Virtual Prototyping of Automotive Open Air Systems Using CAT/ADAMS

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Abstract

ASC Incorporated uses CATIA (Dassault Systemes) as its primary CAD package. CAT/ADAMS allows one to analyze the dynamic behavior of mechanisms without leaving the CATIA environment. Representing a significant leap over the basic CATIA kinematics package, CAT/ADAMS captures the effects of external loading and component mass/inertia in the modeling of mechanisms. This presentation details how ASC has begun to use CAT/ADAMS to model complex mechanisms to support our open-air system programs. Because virtual prototyping is relatively new to ASC, several existing mechanisms were modeled using CAT/ADAMS and the results were correlated to test data. Successful test correlation of existing mechanisms provides the practice and confidence necessary to model mechanisms that are still in the early feasibility/prototype stages of the design process. A series of case studies will be presented that demonstrate this approach.

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ASC Incorporated

- Established as American Sunroof Company in 1965 by Heinz Prechter
- Based in Southgate, Michigan
- Tier 1 supplier to automotive and heavy truck industries
- Aftermarket supplier of automotive sunroof systems
- Employs over 4500 in more than 30 facilities in the U.S. and Canada with additional operations in Germany and Korea
- Core products developed at Southgate headquarters are open air systems (convertible tops, sunroofs, other neat stuff) as well as mobile entertainment systems

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ASC's Use of CATIA

- ASC uses CATIA as its primary CAD package
- While CATIA serves as an excellent 3D design tool, its integrated kinematics package does not allow one to analyze mechanisms dynamically
- Because of this limitation, ASC has traditionally had to construct physical prototypes to understand how a proposed mechanism reacts under actual loading
- There existed a definite need to acquire a 3D dynamic analysis tool to eliminate the often costly process of repeated "build and test" design cycles
- Ideally, this dynamic analysis tool would be integrated into CATIA to eliminate the need to import and export model geometry

CAT/ADAMS Benefits vs. CATIA Kinematic Package

- Takes into account mass and inertia properties of bodies within a mechanism
- Allows one to add loads to their models along with dynamic elements such as springs and bushings
- Allows modeling of contact between bodies
- Uses the same post processing tool as ADAMS/View (PPT). This tool allows one to analyze joint loads, load input requirements, component velocity and acceleration, and many other simulation results

CAT/ADAMS is essentially a function within the CATIA environment that builds upon the basic CATIA kinematic model

Poor approach to implementing CAT/ADAMS in the design process

Provide CAT/ADAMS training to selected engineers

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Attempt to use CAT/ADAMS immediately to analyze complex mechanisms

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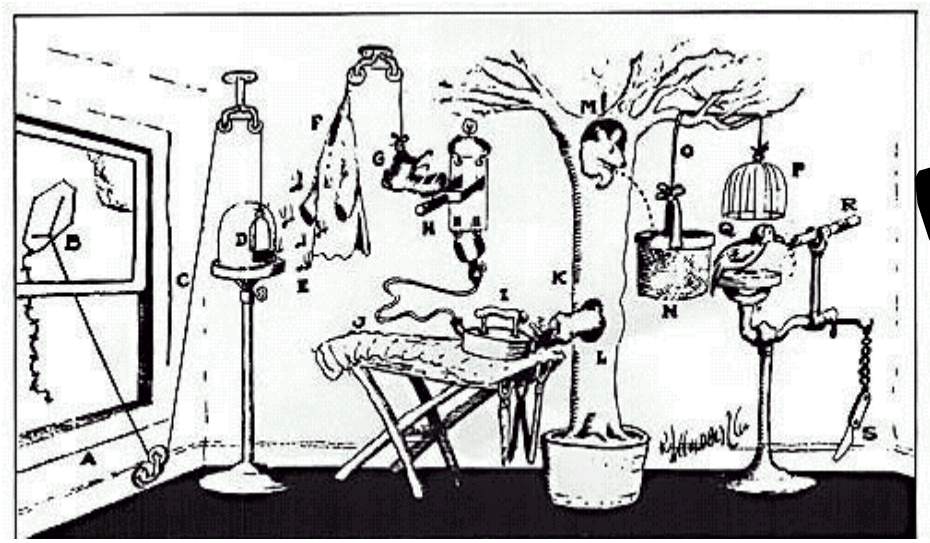
Leads to confusion, inaccurate results, and poor modeling practice



