Comparing commercial 3D scanning processes for custom-contoured seating provision

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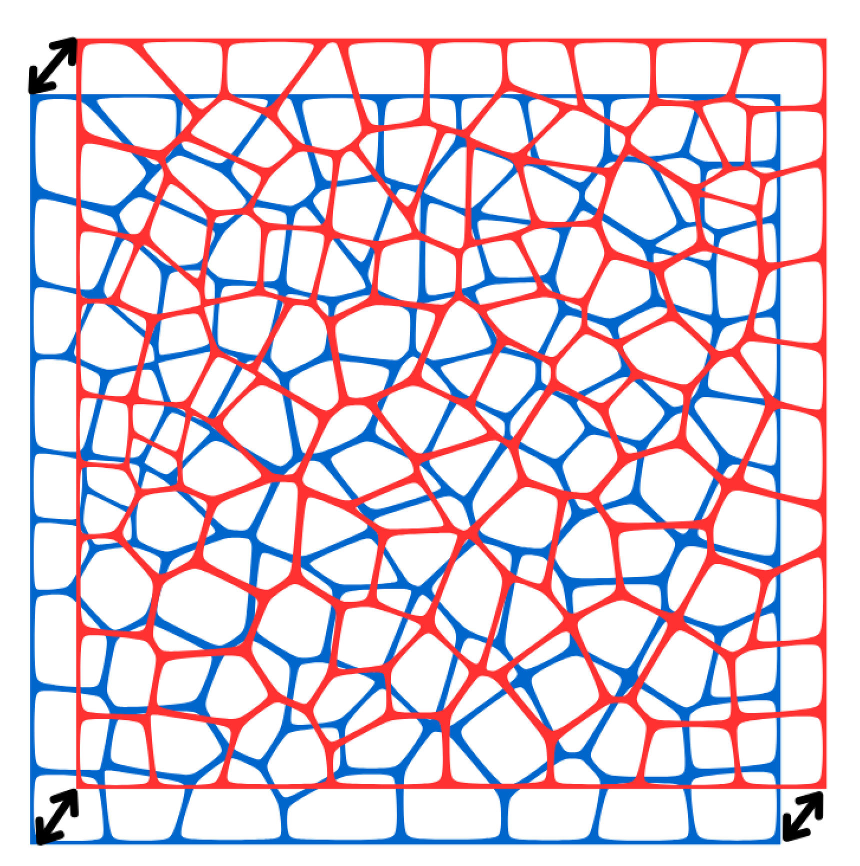


