

MAKO SURGICAL CORP.

Expanding the availability of partial knee resurfacing with SolidWorks technology



Using SolidWorks software, MAKO developed the first robotic arm orthopedic system cleared by the U.S. Food and Drug Administration.

Surgical treatment options for people suffering from the severe pain of a knee afflicted with osteoarthritis typically include either a total knee replacement or partial knee resurfacing. The latter procedure—which is preferable in many cases as it is less invasive—used to require access to an orthopedic surgeon highly skilled in the manual technique for this procedure, an option that as a practical matter was not widely available to many patients.

MAKO Surgical Corp. was founded in November of 2004 to develop the surgical solutions and precision technologies necessary to assist orthopedic surgeons in performing partial knee resurfacing, or MAKOpasty®, with consistently reproducible precision, making the procedure more widely available to patients. Partial knee resurfacing is a bone-and-tissue preserving treatment option compared to total knee replacement for patients with early-to mid-stage osteoarthritis of the knee. But, when performed manually, it is often technically challenging, and has variable results.

MAKO's robotic arm system—the first robotic arm orthopedic system cleared by the U.S. Food and Drug Administration (FDA)—assists surgeons in resurfacing the medial (inner) compartment, the patellofemoral (top) compartment, or both compartments of the knee, to match the contour of an implant. Using a 3D visualization system to pre-plan surgery, the RIO® Robotic Arm Interactive Orthopedic System assists the surgeon in precise bone resurfacing and optimal positioning of the company's RESTORIS® implants.

Developing the robotic arm system that supports the procedure required advanced 3D design and simulation tools, according to Rony Abovitz, senior vice president, co-founder, and chief visionary officer at MAKO. “Before we founded MAKO, there were few surgeons who performed partial knee resurfacing with consistently good results,” Abovitz explains. “We set out to develop a computer-controlled, robotics-assisted system that could codify this surgical technique and allow more surgeons to conduct this procedure with reproducible precision. We needed a 3D design platform that would enable us to develop and visualize robotic concepts, and communicate our ideas with surgeons.”

Challenge:

Develop a robotic arm interactive orthopedic guidance system that assists surgeons in performing precision partial knee resurfacing operations.

Solution:

Implement SolidWorks design and simulation solutions to model and refine designs for a robotic arm interactive orthopedic surgical system.

Results:

- Shortened development cycles
- Reduced prototyping costs
- Extended knee treatment options to a growing number of patients
- Acquired photorealistic rendering capabilities

MAKO chose SolidWorks® design software to develop the system because SolidWorks software is easy to use, provides advanced surfacing tools, and includes powerful, large assembly and motion simulation capabilities. MAKO, which has multiple SolidWorks software licenses, also values the training and technical support services supplied by The SolidExperts, its SolidWorks reseller.

Visualizing innovative surgical procedures

MAKO uses SolidWorks software to develop every aspect of the system: from the proprietary, cable-driven robotic arm, which provides human-like interactivity with an extremely high-fidelity tactile response, to the novel resurfacing implants and instruments. Abovitz says, "SolidWorks 3D visualization tools enabled MAKO designers to quickly explore and refine design concepts, while compressing development time and reducing prototyping costs."

"SolidWorks software was a critical tool for us," Abovitz stresses. "Developing RIO® was extremely challenging. The ability to conduct virtual object modeling of tactile guidance and visualizations of complex surfaces was vital to our success. We were able to do it all with SolidWorks software, which saved us time and money."

Assisting surgical precision

Today, more than 50 surgeons throughout the United States perform MAKOplasty® partial knee resurfacing, and the number is growing. Providing surgeons with its robotic arm system not only requires a high degree of technological precision, but also a great deal of confidence in the system's performance. MAKO engineers leveraged SolidWorks Simulation software to conduct kinematics and biomechanics studies to validate and improve the design, and a 3D printer for cost-effective rapid prototyping.

"SolidWorks software enabled us to push the design as far as possible, so we could achieve the precision surgeons need to do partial knee resurfacing," Abovitz notes.

Configuring variety, rendering clarity

MAKO takes advantage of the design configuration capabilities of SolidWorks software to incorporate the wide variety of patient anatomies in the development of implant geometries. Shape data from more than 100 anonymized knee CT scans was quantified to create eight different implant size configurations for the RESTORIS® MCK MultiCompartmental Knee System, each containing over 300 SolidWorks Design Table parameters. Individual control of these varying parameters creates extremely accurate anatomical implant models, which enable surgeons to optimally match the implant shape to actual patient knee geometry.

The company also uses PhotoWorks™ photorealistic rendering tools to show how the system works. "Photorealistic rendering is very important to us," Abovitz points out. "It makes a real conceptual difference, and is helping us win mind share with surgeons."

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Rony Abovitz
Senior VP and Chief Visionary Officer



With PhotoWorks rendering software, MAKO creates photorealistic renderings to show how the system works.



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