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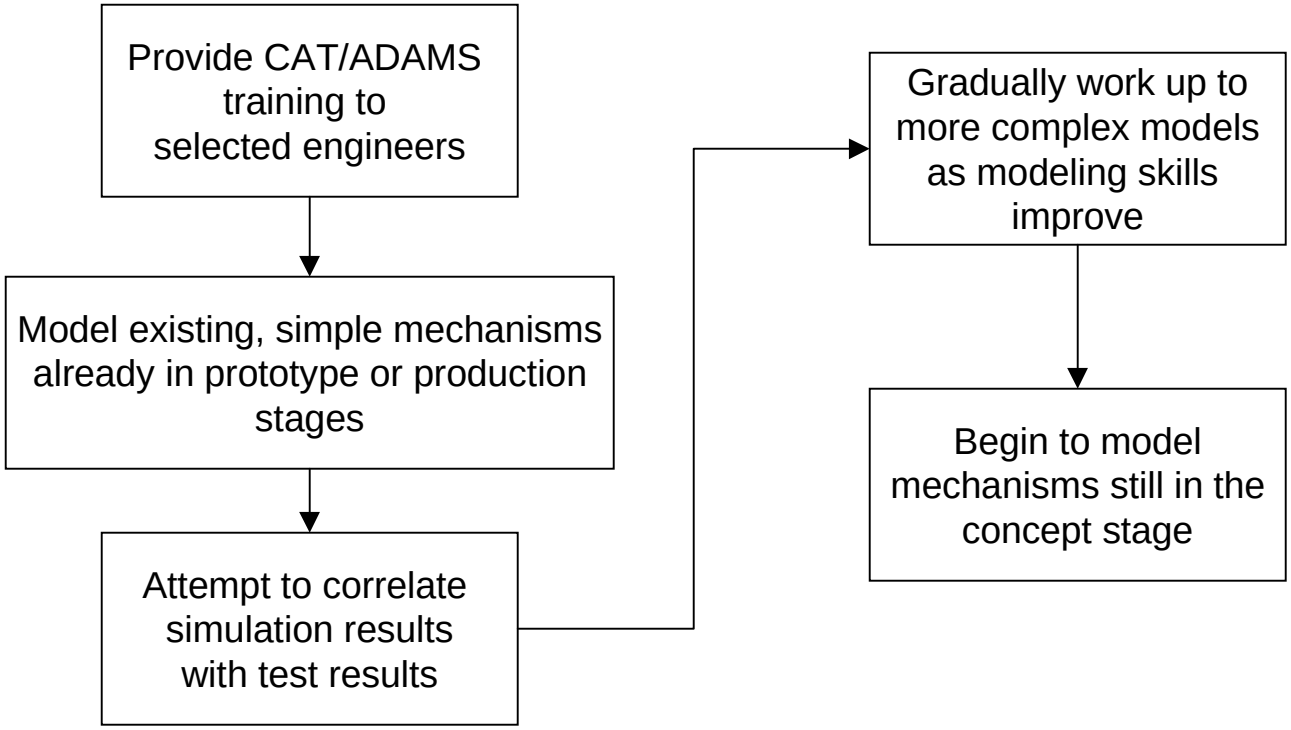
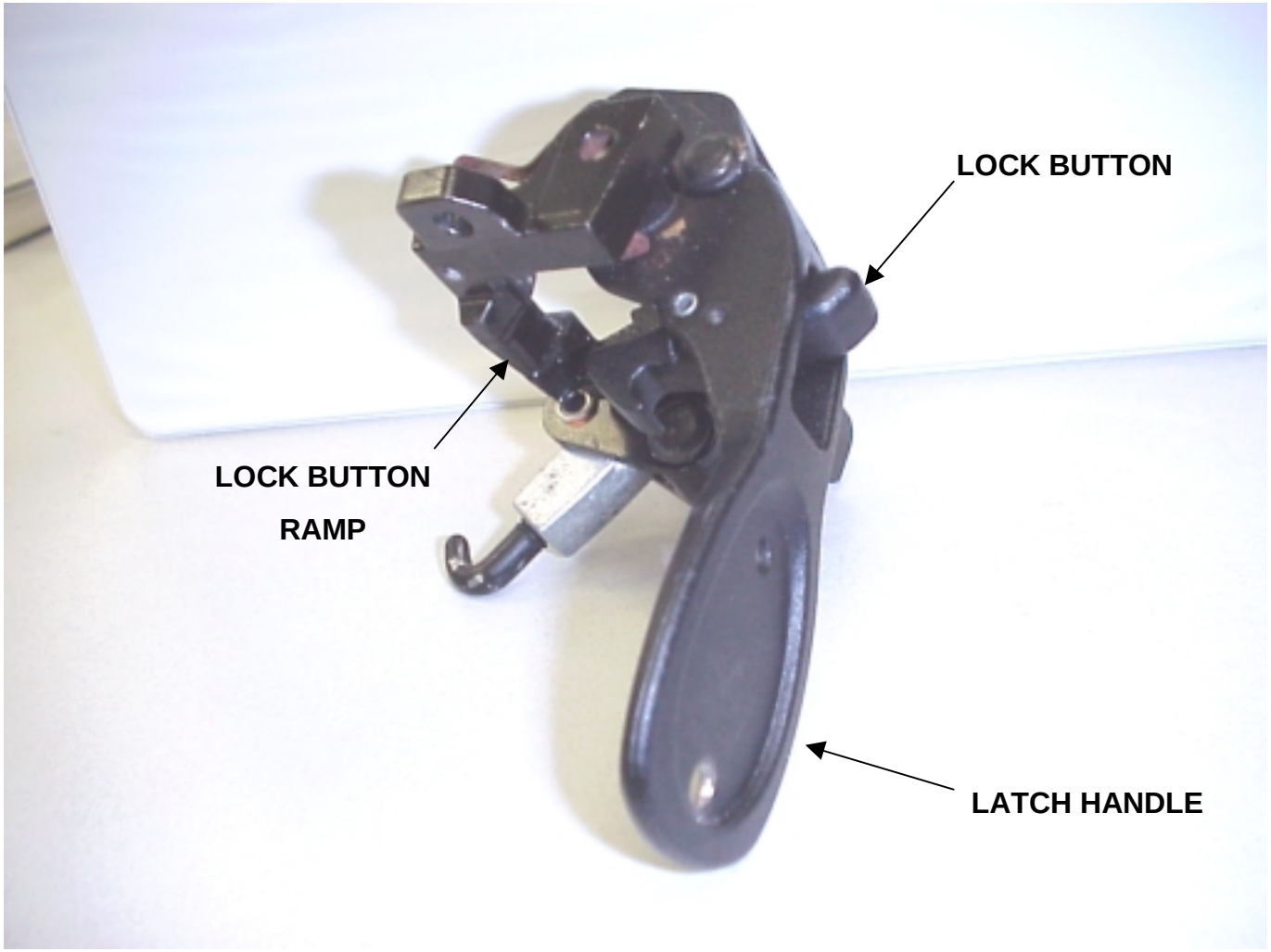
Improved approach to implementing CAT/ADAMS in the design process



