Simulating Reality With 3D Printed Medical Models

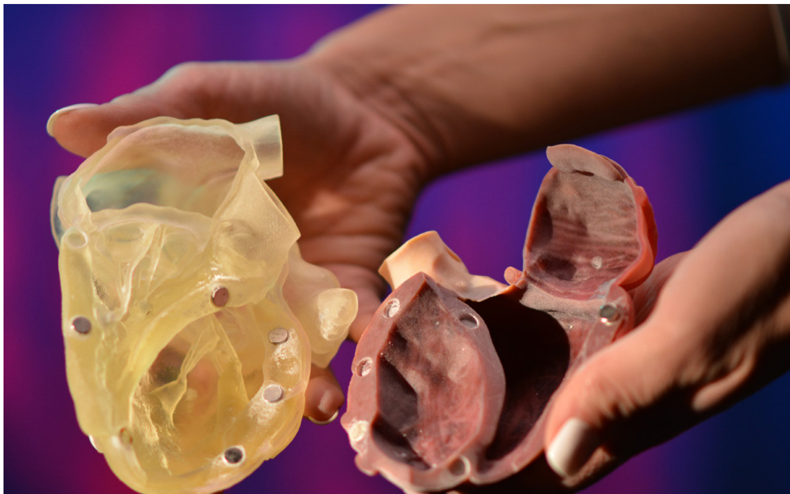
Case Study

Advancing Medical Modeling for Improved Research, Training and Economics

The medical breakthroughs that cure disease, restore health and prolong life aren't created in a vacuum. They rely on the convergence of visionary minds and cutting edge technology. Both are necessary, and the Jacobs Institute (JI) in Buffalo, New York, is the embodiment of this reality. The JI's mission is to pursue next-generation technologies in the treatment of vascular medicine. It does that through a potent collaboration of physicians, engineers and industry, dedicated to finding new ways to improve the treatment of vascular disease.

3D printing is one of the ways the JI has leveraged technology. Early on, JI physicians and biomedical engineers recognized its value for creating realistic medical models. These models are used to validate new medical devices and prepare for difficult procedures, ultimately resulting in more effective treatments.

In particular, multimaterial 3D printing, with its unique ability to create soft and hard textures, enabled the JI to replicate patient-specific vascular models. These models allow Dr. Adnan Siddiqui, chief medical officer at the JI, to rehearse complex vascular procedures, greatly increasing the odds of successful patient outcomes. “Before 3D printing, we really had no real alternatives to utilize the rehearsal methodology that is so easily available to us now,” related Dr. Siddiqui.



This human spine model incorporates both rigid and flexible materials.

But despite this capability, the JI had reached the limits of current 3D printing materials. To stay true to its mission of innovation, new technology was needed. That meant new materials with a realistic feel and response, more representative of real human tissues. Human cadavers and animal models provide a close approximation, but they can't replicate specific human pathologies. They can also be costly to acquire and maintain.

"One of the questions we've repeatedly heard from our customers, both medical device customers as well as hospitals, is the need for biomechanical accuracy," said Scott Drikakis, Stratasys healthcare segment leader. "Our medical device customers, as well as our hospitals, have asked us for a solution that allows specific anatomies, and more importantly, specific pathologies that give them the control to print whatever they need on demand," Drikakis added.

To meet that need, Stratasys developed the J750™ Digital Anatomy™ 3D printer. The Digital Anatomy printer creates medical models with incredible realism that accurately represents the appearance and response of human tissue. Whether for surgeon training or testing new medical devices, these models provide unmatched clinical versatility.

For Mike Springer, vice president of technology and operations at the JI, the Digital Anatomy printer provides the needed next step in medical modeling technology. "We use 3D printing not only to test devices, but also to train. Digital Anatomy printing has really given us more tools to do that," Springer related. "Certain materials that we've used to print out these models over the last six, seven, eight years, were at their limits. Digital Anatomy printing really gives you the control and the tunability to design the model the way the physician needs it for the patient they're trying to treat," he added.

Three new materials specifically designed for medical modeling applications set the Digital Anatomy printer apart from other solutions. TissueMatrix™ is an incredibly soft, translucent material, ideal for replicating the look and feel of heart tissue. BoneMatrix™, as its name implies, is a strong yet flexible material with the right constituency to represent bone and connective tissue. GelMatrix™ is a support material designed for easy removal from vascular models with small inner diameters and thin walls.

