

BIOMODEX

Case Study



Photo © Biomodex

Challenge

Biomodex has developed biorealistic haptic simulators for physicians' complex procedures rehearsal and advanced training. The company sought proven and powerful partners to help design and produce lifelike cartridges and sophisticated stations that accurately simulate the biomechanical properties of a patient.

Solution

Biomodex takes advantage of the **3DEXPERIENCE** platform on the cloud to design virtual 3D models of organs, create exact 3D-printed replicas and accurately simulate the organ's behavior during a medical procedure. Each model incorporates biomechanical and imaging properties, fluid dynamics and clinical data to precisely replicate

the patient's unique anatomy, including living tissue mechanics, blood flow and fluoroscopic conditions, and carry out stress analysis.

Benefits

Backed by the **3DEXPERIENCE** platform, Biomodex has successfully brought to market several 3D-printed products for neurovascular and structural heart procedures and is rapidly expanding its product portfolio. Each 3D-printed model combines masses of data without losing any precision to deliver an experience that simulates exactly how an aneurysm or organ would respond during a real medical procedure. This approach delivers unique insights in advance of intervention treatment and transforms medical training and case-specific rehearsal.

A STUNNING REALISM

Rennes University Hospital (CHU Rennes) in France is one of the top medical centers for interventional neuroradiology. Its team of physicians monitor almost 700 patients for brain aneurysms and treat nearly 200 patients per year for ruptured and unruptured aneurysms. Procedures are complex, time consuming and carry a high risk of complications. But revolutionary technology from French-American digital health company Biomodex® is helping to change that. The company's solution enables physicians to create an exact 3D-printed model of the patient's aneurysm – or any other specific anatomy – to simulate interventions in advance, so they can choose the optimal device and approach for each individual.

"What we're offering is the capacity to rehearse an entire procedure on the exact model of the specific patient so that a physician can be better prepared to tackle the actual technical aspects of the case," said Ziad Rouag, president and CEO of Biomodex.

"Using the models for pre-procedural rehearsals allows us to know in advance if an approach is going to work and, if not, helps us to determine which medical device would be more effective," said Dr Anthony Le Bras, interventional neuroradiologist at CHU Rennes. "This not only boosts physician confidence, but also reduces operating times and decreases the risk of complications during the real procedure."

Biomodex uses the **3DEXPERIENCE®** platform to create the sophisticated 3D-printed anatomical twins and simulated procedures. Imaging scans and other diagnostic information are fed into the platform to generate a point cloud, visualize the inside of blood vessels and organs, and construct the 3D virtual model. This is then 3D printed using biomechanical responsive advanced materials to create a patient-specific "cartridge," which can be plugged into the simulation system for the physician to carry out a lifelike procedure. Unlike basic silicone models already on the market, Biomodex's models realistically simulate the characteristics and haptic feedback of the individual's anatomy.



"Without the 3DEXPERIENCE platform, we would not be able to achieve our goal."

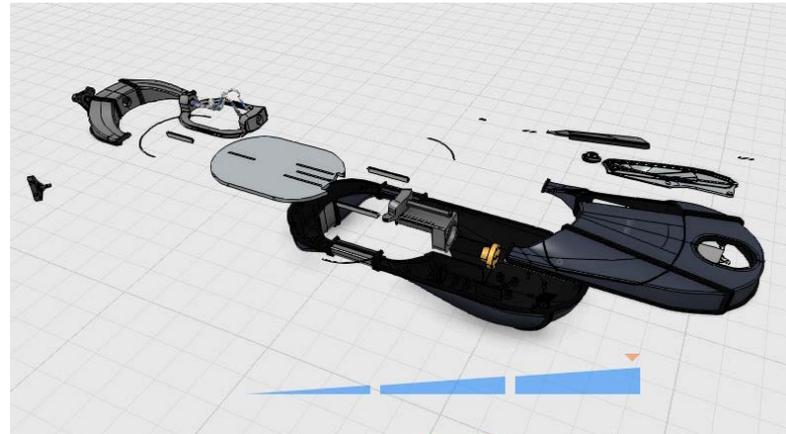
- Ziad Rouag, President and CEO, Biomodex

"Biomodex has created a complete solution that replicates the patient's anatomy, but also the mechanical behavior of the tissue," Rouag said. "Using these 3D-printed models, physicians get to see and feel how the vessel behaves."

