MORRIS TECHNOLOGIES

Facts

Challenge

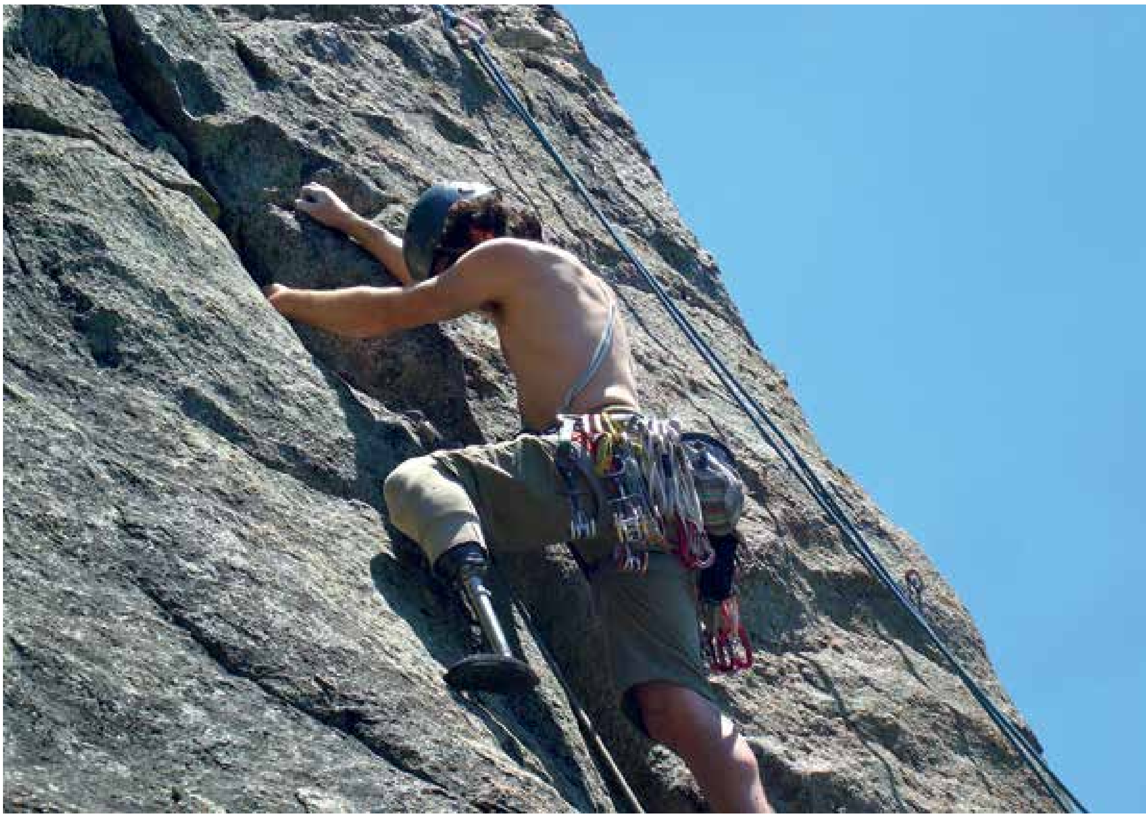
Develop a lightweight but stable prosthesis for a disabled climber.

Solution

Production of an individual climbing prosthesis made of titanium by using Additive Manufacturing.

Results

- Optimised: material and hole production for an ideal compromise between low weight and high stiffness
- Personalised: prosthesis is customised to one's individual anatomy and purpose
- Freedom of design: EOS technology is disrupting conventional manufacturing methods



Climber and amputee C. J. Howard makes a move with his laser sintered titanium climbing prosthetic on Hey Y'all Watch This (5.7 rating) at Luther Spires in the South Lake Tahoe, CA area (Source: Anna Knor).

If the Climbing Shoe Doesn't Fit, Design a New Foot

EOS e-Manufacturing Solutions

Using EOS Direct Metal Laser Sintering, Morris Technologies shows how extreme customisation can team up with extreme sports

Short profile

Morris Technologies, Inc. has been helping engineers, scientists, product designers, and industrial and military leaders innovate since 1994. Providing the latest manufacturing technologies, MTI strives to be a collaborative partner. Getting products to market first is paramount in today's global economy.

Address

Morris Technologies, Inc.
11988 Tramway Drive
Cincinati, OH 45241 (USA)
www.morristech.com

Exposed on a vertical face, rock climbers rely on their instincts, experience and, just as importantly, their equipment. Depending on the rock and route, they use an assortment of gear from carabiners, cams, and chocks to harnesses, helmets and specialised climbing shoes. Some footwear is stiff while other shoes are extremely flexible. Different styles can be used for finessing cracks, balancing on small toeholds, or smearing sloping slabs. But, the choice depends on individual preference.
For C. J. Howard, a northern California-based climbing enthusiast, as with all climbers, the shoes are important. But as a lower-leg amputee, even more important is the customised prosthetic foot that he designed with climbing partner and environmental/aerospace engineer, Mandy Ott.

