Figure 6: An example of scanning a model. Note the wooden table, placement of the Transmitter, and the position of the Wand.

In the default **Transmitter is Reference** mode it is vital that the object remains stationary relative to the Transmitter during the scan. If the object cannot remain stationary, then the Transmitter may be attached to the object, or alternatively the Reference Receiver may be attached and **Receiver is Reference** selected in the **Scanner** menu (refer to Section 3.5.1).

Note - Multiple standard *FastSCAN*[™] systems will not work alongside one another without interference. This can be remedied with a replacement Frequency Module. Contact your vendor if required.

3.2 The Wand

The **Cobra C1**[™] is a light and compact single camera wand.

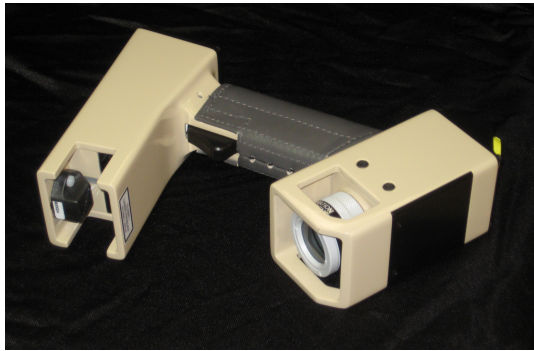


Figure 7: The **Cobra C1**[™] Wand.

Handling the Wand

- The Wand is a sensitive optical instrument—**handle it with care** at all times.
- Place the Wand carefully on the Wand pad when not in use.
- After finishing your scanning session switch off and return the Wand to its protective case.
- If the Wand is mishandled or dropped it will need calibrating.

3.2.1 Wand Controls

The 2-position trigger switch of the Wand controls scanning:

Preview position (trigger pulled in to the first click):

- displays laser profiles on the screen in real-time, but does not store them
- provides feedback to help align successive sweeps in a scan and for filling in gaps.
- reorients the display on the computer screen to a 'Wand's eye' view
- illuminates the **Laser LED** (shown in Figure 8).



Figure 8: The Wand control panel with the power and Laser lights illuminated.

The secondary function of the Preview position is to reorient the on-screen image without having to return to the keyboard. This is achieved by pointing the Wand at the object, pulling the trigger to the Preview Position so that a profile is displayed on screen and releasing the trigger. The display will then automatically assume a 'Wand's eye' view.

Scanning position (trigger pulled in completely):

- displays laser profiles and surface data on the screen in real-time and stores them in memory
- illuminates both the **Laser** and **Scan** LEDs.

Note: If the scanning equipment is set up incorrectly the Laser and Scan lights may flash alternately when the trigger is depressed into either position.



3.2.2 Wand Sensitivity

The **Sensitivity Control** allows you to compensate for different subject surface types, colors and lighting conditions. Position 1 is the least sensitive and position 4 the most sensitive. For most subjects 2-3 is a good sensitivity setting.

Setting and/or adjusting the sensitivity when scanning any new object can be done using the **Up/Down** buttons on the wand. This is best done in **Camera View** mode in *FastSCAN*TM:

1. Click on the **Camera** icon, or select **View/Camera View**.
2. Set the sensitivity control to position 1.
3. Pull the trigger to the Preview position.
4. Push the sensitivity control **Up** arrow to increase the sensitivity.
 - For the **Cobra C1**TM the red curve of the laser profile should become visible.
5. If no laser profile ever becomes visible, try moving the Wand towards or away from the object.
6. Set the sensitivity control to the lowest value that gives a clean unbroken curve.
7. Return to the standard view by deselecting **Camera View** mode.

On powering down the system, the Wand will remember the sensitivity control's last setting.

Note:

A too low sensitivity setting will cause only a small amount of (or no) data to be collected.

A too high sensitivity setting may result in unwanted data or noise being collected due to reflections or extraneous light.



3.3 Scanning With the Wand

The **Transmitter is Reference** option is the default setting for a typical scanning situation (a small–medium size stationary object; the **Tx** icon selected) and normally this button should always be selected.

To scan unstable or large objects you may need to use the **Receiver as Reference** (**Rx** icon)—see Section 3.5.

3.3.1 Scanning Technique

To scan a complete object you will need to perform a number of sweeps with the Wand. Keep the Wand approximately 10–15 cm away from the subject. Due to the Wand's field of view, objects too close (less than 8 cm) or too far away (greater than 22 cm) will be outside the range of the camera.

Scans are built up from a number of overlapping sweeps, in a manner analogous to spray-painting. A smooth consistent action is required for best results.

To collect a single sweep of data from an object:

1. Prepare the equipment for scanning as outlined in Section 2.5: Running *FastSCAN*TM.
2. Depress the Wand's trigger into the Preview position, and ensure you can view the laser profile/sweep start-point on-screen in the *FastSCAN*TM viewing window.
3. Press the trigger to the Scan position. The Scan LED on the control panel will illuminate to indicate that scanned data is being collected, and the scanned data will appear on-screen simultaneously.
4. Move the Wand across the surface of the object in a smooth motion.
5. Release the trigger at the end of the sweep.

As you perform the scan data appears in the viewing window on screen. This lets you see any areas that may have been missed or that might need going over again, to enable an accurate complete scan of the whole object.

Pointing the Wand at the region of the object you wish to scan, pressing the trigger to the Preview position and releasing it will reorient the on-screen object to enable viewing of that region.

For best scan results:

- allow the wand to warm up for 5 minutes before scanning an object
- minimize the distance of the Wand from the object to increase the accuracy of the scan. Also keep the Wand as close to the transmitter as conveniently possible
- each sweep of the Wand should be a smooth action, as if spray-painting
- use both hands on the Wand to improve steadiness
- remove any metal objects from the scanning environment before beginning
- sweeps should overlap slightly, and missing patches can be rescanned
- a slow steady scan is typically best, to get the most accurate data and achieve the smoothest final surface
- avoid repeated scanning of the same part of a surface, to reduce file size
- for large objects requiring many sweeps, save your scan at regular intervals to prevent loss of scanned data.

You can erase the last sweep by clicking on **Scanner/Undo Sweep**, or by double clicking the Wand trigger (see Section 3.4: Undoing Scans). The erased sweep can be put back into the scan by clicking on the **Redo Sweep** button.

The speed at which you move the Wand over the surface of the object is the major determinate of the resolution of the sweeps. Selecting **Points** from the **View** menu will allow you to experiment with different scanning speeds and see the difference in results. The closer the points are together, the higher the resolution and quality of the data.

3.3.2 Scanning Resolution - Limits Control

In some situations you may wish to place a limit on the resolution at which data is collected, e.g. to reduce memory and processing requirements. This can be achieved by adjusting the **Best Scanning Resolution** in the **Scanner Limits Control** dialog box (accessed from **Scanner/Limits Control**).

You can control the coarsest scanning resolution at which data is collected via the **Worst Scanning Resolution** in the **Scanner Limits Control** dialog box.

Use this to avoid inadequate resolution when scanning very quickly, in order to maintain a desired accuracy and not miss important detail, or to avoid filling in holes.

Selecting **Wireframe** from the **View** menu will allow you to experiment with different scanning speeds and **Best/Worst Scanning Resolution** values to assess the effect on resolution.



Figure 9: The *Scanner Limits Control* dialog box.

3.3.3 Profile Smoothing

The *FastSCAN*TM program filters and applies a degree of smoothing to each profile during collection. This filter removes noise and errors in the scanner data, but can also remove surface detail. A high value will remove a larger amount of detail while a low value will preserve detail where it is present but tend to give a rougher surface.

A side effect of the profile smoothing is that some points are lost from the ends of each profile. If the data has a gap in it (as might occur when scanning a hole in a surface) then points are also lost from both sides of the gap. Higher smoothing values increase the number of points lost.

You can control the amount of smoothing using the **Profile Smoothing** option in the **Scanner Limits Control** dialog box (High, Medium, Low (default), or Off—see Figure 9). Changing this value affects newly captured profiles—it cannot change data that you have already collected. You may need to experiment to find the optimal value before you begin scanning. Figure 10 shows how smoothing can affect a profile.

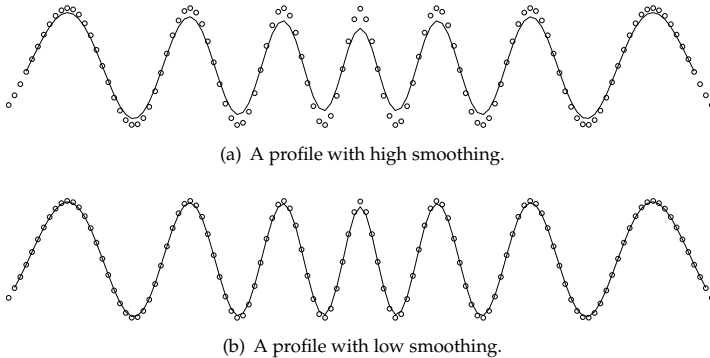


Figure 10: Examples of profile smoothing applied to a single profile when scanning a corrugated surface. The dots are the original scanned points and the black line is the resulting profile. Note that high smoothing drops three points at the end of the profile, while low smoothing only drops one.

