Are We Making What We're Moulding?

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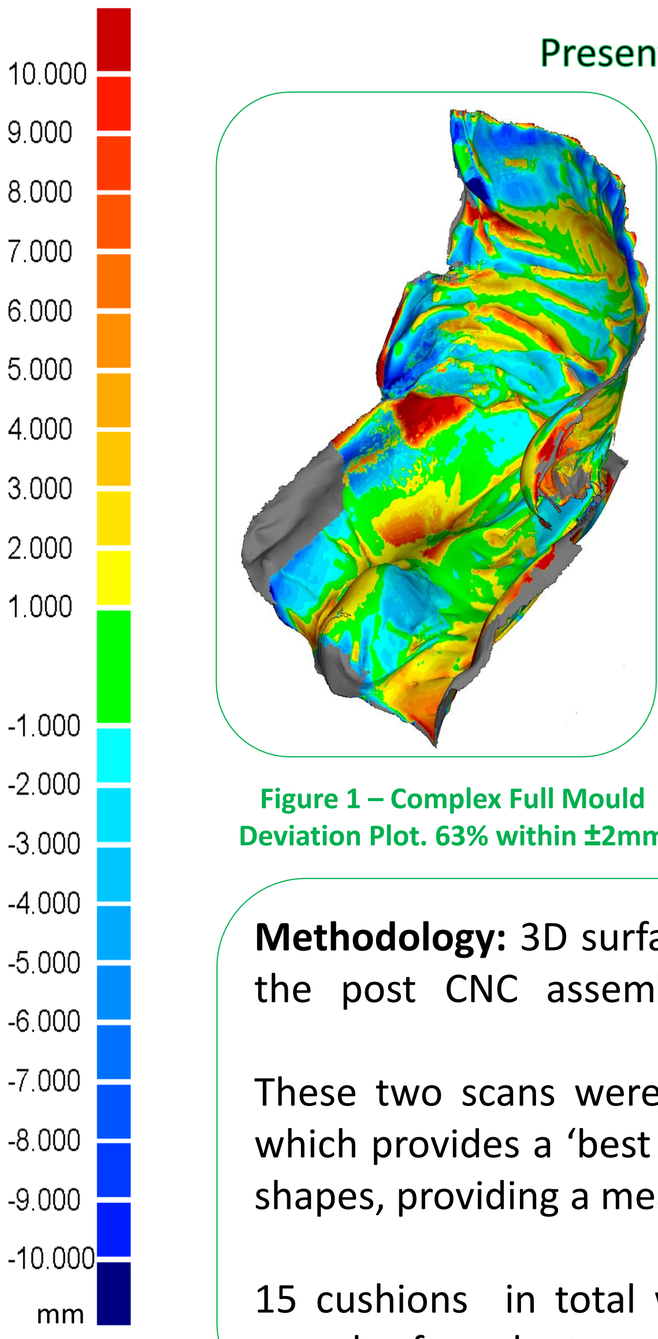

Aim: To quantify the accuracy of the digital seating process at Swansea REU and identify areas where accuracy could be improved.

Background: Our department produces custom contoured seating solutions by moulding clients in their optimum seating position using vacuum consolidation bead bags. A white light scanner is used to capture the 3D surface geometry of the bead bag mould. Data is processed in a CAD/CAM package to design tool cutting paths which are sent to a CNC machine where the moulded shape is carved out of foam blocks for assembly.

Previous work has quantified the accuracy of the scanning process [1], however the accuracy of the whole manufacturing process was not known.

Figure 1 – Complex Full Mould Deviation Plot. 63% within ±2mm

Methodology: 3D surface geometry of 1) the vacuum consolidated bead bag mould and 2) the post CNC assembled cushion were captured using the 3D white light scanner.

These two scans were compared using Geomagic Qualify 10 shape comparison software which provides a 'best fit alignment' of similar shapes and allows a 3D comparison of those shapes, providing a measurement of their deviation.

15 cushions in total were tested: 10 manufactured for complex seating clients, 5 non-complex for volunteers with no physical impairments.

