August 2020

3D PRINTED MIDSOLES WITH SPORT FUNCTIONALITY

HP INC

3D printed midsoles with sport functionality

This document suggests a novel method to manufacture midsoles with included functionality for certain sports such as cycling. The proposal is to leverage the potential of 3D and optimize mechanisms used to fix the shoe to different objects (canoe, bike, etc.) and reduce post-assembly processes, simplify supply chains and improve performance of the biking shoes, among others.

When riding a bicycle, the feet are the parts that receive the highest pressure and this contact is used to distribute the force properly on the pedal at each stroke. Having a rigid midsole allows the distribution of the whole body's weight during pedaling even only a third of the midsole is in contact with the pedal.

Additionally, not fixing the bicycle shoes at the right point in the pedal can also lead to future injuries. For getting the right positioning, the cyclist should do 3 tedious adjustments (Anterior-Posterior adjustment, Lateral adjustment and rotation adjustment) and follow a method to fix the mechanism to the shoe correctly (to grease the screws and to tighten them sequentially by using an hex key and turning 1/5 each time).

The process explained above shows the difficulty of adjusting the mechanism to the bicycle shoe and the step 3 is kind of subjective as it depends on the user comfort. This disclosure pretends to give extra functionality to the midsole design by incorporating the fixing mechanism for the bicycle shoes or the pattern for canoeing. Using the geometrical data from a 3D scanner (and potentially pressure foot patterns) from the users it could be identified the optimal to place the fixing mechanism. Once the data is generated, and transformed into a 3D design, the midsole can be manufactured using 3D printing technology.

The problems that this disclosure would solve are the following:

- Avoid wrong positioning of the bicycle shoes to the pedal (by removing subjectivity of the process) and consequently avoid possible injuries of the cyclist
- Improve performance of the shoes thanks to a better positioning of the fixing mechanism
- Customize each product for each customer by looking at their data (pressure and geometrical foot patterns), providing higher comfort
- To create a more convenience assembly process for the cyclist (easier and faster)
- Reduce the number of parts manufactured while reducing the cost of the product and removing the post assembly process

From prior solutions, it is seen that although there are different types of pedals and bicycle shoes depending on the route the cyclist wants to make (trekking, mountain bike, road, etc.), they all use the same system to adjust the mechanism to the shoe. The mechanism incorporates several separate parts that must be assembled and fixed to the pedal for a good performance of the cyclist and to avoid damages.

The adjustment of the current system is based on 3 steps:

1) Anterior-Posterior adjustment (moving forward/backward the mechanism in reference to the bicycle shoe)
   This adjustment is used to find the right contact point between the pedal and the shoe. First, we should look for two points as reference (the first metatarsal and the fifth), which will be joint by a line. This will be used to draw a perpendicular line to it, crossing from the toe to the heel. The intersection point between the two lines is where the mechanism should be placed.

2) Lateral adjustment (Fit left or right)
   The second step is to correct the point according to the cyclist pedaling. If his/her knees tend to tuck into the frame, the shoe should be adjusted to bring the foot closer to the crank. If not, should be adjusted towards the bike's frame.

3) Rotation adjustment
   This last adjustment is critical to avoid injuries and is the one orienting the shoe. However, it is a subjective decision as the cyclists place it in the most comfortable way for them.

Finally, to fix the mechanism to the shoe, you need to tighten the two screws with a hex key but alternating the pressure, meaning you should tighten each screw successively with turns of 1/5 each time. One should not fully press one of the screws at once. Also, it is recommended to grease them.

As you could see above, what affects to cleat positioning is foot geometry (the line generated by the 1rst and 5th metatarsophalangeal joint) and depending on this positioning, the performance of the cyclists will be optimal or not. Also, this has consequences on the cyclist health as well (injuries).

So, the idea of this disclosure is to design a bicycle mechanism (or midsole fixing mechanisms used in other sports) integrated in the midsole design and designed leveraging custom data from the user. This increases part functionality and customer satisfaction while reducing TCO. Also, this alternative allows the customization of each product by obtaining the data from 3D Scanning systems of the foot of the final user (Figure 1).

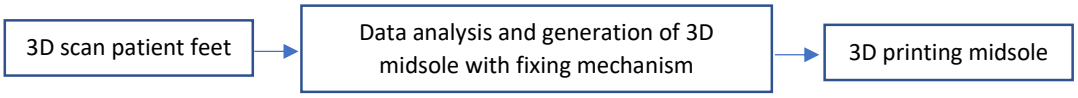

Figure 1: Workflow for generating and printing midsoles with fixing mechanism

The same idea can be applied to other sports such as canoeing. It is possible to add patterns on the below surface of the midsole to adapt the shoe to the canoe surface.

The proposed solution has the following advantages:

- Creation of a more convenient workflow for the final user (faster implementation and no posterior adjustment)
- Reduction of number of parts of the mechanism and to generate an optimized design with 3D printing technology. Avoid assembly process. Reduction of supply chain complexity
- Automatization and objectivize the adjustment of the shoe to the pedal by knowing the geometry and pressure patterns of the foot of a cyclist (3D scanning data)
- Avoidance of injuries due to a bad positioning of the shoe in the pedal

Disclosed by Davinia Font Calafell and Alberto Maria Canals, HP Inc.