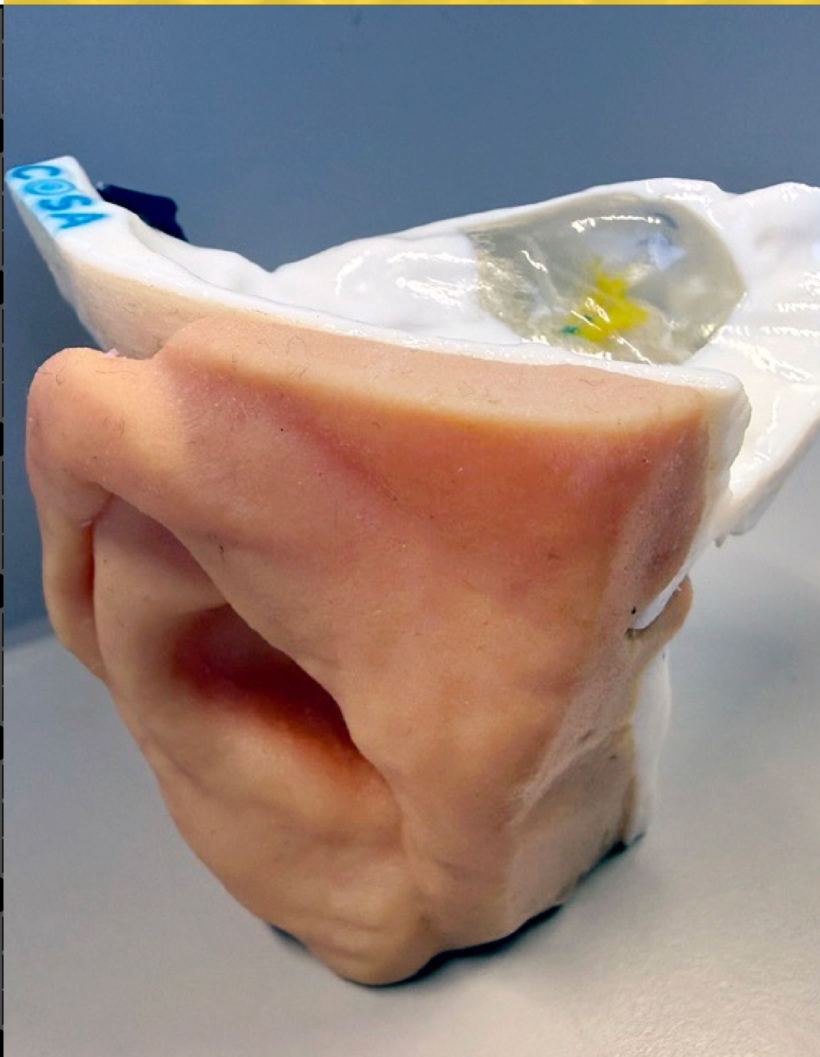
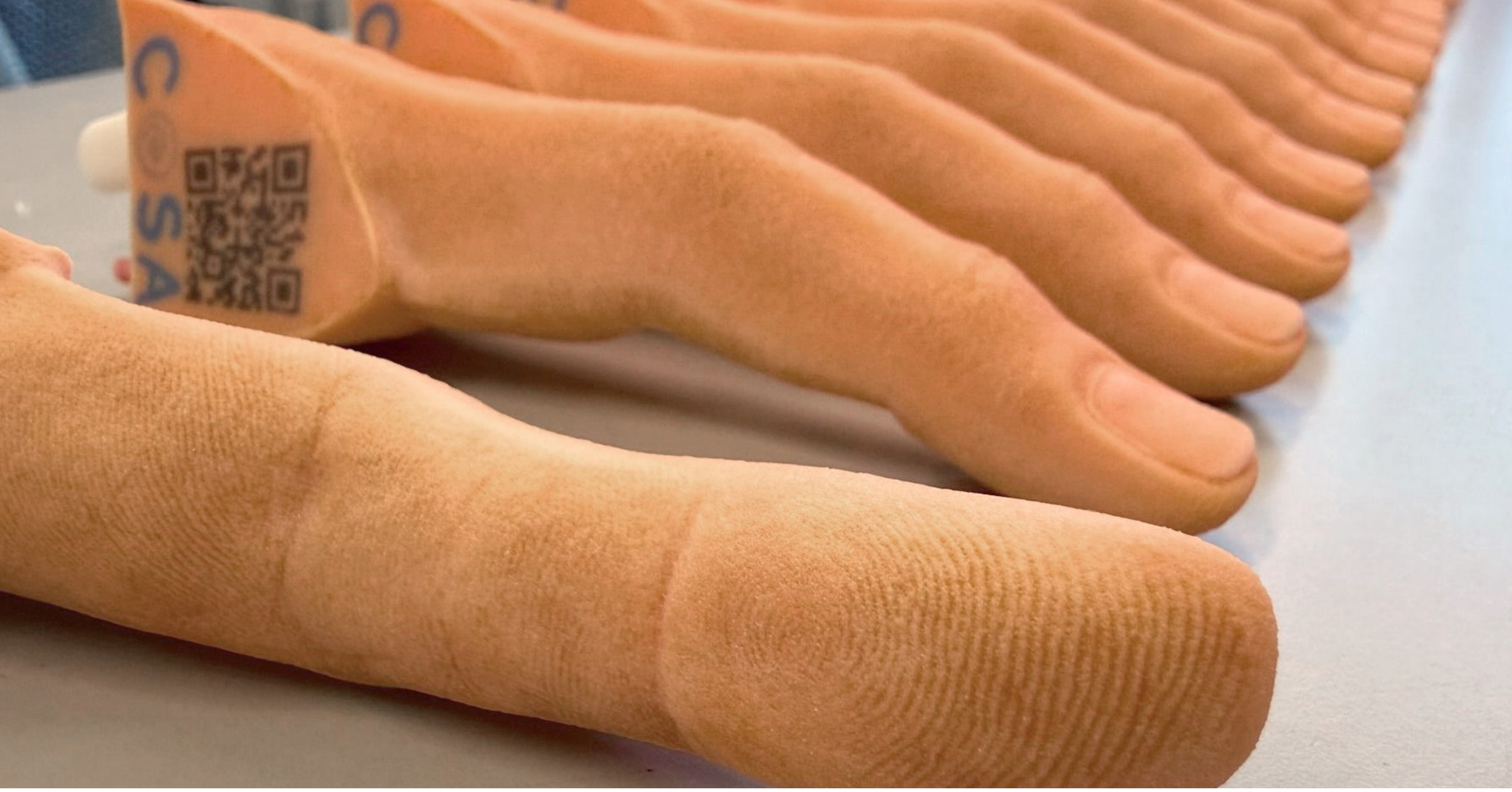
CASE STUDY
MEDICAL