Through its innovative technology and digital-first approach, Biomodex is helping to support healthy lives, promote well-being for all and improve medical safety in a sustainable manner. Its first solutions on the market are already proving an innovative alternative to the traditional methods used for pre-operative preparation and training, and transforming the way the medical profession gains knowledge and experience without putting patients' lives at risk.

This approach is transforming the way medical interns and fellows are taught to perform complex procedures.

"The system is the equivalent of a full-motion flight simulator for training and rehearsing procedures – something that hasn't really existed in the medical industry before," Rouag said. "Pilots develop their skills and train in a safe environment, and we wanted to do the same thing for medicine."



Top image: Biomodex® EVIAS™ station and cartridge for unruptured aneurysm
Bottom image: 3D modeling of the Biomodex® EVIAS™ station with the 3DEXPERIENCE platform

"Since we have had access to the Biomodex 3D prints, we have set up a perfect training program for students," said Stephan Haulon, professor of vascular surgery and head of the aortic center at Hospital Group Paris Saint-Joseph. "They know that they will come to the cath lab to perform a couple of procedures and throughout the semester they will perform more and more complex procedures. At the end of a six-month rotation in my department, they will have seen real cases and performed the same cases in the cath lab."

PARTNERSHIP CRITICAL FOR GROWTH

Since the company was founded in 2015, it has been supported by Dassault Systèmes and its 3DEXPERIENCE Lab. The startup accelerator program nurtures and empowers disruptive projects with mentoring, training and cloud access on the 3DEXPERIENCE platform set of applications.

"Dassault Systèmes is a critical component of our production as well as our development," Rouag said. "In the early stages of the business set up, the 3DEXPERIENCE Lab and access to

these CATIA and SIMULIA design and simulation apps were instrumental. It allowed us to bring onboard a lot of engineers and work with really advanced tools and software, which eventually led to the development of our technology.”

For Biomodex, the **3DEXPERIENCE** platform is more than a simple technology platform; it’s the environment on which it develops all its cutting-edge capabilities.

“The platform gives the team the level of precision we need in terms of data handling and being able to manage the complexity,” Rouag said. “It brings processes a tremendous robustness. For example, when we receive segmented 3D patient images and import them into CATIA, it makes no compromises; we preserve all the data and all the precision throughout. We wouldn’t be able to do all that we do without **3DEXPERIENCE**.”

Having access to all of the platform cloud capabilities has been advantageous for Biomodex, too. With offices in the US and Europe, the company’s distributed teams are empowered to work together effectively by collaborating seamlessly on the cloud, regardless of location. Biomodex also has more options in terms of balancing its resources and managing office occupancy, as it doesn’t need to have all employees in the office at all times – they can work from home as well.



Biomodex team at work in its Paris office

“The **3DEXPERIENCE** platform on the cloud is critical to our manufacturing and R&D process,” Rouag said. “The flexibility and mobility of being on the cloud means people don’t have to be tied to a big, powerful machine in the office. We can access all the applications and data we need on demand, from wherever we are. This has obviously been invaluable during the COVID-19 pandemic, but we have offices in Boston and Paris, so we need that flexibility anyway and really appreciate the ability to work within the virtual world.”

Now, as a fully-fledged business, Biomodex has graduated from the **3DEXPERIENCE** Lab and is supporting itself. Dassault Systèmes partner XD Innovation (XDI) provides all ongoing consulting services.

“XDI has been very present, helping us along the way as we’ve made the transition into a Dassault Systèmes customer,” Rouag said. “They have supported us with technical changes and making things clear as we’ve gone from the Lab into the general field. They meet us when possible to sit down and talk through any issues. Even though we still have a lot of direct contact

with Dassault Systèmes, XDI has helped us get to our new state of operation.”

REALISTIC PATIENT ANATOMY TWINS

There are so many different types of medical procedures that Biomodex could cover that it had to be very focused.

“We decided to concentrate first on the most complex procedures that require the most training and preparation, which is why we launched the Biomodex® EVIAS™ (EndoVascular Intracranial Aneurysm System) station first,” Rouag said. “We know that interventional neurologists use highly complex imaging and have to take specific measurements to ensure the implant fits properly.”

