



A COMPLETE PRODUCT DEVELOPMENT PARTNER



Brainstorming and Concept Generation



Feasibility Studies and System Architecture



Detailed Product Design



Prototyping



Design for Manufacturing (DFM)



Verification Testing



Manufacturing Assembly and Test Equipment



Sustaining Engineering

INNOVATION AT A GLANCE

Client

- A prominent U.S. launch service provider

Project

- Structural Analysis for a Mobile Launch Platform, Transportation and Handling Equipment, and Flight Components

Objectives

- Complete strength and stiffness analyses of launch platform, decoupler booms, and other ground support equipment
- Perform analysis of flight vehicle components and provide design recommendations that produce acceptable safety margins

Approach

- Provided a detailed plan to complete strength analysis for customer's launch platform and ground support equipment.
- Improved analysis efficiency with computational tools developed to automate the simulation of launch loads.
- Consulted with customer stakeholders in-person and remotely to report results, generate design solutions, and support group meetings.

Results

- Delivered detailed strength and stiffness analyses reports and margins of safety.
- Completed slides for customer's Critical Design Reviews and Finite Element Models (FEMs) that included 654 design and analysis iterations.
- Managed a backlog of analyses, which allowed the team to continue conducting stress analysis during design iterations.
- Performed quasi-static strength analysis of avionics brackets and installation fasteners to ensure the customer's requirements were satisfied across critical loading environments.

Detailed Structural Analysis to Support Rocket Launch Program

One prominent customer, a U.S. launch service provider, requested Synchroness to conduct strength analysis to support a new launch platform. Synchroness created a team of stress analysts that completed work in parallel with customer designs, meeting the rigorous aerospace standards of AS9100.

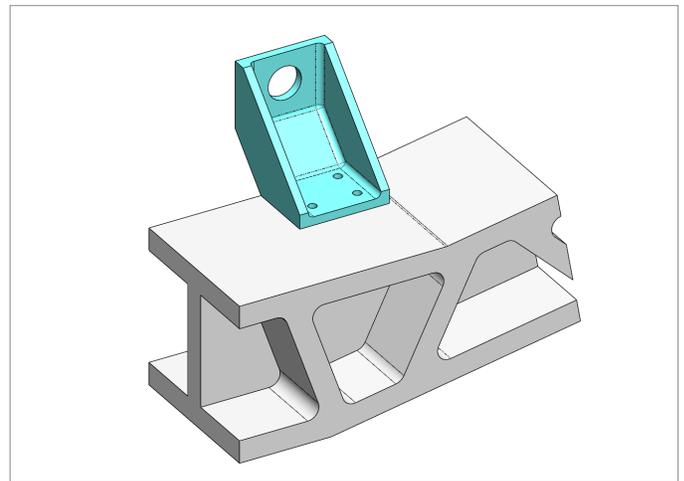
“The project went great, and an indication that we did well was that they kept adding on to it. We became an integral part of the customer’s team,” said Synchroness Principal Mechanical Engineer Linda Knudsen.

Ground Support Equipment – Transportation and Handling

The Synchroness team analyzed weldments and assemblies to transport, support, and hoist structures for testing and assembly. Starting with CAD files and load cases from the customer, Synchroness developed both free-body diagrams (FBDs) and Finite Element Models (FEMs) containing plate, beam, and solid elements in Simcenter Femap with NX Nastran. The resultant forces from the FBDs were used for overturn analyses and for specifying hoists. The reaction forces and stresses were extracted from the FEM and were used to support proof-load testing, roller and pin sizing, material selection, and weld size determination.

Ground Support Equipment – Mobile Launch Platform (MLP)

The customer set a goal to create a low-cost Mobile Launch Platform (MLP) for their new launch vehicle fleet. The launch platform stands 180 feet tall and weighs over 1 million pounds—needing to withstand transportation to the launch pad, forces imparted by weather phenomena, and plume loads as the vehicle launches with over 3 million pounds of thrust.



