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CASE STUDY
MEDICAL

“Lightning-Speed” Prototyping Accelerates Innovation at University of Iowa’s Protostudios Lab with FDM and PolyJet™ 3D Printing

The Opportunity

Improve non-surgical treatment of clubfoot birth defects for more than 200,000 children each year.

Dr. Thomas Cook, the co-founder of the 501(c)(3) Clubfoot Solutions, saw an opportunity to significantly improve the traditional approach to correcting clubfoot birth defects.

Cook, who serves as professor emeritus for the University of Iowa College of Public Health, wanted to improve the design of the "Iowa Brace," a simple plaster casting technique that was pioneered by Dr. Ignacio Ponseti in the 1950s. The Iowa Brace was designed to be worn during treatment to hold the child's feet in the correct position." The original static model consists of two platforms, one for each foot, and lightweight mesh booties connected by a fixed bar. While the device is extremely effective, the brace's fixed connecting bar significantly limits mobility and keeps young children from moving independently.

Cook reimagined the Iowa Brace with an articulating platform so that children could move their feet and stretch their muscles while still maintaining the correct therapeutic position of the foot platforms.

When he saw that his design concept would require a great deal of testing and iteration, he turned to Protostudios, the on-campus lab specializing in medical device prototyping and 3D printing, to make it happen.

The Technology

Leveraging Stratasys additive manufacturing technology to accelerate prototyping, testing, and production.

The Stratasys F370 3D printer

Rapid prototyping and testing

The Protostudios prototyping lab began their workflow by considering the model and design inputs, said Spencer Kuhl, director of operations for Protostudios.

"Like most manufacturing processes, the components need to be redesigned or designed from the outset to be optimized for the targeted manufacturing equipment," said Kuhl.

The models were 3D printed using a high-strength material, PC-ABS, on the Stratasys F370 FDM (fused deposition modeling) printer, a widely-used form of 3D printing where strong thermoplastics are deposited layer-by-layer from the bottom up by heating and extruding thermoplastic filament, allowing engineers to build parts quickly in early-stage prototyping.

This process allowed Dr. Cook to test the device's functionality often in the early stages.

“After trying the prototype on about six children, we quickly learned that the locking mechanism attachment could crack,” said Dr. Cook. “Thanks to 3D printing technology, we were able to produce a few prototypes and test them on patients immediately to find the breaking point. We ended up redesigning the attachment piece and effectively doubled the thickness of the connecting bar.”

In a short amount of time, Dr. Cook and the Protostudios team were able to manufacture 18 iterations of the device.

> “3D printing allowed us to quickly meet our design requirements and inch our way up to a much more reliable product. It’s lightning speed compared to what it used to take to get from one version to another.”

Dr. Thomas Cook

co-founder of Clubfoot Solutions and professor emeritus for the University of Iowa College of Public Health and the Department of Physical Therapy and Rehabilitation Science, UI Carver College of Medicine Prosthodontist at Renew Dental

Design Requirements

The Improved Iowa Brace

Because the Iowa Brace is almost exclusively worn by children, the design team defined a number of non-negotiable design inputs.

Safety and comfort: No mechanisms that could pinch a child’s fingers or cause skin irritation.

Security: Detachable foot platforms with a locking mechanism and release button so the connecting bar could be safely inserted and removed, and securely held in place.

Adaptability: Universally able to accommodate children’s shoe sizes 000 to 10 and receive connecting bars of various lengthens to match a child’s shoulder width as they grow.

Affordability: Injection moldable for mass production at a low cost to achieve Clubfoot Solutions’ mission to make the braces affordable and accessible to families in developing countries.

Optimized for injection molding: Targeted for the manufacturing equipment with considerations for draft angles, parting lines, overhands, through-holes, and other features.