Mesh Deviation Surface Analysis

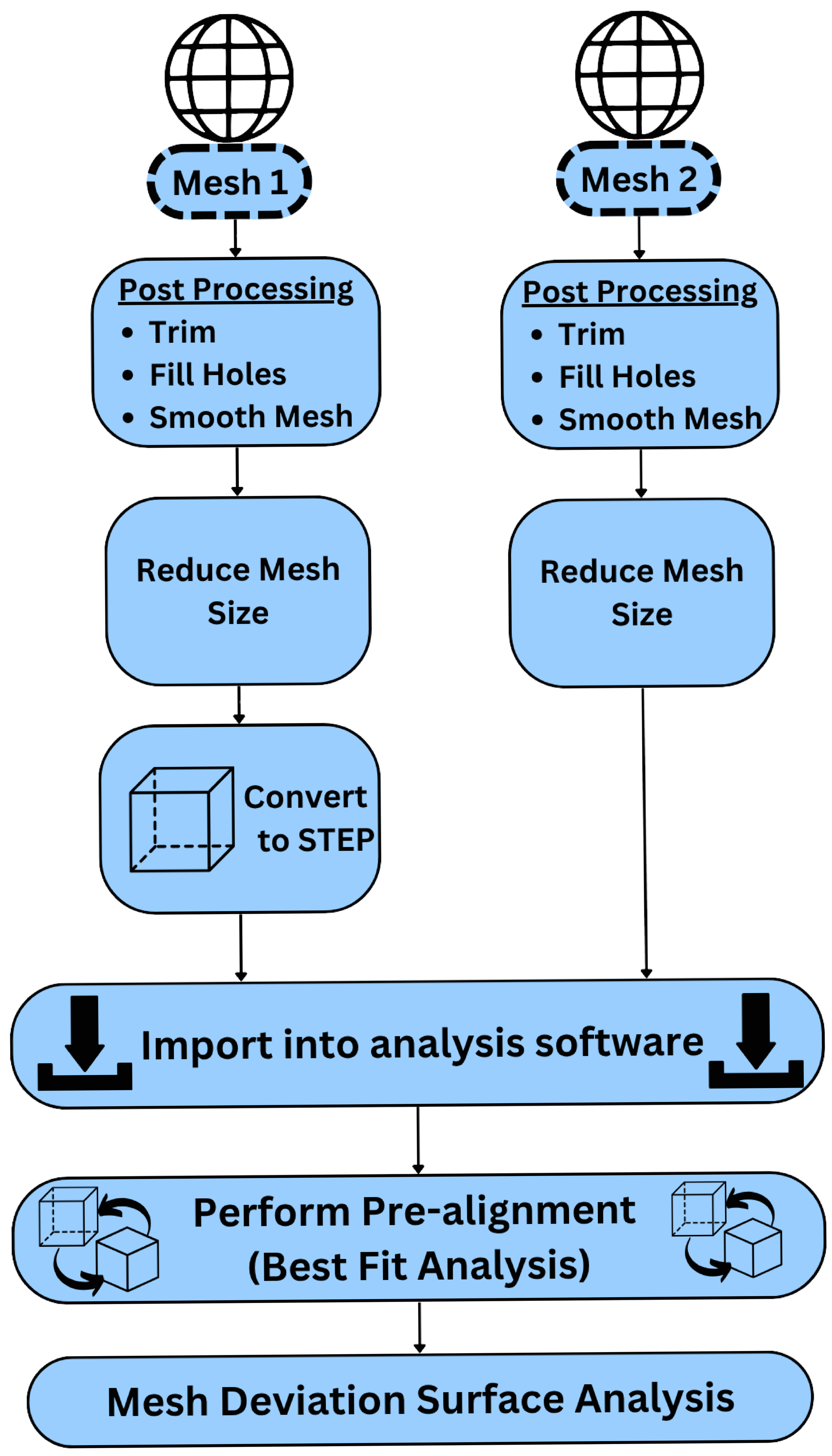
- Overlay two meshes onto each other
- Calculate distances between each vertex of one mesh and the closest vertex on the other.
- Present deviation values as a colour gradient.

Introduction

Custom contoured seating is used for patients with complex postural needs which cannot be met by off the shelf or modular seating options. When custom seating is prescribed, a casting bag is used to create a negative of a patient's best corrected posture. The mould is then scanned using infrared or white light 3D scanners (Tasker, Shapcott and Holland, 2011).

With the wide availability of 3D scanners on the commercial market, it is important to evaluate the geometric accuracy and consistency of 3D models produced, particularly for custom seating applications.

Surface Validation offers a digital method of comparing two mesh surfaces using Mesh Surface Deviation Analysis. Surface Validation enables the detection and visualization of surface deviations between original and replicated geometries (Rudari et al., 2024). Surface validation can therefore be used to examine surface deviations between meshes produced by different scanners.