Biomodex also concentrates on cardiovascular procedures. The Biomodex® LAACS™ (Left Atrial Appendage Closure System) station is a training and case-specific rehearsal solution for simulating a procedure that helps prevent stroke by sealing off a small section of the heart.

“There are a number of structural heart procedures that are very complex, so we are developing solutions for them too,” Rouag said. “And then, there are endovascular procedures for aortic aneurysms. These are our primary focus.”

SIMULIA on the **3DEXPERIENCE** platform enables Biomodex to accurately simulate how the 3D-printed model of an aneurysm or organ would respond during a procedure. Using SIMULIA, the company carries out finite element analysis (FEA) to determine how each anatomical structure reacts to pressure, incision and separation, just like a living tissue, and identifies points of weakness.

“Without SIMULIA, we would be producing un-lifelike pieces of plastic,” Rouag said. “It would be nothing like a patient’s anatomy in terms of haptic feedback and what it looks like under X-rays. We apply a lot of clinical information, which has been synthesized into a model, and use SIMULIA to actually implement this very precise model and reproduction that comes out of the printer.”

Critically, SIMULIA enables Biomodex to produce 3D-printed models that feel and behave exactly as they would within the context of a specific area of the body in each individual patient.

“These models are used as input data for our INVIVOTECH® materials, which takes into account the local deformations of the

More about the solution:

The *Engineered to Cure* solution offers a data-driven and model-based engineering platform that facilitates collaborative design and development of medical devices using best-in-class apps and processes for 3D design, systems engineering, multiphysics simulations, and virtual human modeling. Designers and engineers can rapidly explore the device design space, virtually test promising designs in real world usage scenarios, and validate optimal designs.

Benefits:

- Increase the range and value of novel medical devices satisfying unmet practitioners and patients’ needs
- Reduce cost and time of new product development
- Improve patient experience and treatment outcomes

simulated model to optimize a distribution of materials which will be reproduced in the 3D-printed model," said Frédéric Champ, director of technology development at Biomodex. "The goal is to reproduce the physical sensations and haptic feedback when navigating the catheters in our models to provide a realistic simulation for physicians. For example, when the artery goes through the cranium, it feels hard, almost like a metal pipe, as it passes through the bone."

With the ability to test new devices in realistic conditions ahead of procedures, both industry and physicians can ensure they will fit and perform exactly as intended.

"Recently, we had an ascending aorta aneurysm 3D-printed and the endograft that I had designed for that specific case was a bit too short," Pr Haulon said. "Thanks to Biomodex, we were able to change the endograft and ensure it was the perfect design for the procedure."



Test of the Biomodex® EVIAS™ station and its cartridge



"I can no longer visualize myself working without having access to these 3D prints."

- Stephan Haulon, Professor of vascular surgery and Head of the aortic center, Hospital Group Paris Saint-Joseph

Being able to rehearse and define the best procedures ahead of live surgery helps physicians prepare effectively and transforms the patient experience for the better.

"When we perform a new procedure with a new device, we sometimes have quite a high level of stress because we want to make sure that we do it right," Pr Haulon said. "That's one main reason for our collaboration with Biomodex. We can simulate the whole procedure prior to performing it on a patient, using their exact anatomy. It's a real-life rehearsal with all the team and it makes us feel much more confident. It instills confidence in our patients too. They are happy to learn that we've practiced the procedure and tested the device on an exact 3D-printed model of their anatomy."

WORLD-LEADING MEDICAL TRAINING

From the start, Biomodex has worked closely with medical experts to understand exactly what they need and how they will benefit from its solutions.

"Listening to the doctors and understanding how they perform their procedures is critical to our success," Rouag said. "We have a very clinically-oriented culture and I'm proud of it. We don't work in a vacuum."

This close working relationship with medical professionals has enabled Biomodex to create products that allow physicians and students to train for procedures they wouldn't otherwise be able to practice.

"Our partnership with Biomodex has been a real game-changer for our training and development of new procedures," Pr Haulon said. "I can no longer visualize myself working without having access to these 3D prints."