Case Study #1: Convertible Top Latch Lock Button Mechanism

Latch in partially open position



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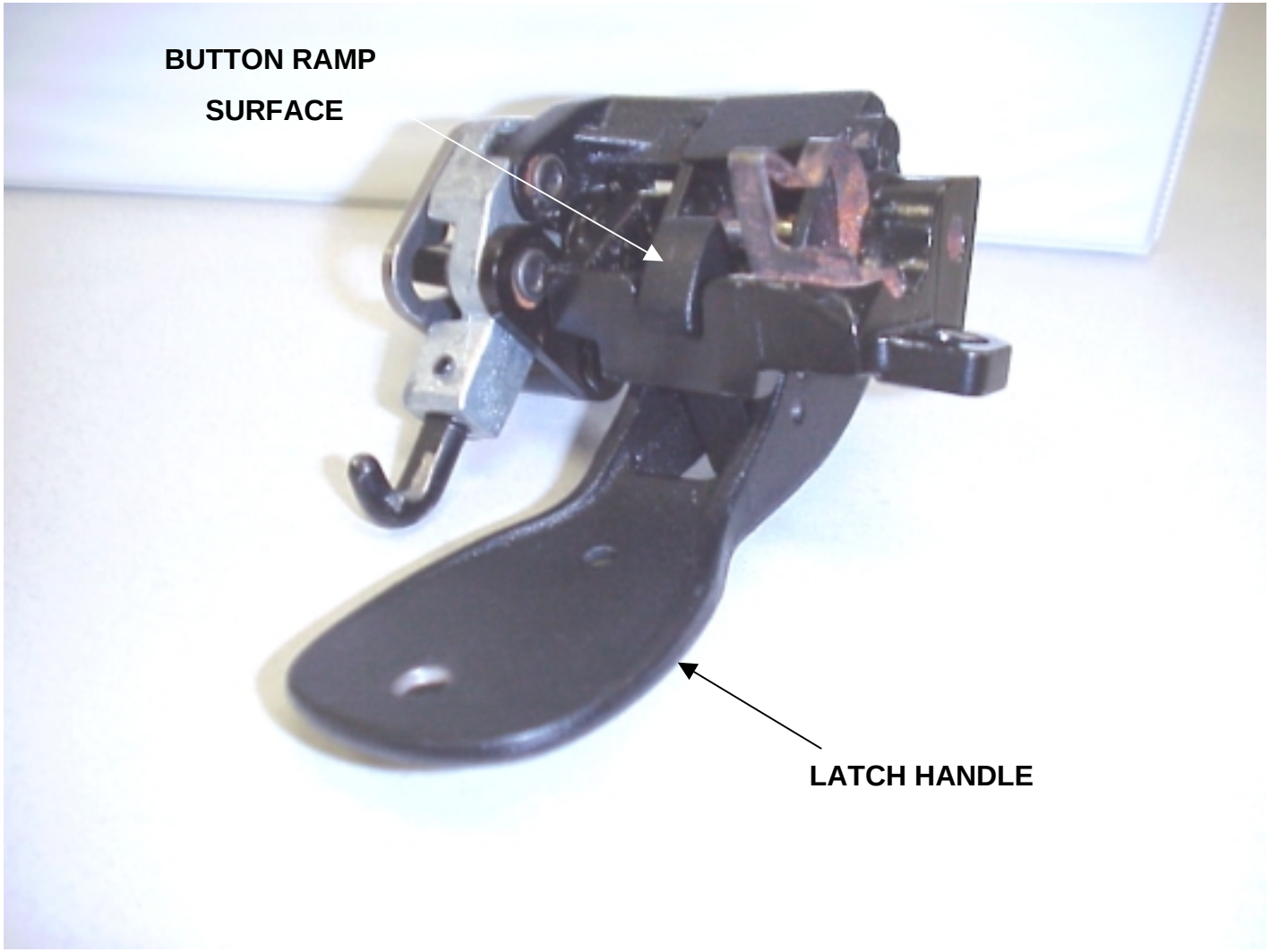
Latch in closed position



