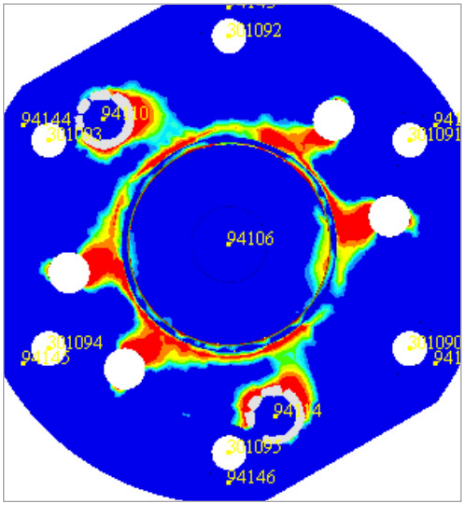
Maintaining Industry Leading Reliability of Manufacturing Robotics



ABB

Key Highlights

Industry
Robotics

Challenge
Assess and improve fatigue performance of a part transfer robot.

Altair Solution
Combined multi-body dynamics and fatigue analysis to identify areas of concern. Enhancements suggested to improve performance.

Benefits
- Rapid exploration of designs
- Reduced need for physical tests

Industrial robots are used throughout the world's manufacturers to accelerate part production while ensuring a consistent, repeatable level of quality. Operating in a huge variety of scenarios, robots are able to assist in lifting heavy components, joining them together, applying protective coatings and paint finishes and more in an almost limitless number of applications in modern manufacturing processes.

ABB's Discrete Automation and Motion division is a leading supplier of industrial robots, modular manufacturing systems and services having installed more than 300,000 robots worldwide. The reliability of its industrial robots is crucial for ABB in ensuring that its customers' highly precise production lines are not held up, a problem which could potentially cost significant amounts of time and money to correct. During the revision of one of its robotic systems, ABB's Spanish division wanted to explore ways of maintaining its leadership in product reliability through the use of simulation technologies.

Robotic arms perform the same action time and time again, supporting the 24 hour manufacturing processes employed in today's production lines. As a result, component fatigue is a potential issue that can impact the reliability of ABB's systems. Simulation techniques have become vital in exploring the fatigue life of a product, as unlike physical testing, simulation technologies allow engineering teams to identify problems and explore potential improvements very rapidly without the need for physical prototypes.

Keywords: Fatigue analysis, Multi-body dynamics analysis

ABB Success Story

"Collaborating with Altair for a Multi-Body Dynamic simulation was really helpful in order to validate a critical component of one of our products. It allowed us to simulate the full component dynamically and introduce different load cases, much faster than a real workshop test."

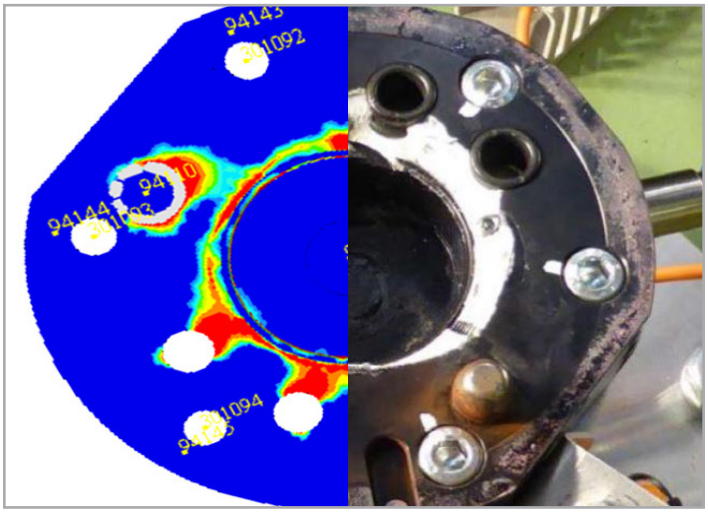
Òscar Monje
Products Technical Coordinator
ABB

To support the use of simulation tools in this endeavor, ABB in Spain enlisted the help of Altair ProductDesign's regional team, thanks to the company's experience in utilizing simulation tools to solve engineering challenges in the robotics industry.