The attributes of these materials have been vetted by medical device centers like the JI in the effort to achieve a new level of realism. "The Jacobs Institute has conducted third party testing to compare how these materials compare biomechanically to native tissue, to specific anatomies and pathologies that you'd expect to see in practice," said Drikakis. "We're really proud to be the first company to focus on the biomechanical properties and establish baseline published data that shows how those materials react, compared to native tissue, bone anatomy and pathologies."

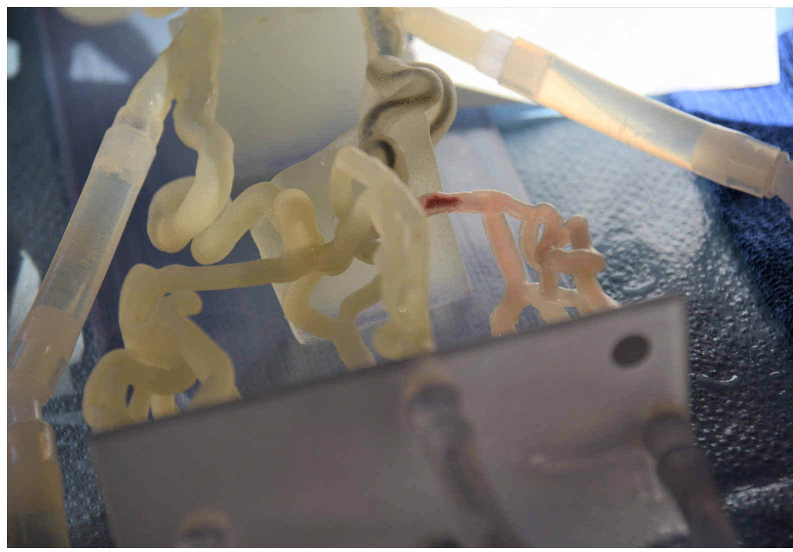
Realistic materials are only half of the story, however. Combined with GrabCAD Print™ Digital Anatomy™ software, the result is a powerful synergy that makes the Digital Anatomy printer the next generation in 3D printed medical modeling. Specifically designed for medical applications, the key benefit of GrabCAD Print software is the ability to select specific human anatomical tissue with

Removing a vascular model from the Digital Anatomy printer.

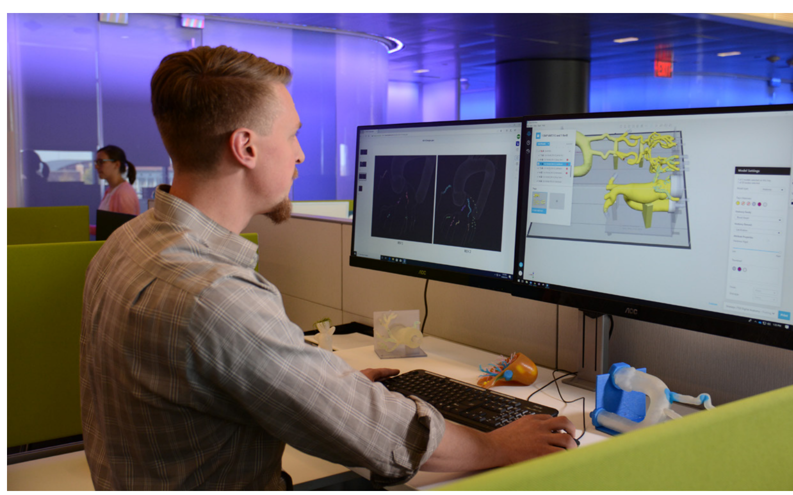
"dropdown menu" simplicity. Stratasys application engineer Evan Hochstein knows its benefits well and highlights how the software does all the heavy lifting in the medical modeling design phase. "With the J750 Digital Anatomy printer and GrabCAD Print, we can now go in and actually select specific anatomies. If we want a femur for a 70 year old, we can do that. If you want a femur for a 20 year old, we can do that. We can vary the density of our structures on our bones," Hochstein said.

The JI's Mike Springer agrees. "GrabCAD print now allows us to really select certain materials on a point by point voxel-based approach. And what that means is we can actually control the droplet-by-droplet composition of these models that we use. I think it really changes the way we design and manufacture the models that we print," Springer said.

This all comes back to the mission of medical device innovation centers like the JI, which is to leverage technology in the pursuit of better medical treatment. It's a role that the Digital Anatomy printer serves well. The JI's Mike Springer sees a bright future for this technology. "Digital Anatomy printing I think is going to be the standard. We're using (it) in applications we've never done before. It's exciting to see where it's going to go."



This 3D printed vascular model is being used to train on the removal of a clot.



GrabCAD Print Digital Anatomy software offers powerful simplicity for creating highly realistic medical models.

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