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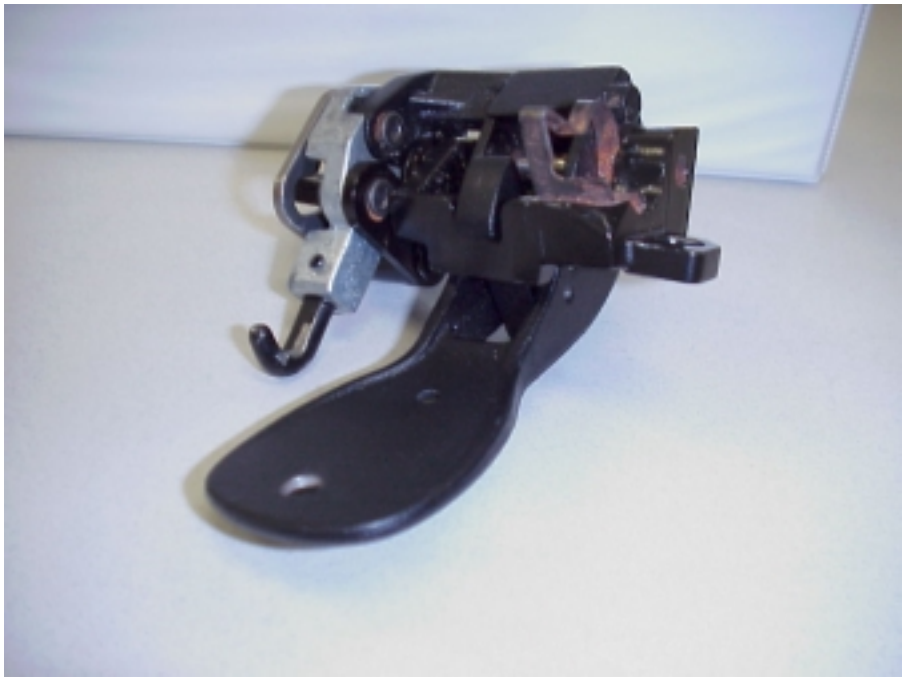
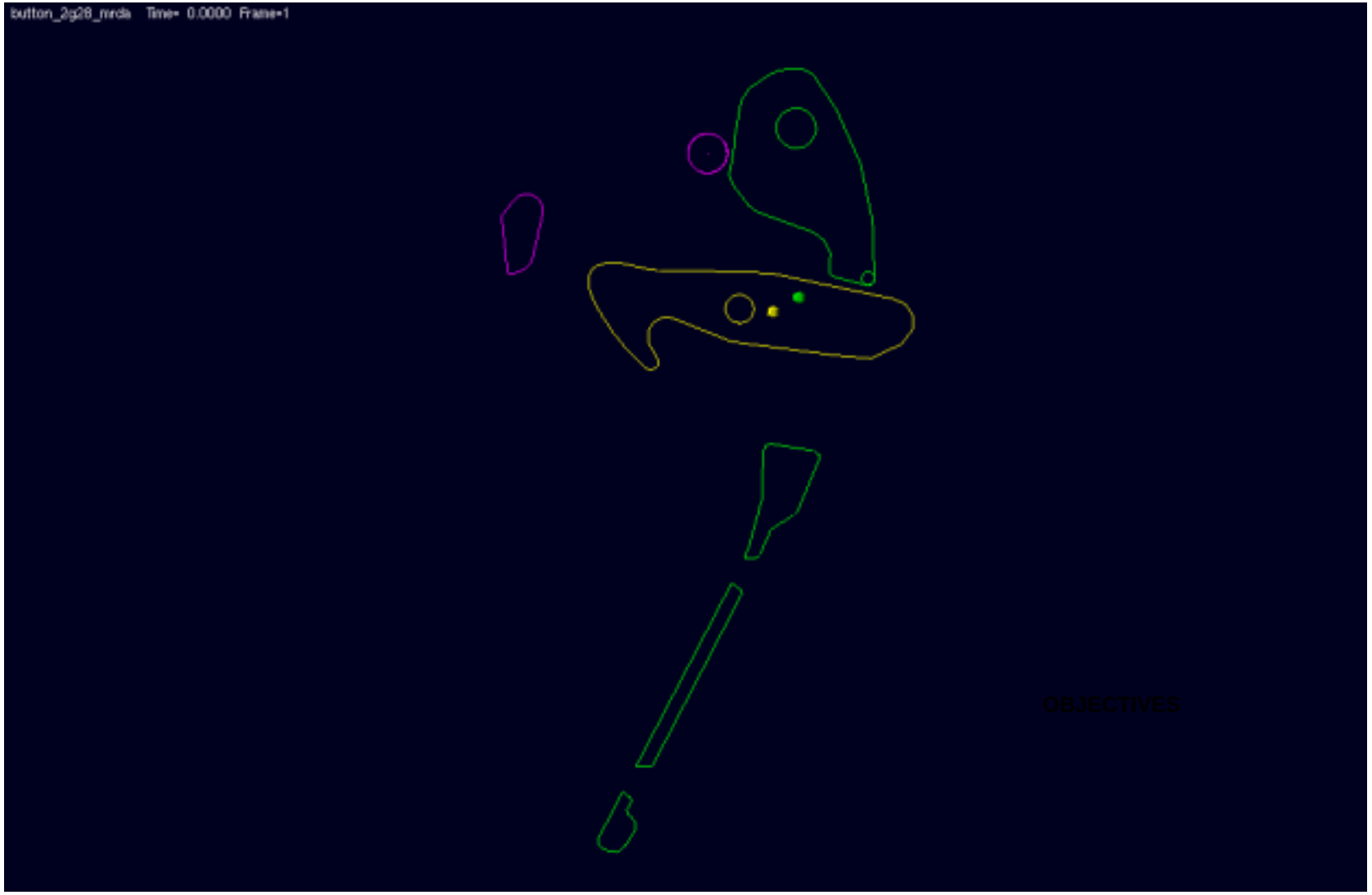
Objective of analysis