The generation of Basic and RBF Surfaces (Section 4) applies a different type of smoothing to profile smoothing. Unlike the profile filter, you can adjust this *without* having to rescan your object.



3.4 Undoing Scans



This Wand function is switched **ON** by default. By clicking on **Settings/Wand** you can choose to switch off/on **Double-click Undoes Sweep** and/or **Triple-click Undoes Scan**. Selecting this option allows you to double or triple click to the Preview position while scanning, to delete the previous sweep or entire scan respectively. **Use with caution!**

Clicking on the **Undo Sweep/Redo Sweep** icons (above) enables you to remove single sweeps (in reverse order to which they were created) and place them back again if desired (in the same order).



3.5 Using the Secondary Receiver - Rx as Reference

By attaching a secondary receiver (Rx) to the subject it becomes possible to move and/or reposition the subject while building up the scan, allowing full 360° coverage. This can also be used to compensate for small movements that may occur in the subject while scanning or to scan large objects.

3.5.1 Moving the Subject During Scanning

Attach the **Receiver** *firmly* to the object you are scanning. From the **Scanner** menu, select **Receiver is Reference**. Note that the Receiver becomes the origin of the Reference Coordinate System. It is also important to note that although the object and Transmitter can be moved—for example, held in the hand—they should not be moved in a rapid or jerky manner.

To achieve the best results, keep the Transmitter as close as practical to the Wand and Receiver. However, you must keep the Receiver at least 100 mm away from the Transmitter to avoid signal overload. The subject can be rolled or rotated as required during scanning to enable full access for the Wand.

It is possible to remove the Receiver if required, allowing you to scan the part of the object where it was attached. Place the object and the Transmitter near to each other, remembering that once you remove the Receiver, the object and the Transmitter must not move. Select **Freeze Receiver** from the **Scanner** menu; the software will then provide instructions.

3.5.2 Scanning Unstable Objects

A live subject being scanned will often move involuntarily, for example, small head movements while scanning a face. This problem can be overcome by attaching the Receiver to the subject's head with a plastic headband **optionally included** with the FastSCAN™ system.

Attach the Receiver firmly to the headband with the nylon screws provided and adjust the headband size to give a firm but comfortable fit, as shown in Figure 11.



Figure 11: Using the Receiver attached to the headband.

3.5.3 Scanning Large Objects

You can also use the Reference Receiver to scan extra large objects. Fix the Receiver to the center of the object and place the Transmitter midway between the Receiver and the Wand. As you move around the object also move the Transmitter, keeping it within 100 mm and 750 mm of the Receiver and Wand (Figure 12).

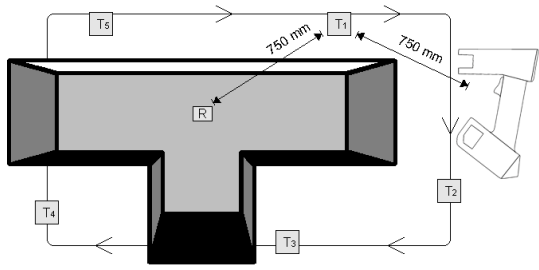


Figure 12: Scanning a large T-shaped object with Receiver as Reference. R is the Receiver (fixed to the object) and T is the Transmitter (moved around the object during scanning, in positions 1 to 5).

3.6 Viewing Options



3.6.1 Data View/On Screen Format

The appearance of the data can be changed by clicking on **View** and choosing from the 3 options: **Points**, **Wireframe** and **Solid**, or their icons in the toolbar. These allow you to view the data in different formats and use this information to get the best possible scan. Many of these functions can be performed via the keyboard **Hotkeys**. See Section 9.1 for a full list.



Points:

Shows the individual data points that make up the scan (Figure 13 (a)).



Wireframe:

Displays the surface triangular mesh, created by linking the points data (Figure 13 (b)).



Solid:

Displays the scanned object as a solid surface (Figure 13 (c)).



Outlined:

Displays the object as a solid surface with the wireframe overlaid upon it (Figure 13 (d)).

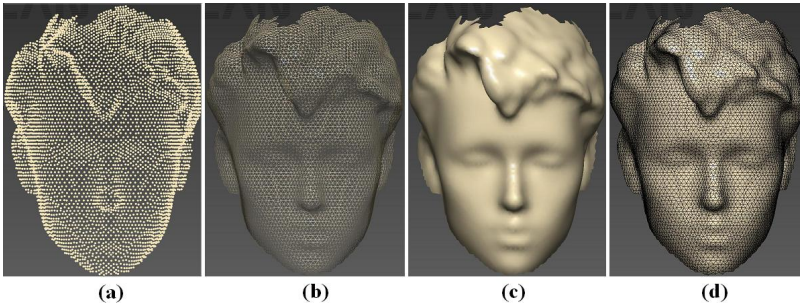


Figure 13: A scan as it appears with the different data viewing options applied.

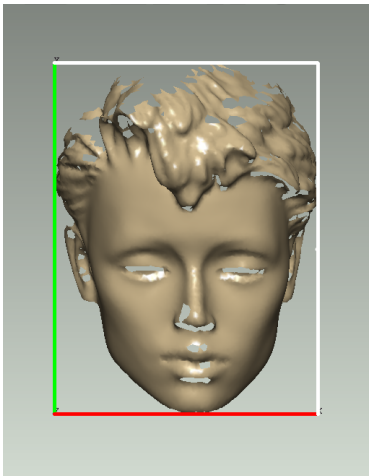


Bounding Box:

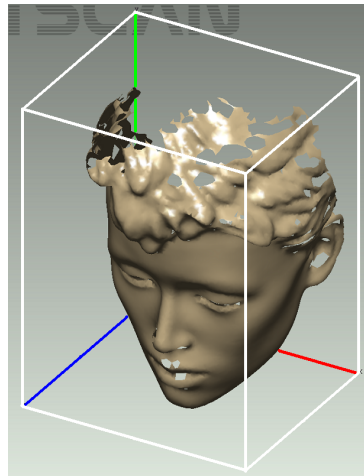
The **Bounding Box** enclosing the perimeter of the data is used in the RBF surfacing process and, in coordination with the **Extents Window**, gives the physical size of the object. It can also be useful for users needing a file for CAD systems or wanting a watertight model or closed object.

Click on **View/Bounding Box** to see the Bounding Box. The **View/Set Bounding Box to View** allows you to reorient the Bounding Box around the data, and the exported data will be exported with the changed coordinate system.

View/View Bounding Box From enables viewing of the Bounding Box from other angles (Front, Back, Top, etc).



(a) Press **F1** to get the view of the front of the Bounding Box.



(b) Use the **movement keys** or **mouse** to get this view.

Figure 14: The Bounding Box as seen from: (a) the front (b) above and to the side.

The Extents Window:

The **Extents Window** displays the exact dimensions of the scan, as enclosed by the Bounding Box. Click on **View/Extents Window** to see it. Click on **Settings/Display Units** to choose between millimeters and inches.

3.6.2 Other Viewing Variables

Viewpoint: The data/object can be moved on-screen by clicking and dragging with the mouse or by clicking on **View/Viewpoint** and selecting the desired direction. **Shortcut keys** to use these functions via the keyboard are also listed here.

Movement: Clicking on **View/Movement** allows you to set the speed at which the data/object changes position when manipulating it using the **View/Viewpoint** options or the keyboard.

	Rotate	Translate	Zoom
Normal	30.0°	25 mm	$\sqrt{2} \times 100\%$
Fine	5.0°	5 mm	1/5 x Normal
Very Fine	1.0°	1 mm	1/5 x Fine
Ultra Fine	0.2°	0.2 mm	1/5 x Very Fine

Table 1: Movement amounts. The zoom increases movement by 5X for each increment.

Normals: Clicking on **View/Normals** will display the normals (90° to the object surface) of all the data points that make up the object.

Scanning Feedback—Color Mapping:

The **View/Color Mapping** options (listed below) display the object’s surface in color, highlighting optimum or poor parts of the scan.

- **Pseudo-Grayscale:** displays a texture map based on the surface showing the object in black and white and can enable finer details like text to become visible.
- **Scanning Resolution:** dictated by the speed of the Wand during each sweep. Red is fine resolution/slow speed, blue is coarse resolution/high speed.
- **Tracker Range:** displays the distance between the Receiver (usually the Wand) and the Transmitter during scanning. Green is optimal, red is poor.
- **Wand-Point Range:** displays the distance of the end of the Wand to the object’s surface during scanning. Red is good.

Tracking: View/Tracker Positions enables you to see where the **Transmitter**, **Wand** and **Reference** were during the scan, which can assist in improving the quality of your scanning.

Lighting and Colors: Settings/Lighting and Colors allows you to change the object, laser and background colors as well as altering the position and strength of the lighting on the object, enabling easier viewing of hard to see areas, or those previously in shade.

Magnification: Use the mouse wheel or right-click and move the mouse arrow up/down to zoom in/out. The magnification is displayed in the status bar at the bottom of the viewing window.