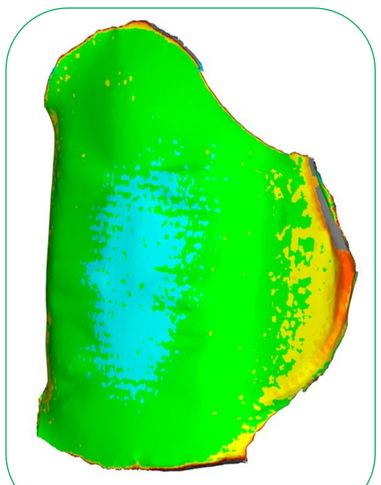

Figure 2 – Indexed Backrest Deviation Plot. 74% within ±2mm

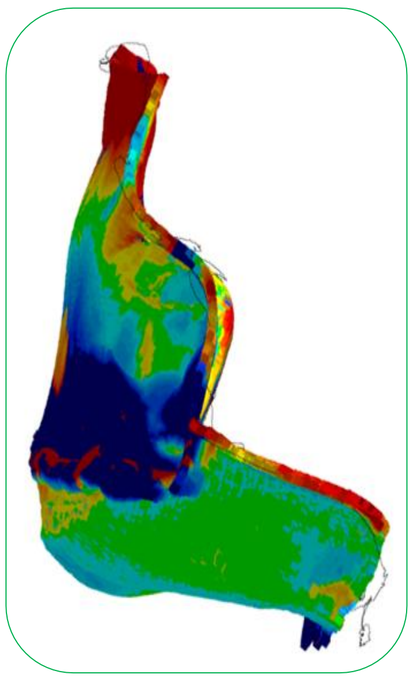

Figure 3 – Misaligned Full Mould Deviation Plot. 46% within ±2mm

Results:

Complex (see example in figure 1) **:** (n=9). 67% (S.D 3%) of data points were within a deviation of ± 2mm. 90% (S.D 4%) were within a deviation ± 6mm. 94% (S.D 3%) were within a deviation ± 10mm.

Of the complex cushions, 1 Backrest (figure 2) was indexed (both the back and front of the cushion were custom contoured) . 74% of data points for this cushion were within a deviation of ± 2mm.

1 anomaly (figure 3) was excluded from the results. This anomaly was due to an error in CAD/CAM processing which resulted in misalignment of the seat back and base components at assembly stage. 19% data points >± 10mm deviation.

Non –complex (see example in figure 4): (n=5) 84% (S.D 3%) of data points were within a deviation of ± 2mm. 94% (S.D 3%) were within a deviation ± 10mm.

Discussion & Conclusions:

- The greatest deviation (n=1) shown was due to an error in CAD/CAM processing (figure 3).
- Deviations are shown to be greater and more variable for complex cushions compared to non – complex. This is thought to be due to a greater number of undercuts within complex shapes. Undercuts can be limited by techniques in CAD/CAM processing) but are not completely avoidable due to the use of a 3 axis CNC machine.
- Indexing cushions does not appear to affect the accuracy of manufacturing.
- 94% (S.D 3%) data points for both complex and non complex cushions were within a deviation ± 10mm.
- Results indicate the digital seating process is sufficiently accurate for the manufacture of bespoke seating systems although an acceptable tolerance is not known and will invariably depend on the client's clinical needs.
- This work has demonstrated the value of using this 3D comparison tool to audit custom contoured seating manufacturing processes.

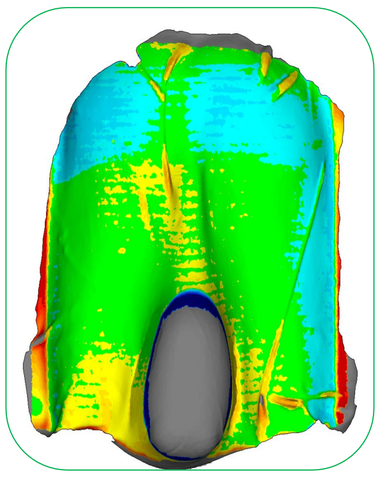

Figure 4 – Non-complex Base Cushion Deviation Plot. 85% within ±2mm

REFERENCES [1] Tasker LH, Shapcott NG, Holland PM (2011), The use and validation of a laser scanner for computer aided design and manufacturing of wheelchair seating, Journal of Medical Engineering & Technology, 35 (6-7): 377-385