- Reshape button ramp in order to reduce latching efforts



Animation



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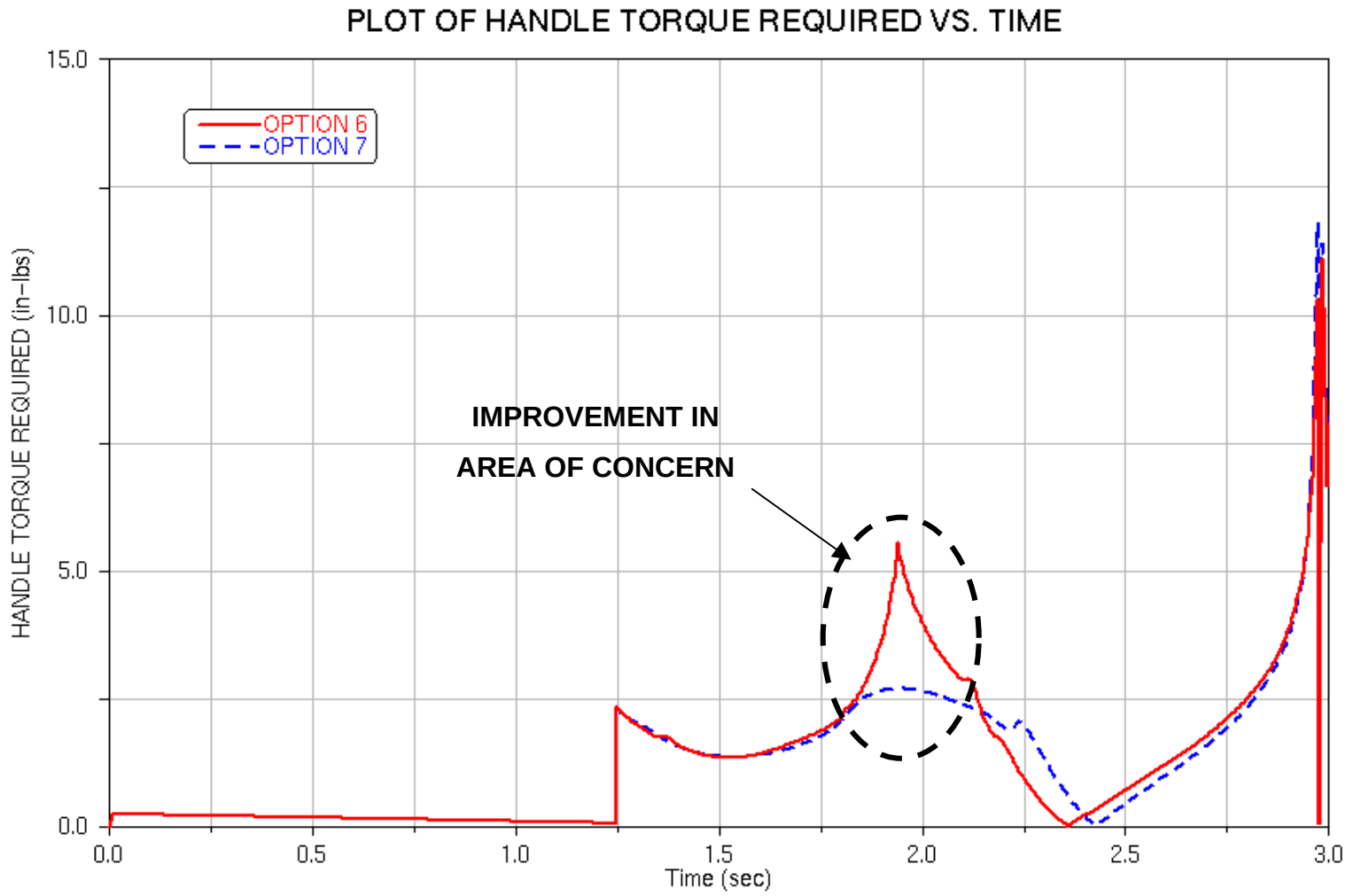
Simulation Results



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Case Study #2: Convertible Top Latch Mechanism