3Dconnexion SpaceNavigator 3D Mouse: *FastSCAN*TM 4.0.7 onwards supports this mouse which is designed for use with 3D Software. Once it's drivers are installed and the mouse connected, it will work automatically. The button on the left of the mouse centers the scanned object within the viewing window.

Users may find the following useful:

- The right mouse button is used to open the **3Dconnexion Control Panel**.
- The mouse may need occasional recalibration, to recalibrate select **3Dconnexion Control Panel/Device Configuration/Calibrate**.
- It has been found that selecting **Dominant** in **3Dconnexion Control Panel/App Configuration** makes the mouse easier to use.

4 Processing Scanned Data

4.1 Surfacing Options



The *FastSCAN*TM software deals with three surfaces: the **Sweeps Surface**, the **Basic Surface** and the **RBF Surface**. Figure 15 shows the path taken to generate these three surfaces.

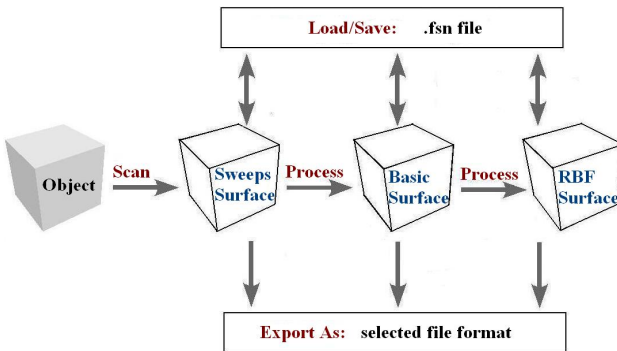


Figure 15: Objects and processes in the *FastSCAN*TM program.

The display view may be changed between the Sweeps Surface, Basic Surface and RBF Surface. If processing is required to obtain a view it will begin automatically when that display option is selected.



4.1.1 Sweeps Surface

The Sweeps Surface is effectively the raw data gathered by the scanner and is made up of a number of individual sweeps of the object. The (individual) sweeps may overlap and intersect each other, contain holes and may have been scanned with differing resolutions.



4.1.2 Basic Surface

The Basic Surface is generated from the Sweeps by:

- merging overlapping sweeps
- changing and filtering the data
- standardizing the resolution
- simplifying the triangular mesh (optional)
- limiting the number of objects (pieces of data contained in the Sweeps (optional)).



4.1.3 Radial Basis Function (RBF) Surface

The RBF Surface is generated from the Basic Surface by:

- modeling the points of the Basic Surface with a Radial Basis Function (RBF)
- constructing an isosurface (a mesh with evenly spaced points)
- constraining the boundary of the RBF Surface in space
- simplifying the isosurface (optional).

See the FastRBF™ Extensions Manual for more details regarding the RBF Surface.



4.2 Export Format

Surfaces can be exported in a variety of industry-standard formats using the **File/Export As** submenu—this is also accessed by clicking on the **Export As** icon. Supported export file formats include:

.psl .3ds .txt .dxf .igs .iv .lwo .aop
 .op3 .mat .ply .stl .wrl .vtk .obj

For a full description of the various export formats see Section 7.

4.3 Scan Files

4.3.1 Opening and Saving Scans



New Scan:

To commence a **New Scan** click on **File/New** or the **New** icon in the toolbar.



Open:

To **Open** a scan click on **File/Open** or the **Open** icon in the toolbar. Only **.fsn** and **.hls** file formats can be opened. Saved scans can be processed and exported, but you cannot add more sweeps to them after exporting.



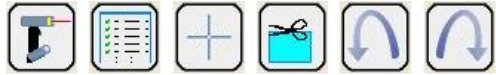
Save As:

To **Save** a scan under a new name or format click on **File/Save As** or the **Save As** icon in the toolbar. Scans can only be saved in the **.fsn** and **.hls** file formats. Saved scans can be processed and exported, but you cannot add more sweeps to them once exported.

Note:

If you want to export to a different format, or to change the processing parameters at some time in the future, make sure that you save the scan as an **.fsn** file so that you can reopen it.

4.4 Editing Raw Data



4.4.1 The Sweeps

During scanning your data appears on-screen as the **Sweeps**. You can revert to this view at anytime during the surfacing process by clicking on **View/Sweeps** or on the **Sweeps** icon in the toolbar.



4.4.2 The Sweeps List

You can view a log of all the sweeps in a scan by clicking on **Edit/Sweeps List...** This log allows you to view each sweep individually and to remove single sweeps from your scan if desired.

The **Sweeps List** dialog box (shown in Figure 16) contains a list item for each sweep. The second column gives the number of points in the sweep.

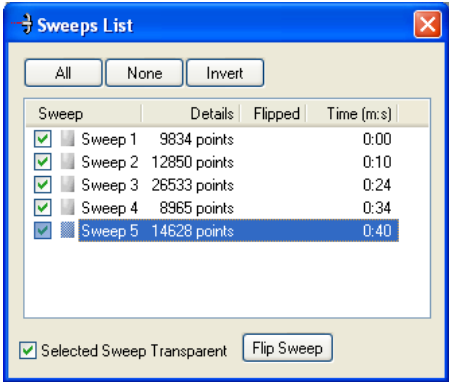
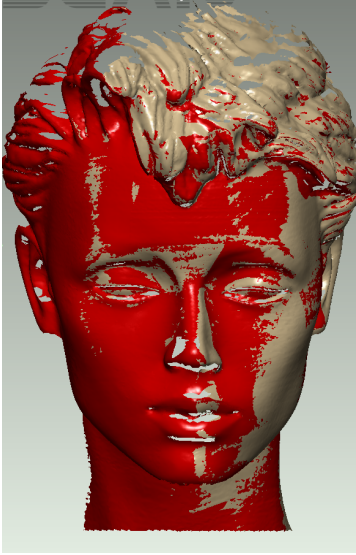


Figure 16: The Sweeps List dialog box.

To highlight a sweep (best viewed with the **Solid** option), click on it in the list. Hold down **Ctrl** or **Shift** while clicking to select multiple sweeps. The color of the highlighted sweep(s) in the main window will be changed to the preview color. The actual display of the highlighted sweep(s) depends on the status of the **Selected Sweep Transparent** check box in the Sweeps List dialog box. If unchecked, only those parts of the sweep not concealed by other sweeps will be colored, as shown in Figure 17(a).



(a) With some sweeps highlighted, and Selected Sweep Transparent box **unchecked**.



(b) With some sweeps highlighted, and Selected Sweep Transparent box **checked**.

Figure 17: Scan with highlighted sweeps, showing color differences. With (a) only visible parts of selected sweeps shown (b) all parts of selected sweeps shown, with different color shades.

If checked, the shading will vary depending on the surrounding sweeps, as shown in Figure 17(b):

Darker sweep color: this sweep is the only one covering this part of the surface.

Medium sweep color: this sweep is on top, but has other sweep(s) behind it.

Light sweep color: this sweep is underneath other sweep(s).

To hide a sweep uncheck the box to the left of the list item. Hidden sweeps will not be displayed in the main window. Hidden sweeps are ignored when processing and exporting, but they are still saved by default when you save in **.fsm** (*FastSCAN*) format. You can hide sweeps at any time, and you can continue scanning after hiding sweeps.

Clicking on **Invert** will reverse the status of all the check boxes in the list and the sweeps visible/invisible on-screen.

Use the **Flip Sweep** button to turn the selected sweep(s) inside out. This reverses the orientation of the sweeps, and can be used to make a mould with further processing.



4.4.3 Selecting and Deleting Data



It is possible to delete unwanted or inaccurate areas of the scan. Change the cursor to a selection tool by either choosing **Edit/Select**, clicking on the **Select** icon in the toolbar or by holding down the **Ctrl** key. Then left-click-and-drag the mouse to enclose the area you wish to delete. To delete either select **Edit/Delete**, click on the **Delete** icon or use the **Backspace** key. Be aware that you may be unwittingly selecting other sweeps behind the one you intended to edit (e.g., the back of a scanned object). To prevent this, you may want to hide all of the sweeps other than the one to be edited by unchecking them in the left hand column in the **Sweeps List** dialog box.



4.4.4 Undo/Redo Sweeps



The **Undo Sweeps** icon enables the removal of single sweeps from the scan (from the most recent to the first created). The **Redo Sweeps** icon places a single sweep back into the scan (from the last removed to first removed).

5 Generating A Basic Surface



5.1 Basic Surface

Creating a Basic Surface removes redundant points in overlapping sweeps. The scanned points can be repositioned and the minimum distance between them fixed to determine the amount of detail present in the final surface.

When you have sufficiently edited your Raw Data click on the **Basic Surface** icon to generate the **Basic Surface**. This uses default parameter settings—you can change these parameters via the **Generate Surface** dialog box—as outlined in the next section.



5.2 Basic Surface Parameters

Clicking on **Edit/Generate** or the **Generate** icon on the toolbar will bring up the **Generate Surface** dialog box (Figure 18). This enables the user to alter the characteristics of the Basic Surface before processing it.

5.2.1 Smoothing

When scanning, you will probably scan some parts of the surface with multiple sweeps. These sweeps may not always align perfectly. Possible causes can include:

- small errors in the scanner measurements
- metal objects interfering with the magnetic locator
- the object or reference moving unintentionally during scanning.