"When patients have a clot on their brain, those are procedures you can't really train for as you've got to treat the patient right away," Rouag said. "How do you train, for example, young neurointerventionalists how to do these procedures versus having them in there with you? There was really nothing out there that mimicked this kind of procedure, so we were asked to develop a model to teach this procedure in a controlled environment in many different scenarios. When we showed the results to one of the world's leading neurointerventionalists, his response was a big smile and a 'Wow, I guess you guys have been busy.' There is no bigger compliment than that."

Biomodex's vision is to completely revolutionize how medical professionals plan for complex procedures and be the first choice for medical training and rehearsal solutions.

"Nobody else does what we do in terms of training for these types of procedures with this sophisticated technology," Rouag said. "We're ahead of the game and we want to stay that way. Without the **3DEXPERIENCE** platform, we would not be able to achieve our goal."

Focus on Biomodex

Biomodex® is a Paris and Boston-based medical technology company whose mission is to transform the way physicians train and rehearse procedures. The company 3D prints anatomical models using advanced materials that provide biorealistic haptic feedback. The next-generation biorealistic haptic simulators are fully customizable and integrate with a patented blood flow system and intraprocedural imaging tools such as transesophageal echocardiography (TEE) and intracardiac echography (ICE), enabling clinicians to gain life-like experience to advance skill sets and promote the adoption of new medical devices or techniques in their pursuit of improving patient outcomes.

For more information: www.biomodex.com

Focus on XD Innovation

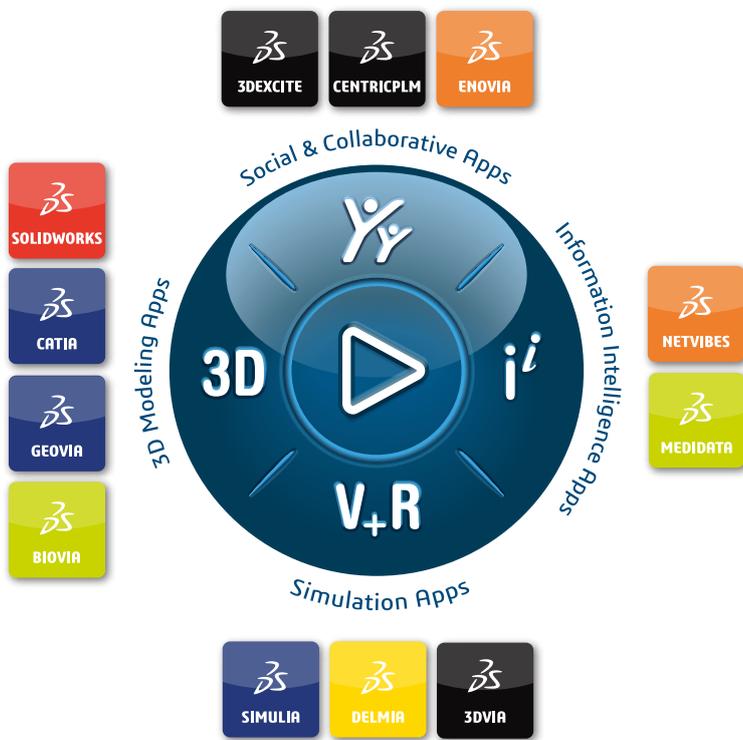
XD Innovation is a Dassault Systèmes partner that strives to help its customers innovate more efficiently by supplying the best-in-class technologies powered by the 3DEXPERIENCE platform. The company provides software, consulting and value-added services covering product development technologies, 3D design, engineering, modeling, simulation, data management, process management, and quality and compliance. XD Innovation takes advantage of a consultative customer engagement strategy and rapid implementation methods to provide superior training and support.

For more information:

Europe: www.xdinnovation.eu

North America: www.xdinnovation.com





Our 3DEXPERIENCE® platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the 3DEXPERIENCE Company, is a catalyst for human progress. We provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating ‘virtual experience twins’ of the real world with our 3DEXPERIENCE platform and applications, our customers push the boundaries of innovation, learning and production.

Dassault Systèmes’ 20,000 employees are bringing value to more than 270,000 customers of all sizes, in all industries, in more than 140 countries. For more information, visit www.3ds.com.

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