Advancing surgical training with 3D printed anatomical models

How COSA Uses Stratasys Digital Anatomy® Technology to Advance Surgical Simulation





Customer Overview

COSA Ltd. specializes in advanced 3D printing solutions for healthcare, creating high-fidelity anatomical models, surgical training tools, and medical device prototypes. Their bespoke solutions help surgeons and medical technology companies improve training, support innovation, and accelerate the development of new healthcare technologies.

The Challenge

Limitations of traditional surgical training methods

- Inconsistent anatomy and inability to reproduce specific pathologies
- Difficulty providing repeatable hands-on surgical practice
- Limited access, high costs, and logistical complexity of cadavers

The Solution

High-fidelity 3D printed anatomical simulation

- Multi-material 3D printed anatomical models with realistic tactile feedback
- Realistic mechanical and visual behavior during procedures
- Customizable Digital Anatomy materials engineered for procedural realism

The Impact

Controlled, repeatable surgical simulation

- Repeatable training across different anatomies and pathologies
- Scalable, on-demand simulation to drive clinical innovation
- Improved surgical preparedness and device testing

The Challenge:

Advancing Surgical Training Beyond Traditional Methods

Surgical training has always depended on hands-on experience, particularly for procedures involving highly complex anatomy where precision and tactile feedback are critical. In otology, this challenge is particularly significant. Deep within the skull, the temporal bone contains some of the most delicate anatomical structures in the human body, requiring surgeons to navigate extremely small spaces with accuracy and control. Traditionally, cadaveric specimens have been the primary way to learn these techniques, offering valuable anatomical realism but also presenting substantial limitations.

