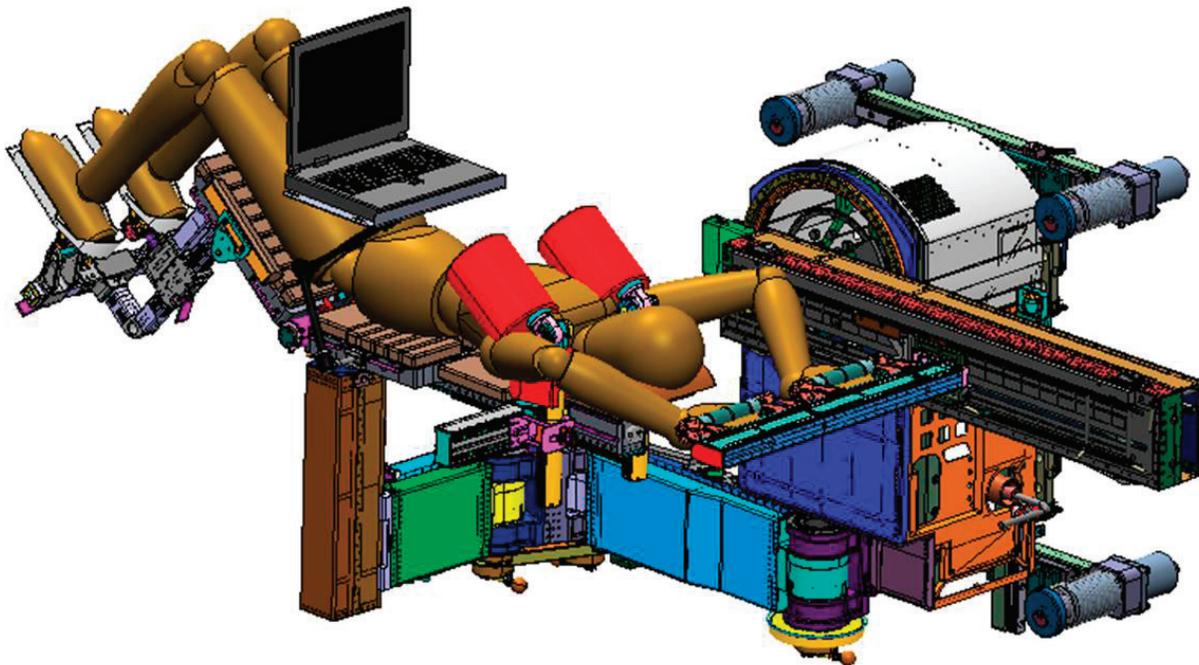


NTE-SENER

Creating a research and exercise system for the International Space Station with SolidWorks



NTE-SENER used SolidWorks design software to develop the Muscle Atrophy Research and Exercise System (MARES), which astronauts on the International Space Station (ISS) use to offset the debilitating effects of zero gravity on muscle mass.

Inhabiting the International Space Station (ISS) is certainly a dream come true for astronauts around the globe. However, the zero-gravity environment is also quite debilitating physically. Prolonged exposure to the conditions of space results in muscle atrophy, with deterioration of muscle mass and a weakening of strength, as well as osteoporosis related to the loss of calcium in the bones. To combat these phenomena, space station inhabitants have to complete rigorous muscle exercises for two hours each day.

As humans spend longer periods of time in space, gaining more knowledge about the effects of zero gravity on neuromuscular physiology becomes increasingly important, and may have ramifications for treating victims of trauma and paralysis here on Earth. As the main contractor for the Muscle Atrophy Research and Exercise System (MARES), NTE-SENER developed a sophisticated system that not only helps astronauts exercise while onboard the space station, but also enables researchers to study the negative impacts of zero gravity on human muscles, so they can develop ways to offset them.

Working on behalf of the European Space Agency (ESA), and in tandem with the National Aeronautics and Space Administration (NASA) Human Research Facility (HRF), NTE-SENER faced significant engineering and communications challenges on the development of the MARES system, according to Head of Mechanics Area Manuel Canchado Morales. "Although we needed 2D drawings for production, we also had to communicate with ESA and NASA partners, as well as address how the MARES system would operate and fit within the close confines of the ISS's European Columbus Module," Canchado says. "In short, we had to use a 3D design tool to satisfy these requirements."

Challenge:

Develop the Muscle Atrophy Research and Exercise System (MARES) to support astronaut exercise needs on the International Space Station, study astronaut muscle atrophy in space, and expand understanding of the effects of zero gravity on the human neuromuscular system.

