

3D CAD Case Study: Modeling 3D Data in SolidWorks

Background

Tru-Test Ltd is a multinational company who designs and develops, manufactures and markets agritech and electrophysiological solutions. Tru-Test required 3D data of peri-natal infants to aid in the design of a specific electrode array for pre-mature infants, to be used with a new type of EEG monitoring device.

This required Tru-Test to use a computer model in order to determine the size and geometry of the electrode to fit the shape and curvature of the heads. The need for accurate data was paramount. However, suitable 3D data was not available.

The solution was found in the Polhemus FastSCAN™, a handheld 3D laser scanner, which was used for scanning two anatomically correct, premature baby dolls. FastSCAN's "FastRBF Extensions™", was used to create a model for exporting to SolidWorks.



Figure 1: Foetal doll (left) and newborn doll (right)

Scanning and Processing

The head and shoulders of the two dolls were scanned using the FastSCAN (Figures 2(a) and 3(a)). The FastRBF Extensions automatically fits a surface to the original data points to guarantee that the output mesh is free from holes and water-tight (Figures 2(b) and 3(b)). The FastRBF surface is also guaranteed to pass within a specified tolerance (in this case 0.1mm) of the original surface points. Furthermore, it has smoothing capabilities that can remove noise from the data. This proved invaluable when scanning the foetal doll. This doll's surface was a semi-opaque silicon rubber, that gave a very poorly defined (noisy) surface as viewed by the laser scanner (Figure 2(a)). Powdering or painting the surface would have solved the problem, but it became apparent during processing with the FastRBF Extensions that this was not required. Its smoothing feature ensured that the noise was removed but the detail of the original surface was retained (Figure 2(b)).

As a CAD package, in this case SolidWorks, was the target program for the output model, it was important to reduce the facet count to a manageable size. The FastRBF Extensions simplification reduced the polygon count for the foetal doll from approximately 169,000 facets to 23,000 facets (a reduction of 86%), and for the newborn doll, from approximately 97,000 to 17,000 (a reduction of 82%). A close-up of one of the dolls before and after simplification is shown in Figure 4. To achieve this, an accuracy parameter of 0.05mm was used, so that the simplified mesh will be no further than 0.05mm from the non-simplified surface.

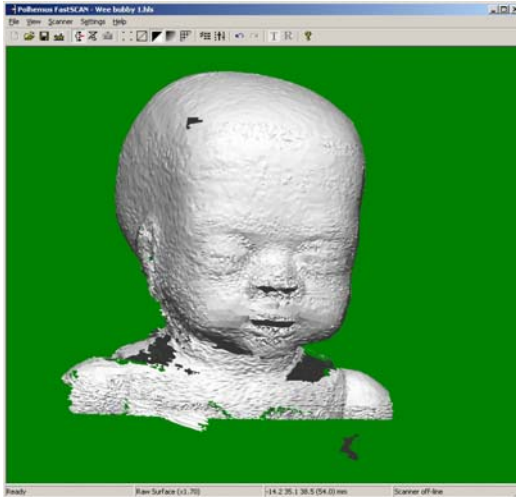
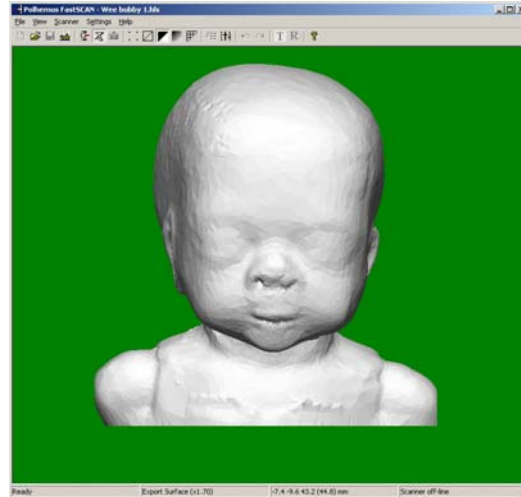


Figure 2(a): The foetal doll: raw data comprising approximately 141,000 facets



(b): The FastRBF processed surface comprising approximately 97,000 facets

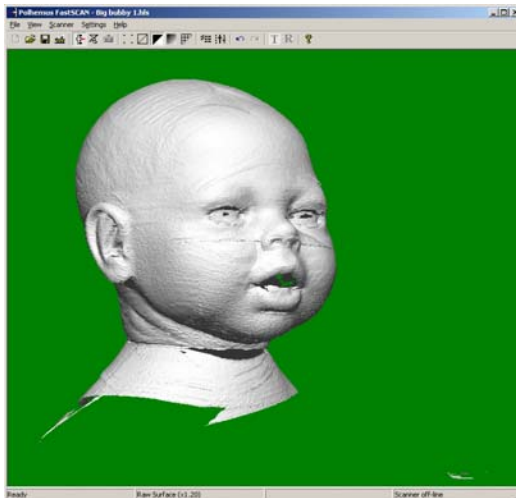


Figure 3(a): The newborn doll: raw data comprising approximately 247,000 facets



(b): The FastRBF processed surface comprising approximately 169,000 facets

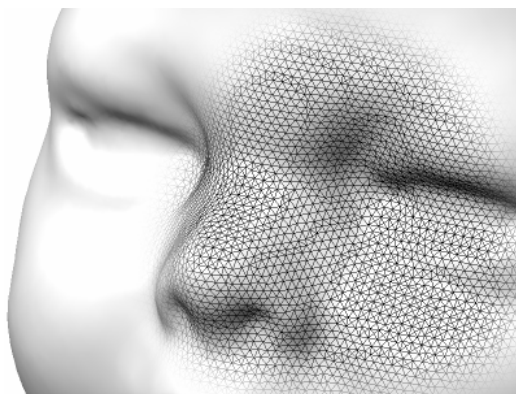


Figure 4: The newborn doll before and after FastRBF simplification: the fine mesh (left) and the simplified mesh (right)

Exporting

The models were exported as IGES 128 (NURBs) entities, which is one of the many industry standard formats that FastSCAN supports.