The **Smoothing** parameter controls the degree of smoothing *FastSCAN*[™] uses when aligning sweeps. A low value creates a more detailed surface, but will fail to merge the more widely separated sweeps. A higher value will merge sweeps better, but remove more surface detail. Typically the smallest possible value that merges sweeps correctly is ideal. Figure 19 shows the effect of different values.

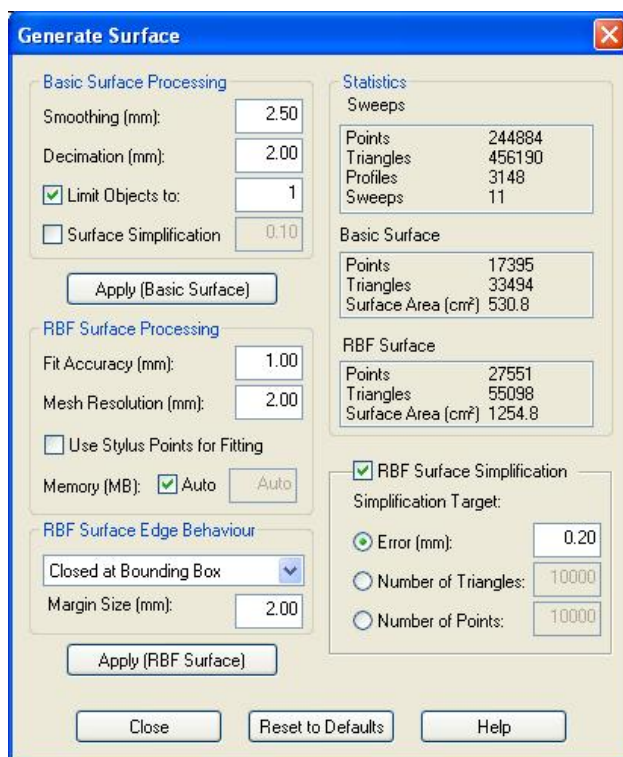


Figure 18: The Generate Surface dialog

If the *FastSCAN*TM program does not merge the overlapping sweeps correctly when it creates the Basic Surface, the surface will appear 'blistered'. Figure 20 shows how the blistering occurs as the Basic Surface jumps between the points in the two sweeps.

5.2.2 Decimation:

Increasing the **Decimation** value in the **Generate Surface** dialog box (Figure 18) reduces the number of points and triangles. This means a smaller export file and subsequently faster rendering of exported scans when loaded into other programs. Decreasing the value produces a more detailed mesh and a larger, slower file. Figure 21 shows the same object exported at two different decimation values.

The amount of blistering that occurs is also dependent on the Decimation param-

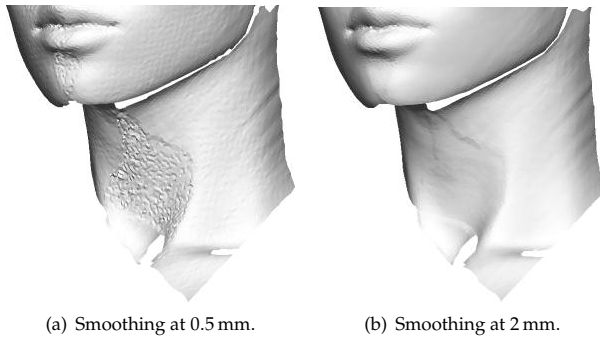


Figure 19: Two Basic Surfaces generated from the same Sweeps using different Smoothing parameters. In (a) the sweeps did not combine correctly, while in (b) they did.



Figure 20: An illustrative example of how a blistered surface (black line) can form between two misaligned sweeps (gray lines).

ter. Smaller Decimation values will have more blistering, while larger values may be completely free of it. If you lower the Decimation value you may also need to raise the **Smoothing** value to compensate.

If you cannot find a suitable value that merges sweeps while also preserving detail, try the following:

- Register the sweeps (see Section 5.3).
- Delete the portion of the sweep(s) which is causing the problem.
- Undo the sweep(s) over the problem area, and re-scan if necessary.
- Re-scan the object after removing metal objects from the scanning area.
- Fix the object and the reference securely so that they cannot move during scanning. Tethering the cables of the transmitter or reference receiver is often important.
- Ensure that the Wand, Transmitter and object are kept as close to each other as is conveniently possible. This also applies to the Reference Receiver if it is the reference device.
- Perform a User Calibration to ensure the optics are correctly aligned (see Sec-

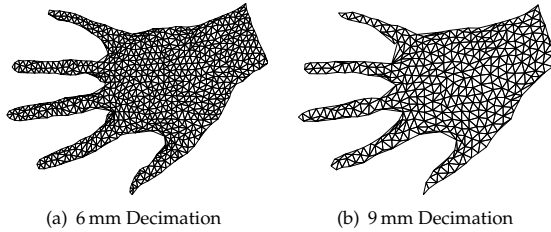


Figure 21: The same object at different decimation values. The 6 mm version (a) has 1378 triangles, while the 9 mm version (b) has only 704 triangles.

tion 10).

5.2.3 Limit Objects to:

You may find that your surface contains parts of background objects (such as the scanning table) that you did not mean to scan—the camera can pick-up partial profiles on objects behind the target object. You can use the **Limit Objects to** control to remove these extra bits of surface, but only if they are disconnected from and smaller than all the pieces of the main object.

Check the **Limit Objects to** box in the **Generate Surface** dialog (Figure 18) and enter the number of objects N that you wish to be preserved. The export process will remove all the smaller objects, leaving only the N largest.

If this method fails, you can:

- delete parts from the Sweeps (see Section 4.4.4)
- edit the Basic Surface afterward using a separate application
- rescan after covering background objects in a black cloth (or similar arrangement) in order to suppress the laser return from them.

5.2.4 Surface Simplification:

Check the **Surface Simplification** box to reduce the complexity of the Basic Surface—this generates fewer triangles for roughly the same accuracy.

5.2.5 Apply Basic Surface:

When you have set the **Basic Surface Processing** values click on the **Apply Basic Surface** button to generate the Basic Surface.

5.3 Registering the Sweeps

The various sweeps of the scan may not always overlap perfectly. This may be due to:

- small errors in the scanner measurements
- metal objects interfering with the magnetic locator
- the object or reference moving unintentionally during scanning.

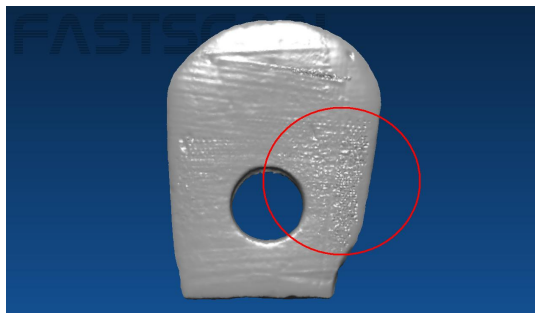
Such errors in sweep alignment are manifested as bumpy patches or blistering on the Basic Surface. You can attempt to correct these by selecting **Register Sweeps** from the **Edit** menu. The process is automatic and takes just a few seconds for a typical scan. Once you have performed sweep registration, regenerate the Basic Surface in the normal way and see if the **RMS error** has improved. Figure 22(a) shows an object with artifacts before **Register Sweeps** has been used and 22(b) the improved result after it has been applied.

Occasionally **Register Sweeps** can cause deterioration in the quality of the Basic Surface. If the RMS error is larger after **Register Sweeps** has been applied, choose **Unregister Sweeps** from the **Edit** menu. The registration algorithm only applies a rapid body transformation to each sweep, i.e. a translation and a rotation. Such transformations cannot correct misalignments due to problems that cause distortion of the data *within* the sweep.



5.4 Surface Information

To view the statistics of your surface, open the **Generate Surface** dialog box (Figure 18). For the raw data this shows the number of points, triangles, sweeps and profiles. For the Basic and RBF Surfaces it shows the number of points and triangles and the surface area.



(a) The object with artifacts visible on the Basic Surface.



(b) The object after **Register Sweeps** has been used.

Figure 22: **Register Sweeps** is used to better align the Sweeps and remove any artifacts.

5.5 Batch Processing

The **Batch Processing** interface allows you to process and export several scan files at once, each with different parameters if required. Figure 23 shows the batch processing dialog.

Select **File/Export As/Batch Process** to open the **Batch Processing** dialog. On the left of the dialog is the list of scans to be processed. If you currently have a scan open it will be placed in this list, otherwise the list will be empty.

On the right of the dialog box are the controls for changing the settings of the selected scan. The upper-most box displays the input scan file name, which cannot be changed.

Choose from **Export Sweeps**, **Export Basic Surface**, or **Export RBF Surface**. The

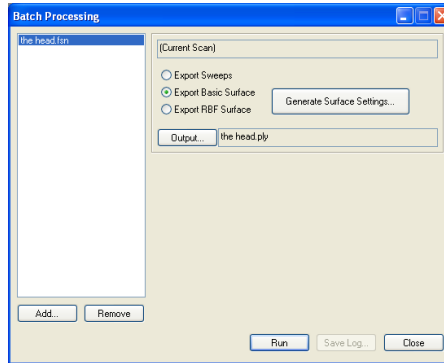


Figure 23: The Batch Processing dialog.