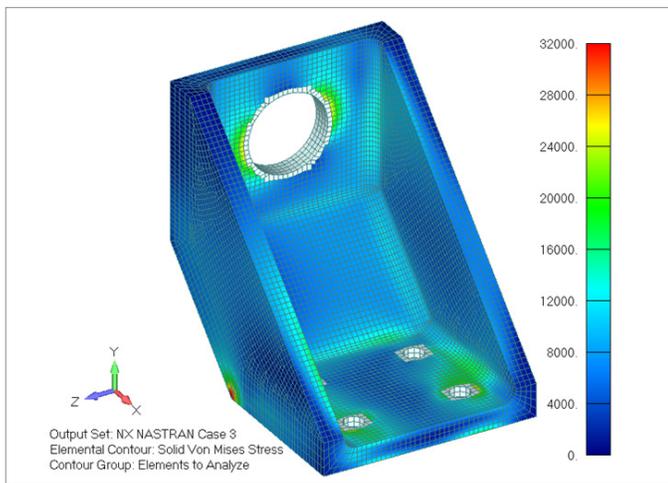
Hydraulics bulkhead bracket with portion of engine support beam to be included in the FEM as a boundary condition.

The engineering team conducted a strength analysis on booms that reach from the MLP to the launch vehicle, including decoupler booms, which hold umbilical tubing that deliver liquids, gases, electric power and command signals to the vehicle prior to launch. The team also analyzed the ground wind damper, which can reduce on-pad motion before takeoff. Calculations included free-body diagrams, load case consolidation, worst-case determination, and capability studies. The Synchroness team created simulation models that represented connections to the launch vehicle and resultant loading as the booms retract into the MLP when the vehicle launches.

Flight Components

The Synchroness team provided assistance with the structural analysis of flight hardware components. These components included the primary structural components that transfer loads from the engines to the skin of the rocket, as well as a multitude of brackets which support fuel pressurization and vent ducts, hydraulic lines, avionics, and ordnance.

Many components required the pre-processing and post-processing of large data sets. This was usually in the form



Stresses in component evaluated for each case, with model refinement, sub-models, or hand calculations completed where required.

of large assemblies with hundreds of loads and hundreds of fasteners or small assemblies with thousands of load cases. In these cases, Synchroness automated the data processing to down-select which load cases to run—saving hundreds of hours of analysis time.

The customer provided the Synchroness team with CAD files, tabulated loads, and analysis requirements for each component or assembly. The engineers created FEMs in Simcenter Femap with NX Nastran to evaluate strength and stiffness of the components and resultant loads carried by their installation fasteners. Efficient meshes were created in order to minimize analysis run time and allow for incorporation in system models. Safety margins for the fasteners were calculated per NASA-STD-5020.

Based on the results, the Synchroness engineers proposed geometry and material changes with the intent of increasing structural margins, reducing cost, improving manufacturability, or alleviating installation challenges. Once changes were approved, the analyses were peer reviewed, finalized, and released through Synchroness' quality process.

Delivering Results

Over the course of 2 years, the customer reduced component costs and design time, in part due to the Synchroness team's rigorous and responsive strength analysis iterations of both flight components and ground support equipment.

About Synchroness

For more than two decades, Synchroness has provided inspired solutions to highly complex business and technical problems. We have a strong portfolio of clients in the medical device, aerospace, and industrial equipment industries. By providing a full complement of engineering services aligned to the entire product lifecycle, Synchroness enables companies to accelerate product development and drive more predictability and productivity into their businesses. Working with Synchroness, companies gain the critical insights necessary to develop products that make a difference and create a better world.

Sources:

1. NASA-STD-5020 for Fastener Calculations
<https://standards.nasa.gov/standard/nasa/nasa-std-5020>
2. LH2 and LO2 Valve Simulation
<https://www.synchroness.com/case-studies/lh2-and-lo2-valve-simulation/>