COSA LTD co-founders Dr. Filip Hrncirik and Dr. Iwan Vaughan Roberts spent years studying the temporal region at the University of Cambridge before translating their work into models for cochlear implants and surgical techniques. As they worked with clinicians and industry partners, a recurring limitation became impossible to ignore: Cadavers offer realism, but they lack consistency and accessibility.

Each specimen presents different anatomy, often without the specific pathologies surgeons need to practice. Tissue preservation can alter mechanical behavior, especially in soft tissue, and access is constrained by cost, regulation, and logistics.

“You get what you receive,” says Hrncirik. “There’s no control over the anatomy, and you often only discover what’s inside during the procedure.”

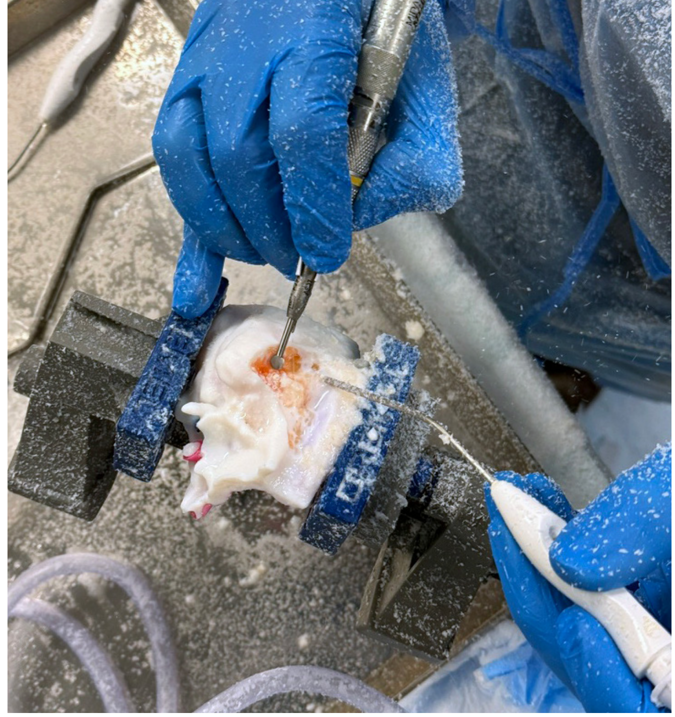
For a structure as intricate as the temporal bone, these limitations become even more pronounced. Surgeons rely on subtle cues such as changes in resistance while drilling or slight variations in color to navigate safely. Replicating these cues consistently across training sessions is nearly impossible with cadavers.

COSA set out to solve this problem by building a model that could match the experience of cadaveric training while overcoming its constraints.

> Anatomy is not a single material. It has structure and variation. With PolyJet™, we can control those properties in a way that simply wasn’t possible before. Being able to tune that at a fine level is incredibly powerful.”
>
> **Dr. Iwan Vaughan Roberts**
> Co-founder of COSA LTD

The Solution:

High-Fidelity Anatomical Models to Improve Surgical Training



The answer came through Stratasys Digital Anatomy technology, powered by PolyJet multi-material 3D printing on the Stratasys J850™ Digital Anatomy 3D printer.

Unlike conventional 3D printing methods, Stratasys Digital Anatomy solutions enable multiple materials to be combined within a single build at a very fine resolution. This allows COSA to engineer not just the shape of the temporal bone, but its internal composition and biomechanical behavior.

The resulting model recreates more than 30 anatomical structures within the ear, including the cochlea, ossicles, and internal cavities, all positioned with high precision.

What sets the model apart is how it behaves during surgery. As a surgeon drills into the printed bone, the resistance changes in a way that reflects real tissue. At the same time, embedded color gradients provide visual guidance, helping identify critical landmarks just as they would appear in a real procedure.