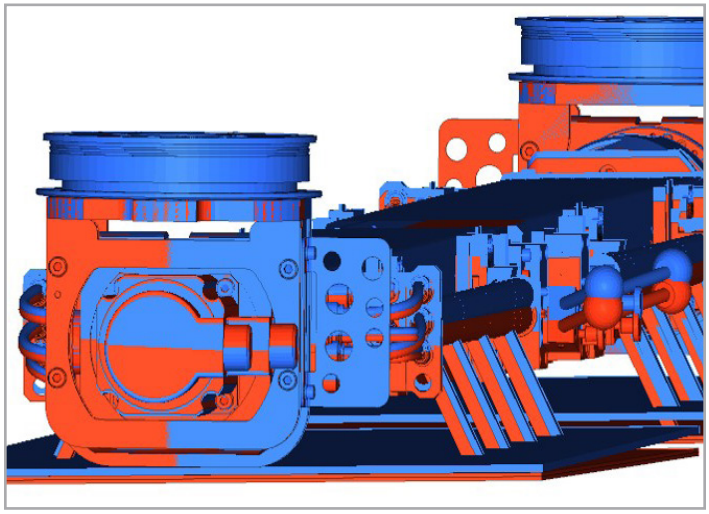
The project centered on improving the fatigue performance of a Twin Robot Xbar (TRX), one of ABB's robotic part transfer systems that moves components between manufacturing stations.

Component Level Analysis

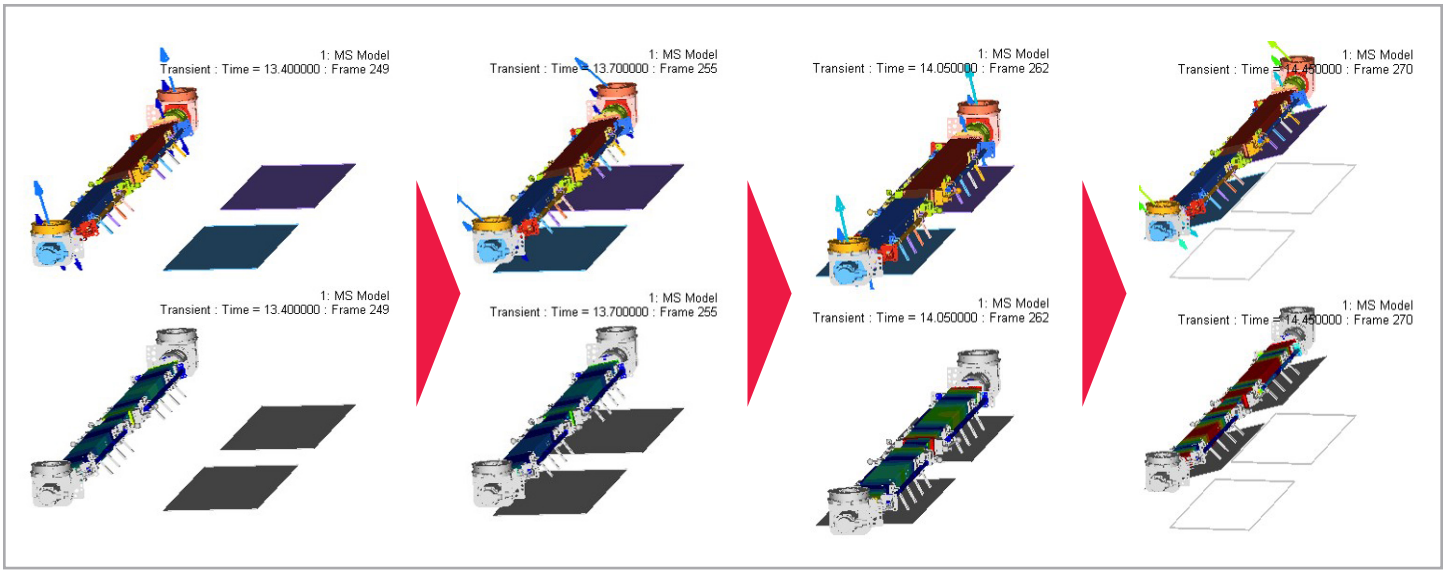
Working alongside ABB's engineering team, Altair ProductDesign's first task was to prove that a combination of multi-body dynamics (MBD) and fatigue analysis could accurately replicate the physical tests of a tooling changer subsystem know as an ATC unit. To characterize the structural behavior of the ATC, finite element models suitable for MBD analysis were built by Altair ProductDesign's team using HyperWorks' parametric modeling interface, MotionView. The models provided an accurate representation of the movement of the ATC, allowing the team to define the dynamics loads required to inform the fatigue analysis stage. Altair and ABB's teams could then use these results to investigate the dynamic structural response data and calculate the durability limit of the critical components using HyperWorks' MBD analysis solution, MotionSolve. nCode's DesignLife fatigue analysis solution (part of the Altair Partner Alliance) was then used to calculate the fatigue performance of the ATC.



