



*“ 80 per cent of our design concept for the bebionic small is done in SOLIDWORKS. The software lets us get knee deep into designing without worrying about the tools we are using. ”*

Ted Varley, Technical Director, Steeper

## World-leading prosthetics in SOLIDWORKS



Steeper is a leading manufacturer of innovative prosthetic, orthotic and assistive technology. Based in Leeds, its prosthetic development team has developed some of the world's best upper extremity prosthetics including their bebionic range and natural Skinergy coverings. The company also works in partnership with the NHS in the UK as well as the London Prosthetics Centre to provide cutting-edge prosthetic services.

### The Challenge

To build the world's most lifelike bebionic hand for the female, adolescent and Asian market. Steeper's flagship bebionic prosthetic range currently features two hand sizes, large (measuring 200mm from middle finger tip to hand base) and medium (190mm). Market research revealed there was no hi-tech, multi-articulated prosthetics available for the smaller frame.

Technical director at Steeper, Ted Varley said, "Some women would be wearing the medium hand because they wanted the functionality but the look and actual size of it wasn't correct for them. We wanted to create something that would give them a true lifelike option."

The starting point for the design was a skeletal structure created from the hand of a 50 percentile American Female. All the elements needed to fit into this volume. The bebionic small had to measure 165mm from middle finger to hand base and be a similar weight to a small human hand - around 390g. A large hand could weigh around 600g. The challenge for Steeper would be in retaining all the functionality of the medium hand - including strength, robustness, ease-of-use and control - but with a 30 per cent reduction in size.

### The Design Solution - Modelling

A design team of seven electrical and mechanical engineers worked collaboratively in SOLIDWORKS 3D CAD for all their conceptual and prototype designs of the bebionic small.

"The digital surfacing in SOLIDWORKS facilitates our whole product design including the biological shapes we needed," says Ted. "We could use some parts of the original medium hand, in other places we could use the same mechanisms but shrink them down, and then there were new challenges where we had to completely start from scratch.

"We wanted to get into SOLIDWORKS as quickly as possible," he adds. "We could have spent all our time devising the spec, but we felt our time as a team is better spent designing it and communicating. That is where SOLIDWORKS comes into its own. 80 per cent of our design concept is done in SOLIDWORKS, there is a very little bit of paperwork - a quick five-minute sketch to communicate with the team - but that's it. SOLIDWORKS lets us get knee deep in designing without worrying about the tools we are using."

The prosthetics team used the full range of the SOLIDWORKS modelling functionality, including lofting, surface profiles and splines to produce drawings quickly and easily.

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Senior mechanical design engineer Martin Wallace, says: "We used a lot of these tools in assembly to check that our geometry was correct and the tolerance stack was accurate. The last thing we wanted was wobbly fingers.

"The Interference Detection and Mass Properties tools allowed me to set dimensions and work confidently within the confines of small package spaces. While the Assembly Artist was key in helping me check that our Gear Mate relationships would work the way I wanted them to.

#### Design Integration in SOLIDWORKS

The key thing for Martin was that the team designed the shell of the hand first, and then designed the mechanisms to fit inside and not the other way around. This approach meant they could focus on both functionality and aesthetics equally but to do so they required an integrated workflow between mechanical and electrical.

"SOLIDWORKS lets us integrate our electronics hardware design in 3D to investigate and solve any component clashes or areas of concern," explains Martin. "It meant there was a lot of interactive, collaborative design between the electrical and mechanical teams. There was a lot of give and take for example in designing a component around a circuit board or a circuit board needing a bit more space and cutting off a bit of a chassis to make room.

"It encouraged a more efficient design and even more integration between the two disciplines of mechanical and electronics, which can only be a good thing."

#### Design Collaboration in SOLIDWORKS

Steeper did a lot of outreach with amputees at every stage of design and also with suppliers. With so many people working on the same product, it was key that their CAD management was fluid and their workflow processes were consistent.

"Having a fluid workflow during this process was key in encouraging a more integrated and efficient design process. We use SOLIDWORKS PDM Professional to share assemblies work on certain models and most crucially keep all the drawings up to date when a part was changed."

#### Design Validation in SOLIDWORKS

When it came to validating the design, the team used SOLIDWORKS Simulation to check and investigate any gaps and clearances to make sure there weren't any clashes in the assemblies. "We used FEA software for testing the spring designs, but the majority of our tests was from a mechanical assembly point of view - making sure it was all going to fit and move together," says Martin.

#### The Results

After a two-year process Steeper launched the bebionic small onto the market. The device uses myoelectrical signals collected from the surface of the user's skin to control movement. With 14 different grip patterns, it means the user can handle almost any situation including eating meals, opening doors and carrying bags. It provides a maximum grip of force of 140N and this grip opens and closes in less than 0.5s. It can support loads of 25kg per finger and a maximum safe load across the knuckles of 90kg.

Individual motors in each finger means the hand can move in a natural, coordinated way. There is proportional speed control, which gives the user precision control over delicate tasks such as picking up an egg or crushing an empty can. While the auto grip function automatically sense when a gripped item is slipping and naturally adjusts the grip to secure it.

In 2015 the bebionic small was awarded a British Engineering Excellence award for mechanical product of the year.

"The bebionic products have put us on the radar with a lot of international customers, so we are now totally redeveloping some of our older ranges to make them suitable for international markets. SOLIDWORKS and the bebionic small has opened the market for us with a lot of new customers," says Ted.

#### Benefits:

- Award-winning design
- Small package design
- Electronic and mechanical integration
- 30 per cent reduction of complex mechanisms
- Fluid processes with SOLIDWORKS PDM Professional
- 80 per cent of design concept in SOLIDWORKS

#### Industry:

- Hi-Tech/Medical

#### Product Used:

- SOLIDWORKS Standard
- SOLIDWORKS Premium
- SOLIDWORKS PDM Professional
- PDM Viewer & CAD Editor



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