SIMULIA

TADANO

Case Study

DASSAULT SYSTEMES

Challenge:
Boom cranes are long arm-like construction parts used to move heavy or awkward materials. Sometimes when a crane is lifting a particular load boom deflection can occur causing "load swing". Well-experienced crane operators have learned how to manage "load swing" by using sensory analysis. However, sensory analysis requires an actual machine, as well as time and money to manufacture a prototype. Any adjustments found during a sensory analysis means that you have to start again from the beginning of the process. For this reason, speeding up the R&D process by establishing an environment makes it possible to validate the development process from an early stage, and facilitates the development of a real-time crane simulator (below, "simulator") with a high level of safety that controls boom crane load swing.

Solution:
Utilizing Simpack multibody simulation software, which provides real-time simulation for large-scale 3D vehicle models, we succeeded in the development of a simulator that takes into consideration human sensor analysis.

Results:
By enabling sensory analysis through real-time simulation, Tadano significantly reduced their manufacturing prototype costs and time for rework, and accelerated the time for adding new functions. In addition, they are using it as a communication tool so that the research department can communicate new ideas to the development department in a manner that is easy to understand.

DEVELOPMENT OF A SIMULATOR THAT ENABLES INDISPENSABLE SENSORY ANALYSIS IN TERMS OF THE PROPERTY OF THE CRANE

Tadano Ltd. is engaged in the manufacturing and sales of products including construction cranes, vehicle-mounted cranes, and aerial-work platforms. They celebrated their 100th anniversary in 2019 as one of the world's leading construction crane manufacturers. Currently, the group's business domain has been defined as machines for anti-gravity and aerial work called lifting equipment (LW), and it is engaged globally in locations including Europe, North America, South America, Asia, Middle East, Oceania and Russia. Among its construction cranes, Tadano is a global leader in the number of shipments of rough terrain cranes that are in high demand in Japan because they can maneuver rough terrain. Tadano offers work vehicles optimized for customer needs in the market through its abundant line of construction cranes, including the active use of M&As for the market roll-out of all terrain cranes that lift up to 1,200 tons and crawler cranes that have a traveling body equipped with a crawler belt device (crawler). The crawler cranes lift up to 3,200 tons.

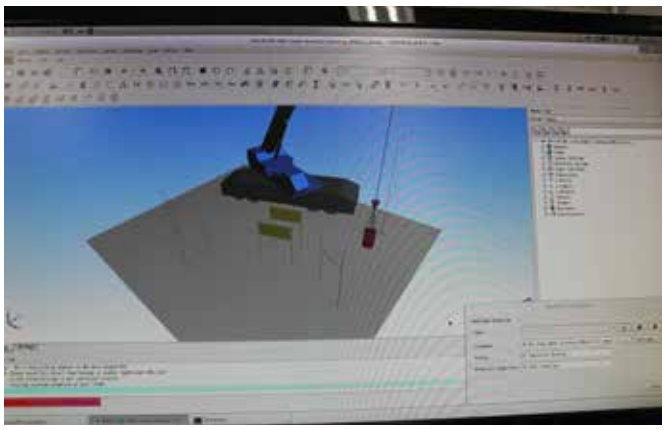
Tadano has leveraged its advanced technological capabilities including the development of Japan's first h ydraulic c rane

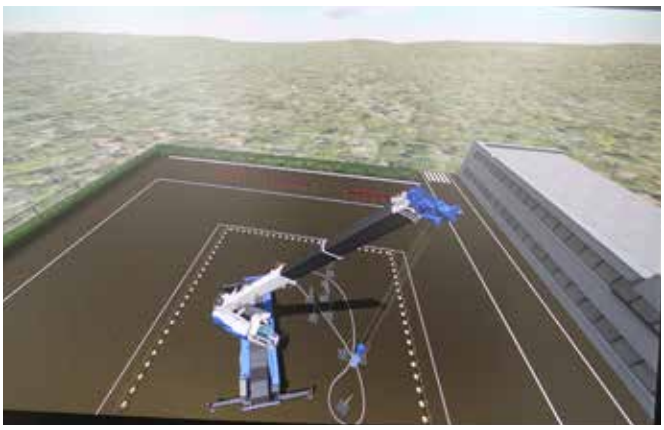
named the OC-2 actively engaging in construction crane technology development. They have also aggressively invested in further technical innovation in order to respond as quickly as possible to the needs of the market through means such as establishing the Advanced Technology Research Division in 2017 as an independent organization under the direct supervision of the president to enable prompt decision-making. The Technical Research Center located in Takamatsu City, is where Kagawa Prefecture plays a central role in this R&D process. Under the Center's vision of "polishing skills and polishing usability" they are looking to achieve dramatic transformation in the construction industry in regards to safety and productivity. They have worked day and night to develop new technologies that resolve various social issues, including the use of advanced technologies to provide support in response to the lack of skilled operators because of a decrease in the number of construction workers, and also to reduce accidents at construction sites.

A crane boom that is equal to an arm of a crane can cause boom crane deflection and load wing when it attempts to lift a load. To understand the physical property of a load swing and how cranes are actually used at construction sites, it is essential to consider the control method of a load swing. However, designers are not able to enter construction sites where cranes are at work due to hazardous areas. Therefore, as explained by Shinji Noguchi, Advanced Technology Research Center,

"A real-time simulator was necessary to enable the sensory analysis of operations at an early stage in the development process."

