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TOP COVER PRECISE MANUFACTURING: DESIGN, TRIMMING AND POSITIONING

HP INC

Top cover precise manufacturing: design, trimming and positioning

Insoles have traditionally been built in a manual way. 3d printing technology opens a new way to manufacture insoles following new procedures that enable automatized customization during the whole process: from the design to the manufacturing. That personalization at each of the steps require to update processes and workflows, when possible, or to create new ones if needed.

With the incorporation of 3d printing in the insoles business, most of the manufacturers have kept the old processes and keep using many manual operations. The positioning and trimming of the Top cover on the main shell is one of them that have not been moved to the digital manufacturing. The presented solution includes the contour drawing and trimming in the digital process, both for design and manufacturing phases.

Traditional manufacturing process follows these four steps:

- Obtaining the personalized main shell, which is a rigid material (either 3d printed or not)
- Gluing it to a rectangular pre-cut piece of Top Cover / Intermediate foams
- Manually cutting the top cover following the desired shoe contour using physical templates, throwing away the excess of material (see Figure 1 below)
- Grinding edges to ensure proper fitting

Figure 1: Top cover manual cutting

Intermediate foams may also require some adjustment, like cuts to accommodate pads or due to anatomical particularities.

This means that high time of operator is needed to complete the process (~10-14 min, depending on the complexity of the insole). In addition, the result is totally operator dependent, and it is hard to ensure uniformity and quality.

The most obvious solution to speed-up the process would be to pre-cut the Top cover templates following standardized shoe contours, but that would not work since the main shells are personalized and have different shapes for each user. Not only the transition would be inaccurate, but also the edges of the main shell would not fit since each personalized insole has a different unfolded area due to different shapes and curvatures.

The proposed solution digitalizes the definition, trimming and positioning of the top cover on the main shell, making the process almost fully automatized. The same approach might be used for any foam or pad that are inserted between main shell and top cover.

Top cover definition:

The top cover must match the main shell on the heel and mid area of the foot and must follow a standard contour at the front to fit commercial shoes. In addition, the transition between the personalized area and the forefoot needs to be smooth.

Including the definition of the top cover in the design phase allows to crate smooth transitions from the main shell to the standardized contour, as well as creating a surface that perfectly fits the hard shell once the top cover is bent and accommodated to the surface.

Each of the feet have its own top cover that might not be equal due to feed specificities or deformities.

The precise shape is obtained by unfolding the hard-shell surface through design software.

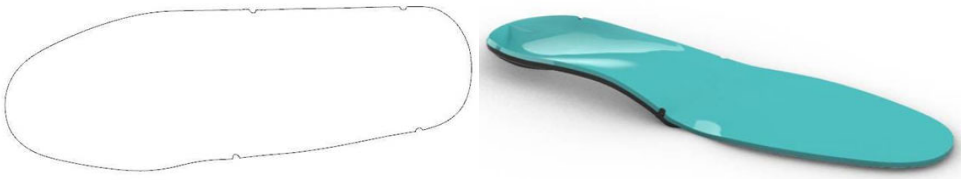

Figure 2: Unfolded and positioned top cover example

Top cover trimming:

Once Top cover is defined digitally, the manufacturing process of trimming it can be moved to many processes: water or laser cutting.

Obviously, 3d printing would also be enabled, although in that case, the design phase would avoid the unfolding of the model and would work directly on the final shape design.

Top cover positioning:

Although having a main shell and a top cover that have been precisely manufactured and fit perfectly, the relative positioning of them can be tough. Top cover is made of a flexible material that can be easily deformed and that it can lead to significant misalignments, error, and asymmetries between the two feet.

This solution incorporates some poka-yokes both in the main shell and in the Top cover that force some points and areas to fit, ensuring the proper positioning of the whole foam on the hard shell.

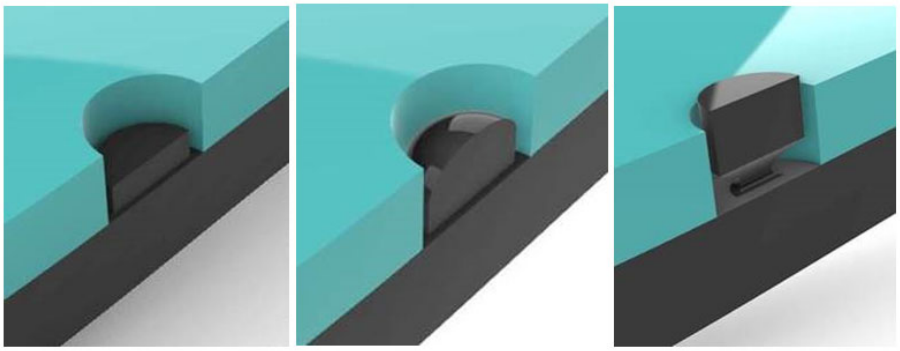

Figure 3: Poka-yoke positioners example (low profile, standard profile, removable)

Those poka-yokes are small enough to ensure no pains or discomforts for the user. The tips may be also removable, in case of needing smooth surfaces with no protuberances.

Using the poka-yokes does not leave any change to the operator when positioning the Top Cover, ensuring that the final module reproduces exactly the 3d design, both in the main shell and the top cover.

Top cover grinding:

Grinding process (or similar) might be still necessary to ensure smooth finishing but becomes a standardized step that will have no impact in the shape the insole. Contour has been totally defined in previous steps and there are no operator decisions needed.

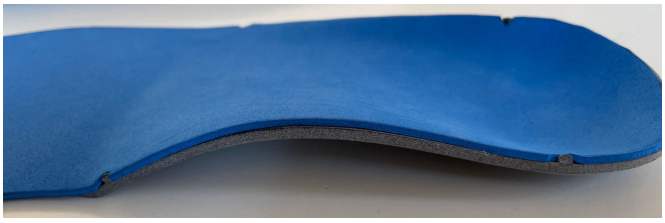

Figure 4: Real testing of the proposed solution, with precise fitting with no manual correction applied

Figure 5: Real testing of the proposed solution, with precise fitting with no manual correction applied

The proposed solution has the following advantages:

- Fully digital definition of all the components, ensuring manufacturing accuracy
- No operator dependencies in manufacturing. Lower quality control needs
- Lower manufacturing times

- Possibility to easily automatize the whole process
- Less exceeding material due to digital cutting
- Higher level of personalization not only in heel and mid area, but also in forefoot (e.g., different widths of forefoot contour, according to the shoe where the insoles will be used)
- Possibility of ordering different Top covers (if combined with replaceable solutions)

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