> “With no polishing layer and no post-processing, the time to injection was a huge benefit. And the J750 platform is the only solution that can print at 14-micron layers.”
>
> **Spencer Kuhl**
> Director of operations for Protostudios

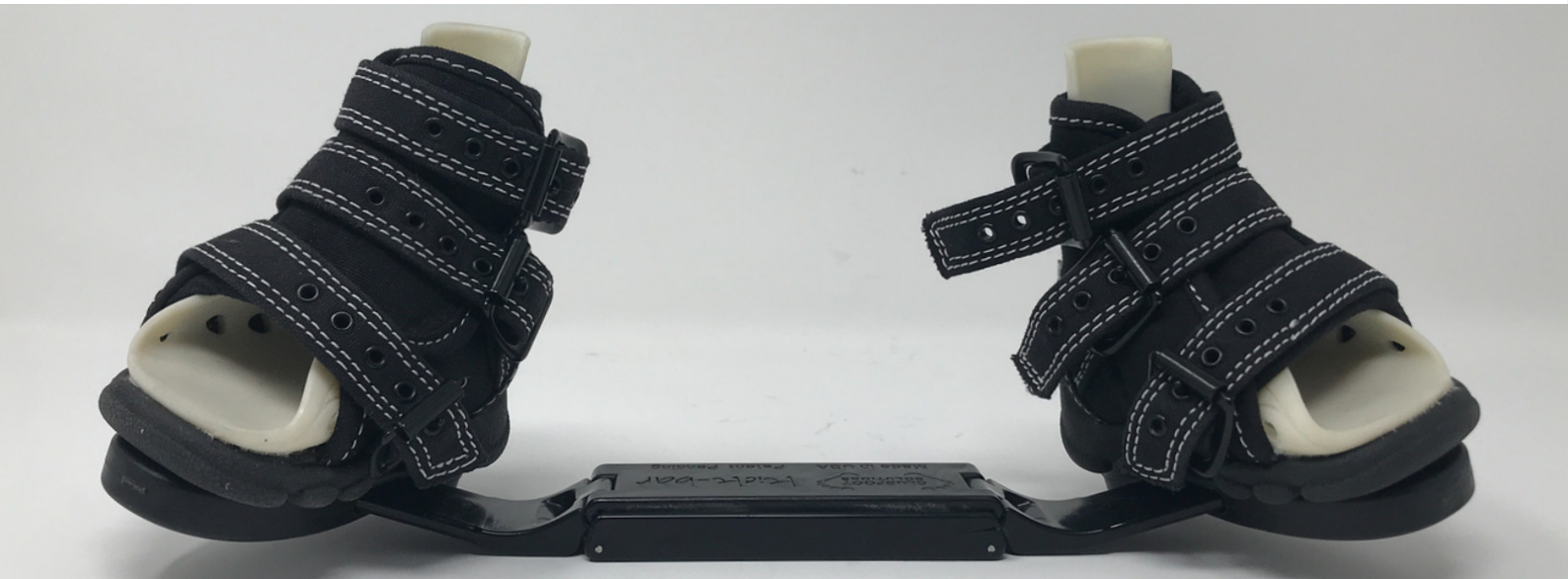
The Stratasys J750 platform

Injection molding production at scale

Another part of the process that enabled rapid prototyping was the quick time to injection with the help of the Stratasys J750 Digital Anatomy Printer.

Protostudios’ injection molding system is designed to use a Master Unit Die (MUD) base, which allows the team to create relatively small mold inserts rather than machine a dedicated mold base, explained Kuhl. The inserts can be machined from tool steel or aluminum, or 3D printed on the J750 platform with PolyJet Digital ABS material and its glossy surface feature.

Once they completed functional testing, the team could print the same model, choose the colors and textures that matched the final injection-molded parts for visual appeal and aesthetic approval, and check that the part could be injection molded and fulfilled all design criteria.



The Result

Turning today's ideas into tomorrow's innovation with Stratasys medical solutions

80% of the children who are born with congenital clubfoot live in developing countries, where access to affordable medical care is limited. The improved Iowa Brace serves as effective, affordable, and accessible nonsurgical treatment for families around the world—and gives energetic children the gift of independence and mobility.

"Our partnership with Clubfoot Solutions was one of the most impactful projects in recent memory," said Kuhl. "And the capabilities of the two Stratasys 3D printers complimented each other perfectly."

By leveraging FDM and PolyJet together, the Protostudios team was able to bring Cook's design to life quickly and efficiently.

To date, Cook's nonprofit, Clubfoot Solutions, has distributed nearly 100,000 Iowa Braces and counting to children in need.

Featured Stratasys technology

"The perfect complement"

FDM

End-use parts and prototypes that require mechanical strength or tear resistant TPU (thermal plastic urethane).

PolyJet

Anatomy models for complex surgery planning at the university hospital and accurate part modeling for visual impact and aesthetic validation.

Experience the power of Stratasys additive manufacturing for medical innovation. Learn more today.

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stratasys.com
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Stratasys Headquarters
7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)