In order to compare the ability of SolidWorks to import these surfaces, the foetal doll model was exported as a closed surface, ie with closed planes at the bounding box (Figure 5), and the newborn doll was exported as an open surface, ie the model was not closed at the shoulders and base.

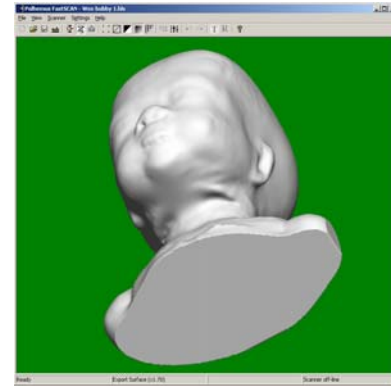


Figure 5: Closed surface

Importing into SolidWorks

A Product Engineer from Tru-Test, was given the task of importing and manipulating the objects in SolidWorks. For the (closed) foetal model, importing took approximately 3 minutes, resulting in an “imported solid” (as seen in the feature manager tree). The Product Engineer was able to start working on the model immediately.

With the open newborn model, the task of creating a solid model involved a few more steps before SolidWorks would recognise the model as a solid. Briefly, these included:

- Lofting surfaces over the open boundaries using the ‘create planar surface’ command
- Saving the model as a Parasolid file, and reloading the file
- Using ‘import diagnosis’ on all the surfaces, and choosing the ‘close all gaps’ option
- Again, saving the model as a Parasolid file, and reloading the file - which was now a perfect SolidWorks imported solid model.

The resulting models as exported into SolidWorks are shown in Figure 6.

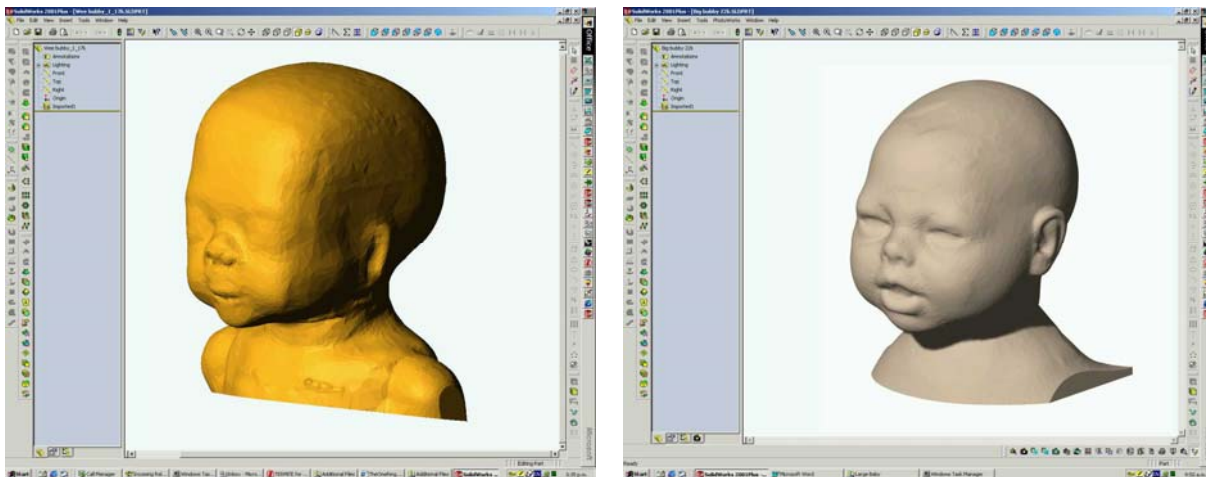


Figure 6: Screen captures of the two models in SolidWorks

The Product Engineer's final comment:
"Very satisfying and very successful"

Summary

The mathematical consistency of the post-processed data guaranteed by the FastSCAN FastRBF Extensions was critical in creating models that could be loaded and manipulated in SolidWorks. The following table summaries the steps involved (times for the foetal model).

Step	Time (minutes)	Advantages
1. Scanning	2	<ul style="list-style-type: none"> • Handheld, so able to scan entire surface • Number of facets: 141,000
2. FastRBF processing	4	<ul style="list-style-type: none"> • Automatic hole filling • Smoothing of noise • Water-tight • Closed surface (optional) • Number of facets: 97,000
3. FastRBF simplification	26	<ul style="list-style-type: none"> • Decrease number of points ... • ... while remaining faithful to the original model, in a way that's determined quantitatively • Plus all the features of the above step • Number of facets: 17,000
4. Export	0.01	<ul style="list-style-type: none"> • Export to industry standard formats
5. Importing, SolidWorks	3	<ul style="list-style-type: none"> • Parsing and solid model processing automatic for the closed surface

CAD Modeling by the Research and Development team of **Tru-Test Ltd:** www.trutest.co.nz