This combination of mechanical and visual realism is achieved through Digital Anatomy materials. By blending photopolymers at the voxel level, COSA can tune properties such as stiffness, flexibility, and texture across different regions of the model.

“Anatomy is not a single material,” says Roberts. “It has structure and variation. With PolyJet, we can control those properties in a way that simply wasn’t possible before. Being able to tune that at a fine level is incredibly powerful.”

From Geometry to Behavior: A New Design Approach

COSA’s early work relied on SLA printing technology, which delivered high geometric accuracy. However, these models were limited to a single material, which meant they could not replicate the layered nature of real anatomy.

With Stratasys Digital Anatomy solutions, the design process changed fundamentally. Instead of focusing only on geometry, COSA began designing both structure and material simultaneously.

Each model starts with imaging data that is segmented into detailed anatomical components. These components are then assigned specific material properties, allowing different regions to behave differently under surgical tools. Bone can be made porous and drillable, while adjacent structures can be softer or more elastic.

This level of control allows the temporal bone model to replicate features such as air-filled cavities, fine internal channels, and the transition between rigid and delicate tissues.

The process is iterative and highly technical. Multiple variables, including material composition, layer structure, and internal geometry, are adjusted and tested systematically. In many cases, dozens of iterations are required to achieve the desired result.

“We’ve gone through forty or fifty iterations to get the bone to feel right,” says Roberts. “It’s about combining engineering testing with what surgeons actually experience.”.

Surgeons play a central role in this process. Their feedback guides the refinement of both mechanical response and visual appearance, ensuring the model aligns with real surgical experience.

The Impact:

Replacing Cadavers with Anatomical Simulation Models

The true impact of the COSA temporal bone model lies in what it enables.

With cadavers, surgeons must work with whatever anatomy is available. Pathologies cannot be selected or reproduced. Training opportunities are limited and often infrequent.

With Digital Anatomy models, training becomes controlled and repeatable. The same anatomy can be reproduced consistently, allowing multiple surgeons to practice identical procedures. Specific pathologies can be introduced deliberately, enabling targeted training.

> “
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> If you can have multiple difficult cases and practice them repeatedly, it completely changes how surgeons build skill and confidence”
>
> **Dr. Iwan Vaughan Roberts**
> Co-founder of COSA LTD

This shift is particularly important for complex procedures such as cochlear implant insertion, where precision and familiarity are critical.

The models also remove many of the logistical barriers associated with cadavers. They require no special storage, can be transported easily, and are available on demand. This makes it possible to scale training programs in ways that were previously impractical.

Realism That Changes Behavior

When surgeons first interact with the models, their expectations are often shaped by experience with traditional silicone or plastic training tools. That perception changes quickly.

The materials respond in ways that feel familiar. Drilling produces realistic feedback, and structures behave as expected under surgical manipulation. In some cases, surgeons apply too much force and damage the model, only to realize that the response mirrors real tissue.

“They treat it like a silicone model at first, and then they realize it behaves like real tissue,” says Hrncirik. “That’s when it clicks.”

The visual clarity of the models also provides new insights. Internal structures can be seen more clearly, and features that are difficult to interpret in cadavers become easier to understand.

COSA has further refined the technology by developing different versions of the models. Durable variants are used for teaching and demonstrations, while high-fidelity versions prioritize biomechanical accuracy for surgical simulation.

Enabling Innovation Beyond Training

The same capabilities that make these models valuable for training also make them powerful tools for innovation.

Medical device companies partner with COSA to use these temporal bone models for preclinical validation and human factor testing of new technologies, including cochlear implants and drug delivery systems. Because the models are consistent and can be integrated with advanced sensing instrumentation, they allow to quantify device-tissue interaction and repeatable testing.

Digital Anatomy also supports usability and human factors studies. Multiple surgeons can perform the same procedure on identical models, making it possible to identify patterns and improve device design before clinical trials.

Scaling High-Fidelity Simulation

Advanced multi-material printing comes with cost considerations, but COSA has developed strategies to make the models practical.