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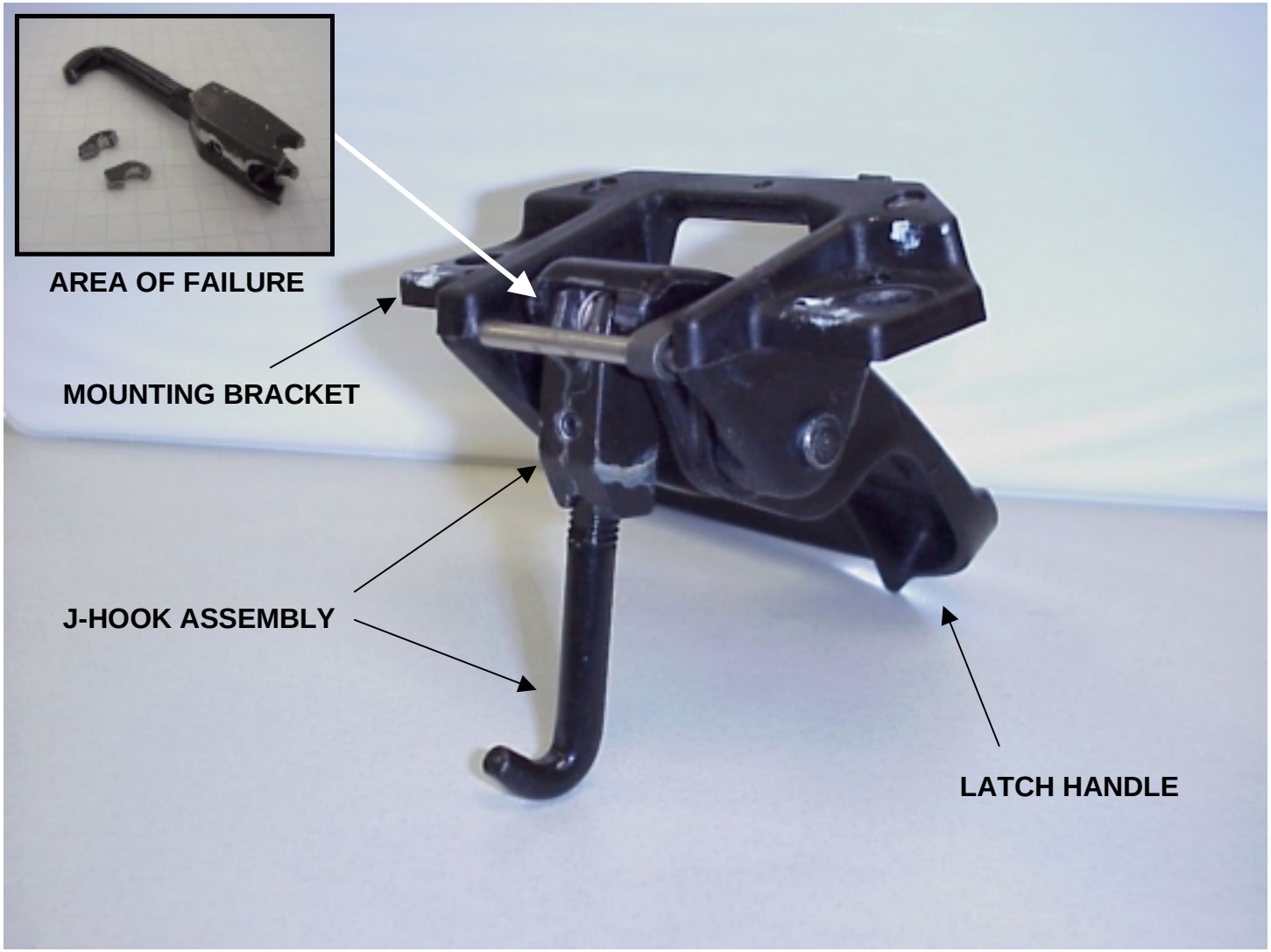
Latch in open position



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Objectives of analysis

- Determine root cause for component failure
- Study the mechanical advantage of the latch mechanism

