The science in your sole

For decades the ASICS INSTITUTE OF SPORT SCIENCE in Kobe has cushioned runners' feet with innovations in polymer gels. Today, advances in research are yielding arch support that changes in response to foot position and very lightweight foams reinforced with the fibres used in bullet-proof vests.

In 2020 the Olympic Games will arrive back in Tokyo's bustling metropolis for the first time since 1964, when 21 athletes won Olympic gold wearing shoes designed by a young Japanese company, Onitsuka. Re-branded ASICS in 1977, today that company is still standing toe-to-toe with the world's most innovative sports-footwear producers.

GEL™ STRUCTURES EFFECTIVELY ABSORB IMPACT FORCE

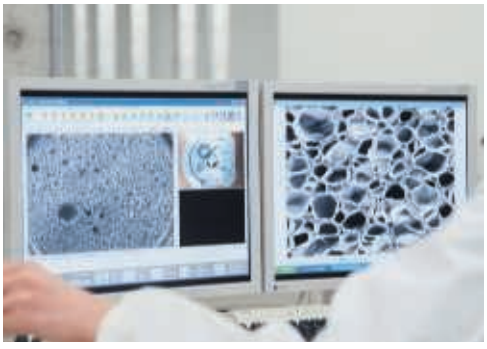
In 1949 research into the company's first prototype began by examining the shoe's performance on the feet of the Kobe High School basketball team. Today, researchers study everything from human biomechanics to the microscopic details of air bubbles in shoe-sole foams at the ASICS Institute of Sport Science (right), a sleek three-storey research facility to the west of Kobe. Scientists here in the 1980s were pioneers in developing silicone-based gels to protect the foot on impact. Realising the gels effectively absorb impact force, these researchers found that gels should be inserted into high-loading areas such as at the centre of the heel.

Pioneers in polymer gels

Gel has now remained at the forefront of sports-shoe cushioning for more than three decades. Its strongest supporters are 'serious runners' who are very aware of the impact on their feet. "The greater part of runners who participate in the major marathons around the world are using our running shoes," says Motoi Oyama, CEO of ASICS. "We believe that this is proof of our customers' trust."

Heterogeneous material expert Tsuyoshi Nishiwaki (far right, middle) is the Senior General Manager of the ASICS Institute, and has helped design many modelling systems for studying running-shoe performance. To date, the Institute has put more than half a million feet through 3D foot scanners to assess the needs of different sports-shoe markets. ASICS tailors its gel insertions to the zones required by different types of sportspeople, while making shoes as light as they can be. Gels are relatively heavy because they contain polymers swollen with solvents, Nishiwaki explains. But, their density and viscoelastic properties also provide the cushioning, impact absorption and stability that make them so useful.

However, the Institute is developing advanced materials and clever engineering to help tackle some of the constraints of gel weight. Australian and North American runners, says Nishiwaki, tend to prioritise injury prevention, choosing gel-focussed products for stability and cushioning. But Japanese long-distance runners prefer lightness, he says – often training in ASICS gel shoes and



then switching to lighter models for races. So, in 2013, ASICS researchers began to address the need both for lightness and cushioning for long-distance runners, in the end patenting two new materials and three design innovations geared towards performance and weight reduction. These were all realised in late 2015 in a shoe called 'MetaRun' (right, bottom), which contains a material that is the lightest-ever mid-sole material ASICS has produced, 'FlyteFoam'. The patented midsole foam was also used in the even lighter 'DynaFlyte' running shoes, which came out a year later.

Cutting-edge developments

FlyteFoam is the result of about three years of testing by the Advanced Technology Team at the Institute, who in that time examined more than 300 types of fibre. Eventually they incorporated short organic reinforcement fibres from a material also used to make bullet-proof vests. These high strength-to-weight ratio strands were combined with a lightweight plastic, reinforcing the walls of the foam's bubble structure. This advanced material, says Nishiwaki, is about 55% lighter than the industry-standard foam and is very elastic, so it quickly returns to its original shape between strides.

One of Nishiwaki's focuses is pronation, or the dropping of the arch of the foot to the side. Long-distance runners, he says, typically have less control over their feet as they tire and excessive foot-joint motion causes injuries. Based on careful measurements of foot-roll angles using both experiments and computer simulations, the Institute developed 'AdaptTruss'. This 'trusstic', a device positioned in the middle part of the sole beneath the foot's arch, gives running shoes stability. "After heel contact or just before toe-off we need a very flexible trusstic to adapt to the bend of the foot," explains Nishiwaki. "But during the foot-flat phase there is a very large vertical load, so we need a very stiff trusstic for stability." The AdaptTruss uses two layers to become either stiff or flexible depending on the weight applied to it. Stiffness is proportional to the thickness cubed, explains Nishiwaki, so when the two layers are pushed together the trusstic is about four times as stiff as when the foot is lifted.

Researchers also developed three gels for MetaRun – two that go under the heel and one under the forefoot. The gels' polymer structures are about 30% more deformable than other gels produced by ASICS, which lends the sole more give.

The future of running shoes however, says Nishiwaki, is still limitless. "As the technology expands, 3D printing could see more intricately designed shoes appear, however the real key to improving functionality is a good computer simulation technique."

The challenge for ASICS as a business, says Oyama, is to translate scientific knowledge of runners into low-key designs that also serve younger markets. As more runners hit the road or track two to three times a week and millennials begin to use sports shoes for everyday wear, the company will need to continue diversifying its designs and materials. The Institute of Sport Science, Oyama emphasizes, will remain "the beating heart of ASICS". ■

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Patents: FlyteFoam: JP / AdaptTruss: JP, DE, US