By focusing on the specific anatomical region required for training, such as the temporal bone rather than the entire skull, the team reduces material usage while maintaining critical detail.

“The ear is actually very small, and that’s where PolyJet really shines—high complexity in a small space,” says Hrncirik.

PolyJet’s ability to print multiple models in a single build further improves efficiency. Different anatomies and material configurations can be produced simultaneously, maximizing the value of each print cycle.

This approach ensures that high-fidelity models can be used not only in research settings but also in broader training programs.

The Future:

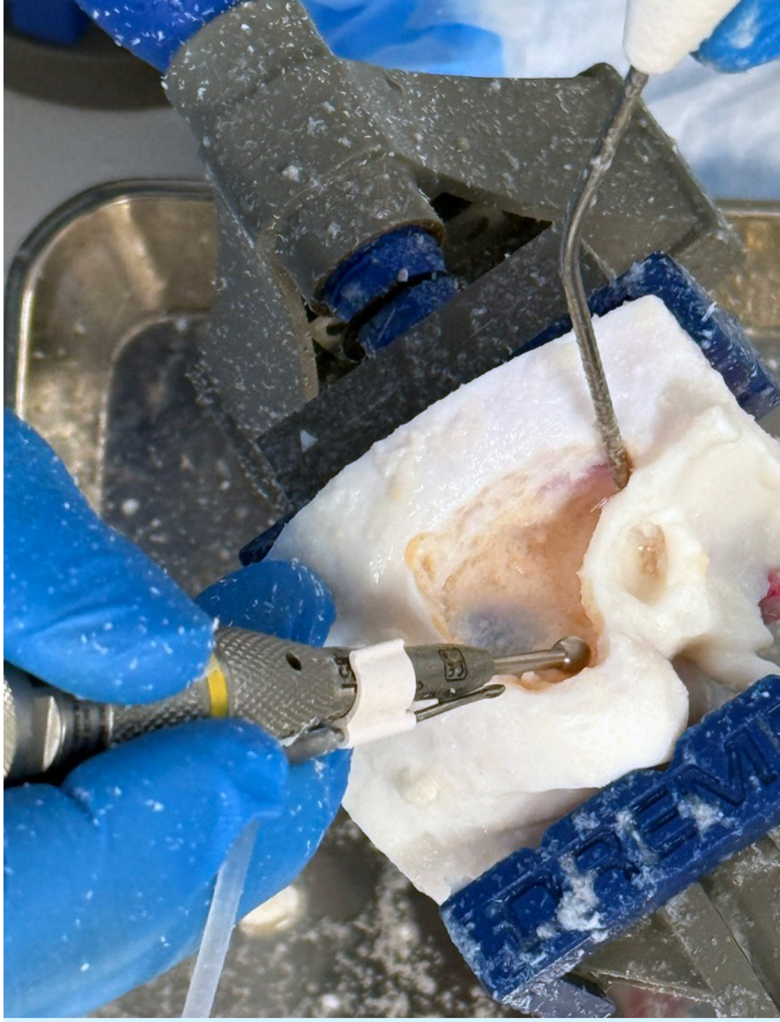
A Digital Alternative to Cadavers

COSA's temporal bone model demonstrates how Digital Anatomy can transform surgical training.

> "3D printing allows us to do what cadavers cannot. We can control anatomy, introduce pathology, and create a truly scalable training platform."
>
> **Dr. Filip Hrncirik**
> Co-founder of COSA LTD

Looking ahead, COSA aims to expand this approach to other anatomical regions, building a platform capable of replicating human tissue across a wide range of applications.

As this work continues, the role of cadavers in training is likely to evolve. High-fidelity 3D printed models are emerging as a scalable, customizable alternative, one that allows surgeons to train more often, with greater precision, and under controlled conditions.



Learn More

Discover how Stratasys Digital Anatomy® solutions can help you create high-fidelity, multi-material anatomical models for surgical training, device validation, and clinical innovation.

"Explore the possibilities and contact us to learn how realistic, repeatable simulation can be integrated into your workflow."

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