Solution:

Utilize SolidWorks 3D design software to develop the MARES system and ensure that it would function properly within the confines of the International Space Station.

Results:

- Shortened development cycle by 25 to 30 percent
- Automated design through use with configurations
- Reduced number of design errors
- Supported modular design for ease of assembly

NTE-SENER chose the SolidWorks® 3D design platform to develop the MARES system because it's easy to use, could import 3D models of existing space station designs, and included 3D design and visualization tools. The company migrated from AutoCAD® 2D design software to SolidWorks several years ago. "SolidWorks has been a great change from our previous CAD software," notes Mechanical Engineer Albert Catalan. "It helped us to quickly create concepts, review them in vivid 3D detail with NASA, and develop a very sophisticated design."

Virtual integration with the space station

Using SolidWorks software, NTE-SENER designed MARES—which consists of an adjustable chair with a system of pads, levers, electronics, software, and a motor—within an existing 3D model of the space station. Because the firm's engineers could incorporate their design work within the space station model, they were able to fully integrate the design in a virtual environment, shortening development time in the process. The NASA *Discovery* Space Shuttle delivered MARES to the space station following its launch on April 5, 2010.

"We are 25 to 30 percent faster using SolidWorks," Catalan stresses. "Because it is so easy to make changes, the time it takes to reach the final design is shorter. For example, on this project, collision detection tools were a major advantage. In addition to allowing us to check for interferences between parts, SolidWorks enabled us to truly understand how the system would operate inside the space station's restricted space and helped us to resolve potential clearance issues."

Configuring body type, motion

NTE-SENER used SolidWorks design tools to overcome other development challenges, including sizing the equipment to handle different-sized astronauts, limiting motion to different muscle groups, and delivering power-assisted resistance to test muscles for weakness and provide exercise benefits. "With SolidWorks, we made design configurations of the entire system," Catalan points out. "These configurations included a range of body types—from the fifth to the 95th percentile—as well as 11 different body movements, including individual joints and limbs."

"SolidWorks helped us automate this process because we could create all of these variations from the base design," Catalan adds. "It allowed us to see how MARES would move and function for every possible configuration, and then show that performance to our partners at ESA and NASA."

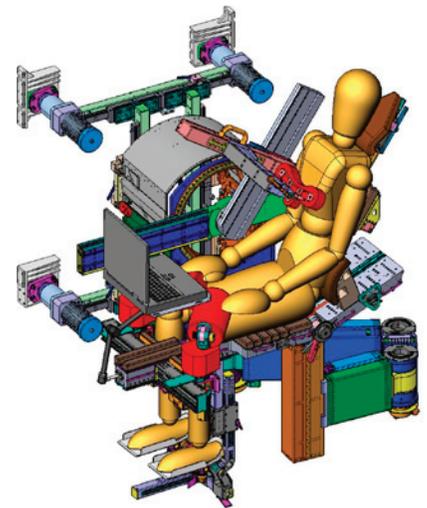
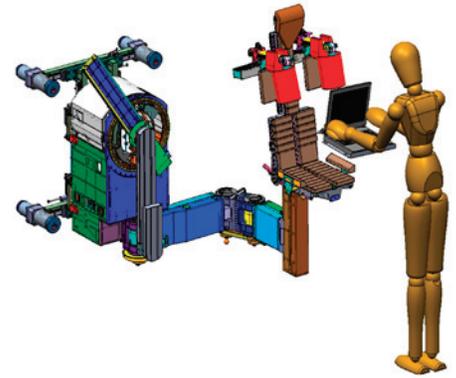
Modular design streamlines production, assembly

In addition to minimizing the number of design errors that NTE-SENER had experienced in 2D, SolidWorks helped the company to utilize a modular design approach. This not only streamlined manufacturing, but also made it easier for astronauts to assemble, break down, stow, and operate the MARES system.

"SolidWorks facilitates sharing data and working with our manufacturing partners," Catalan says. "There are no model translation errors. We use SolidWorks to make sure that our design is free of production issues, such as checking the position and alignment of holes."

"SOLIDWORKS HAS BEEN A GREAT CHANGE FROM OUR PREVIOUS CAD SOFTWARE. IT HELPED US TO QUICKLY CREATE CONCEPTS, REVIEW THEM IN VIVID 3D DETAIL WITH NASA, AND DEVELOP A VERY SOPHISTICATED DESIGN."

Albert Catalan
Mechanical Engineer



With SolidWorks software, NTE-SENER was able to integrate its MARES design with a model of the International Space Station (ISS), as well as simulate the system's various ranges of motion.



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