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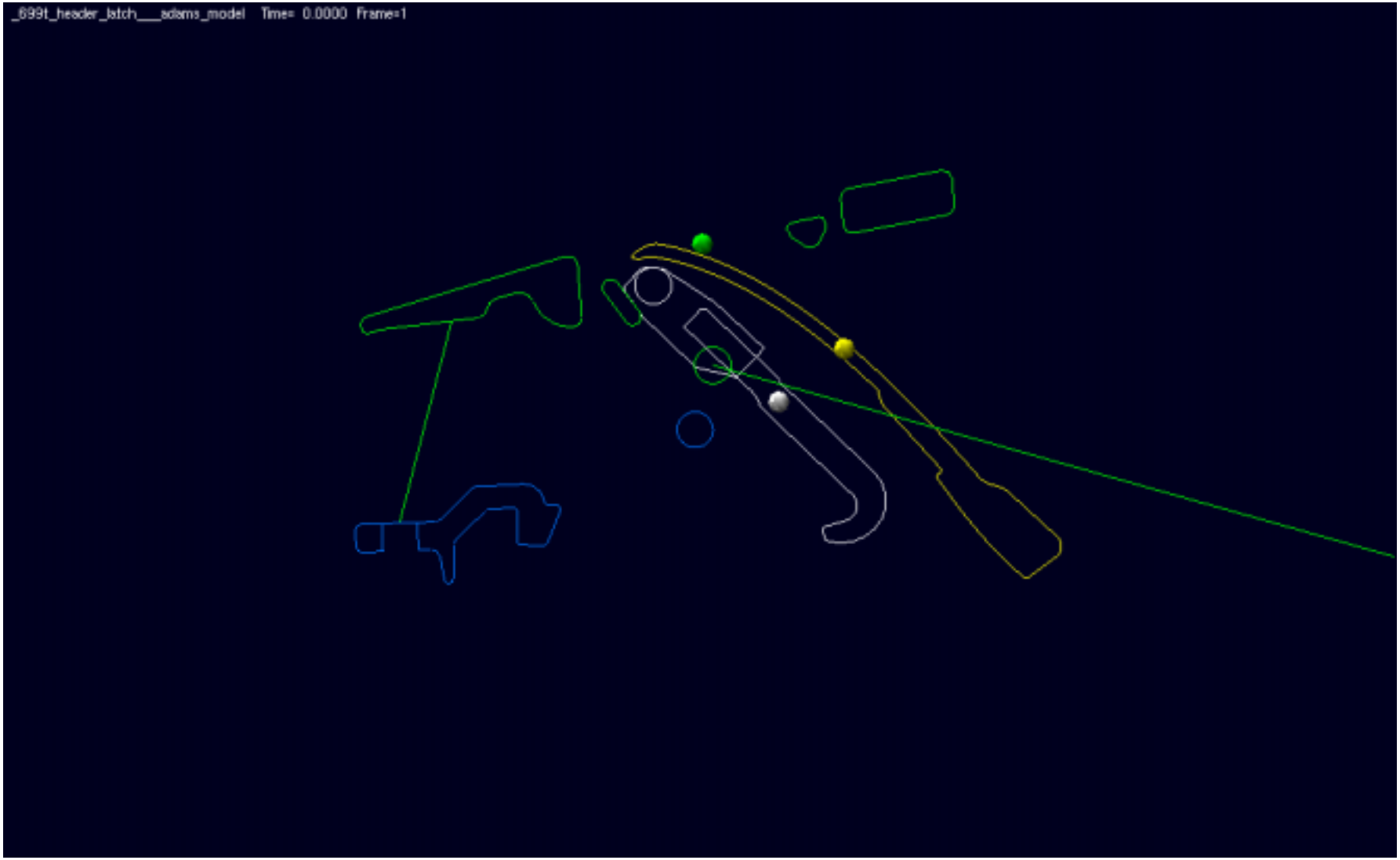
Animation



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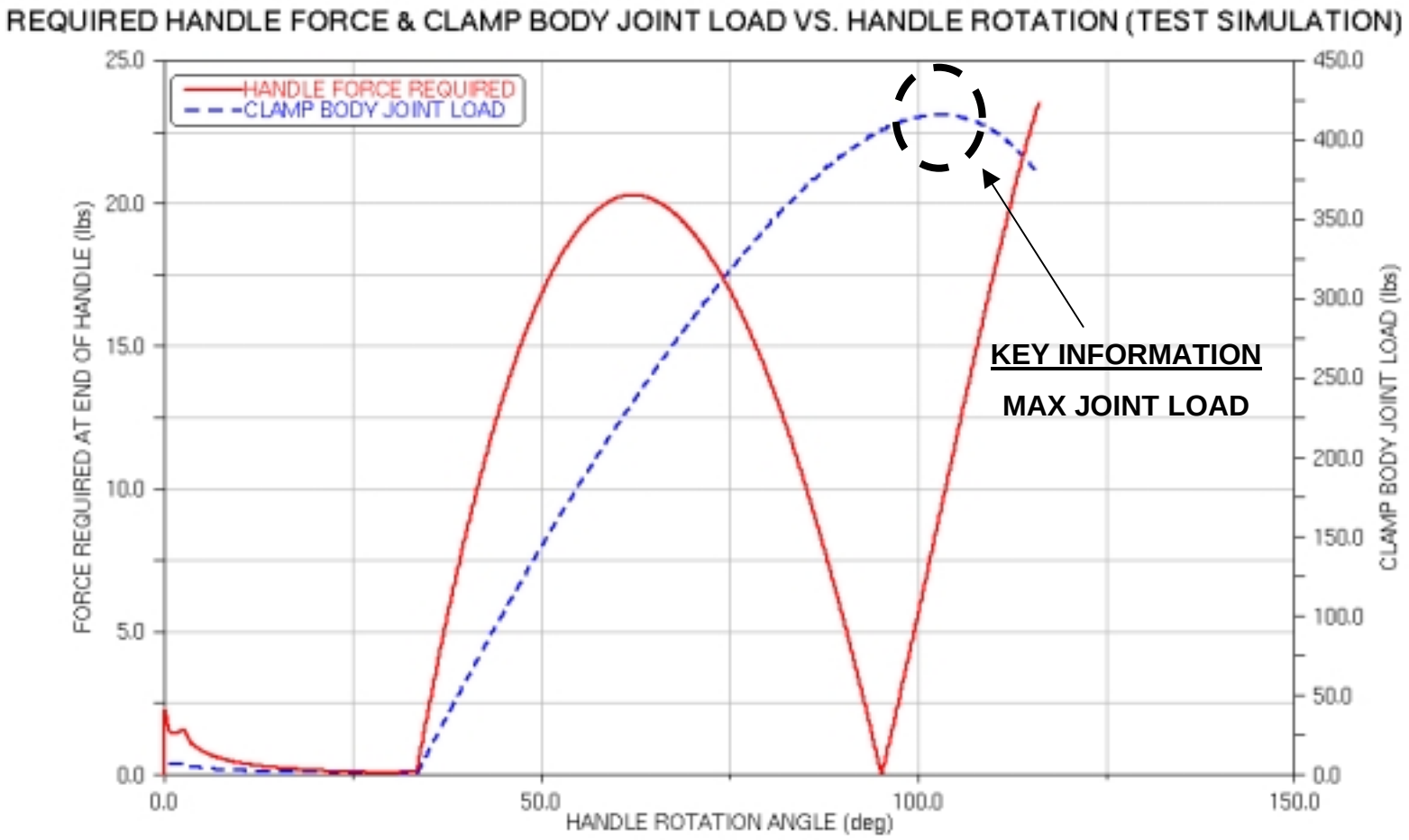
Simulation Results