— Dr. Shinji Noguchi
Advanced Technology Research Center
General Manager





General Manager and Doctor of Engineering, "We have worked to quantify the line of sight of well-experienced crane operators during their work through measurement and analysis. Although sense is important when people operate things, this is not something that has been sufficiently incorporated in product development up until now." According to Kazuya Tanizumi Advanced Technology Research Center Project Manager and Doctor of Engineering when considering development time, "Evaluation based on the sensibilities of the person operating a crane is of course only when that person actually gets on the crane and operates it. For this reason, a lot of time has been necessary just for evaluation, including prototype manufacturing and test environment preparations. Therefore, it was necessary to develop a simulator that would enable sensibility evaluations at an earlier stage in the product design and development process."

DEVELOPMENT OF A REAL-TIME CRANE SIMULATOR THAT ENABLES SENSORY ANALYSIS

The simulator was required to accurately model a crane boom and reproduce thet behavior in real-time. For this reason, what caught the interest of the company was the multibody simulation software, Simpack, as offered by Dassault Systèmes. According to Tanizumi, "We considered multiple software products in the product selection process. While there were products capable of real-time simulation in the case of a rigid body, there were no products besides Simpack with its advanced technologies that enabled the accurate reproduction of the crane boom deflection that is important when simulating a construction crane. In addition, it was only Simpack that made real-time simulation of a human sensory analysis possible."

Being able to generate a physical model for simulation based on accurate design information was another important point that led to the selection of Simpack. According to Noguchi, "What we wanted was not a simple simulator such as those that are used in training by operators, but a high-precision development tool with a high level of reproductivity. Our engineers need to be able to generate and analyze a physical model for structures based on accurate design information."

NOT ONLY ACCELERATES THE SPEED OF R&D, BUT CAN ALSO BE USED AS A COMMUNICATION TOOL

The simulator was built with the support of Dassault Systèmes and it was used to develop a model for major types of rough terrain cranes that are a mainstay product of Tadano. The actual simulator was developed in an integrated manner that includes hardware, such as the cabin that is ridden by operators, operating levers, an overload preventive device called an AML, and displays along with a large one that visualizes the Simpack calculation results in real-time. The simulator makes it possible to directly operate Simpack and confirm the results, including making changes to parameters such as crane conditions and load weight, executing the simulator, and displaying results. Because intermediate files are not required, it is possible to change the type of crane and run a simulation even without any model knowledge. The simulator has contributed to a reduction in manpower hours, which has reduced the product development period from one year to about six months with the release of new functions accelerating.

The simulator is also used as a tool for the development department to understand the ideas of the research department. Tanizumi praises Simpack, stating that "Although there were cases in which it was difficult to convey the functions in new design proposal up until now, virtual experiences using the Simpack simulator have improved the understanding of the people involved compared to before and helped facilitate

"It is necessary to remodel boom from the model in order to change and evaluate crane parameters. These modifications are simple with Simpack because the GUI and simulator are directly linked."

— Dr. Kazuya Tanizumi
Advanced Technology Research Center
Project Manager

"It is not possible to change and evaluate parameters with actual crane. Only the simulator makes easy to change and confirm various simulation variables."

—Dr. Hiroki Ichikawa
Advanced Technology Research Center Chief
Advanced Mechanism Research Unit

development in many cases."

EXPANDING THE SCOPE OF USE WHILE DEVELOPING MODELS FOR MAJOR TYPES OF CRANES

As explained by Hiroki Ichikawa, Advanced Technology Research Center Chief, Advanced Mechanism Research Unit and Doctor of Science, who is currently developing new hydraulic valves for systems, "There are plans to create a hydraulic valve simulation code, link it with Simpack, and create co-simulations in real-time. I hope that motion response evaluation for the mechanism including hydraulic characteristics (a crane model created with Simpack) will make it easier to find areas for improvement with the valve." Ichikawa relays that, "In addition, there are also plans for coupling with MATLAB that is broadly used in control system design, and I also hope that Dassault Systèmes will provide ongoing support going forward regarding the response that is required to expand the scope of utilization."

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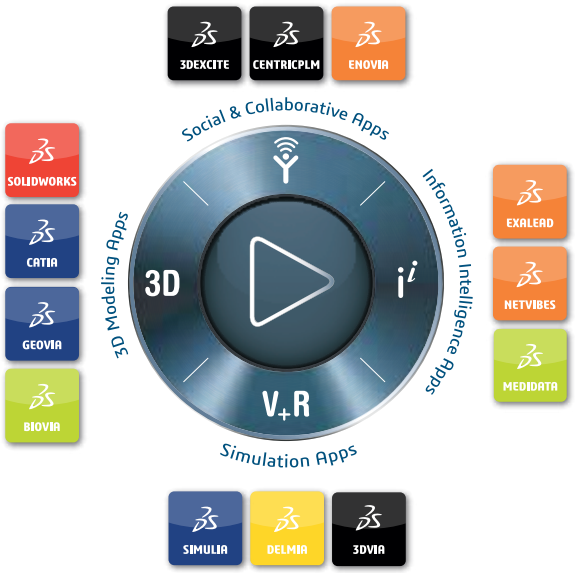

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