A comparison between the simulation and physical testing of the ATC unit



Rigid (blue) vs flexible (red) model superposition during pickup instant



Sequence of forces and deformations of the TRX bar approaching and leaving the pick up position

The areas of potential concern in the ATC identified by the virtual analysis process matched extremely well with the physical test data from ABB, giving the team confidence in the ability of combining MBD with fatigue analysis to investigate this complex problem.

Combined MBD & Fatigue Studies at the System Level

With positive results in this first exploratory stage, ABB was happy to extend the project from investigating the effects of fatigue on a single component to the entire TRX system. A process to define a parameterized model of the TRX was undertaken, building a full kinematic MBD model, including the system's knuckles and composite Xbar, as well as the validated ATC unit using CAD data from ABB within HyperView. As with the ATC investigation, the movement of the TRX was accurately replicated allowing the team to utilize Altair's MotionSolve solution to perform cycle and load evaluations.

nCode's DesignLife was used again to explore the likelihood of fatigue problems occurring in the TRX, using the same parameters as the fatigue tests on the correlated ATC subsystem. Loads and sensitivity analysis was undertaken, using a variety of simulation cases to investigate issues and potential solutions.

The results collected by DesignLife and interpretated by Altair ProductDesign identified the repetitive loads responsible for the durability were related to the vibration of the Xbar. Theese vibration were influenced by the flexibility of the component and the movement sequence imposed by the booms. By varying the velocity during use, a reduction in acceleration and the resulting peak forces could be achieved which could lead to a significant reduction in fatigue phenomena.

Significant Reduction in Physical Test Requirements

Key to the success of the project centered on the time savings achieved through the use of simulation techniques. The physical durability test could not be conducted on the entire TRX system due to the amplitude of the movements and the duration of each test. What could be physically tested would take several weeks to perform. Using a virtual approach allowed ABB to investigate the entire system in just a few hours of model building, set up and analysis time.

Although this was the first project conducted for ABB in Spain by Altair, it proved to be extremely successful. Altair ProductDesign was able to use a correlated MBD model of the TRX system to identify the root cause of fatigue damage experienced by the product and suggest specific changes to its operation to eliminate the potential issue. The team showed how simulation technologies found within Altair's HyperWorks suite and the partner products through the Altair Partner Alliance, could be used to rapidly explore designs for problems and help to find solutions without the need for costly physical prototypes.

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About Altair

Altair is focused on the development and broad application of simulation technology to synthesize and optimize designs, processes and decisions for improved business performance. Privately held and headquartered in Troy, Michigan, USA the company operates globally to serve customers in a diverse range of industries including automotive, aerospace, defense, meteorology, architecture and construction, energy, electronics, and consumer goods.

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About Altair ProductDesign

Altair ProductDesign is a global, multi-disciplinary product development consultancy of designers, engineers, scientists, and creative thinkers. As a wholly owned subsidiary of Altair, the organization combines its product development expertise with proprietary simulation technologies to deliver innovation and automate processes; helping clients find the optimum balance between performance and cost to bring profitable products to market, faster.

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