Facts

Challenge

Helping athletes become faster on the track by personalising a runner's shoes.

Solution

Additive Manufacturing of customised spike plates for competition using an EOSINT P 395.

Results

- Tailor-made: ideal and customised fitting
- Light: reduced weight for minimised load and better performance
- Fast: production of several models within a short period of time

Customised comfort in motion – a 3D-printed spike plate attached to the bottom of a New Balance track spike (courtesy of New Balance)

Shoes, Perfectly Balanced

e-Manufacturing Solutions

Improved Runner Performance: New Balance Uses EOS Industrial 3D-Printing Technology to Individualise Spike Plates

Short profile

Founded in 1908 and based in the Brighton neighborhood of Boston, Massachusetts (USA), New Balance has global sales over $2 billion. Their more than 4,000 associates embrace innovation across all platforms of the business and are constantly exploring advanced methods of product design and manufacturing.

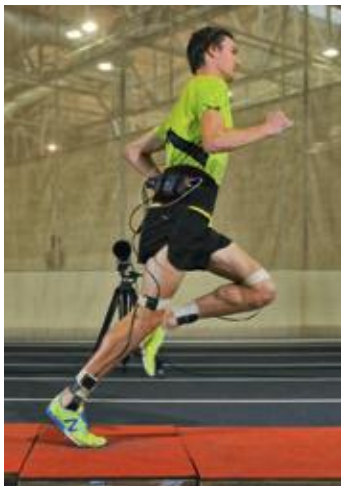
Further Information

www.newbalance.com
www.alm-llc.com

New Balance Athletic Shoe, Inc., best known simply as New Balance, has turned to design-driven manufacturing for 3D printing custom spike plates for their elite athletes, all based on an individual runner's biomechanics and personal inputs. Using a proprietary process to collect race simulation data from Team New Balance runners, the Sports Research Lab then applies advanced algorithms to translate this information into an optimised design that can be manufactured additively by use of EOS technology.

Challenge

No two runners are the same. This is especially true for athletes competing at the most elite levels. Their foot-strike patterns (the amount a runner's foot rolls inward with each step) and braking and propulsion forces are all unique. However, the extent to which most running shoe models vary is rather limited by comparison. As a result, there are some who believe that personalising a runner's shoes, specifically the spike plate that provides traction on the underside of the shoe, can help these athletes become faster on the track. A proponent of this trend is New Balance.



Team New Balance runner Jack Bolas takes a spin around the New Balance Sports Research Lab's test track (courtesy of New Balance).

Track shoe spike plates have three general characteristics that can vary depending on the length of the race the athlete is competing in and their preferences: the fit, stiffness, and design of the plate all of which impact the comfort and performance of the runner. Typically, each spike plate style requires several injection moulds for various sizes, all costing thousands of dollars. These moulds will run thousands of plates before being retired or replaced, often annually, by a new mould indicating a new model.

Solution

New Balance was searching for an optimised process – and found it in EOS technology. Long before the spike plates are additively manufactured, or even designed, New Balance's Sports Research Lab collects each runner's biomechanical data using a force plate, in-shoe sensors, and a *motion-capture system* worn by the runner. This motion-capture system helps determine the relationship of the foot to the force plate, creating a three-dimensional vector map of the impact of each stride. The in-shoe sensors show distinct pressure indicator over the length of the runner's foot strike as well as how the runner's foot interacts with the shoe. When a particular part of the foot exhibits high-pressure values, it generally indicates that the associated 3D vector is important to that area of the shoe at that specific moment in time.

"We establish a relationship between these high pressures and the corresponding forces to help us create a map of forces relevant to each area of the foot," says Sean Murphy, senior manager of innovation and engineering at New Balance. "A simple example is in the toe area. Generally, when you see high pressure there,

it corresponds to a force that is pushing toward the heel to create forward propulsion. We use parametric modeling software to process this data and distribute the position of the spike plate traction elements, calculate the orientation and adjust the size of the elements, and incorporate specific runner preferences into the design."

The designer is then responsible for performing the CAD cleanup necessary to create the final product, including touching up model surfaces and making adjustments to accommodate the full-size range of the spike plate. Once the final geometry has been verified, the CAD files are converted to .stl files and uploaded to the EOSINT P 395 system for Additive Manufacturing.

New Balance worked with high-performance materials manufacturer Advanced Laser Materials (ALM), part of the EOS family, to develop a proprietary nylon blend. The spike plates are built layer-by-layer in the EOS system using the custom-blend nylon powder coupled with tailored laser conditions to yield maximum engineering properties. "We decided to collaborate with ALM on this project because they had experience developing the type of material we were looking for," says Murphy. "We had worked with them on a previous prototyping project and the variety of materials as well as knowledge they offered made them the perfect partner."

Results

"By additively manufacturing our customised spike plates we can manufacture on demand, fluidly adjust our process to accommodate different sizes and widths, and update designs without the continuing capital investment required by injection molding," says Katherine Petrecca, business manager of New Balance Studio Innovation. "The incorporation of the additively manufactured spike plate also allows us to realise a 5% weight reduction compared to traditionally manufactured versions."

Kim Conley, a member of Team New Balance and U.S. Olympic runner, thinks it makes a difference in her performance. She has run personal records in both the 3000m and 5000m wearing her additively manufactured spike plates. She also wore them at the 2013 World Championships, where she had her best international performance to date. After simulation testing in 2012, Conley first wore her customised spike plates for competition in 2013 during a race at Mt. San Antonio College in Walnut, California (USA), and has continued to wear them, especially at such important races as the World Championships. "My shoes are critical to my performance. They're the most important piece of equipment I have," says Conley. "As a professional runner, you obviously want the most effective and comfortable spike plates for competition. For me, these are the ones New Balance designed based on the curve running data their development team collected. They provide better traction and less pressure on the outside of my foot, which allows me to focus on my race plan and not worry about my spike plates."

"This is a totally unique situation where we come away with the runner's data, generate multiple plates we feel will meet their needs, and actually provide several pairs of track spikes for them to try simultaneously. It's great to be able to have them identify and respond to each variation that we produce," says Murphy. But what does all this mean for the amateur or recreational runner? While runner-specific spike plates are currently only available for Team New Balance athletes, this will eventually change. And runners won't be the only ones having all the fun. There is definitely the opportunity to expand the customisation practices developed on the spike plate project to other sports.

"Design-driven Additive Manufacturing really holds the promise of more on-demand production and more individually customised design. These spike plates are the first step we've taken with our athletes to prove that. As the material options expand; as our own proficiency with EOS technology expands; as capacities for Additive Manufacturing grow, we believe we will be able to bring 3D-printed products, in some format, to the everyday consumer."

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