PERSONALIZED SEATING SOLUTIONS FOR TRUCK DRIVERS

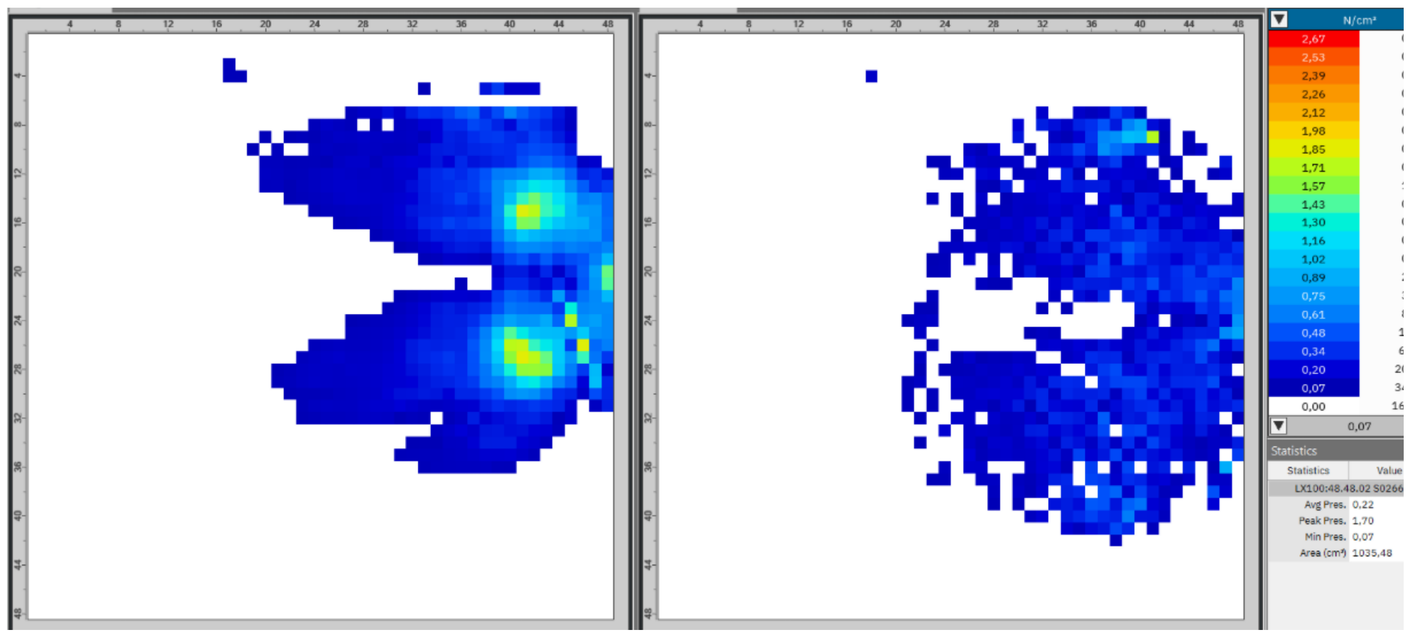
REDUCING MUSCULOSKELETAL DISORDERS & DISCOMFORT WITH THE USE OF 3D-PRINTED SEAT INSERTS.

ABSTRACT

Musculoskeletal disorders (MSDs) are a persistent occupational hazard among professional drivers, particularly truck drivers, due to prolonged static postures, whole-body vibrations, and poor seat ergonomics. These issues contribute to discomfort, sick leave, and long-term health deterioration. This study aimed to develop, prototype, and evaluate a personalized seating solution that addresses these risks through the use of 3D scanning and 3D printing technologies.

Over a 20-week research period, custom seat inserts were created using anthropometric data and vacuum cushion imprints, which were digitally modeled and 3D-printed using flexible TPE filament. The inserts were both fitted in and tested in a simulated truck cabin with 17 participants, using a combination of pressure mapping and short-term comfort questionnaires.

Quantitative results showed a 39.2% reduction in average pressure, 18.1% reduction in peak pressure, and a 15.1% increase in contact area when using the inserts. Subjective comfort ratings significantly improved in regions under the thighs, buttocks, knees, and neck ($p < 0.05$). Observational data revealed improved postural stability and anthropometric fit, though backrest comfort varied due to human error in production.



FINAL DESIGN

The final design of the seat insert system consists of a two-part configuration, composed of a separate seat pan and backrest component. These are split along a 45-degree angle, aligned with the natural hollow region between the seat pan and backrest in a truck seat. This seam is intentionally concealed beneath the seat's upholstery, minimizing visual disruption and preventing direct contact with the user's body. The angled separation not only improves ergonomic fit but also enables the two parts to fold backward onto one another, enhancing portability and simplifying storage when not in use. As shown in the picture above, the seat inserts stay withng the borders of the driver seat.

Both components are 3D-printed using TPE filament (TF40QD-LCNT) in pellet form, chosen for its balance of flexibility, durability, and user comfort. The seat pan is printed with 15% infill, while the backrest uses a slightly softer 13% infill, optimizing pressure distribution and surface compliance according to the differing load demands of each region. A gyroid infill pattern is used in both parts, oriented parallel to the user's back and buttocks, so that the open cellular structure faces directly toward the body. This directionality allows the infill to deform naturally under load, improving tactile comfort while maintaining internal stability.

The entire system is dimensionally tailored to fit within the inner boundaries of standard truck seats, with surface refinements made to accommodate seat-side contours and support structures. Cut-outs at critical rear side support locations allow the seat pan to rest over raised upholstery features, avoiding deformation and facilitating accurate placement. Altogether, the design reflects a synthesis of previous prototypes, combining ergonomic support, modular construction, and user-centered flexibility into a robust and adaptable seating solution for professional drivers.

Lastly, the upholstery that is then put around the 3D-printed inserts uses "AirMesh" fabric for the majority of the products' surface that interfaces with the back and buttocks. This fabric has an open structure that allows for better breathability compared to other standard upholstery fabrics. This is to facilitate the ventilation through the open strucure of the 3D-prints, to regulate the temperature and reduce transipiration.

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