Generate Surface Settings... button opens the **Generate Surface** dialog, where you can specify the surface parameters for the Basic Surface or RBF Surface. The **Output** control displays and allows you to change the output file's format and filename. The default output filename is the scan filename.

Click the **Add** button to add a new scan to the list. The newly added scan's settings (in its **Generate Surface Settings** box) will duplicate those of the preceding scan in the list (if you want to process several scans with the same settings, configure the first scan before adding the rest—if you want different surface settings for each file then be sure to edit them individually via the **Generate Surface Settings** box). To remove a selected scan from the list click the **Remove** button.

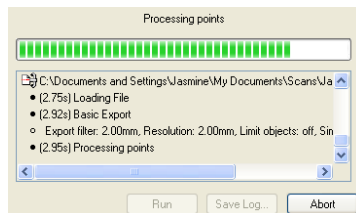


Figure 24: The progress bar and message log displayed during batch processing.

Click the **Run** button to process and export each scan in the list, according to the specified parameters. While running the empty part of the dialog displays a progress bar and message log (Figure 24) displaying which scans and processing steps have been run, the processing parameters and any errors. When processing is complete the **Save Log** button allows you to save this message log to a text file.

6 Generating an RBF Surface



See the FastRBF™ Extensions Manual for instructions on how to generate an RBF surface. While an RBF surface may be generated with the unlicensed *FastSCAN*™ software, a license is required to enable saving of the surface.

7 Exporting a Surface



7.1 Export Options

You can export a surface at any stage of processing—the file formats available are determined by what stage you are at.

*FastSCAN*TM can export files in a number of industry standard formats. We have attempted to support the most popular variant(s) for each—if you have difficulties importing one of these files into your 3D application, try exporting another variant or format. If you continue to have difficulties, please go to our website (www.aranz.com) or contact **Aranz Scanning Ltd** (scanning@aranz.com) with the following information:

- the file format used to export from *FastSCAN*TM
- the importing program's application name and version
- the problem file
- a file that is known to work with your application program.

Scans can be exported with respect to the Screen, Reference or Bounding Box coordinate systems, by selecting the appropriate option in the **Coordinate System** section of the **File/Export As/.....** dialog box. Note: you cannot reload any of these formats back into the *FastSCAN*TM program.

When saving the Sweeps, some file formats support saving each sweep as a separate object in the file—check the **Separate Sweeps** control. This allows you to manipulate the sweeps easily in another application. Currently only the **Wavefront (.obj)** format supports Separate Sweeps, and only for triangle meshes.

7.1.1 File Types for Export

There are two **Surface Types**, both of which may be available for export with some file types:

Triangle Mesh: Contains points and facet information (created by joining points together).

Cloud of Points: Saves only points and no facet information. This is a smaller file as it contains less data.

7.1.2 Export Formats

FastSCAN[™] lets you export your data in the following formats:

Polyworks Line Scan (.psl) A binary file format for saving the sweeps only. It consists of raw scan data requiring further processing.

3D Studio (.3ds) The file format used by 3D Studio and supported by 3D Studio Max; also supported by other programs. This format supports **cloud of points** or **triangle mesh** data.

Ascii (.txt) ASCII stores a plain-text list of vertex locations. Each line contains the x, y, and z location of a single vertex, separated by spaces.

AutoCAD (.dxf) A file format used by Autodesk, AutoCAD, and other CAD programs. Supports **cloud of points** or **triangle mesh** data, the latter as **3DFACEs** or **POLYLINES**, which may be supported differently by various programs.

IGES—Initial Graphics Exchange Format (.igs) IGES is a complex format that can be used to exchange many different types of data. These files tend to be much larger than other export formats. The *FastSCAN*[™] program can save three different types of IGES:

- **NURBS patch—Entity 128:** A **triangle mesh** with each triangle represented as a separate B-spline surface. This format is very inefficient and many programs may run out of memory when trying to load it.
- **Copious data—Entity 106:** A **triangle mesh** with optional normal vectors. This is the preferred mesh format as it is more efficient than Entity 128.
- **Point Cloud—Entity 116:** Automatically used when exporting as **Cloud of Points**.

Inventor (.iv) The native file format of SGI Inventor. Supports **triangle mesh** data only.

Lightwave Object (.lwo) The file format of the Lightwave animation software; also supported by other programs. This format supports **cloud of points** or **triangle mesh** data.

AAOP/OP3(.aop, .op3) These file formats are used by prosthetic and orthotic CAD/CAM vendors (named after the American Academy of Orthotists and Prosthetists (AAOP)). Exportable via the AAOP Export Wizard.

Matlab (.mat) A binary data file format used by The MathWorks MATLAB. Supports **cloud of points** or **triangle mesh** data, both with optional **vertex normal** vectors or **pseudo gray-scale values**. The file will contain five MATLAB variables at most:

- **Points:** A 3-by-N matrix where each column is a vertex location.
- **Normals:** A 3-by-N matrix giving the vertex normal vector for each vertex.
- **Facets:** A 3-by-M matrix where each column defines a triangle as three indexes into the list of Points.
- **Info:** A string containing information about the file.
- **Albedo:** A 1-by-N matrix giving the surface pseudo-grayscale brightness for each point in **Points**.

Note: N = points, M = facets.

Stanford Polygon File Format (.ply) Also known as the Stanford Triangle Format, this format was principally designed to store 3D data from laser scanners. It describes a single object as a series of flat polygons and can be saved as **cloud of points** or **triangle mesh**, in both **binary** or **text** formats. The **.ply** file can also be saved with optional **vertex normal** vectors or **pseudo gray-scale values**.

Stereo Lithography (.stl) A common format that supports **triangle mesh**. The *FastSCAN*TM program supports both **text** and **binary .stl** files (binary is faster and creates a much smaller file).

Virtual Reality Modeling Language (.wrl) VRML is a scene description language common on the Internet. There are different versions of VRML; the *FastSCAN*TM program produces the older 1.0 version, which is still widely supported. Generated files contain a single **triangle mesh** object and a camera object based on the current view.

Visualization Toolkit (.vtk) Supports both **cloud of points** and **triangle mesh**. Only the **ASCII** file format is supported (text files).

Wavefront Object (.obj) The file format used by the Alias|Wavefront software and widely supported by other programs. This is a text file that supports **cloud of points** and **triangle mesh**, the latter with optional **vertex normal** and **pseudo gray-scale values**.

Note: Not all third party software supports color information with **.obj** files.

7.2 Delta



Click on the **Delta™** icon to load the scan data directly into **Delta™** software—you must have **Delta™** installed.

Delta™ is a stand alone tool that enables comparison of surface distance and volume variations between two objects. You will need a license to use the **Delta™** software. A demonstration copy of **Delta™** can be downloaded from:
[http://www.fastscan3d.com /download/](http://www.fastscan3d.com/download/).

7.3 Save Snapshot

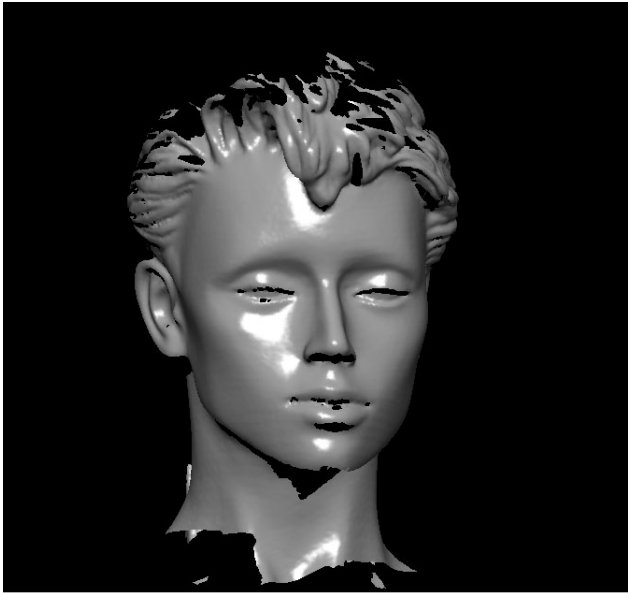
Selecting **File/Save Snapshot** creates a .png screen image of the current data window (Figure 26). Options with this function are available by selecting **Save Snapshot/Advanced** including **Crop to data**, **Automatic file numbering** and **Append information text** (Figure 27).

8 Help



Clicking on the **Help** icon brings up the reference file for the *FastSCAN™* software (also accessible through **Help/Software Reference**. This lists all menu items, with their sub-menus and functions.

Clicking on **Help** in the menu enables the user to view the *FastSCAN™* manuals (in PDF format) and software reference/specification files.