Methodology

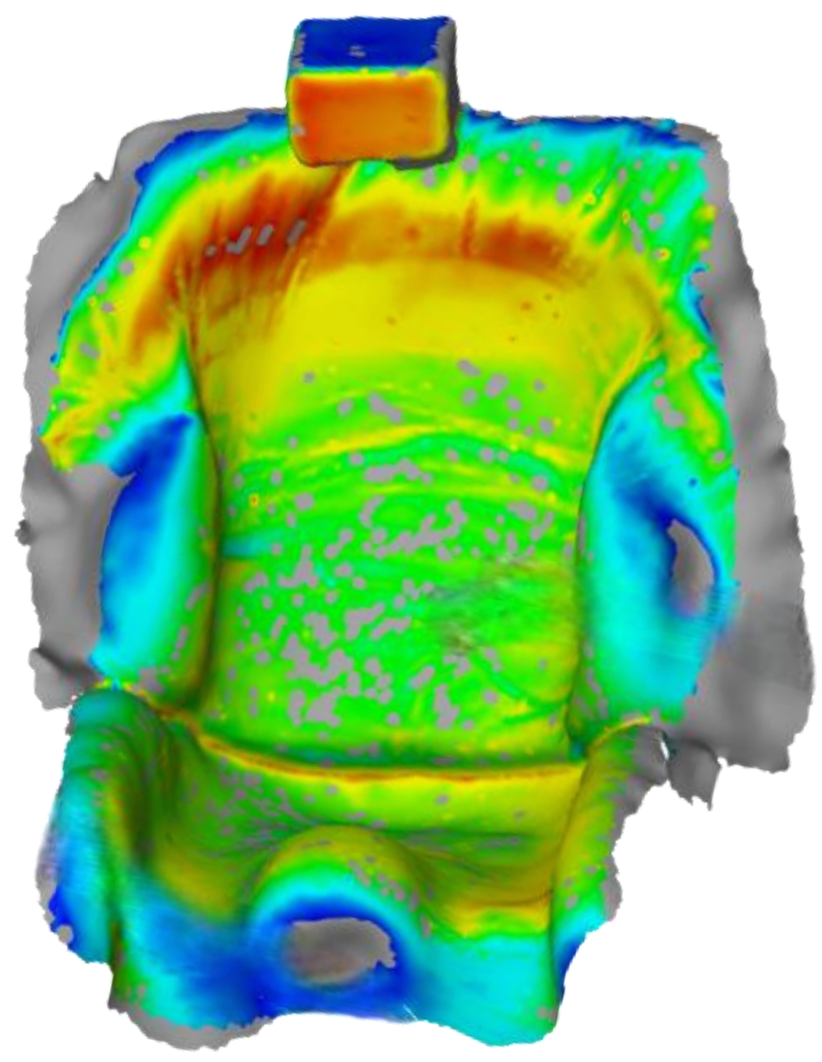
This study evaluated surface deviations between three scanners using the same postural mould, adapting the methodology of Rudari (2024), which used mesh deviation surface analysis to visualise mesh deviations between original and replicated surfaces via 3D scanning.

A seated posture cast was created under consistent lighting conditions and scanned sequentially by an experienced clinician using each scanner to ensure consistency.

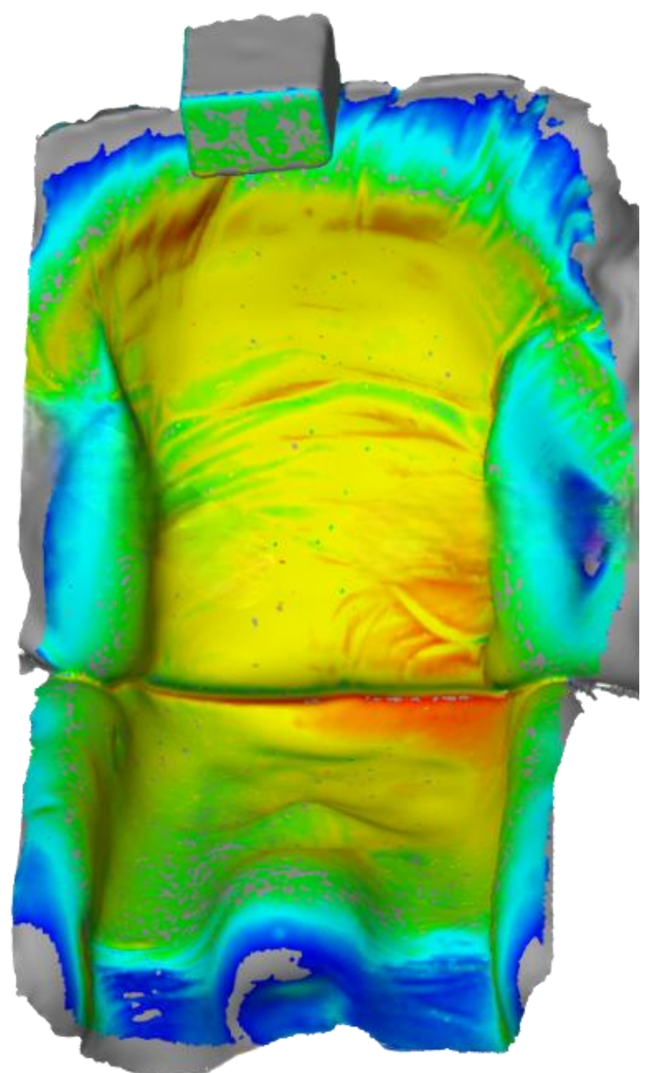
Each scan was post-processed to minimize mesh holes and reduce file size. Pairwise surface comparisons were performed using Zeiss Inspect Optic 3D software (ZEISS, 2023). For each comparison, models were aligned with a best-fit algorithm, and mesh surface deviations were calculated. Results were visualized with color map gradients to highlight discrepancies.

