To provide effective treatment for patients requiring implants, startup company VOLMO has pioneered a software tool that converts patients’ personal data into a computer model. The process relies on ANSYS Mechanical to simulate and virtually test the model before additive manufacturing. Additive manufacturing could be a game-changer in the medical field by creating personalized implants that improve the lives of patients and reduce the overall costs of healthcare.
Our bodies are all unique. Our genetic profile, organ size, bone structure and many other aspects of our internal makeup varies from person to person, yet current healthcare is very much based on a “one size fits all” approach. However, as technology advances in the medical field, personalized healthcare is gaining momentum. In the future, diagnosis, treatments and clinical decisions will be tailored based on a patient’s individual data.

Established in 2012, VOLMO is driving patient-specific healthcare through the use of computational modeling, which, although used extensively in other industries, is not well-established in the healthcare field. With its proprietary 3D image processing and modeling software platform, ImageSim, the company designs new implants, stents and fixation plates that exactly match and fit patient anatomy. Within ImageSim, once the patient’s scan data (CT/MRI) has been converted into a virtual model, ANSYS Mechanical simulation tests the model. This testing on a virtual patient (in silico) will help clinicians, manufacturers and engineers to better understand how an implant or stent is going to behave within the patient before it is even manufactured via additive manufacturing. This 3D printing technology can be leveraged for both preoperative planning as well as in further clinical trials before implantation in the patient.

By combining simulation and additive manufacturing, patients can receive devices that exactly meet their needs to reduce postoperative care, increase quality of life and decrease overall healthcare costs.

"Patients have access to a custom implant that will result in a better surgical outcome with less chance of infection and quicker rehabilitation."

CREATING A CUSTOM PELVIS IMPLANT
VOLMO’s long-term objective is to develop ImageSim into a complete 3D simulator for preoperative planning and for patient-specific implant design and optimization. The company is currently focused on establishing and proving the value of its process.

In a recent case study, VOLMO was approached by a doctor who wanted to discover how this technology could help in the treatment of a chondrosarcoma patient. Chondrosarcoma is a type of bone cancer, and, in this instance, the tumor was on the pubic symphysis, a secondary cartilaginous joint located between the left and right pubic bones.

Given the ideal opportunity to demonstrate its process, VOLMO created a custom pelvis implant for a consultant. This preoperative model was used by the doctor to help gain a greater understanding of the exact location and extent of the tumor in the bone before going into the operating room to physically remove it from the patient.

DESIGNING THE IMPLANT
Using a supplied dataset, and after a discussion and some direction from the consultant, VOLMO established the design process. The first step in the process was to import the patient’s computed tomography (CT) scan data into ImageSim where it was filtered using an advanced anisotropic filtering feature within the tool. The filtered image was then segmented and saved as a pelvic STL model. This model was brought into the computer aided design (CAD) environment where the required resections were made to the bone in...
order to remove the tumor. Using features within ImageSim, the engineers captured the outer shape and topology of the resected bone to create the new implant. The resected pelvis and newly created pelvis implant were then brought back into the CAD environment where they were assembled.

VOLMO engineers imported the CAD data into ANSYS Mechanical where finite element analysis (FEA) was carried out on the fully assembled model. As this case study focuses on static FEA, a variety of structural tests were conducted in the ANSYS simulation environment. Constrained at the hip joints, loading was applied manually at the top of the sacrum. As this patient weighs 80 kg, 80 kg of weight was applied, so that the virtual tests were tailored specifically to that patient.

This virtual testing assured the team that the new implant did not create any unwanted stresses or deformations under specific loading conditions. Understanding how the implant behaves in such a virtual environment can help further optimize the design.

Following simulation, engineers use the digital design files to create a physical pelvis implant via additive manufacturing. Because in this case it was a reference model rather than a physical implant destined to be inserted into the patient, this was done in plastic rather than metal. The end product convinced the consultant that the technology was extremely useful and had potential for further application.

SIMULATION BENEFITS HEALTHCARE

Case studies such as the pelvis implant are helping to educate and build awareness of what can be achieved through VOLMO’s process of computational modeling and simulation. Once the model was tested virtually, the next stage would be to produce real implant designs via metal 3D printing. These would then be physically tested before going into the patient. However, having thoroughly tested the model in ANSYS Mechanical, far fewer physical bench tests will need to be conducted, ultimately saving both time and money.

The U.S. Food and Drug Administration (FDA) as well as other regulators and policymakers are now encouraging the adoption of computational modeling and simulation to accelerate the product development process. The regulatory approval process can take a long time; in silico clinical trials help expedite this process.

With personalized healthcare, time and cost savings extend beyond the product development process. Clinicians benefit from preoperative planning as they now have patient-specific treatment information. Patients have access to a custom implant that will result in a better surgical outcome with less chance of infection and quicker rehabilitation. The patient spends less time in the operating theater, reducing hospital costs. In addition, more patients have access to healthcare while waiting lists for treatments are reduced.

THE VISION FOR PERSONALIZED HEALTHCARE

VOLMO elected to use ANSYS software in its process because it is a highly validated and industry-leading tool. Through the ANSYS Startup Program, VOLMO has full access to ANSYS simulation solutions. In addition, the support received from the ANSYS team has helped grow VOLMO’s business and drive its vision for modern, personalized healthcare.

VOLMO is now eager to scale up and help more users benefit from patient-specific solutions.