Basic Surface: 62890 points, 121717 facets, surface area = 621.889 cm sq
Basic Parameters: smoothing = 1 mm, decimation = 1 mm, object limit = off, simplification = off

Figure 25: Example of a Saved Snapshot file

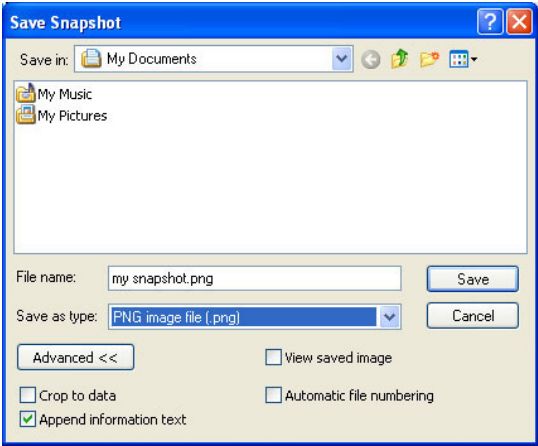


Figure 26: The Save Snapshot dialog box (with advanced options).

9 Hotkeys & Optional Features

9.1 Hotkey List

Menu Item	Shortcut
File/New Scan	Ctrl+N
File/Open	Ctrl+O
File/Save As	Ctrl+S or F4
File/Export Surface	F8
Edit/Undo	Ctrl+Z
Edit/Redo	Ctrl+Y
Edit/Select	Ctrl+left mouse button
Edit/Delete	Backspace
Edit/Sweeps List	Ctrl+W
Edit/Stylus Marks List	Ctrl+T
Edit/Generate Surface	Ctrl+G
View/Sweeps	F5
View/Basic Surface	F6
View/RBF Surface	F7
View/Set Bounding Box to View	Ctrl+B
View/View Bounding Box From / Front	F1
View/View Bounding Box From / Bottom	F2
View/View Bounding Box From / Left	F3
View/Viewpoint/Center	Insert
View/Viewpoint/Reset	Home
View/Viewpoint/Zoom In	Page Up
View/Viewpoint/Zoom Out	Page Down
View/Viewpoint/Rotate Left	←
View/Viewpoint/Rotate Right	→
View/Viewpoint/Rotate Up	↑
View/Viewpoint/Rotate Down	↓
View/Viewpoint/Roll Left	Delete
View/Viewpoint/Roll Right	End
View/Viewpoint/Translate Left	Alt+←
View/Viewpoint/Translate Right	Alt+→
View/Viewpoint/Translate Up	Alt+↑
View/Viewpoint/Translate Down	Alt+↓

continued overleaf...

Hotkey List cont’d...

Menu Item	Shortcut
View/Movement/Normal	Ctrl+1 (object moves by 30.0°)
View/Movement/Fine	Ctrl+2 (object moves by 5.0°)
View/Movement/Very Fine	Ctrl+3 (object moves by 1.0°)
View/Movement/Ultra Fine	Ctrl+4 (object moves by 0.2°)
<i>decrease movement size by 1</i>	Shift+mvmt key (↑←↓→)
<i>decrease movement size by 2</i>	Ctrl+mvmt key (↑←↓→)
<i>decrease movement size by 3</i>	Shift+Ctrl+mvmt key (↑←↓→)
Exit from current edit mode	Esc

9.2 Optional Features



9.2.1 Refraction Correction

Refraction Correction compensates for the surface distortion resulting from scanning through glass and is applied as a “post process” after the scan has been completed. Scanning through glass was primarily developed to enable Orthotics and Prosthetics (O&P) practitioners to obtain high quality scans of the whole foot and lower leg while keeping them stable. This is achieved by placing the feet on a raised pane of glass and scanning from beneath.

Click on **Edit/Refraction Correction...** and a dialog box will appear. Fill in the information boxes and click **Do**.

Normal commercial glass has a Refractive index of approximately 1.52, however this may vary for low lead or tinted glass.

For more information on scanning through glass refer to the Refraction Correction Manual or contact **Aranz Scanning** (scanning@aranz.com, www.aranz.com, www.fastscan3d.com).

(A license is required to enable this function.)

9.2.2 Cast Inversion Mode

The Cast Inversion Mode of *FastSCAN*™ was developed to enable O&P practitioners to scan the inside surface of plaster casts. The data can then be archived or loaded into applicable O&P CAD software to enable modifications and/or fabrication of a pattern or prosthetic.

For more information on Cast Inversion Mode refer to the Cast Inversion Manual or contact **Aranz Scanning Ltd** (scanning@aranz.com, www.aranz.com, www.fastscan3d.com).

(A license is required to enable this function.)



9.2.3 Laser Pointer/Mark with Mouse/Stylus Mode



The **Laser Pointer**, **Mark with Mouse** and **Stylus** modes enable the user to place reference points and/or lines on the surface of the scanned object.



For more information on Mark with Mouse/Stylus Inversion refer to the Mark with Mouse/Stylus Manual or contact **Aranz Scanning Ltd** (scanning@aranz.com, www.aranz.com, www.fastscan3d.com).

(A license is required to enable these functions.)

Note: Special Functions Available With The Stylus:

When in **Laser Pointer Mode** a double-click of the Wand trigger will remove the last stylus point or line placed. A triple-click will remove all points/lines. As noted above these features can be enabled/disabled under **Settings/Wand** drop down menu.

9.2.4 Export as AAOP/OP3 object

AAOP/OP3 is a 3D file format supported by a number of orthotics and prosthetics CAD packages.

(A license is required to gain access to the AAOP/OP3 Wizard.)

9.3 FastSCAN™ Pipe Interface

The *FastSCAN™* Pipe Interface (FPI) allows another application program to access 3D scan data from the *FastSCAN™* program in real-time during scanning of an object. For further details on how to use the FPI, please refer to the file *FastScanPipeInterface.txt*, usually found at:

C:\Program Files\Polhemus\FastSCAN\PipeInterface

10 Calibration

The Wand is fully calibrated before it leaves the factory. However, for optimum performance you may need to check the calibration from time to time. This process is quick and convenient.

You should check the Wand calibration if:

- the Wand has been knocked or dropped
- you notice the visual quality of the scans has deteriorated
- you have not used the *FastSCAN*TM Wand for some time
- you are about to commence a particularly difficult or demanding scan.

The **Calibration Correction** option in the **Scanner** menu allows you to correct the calibration of the Wand. A user correction is not equivalent to a full factory calibration and it may not be possible to restore the scanner to its original condition if it has been badly misaligned. To ensure that your *FastSCAN*TM Wand stays in calibration, always handle it with care.

Windows 2000/XP Note

Under Windows 2000 or XP, you will need Power User or higher privileges if you are going to perform a Calibration Correction.

10.1 Overview

To collect the data required for a Calibration Correction you must scan the Calibration Target with eight separate sweeps. Make the **first four sweeps with a Wand-to-Target distance of 100 mm** and the **last four sweeps with a Wand-to-Target distance of 200 mm**. Make each sweep (in the group of four) at a **90-degree rotation** to the previous sweep, as shown in Figure 27.

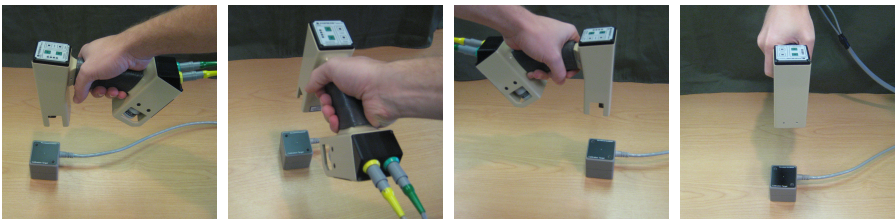


Figure 27: Scanning the Calibration Target at four different angles.



Figure 28: The Transmitter with the Calibration Target attached.

Note: While in Calibration Correction mode, the FastSCAN program monitors the Wand-to-Target distance and will only accept data when the distance is within ± 20 mm of the nominal value.

100 mm data: range is 80 mm to 120 mm.

200 mm data: range is 180 mm to 220 mm.

You may find maintaining the correct distance while scanning the Calibration Target is awkward at first. To assist, the computer “beeps” if the data is within the acceptable range as you scan the Calibration Target.

10.2 Calibration Correction Procedure

Perform the Calibration Correction as follows (please read all the steps before beginning):

1. Set up the scanning environment as described in Section 2.5. It is *imperative* that you keep metal objects (such as computers, monitors and metal furniture) at least one meter away from the scanning area.
2. Attach the Calibration Target to the Transmitter using the two nylon screws provided (Figure 28). The orientation of the target is not important, but you must attach it securely.
3. Place the Transmitter down with the Calibration Target facing upward.