Results

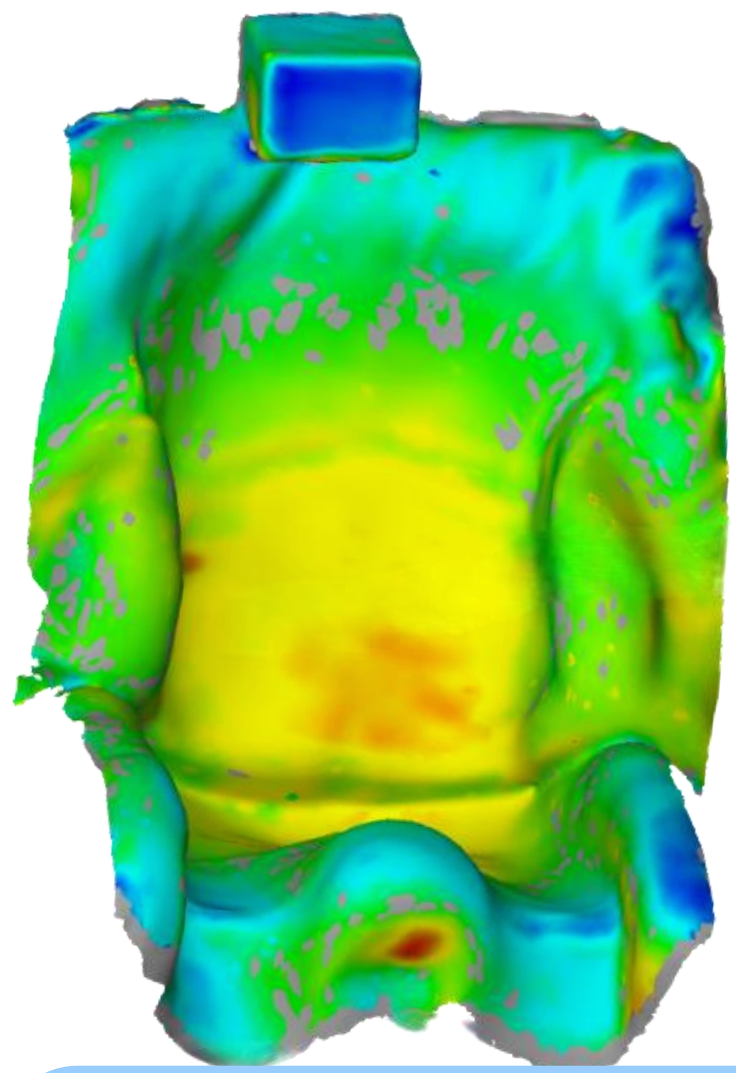
- Best Fit Alignment Errors were less than 4 mm
- Surface deviations under 10 mm were considered acceptable based on the tolerance identified in Tasker's (2011) research
- The average mean distance deviation was 1.09 mm ± 4.22 mm
- Scanner 2 vs Scanner 3 had the most accurate mesh similarity
- 70% of surface deviations ranged from -2 mm to 4 mm across all 3 scans



Scanner 1 vs Scanner 2



Scanner 1 vs Scanner 3



Scanner 2 vs Scanner 3

Conclusion

- Colour map analysis showed that surface deviations between the three scanner outputs were minimal and clinically insignificant.
- Most deviations were under 10 mm, consistent with accepted tolerances in custom seating manufacturing (Tasker, 2008).
- These results indicate that scanner brand has little impact on surface accuracy, supporting the feasibility of a supplier-independent scanning workflow for the scanners tested.
- A flexible, scanner-agnostic approach may enhance clinical and manufacturing efficiency by allowing the use of different devices without compromising model quality.
- Additional testing with irregular or complex seated postures could further evaluate the robustness of this scanning process across diverse clinical conditions.
- Future research should compare pre- and post-manufactured scans to assess how scan accuracy is retained or altered during production and to explore manufacturer-specific variations.

References

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