Challenge

Howard had been an athlete all his life. After his diagnosis of osteosarcoma, which was followed by the amputation of his left leg just below the knee, he continued to run competitively, setting amputee world records in several events. Then he met Ott, who introduced him to climbing. Always eager for a challenge, he quickly took to the sport, which was also easier on his stump than running. He started out climbing with his standard artificial foot fitted to a climbing shoe. However, the prosthesis' generic shape didn't work well with the specialised footwear, wearing them out quickly. His climbing friends mulled over what would work better.

Solution

On-the-spot, they created a new prosthesis on a laptop with an aggressive climbing shoe which had a downturned toe like a banana. But, how best to manufacture it? Ott immediately thought of an Additive Manufacturing process called Direct Metal Laser Sintering (DMLS) that she had encountered

Gearing up for a day of climbing at Luther Spires in the South Lake Tahoe area: Amputee C. J. Howard's 'rack' includes a self-designed customised climbing prosthetic that was manufactured using Direct Metal Laser Sintering (DMLS) technology (Source: Anna Knor).

in her mechanical engineering work at a major aerospace company. "I never even thought about fabricating it using traditional machining techniques, because that process would result in seams in the foot or there might be nuts and bolts sticking out and that wouldn't work well for climbing," explains Ott, who was strongly in favour of it.

The engineer contacted Morris Technologies, a firm that specialises in Additive Manufacturing and had also served as a supplier for an earlier project she had worked on. Right away, they were willing to help the disabled athlete. The manufacturing started with uploading the digital CAD data of the prosthesis to the DMLS machine, where it was converted to a 2D sliced file. These layers were reproduced by the EOS system. Titanium in powder form was deposited on a platform in the build chamber of the system. A focussed laser traced the first cross-sectional slice of the foot, melting and hardening the metal powder at high heat into a solid replica of the digital data. Fresh powder was then reapplied, and the next layer of the CAD model was outlined by the laser, fusing it to the first. As the process repeated, the foot grew one 20 µm layer (about the thickness of five human hairs) at a time. Following the fully automated build cycle, excess powder was removed, and the prosthesis was stress relieved to cure the metal and ensure material strength properties.

Fabricating the approximately 6 x 3 x 2 inch, smooth-edged foot took about 40 hours. The finished five-pound foot was a single-piece construction, hollow to minimise weight and with no seams or fasteners. A separate vendor coated it with a rubber used for climbing shoe soles. The accompanying leg - a solid titanium rod - connects to a socket and C. J. Howard's upper leg.

Results

The material that Morris engineers chose was a commercial-grade titanium (Ti64) with superior strength and lightweight important properties given the intended use. While this prosthesis was the first one Morris Technologies had produced, Tim Warden, Vice President of Sales and Marketing at the company, sees the EOS technology as ideal for this kind of application. "Prosthesis should be customised to an individual's anatomy," says Warden. "After trying it out, if it doesn't fit or function quite correctly, we can just tweak the CAD file and re-grow the product, adding a little more material in a critical area."

As designs go, Howard's climbing prosthesis was fairly simple. Warden points out that the DMLS process is also perfect for producing medical products with even more critical geometries. This could include orthopaedic implants for hips, knees, shoulders, ankles, and even spines, as well as patient-specific surgical instruments. Morris already uses the process for a wide variety of other applications from aerospace to automotive to industrial. "We select DMLS over traditional manufacturing methods in instances where it can reduce both product development lead time and cost," the Morris employee explains. A growing list of materials - including biocompatible plastics and metals - is enabling the company to consider laser sintering for a number of cutting-edge medical applications.

There are some issues still to be addressed with the rubber, which didn't initially adhere well to the surface. Tim Warden notes that specialised software can be used with DMLS to create surface features on the titanium that would make it easier for the rubber to adhere. The technology can also build lattice structures into prostheses to make them lighter. Mandy Ott enthuses: "There are no limitations to what you can make with DMLS. Every engineer should try it."

"There are no limitations to what you can make with DMLS. Every engineer should try it."

Mandy Ott, Environmental/Aerospace Engineer

"We are already using the EOS-Technology for a wide variety of applications from aerospace to automotive to industrial. We select DMLS over traditional manufacturing methods in instances where it can reduce both product development lead time and cost."

Tim Warden, Vice President of Sales and Marketing at Morris Technologies

EOS GmbH
Electro Optical Systems
Corporate Headquarters
Robert-Stirling-Ring 1
82152 Krailling/Munich
Germany
Phone +49 89 893 36-0
Fax +49 89 893 36-285

Further EOS Offices

EOS France
Phone +33 437 49 76 76

EOS India
Phone +91 44 28 15 87 94

EOS Italy
Phone +39 0233 40 16 59

EOS Korea
Phone +82 32 552 82 31

EOS Nordic & Baltic
Phone +46 31 760 46 40

EOS of North America
Phone +1 248 306 01 43

EOS Singapore
Phone +65 6430 05 50

EOS Taiwan
Phone +886 3 657 63 51

EOS UK
Phone +44 1926 62 31 07

www.eos.info • info@eos.info

Think the impossible. You can get it.

e-Manufacturing Solutions