4. Start the *FastSCAN*TM program (if you are running Windows 2000 or XP then you must have at least Power User privileges).
5. Click on **Scanner/Calibration Correction....** The background color of the *FastSCAN*TM window will change to black and the **Calibration Correction** dialog box will appear (Figure 29).
6. Set the sensitivity control of the Wand to position 1.
7. Hold the Wand at a range of 100 mm (4") above the Calibration Target.
8. To confirm that you are holding the Wand at the correct distance pull the trigger to the Preview Position (halfway in) and scan over the target. If the range is acceptable your computer will beep as you scan the Calibration Target. Otherwise continue previewing at different Wand-to-Target ranges until you hear beeping. There is a distance gauge on the right hand side of the screen to assist in obtaining the correct Wand-to-Target distance.
9. When at the correct range pull the trigger fully in and *slowly and evenly* scan the target with one sweep before releasing the trigger. You will hear beeping as you scan the Calibration Target.
10. If the range was acceptable a red spot will appear on the screen.
11. Rotate the Wand by 90 degrees and repeat step 9. Repeat this process two more times until you have scanned the target from all four sides. Four spots are collected at orientations of 0 degrees, 90 degrees, 180 degrees and 270 degrees respectively (Figure 27).
12. Repeat Steps 9 and 11 at a range of 200 mm (8") with the Wand's sensitivity control at position 2.
13. After making all eight measurements there should be two clusters of points in the *FastSCAN*TM window (Figure 29): one representing the data collected at 100 mm and the other the data collected at 200 mm. In each cluster, there should be four red spots.
14. Once the required data is present click the **Compute Correction** button.
15. The variance (RMS) of the collected data will be displayed before and after the calibration parameters have been calculated. A successful Calibration Correction should have an RMS of $< 0.20 - 0.30$ mm. If the RMS is outside of this range you should return your Wand to Polhemus for factory calibration.

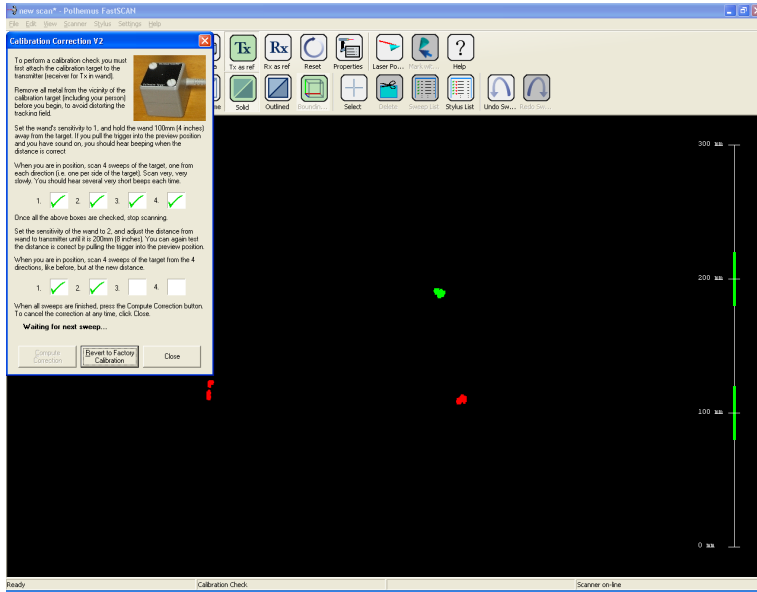


Figure 29: Three of the four calibration spot clusters are visible (for the *Scorpion™*) and the **Calibration Correction** dialog box.

Notes:

- You must collect the 100 mm data first.
- Windows 2000 or XP users must have Power User privileges or greater.
- If desired the most recent sweep (or the point in this case) can be removed with a double click of the trigger, or all data can be removed with a triple click. These functions are switched on by default—see Section 3.4.
- To help reduce artifacts the data is restricted to points within the vicinity of the Calibration Target; it will not matter if you place the Transmitter and Target on a light-colored surface.
- Should the Transmitter already be bolted to a surface then the Calibration Target may be placed on the opposite face. It is imperative that the target is mounted securely.
- To remove all Calibration Corrections made to date click the **Revert to Factory Calibration** button.

11 Troubleshooting/FAQs

- Q. The status bar of the *FastSCAN*[™] program continues to show ‘Scanner off-line’—what has gone wrong?
- A. Run through the following checklist:
- Ensure you do not have another *FastSCAN*[™] program still running from an earlier session (possibly minimized).
 - Ensure that power is getting to the PU. The green ‘Power’ light on the front panel should be on.
 - Ensure that power is getting to the Wand. The green ‘Power’ light on the Wand should be on.
 - Check connections of all the cables.
- Q. I have just performed a scan and there is nothing on the screen. Why?
- A. Possibly the scanned surface is out of view. Try centering the scan—select **Center** from the **View/Viewpoint** menu (or point the Wand at the area you wish to view and pull the trigger to the Preview position). If you are new to scanning, check that you are holding the trigger in the Scanning position when scanning so the Scan LED on the Wand is illuminated.
- If the object still does not appear then you may be holding the Wand too close or too far away from the object while scanning, preventing the camera from recording the movement of the laser. Keep the Wand about 10-15 cm from the object when scanning.
- Q. My scanned image is upside-down on the screen and I can’t get it the right way up. How can I fix this?
- A. The **hemisphere of operation** is not defined correctly. Switch off the PU and switch it on again. Then go through the procedure in Section 2.5: Running *FastSCAN*[™].
- Q. I have “floating” fragments of surfaces in my scan that are unrelated to the object—what’s happening?
- A. The Wand’s camera may occasionally view a bright, broad spectrum light source (e.g., sunlight from a window) that mimics the light of the laser. It is advisable to keep windows shuttered, avoid bright lights above and behind the scanning area, and to set the sensitivity control as low as possible. To check whether extraneous light is being detected, select **View/Camera** (which displays what the camera is seeing), and cover the laser. Anything visible in the display is then due to extraneous light.
- Q. How close do I need to keep the components of the *FastSCAN*[™] system?
- A. To ensure both high resolution and high accuracy, keep the Wand close to the

object's surface during scanning, but no closer than 80 mm to keep within the camera's field of view. If you are using the Receiver, parts of the surface closer to it will scan more accurately. Try to keep the Transmitter close to the Wand and Receiver, as accuracy deteriorates with distance, but no closer than 100 mm to avoid signal overload. The maximum separation of any two components is about 750 mm, but for best results, keep them as close as possible.

- Q. When I generate a Basic Surface, it has “bumpy” or “crystalline” patches—what is wrong?
- A. Successive sweeps over the same part of the surface have not merged properly. Try using **Edit/Register Sweeps** (Section 5.3). If the result is still unsatisfactory you may need to repeat the scan.
- Q. How far away do I have to keep metal objects from the scanner?
- A. The presence of metal objects while scanning interferes with the tracking of the Wand and degrades performance. As long as you keep any large metal objects at least 1 m from the Wand, the Transmitter, and the object you are scanning, they should not pose a problem.

12 Safety Guidelines

12.1 FCC Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. Operation of this equipment in a residential area is likely to cause interference, in which case the user will be required to correct the interference at his own expense.

12.2 Laser Warning

This FastSCAN Cobra C1 laser scanner is classified by the IEC standard 60825-1: 2007-03 as a **Class 1 laser product**.

Definition of Class 1 Laser Products

"Laser Products that are safe during use, including long-term direct intrabeam viewing, even when exposure occurs while using optical viewing instruments (eye loupes or binoculars)."
"Intrabeam viewing of Class 1 laser products which emit visible radiant energy may still produce dazzling visual effects, particularly in low ambient light."

For safe operation of this device, the following precautions should be taken:

- For your comfort, you may wish to avoid staring directly into the beam.
- Operate the device so that it is pointing away from windows, doors, mirrors and other shiny reflective surfaces, and areas where other people are working.
- There are no controls, adjustments or user serviceable parts that can affect the laser output. In the event of equipment failure, return the Wand to the manufacturer or agent for repair and servicing.

The product includes the following safety features:

- The laser is only activated when the spring-loaded trigger is depressed.
- An indicator light is illuminated when the laser is operating.
- All controls can be operated without direct viewing of the beam.

Caution: Use of controls and adjustments, or performance of procedures other than those specified in this manual may result in hazardous laser radiation exposure.

12.3 Warning Labels and Locations



(a) Close-up of the **laser aperture** (circled), and **two-position trigger switch** (bottom).



(b) Wand control panel showing **Laser-On** indicator light (top-right LED)

12.4 Use for Medical Applications

Polhemus is a Good Manufacturing Practices (GMP) Contract Manufacturer under U.S. FDA Regulations. We are not a manufacturer of Medical Devices. Polhemus systems are not certified for medical or bio-medical use. Any references to medical or bio-medical use are examples of what medical companies have done with the Products after they have obtained all necessary or appropriate medical certifications. The end user/OEM/VAR must comply with all pertinent FDA/CE regulations pertaining to the development and sale of medical devices and all other regulatory requirements.

13 Distributors

Master Distributor: POLHEMUS

PO Box 560, 40 Hercules Drive, Colchester, VT 05446

United States of America

Ph. 802/655-3519

Fax. 802/6551439

<http://www.polhemus.com>

Austria:

EST, Engineering Systems Technologies

GmbH & Co. KG

www.est-kl.com

Australia:

Aranz Scanning, StormFX Pty Ltd

www.aranz.com

www.fastscan3d.com

www.stormfx.com.au

Belgium:

Immersion SA, IMAQs

www.immersion.fr www.imaqs.com

Brazil:

Absolut Technologies

www.abs-tech.com

Canada:

AD3R Technologies

www.ad3r.com

China:

Beijing 6DOF Technologies Co Ltd

Tech Trend International Ltd

www.6dof.com.cn sales@tttil.com.hk

Croatia:

VR Logic

www.vrlogic.com

Denmark/Finland:

Contact sales@polhemus.com

France:

CADvision S.A.S, Immersion SA

www.cadvision.fr

Germany:

VR Logic, EST Engineering Systems

Technologies GmbH & Co. KG

www.vrlogic.com www.est-kl.com

Greece/Cyprus:

Contact sales@polhemus.com

Hong Kong:

Techtrend International Ltd

sales@tttil.com.hk

India:

CAD Engineering Services

maanavendra@gmail.com

Ireland:

Contact sales@polhemus.com

Italy:

Unocad S.R.L, GEA Media Group S.R.L
www.unocad.it
www.geamedia.com

Japan:

KBK-Kyokuto Boeki Kaisha Ltd
www.kbk.co.jp/cesd/polhemus.htm

South Korea:

Jek Co Ltd
idkwon@jek.co.kr

Luxembourg:

IMAQS
www.imaqs.com

Malaysia:

Interactive Dreams Pte Ltd
[www.id-dreams.com/020115/044/
welcome_frame.htm](http://www.id-dreams.com/020115/044/welcome_frame.htm)

Netherlands:

IMAQS
www.imaqs.com

New Zealand:

Aranz Scanning
www.aranz.com
www.fastscan3d.com

Portugal:

Aplein Ingenieros S.A
www.apleiningenieros.com/
NORCAM Engenharia E Design
Industrial LDA
www.norcam.pt/norcam/index.html

Singapore:

Interactive Dreams Pte Ltd
[www.id-dreams.com/020115/044/
welcome_frame.htm](http://www.id-dreams.com/020115/044/welcome_frame.htm)

Spain:

Aplein Ingenieros S.A
www.apleiningenieros.com/

Sweden:

Contact sales@polhemus.com

Switzerland:

EST Engineering Systems Technologies
GmbH & Co. KG
www.est-kl.com

Taiwan:

PC from Expert/Apexsun
www.pcexpert.com.tw

Thailand:

Contact sales@polhemus.com

Turkey:

Contact sales@polhemus.com

United Kingdom:

Virtalis Limited
www.virtalis.com

14 Customer Service

If you encounter any problems with your *FastSCAN*[™] system, help is just a telephone call away. Call 802/655-3159 (800/357-4777 U.S. and Canada) and ask for Customer Service. For the most part, our Customer Service engineers can handle your problems over the telephone and get you back into the fast lane right away. If the problem requires repair of your instrument, the Customer Service engineer will issue you a Return Merchandise Authorization (RMA) number. Polhemus strongly suggests retaining the original shipping container for your *FastSCAN*[™] system in the event that the instrument may require repair. Please do not return any instrument without an RMA number, as it will not be accepted. If your instrument is still under warranty, Polhemus will repair it free of charge according to the provisions of the warranty as stated in Section 15 of this document. The proper return shipping address is:

Polhemus
40 Hercules Drive
Colchester, Vermont, 05446
United States of America



P.O. BOX 560, 40 HERCULES DRIVE
COLCHESTER, VT 05446

Telephone (voice):	(802) 655-3159
Toll Free (USA & Canada):	(800) 357-4777
Telephone (FAX):	(802) 655-1439
Email:	techsupport@polhemus.com

<http://www.polhemus.com/>

<http://www.fastscan3d.com/>

Software upgrades for licensed users are available from **www.fastscan3d.com**.

15 Limited Warranty and Limitation of Liability

15.1

Polhemus warrants that the Systems shall be free from defects in material and workmanship for a period of one year from the date ownership of the System passed from Polhemus to Buyer. Polhemus shall, upon notification within the warranty period, correct such defects by repair or replacement with a like serviceable item at Polhemus' option. This warranty shall be considered void if the System is operated other than in accordance with the instructions in Polhemus' User Manual or is damaged by accident or mishandling. Parts or material which are clearly expendable or subject to normal wear beyond usefulness within the warranty period such as lamps, fuses, etc., are not covered by this warranty.

15.2

In the event any System or portion thereof is defective, Buyer shall, within the warranty period, notify Polhemus in writing of the nature of the defect, remove the defective parts and, at the direction of Polhemus Customer Service, ship such parts to Polhemus. Upon determination by Polhemus that the parts or Systems are defective and covered by the warranty set forth above, Polhemus, at its option shall repair or replace the same without cost to Buyer. Buyer shall pay all charges for transportation and delivery costs to Polhemus' factory for defective parts where directed to be sent to Polhemus, and Polhemus shall pay for transportation costs to Buyer's facility only for warranty replacement parts and Systems. Removed parts covered by claims under this warranty shall become the property of Polhemus.

15.3

In the event that allegedly defective parts are found not to be defective, or not covered by warranty, Buyer agrees that Polhemus may invoice Buyer for all reasonable expenses incurred in inspecting, testing, repairing and returning the Systems and that Buyer will pay such costs on being invoiced therefor. Buyer shall bear the risk of loss or damage during transit in all cases.

15.4

Any repaired or replaced part or System shall be warranted for the remaining period of the original warranty or thirty (30) days, whichever is longer.

15.5

Warranties shall not apply to any Systems which have been:

- (a) repaired or altered other than by Polhemus, except when so authorized in writing by Polhemus.
- (b) used in an unauthorized or improper manner, or without following normal operating procedures; or
- (c) improperly maintained and where such activities in Polhemus' sole judgement, have adversely affected the Systems. Neither shall warranties apply in the case of damage through accidents or acts of nature such as flood, earthquake, lightning, tornado, typhoon, power surge or failure, environmental extremes or other external causes.

15.6

POLHEMUS DOES NOT WARRANT AND SPECIFICALLY DISCLAIMS THE WARRANTY OF MERCHANTABILITY OF THE PRODUCTS OR THE WARRANTY OF FITNESS OF THE PRODUCTS FOR ANY PARTICULAR PURPOSE. POLHEMUS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, EXCEPT OF TITLE AND AGAINST PATENT INFRINGEMENT, OTHER THAN THOSE SPECIFICALLY SET FORTH HEREIN.

15.7

IN NO EVENT SHALL POLHEMUS BE LIABLE UNDER ANY CIRCUMSTANCES FOR SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO LOSS OF PROFITS OR REVENUE. WITHOUT LIMITING THE FOREGOING POLHEMUS' MAXIMUM LIABILITY FOR DAMAGES FOR ANY CAUSE WHATSOEVER, EXCLUSIVE OF CLAIMS FOR PATENT INFRINGEMENT AND REGARDLESS OF THE FORM OF THE ACTION (INCLUDING BUT NOT LIMITED TO CONTRACT NEGLIGENCE OR STRICT LIABILITY) SHALL BE LIMITED TO BUYER'S ACTUAL DIRECT DAMAGES, NOT TO EXCEED THE PRICE OF THE GOODS UPON WHICH SUCH LIABILITY IS BASED.

16 Indemnity Against Patent Infringement

Polhemus shall have the right at its own expense, to defend or at its option to settle, any claim, suit or proceeding brought against Buyer on the issue of infringement of any United States patent by any product, or any part thereof, supplied by Polhemus to Buyer under this Agreement. Polhemus shall pay, subject to the limitations hereinafter set forth in this paragraph, any final judgement entered against Buyer on such issue in any such suit or proceeding defended by Polhemus. Polhemus at its sole option shall be relieved of the foregoing obligations unless Buyer notified Polhemus promptly in writing of any such claim, suit or proceedings, and at Polhemus' expense, gave Polhemus proper and full information and assistance to settle and/or defend any such claim, suit or proceeding. If the product, or any part thereof, furnished by Polhemus to Buyer becomes, or in the opinion of Polhemus may become, the subject of any claim, suit or proceeding for infringement of any United States patent, or in the event of an adjudication that such product or part infringes any United States patent, or if the use, lease or sale of such product or part is enjoined, Polhemus may, at its option and its expense: (a) procure for Buyer the right under such patent to use, lease or sell, as appropriate, such product or part, or (b) replace such product or part, or (c) modify such product, or part, or (d) remove such product or part and refund the aggregate payments and transportation costs paid therefore by the Buyer less a reasonable sum for use, damage and obsolescence. Polhemus shall have no liability for any infringement arising from: (i) the combination of such product or part with any other product or part whether or not furnished to Buyer by Polhemus, or (ii) the modification of such product or part unless such modification was made by Polhemus, or (iii) the use of such product or part in practicing any process, or (iv) the furnishing to Buyer of any information, data, service or application assistance. Buyer shall hold Polhemus harmless against any expense, judgement or loss for infringement of any United States patents or trademarks which results from Polhemus' compliance with Buyer's designs, specifications or instructions. Polhemus shall not be liable for any costs or expense incurred without Polhemus' written authorization and in no event shall Polhemus' total liability to Buyer under, or as a result of compliance with, the provisions of this paragraph exceed the aggregate sum paid to Polhemus by Buyer for the allegedly infringing product or part, exclusive of any refund under option (4) above. The foregoing states the entire liability of Polhemus, and the exclusive remedy of Buyer, with respect to any actual or alleged patent infringement by such product or part.