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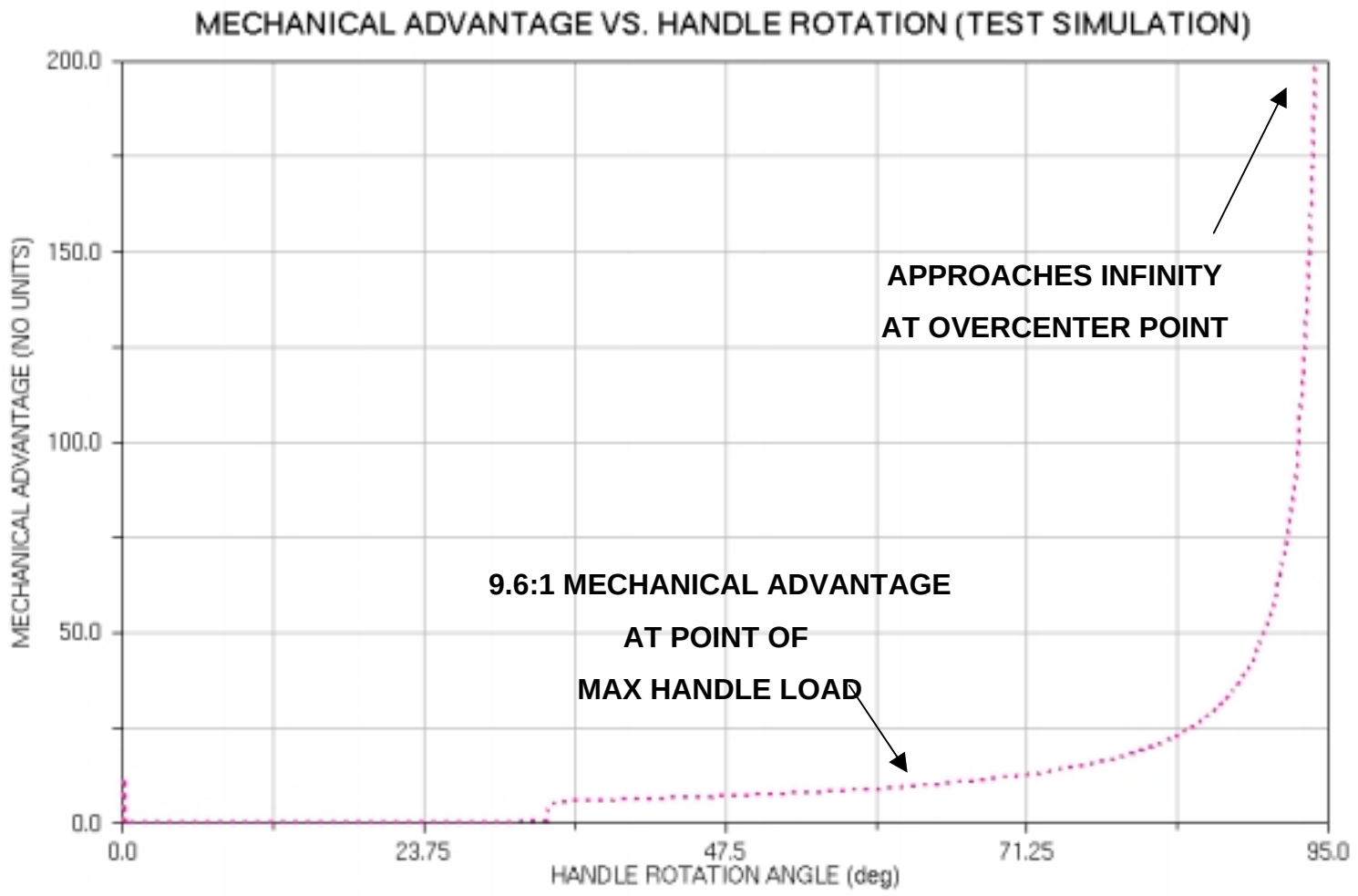
Simulation Results



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Case Study #3: Convertible Top Drive Linkage

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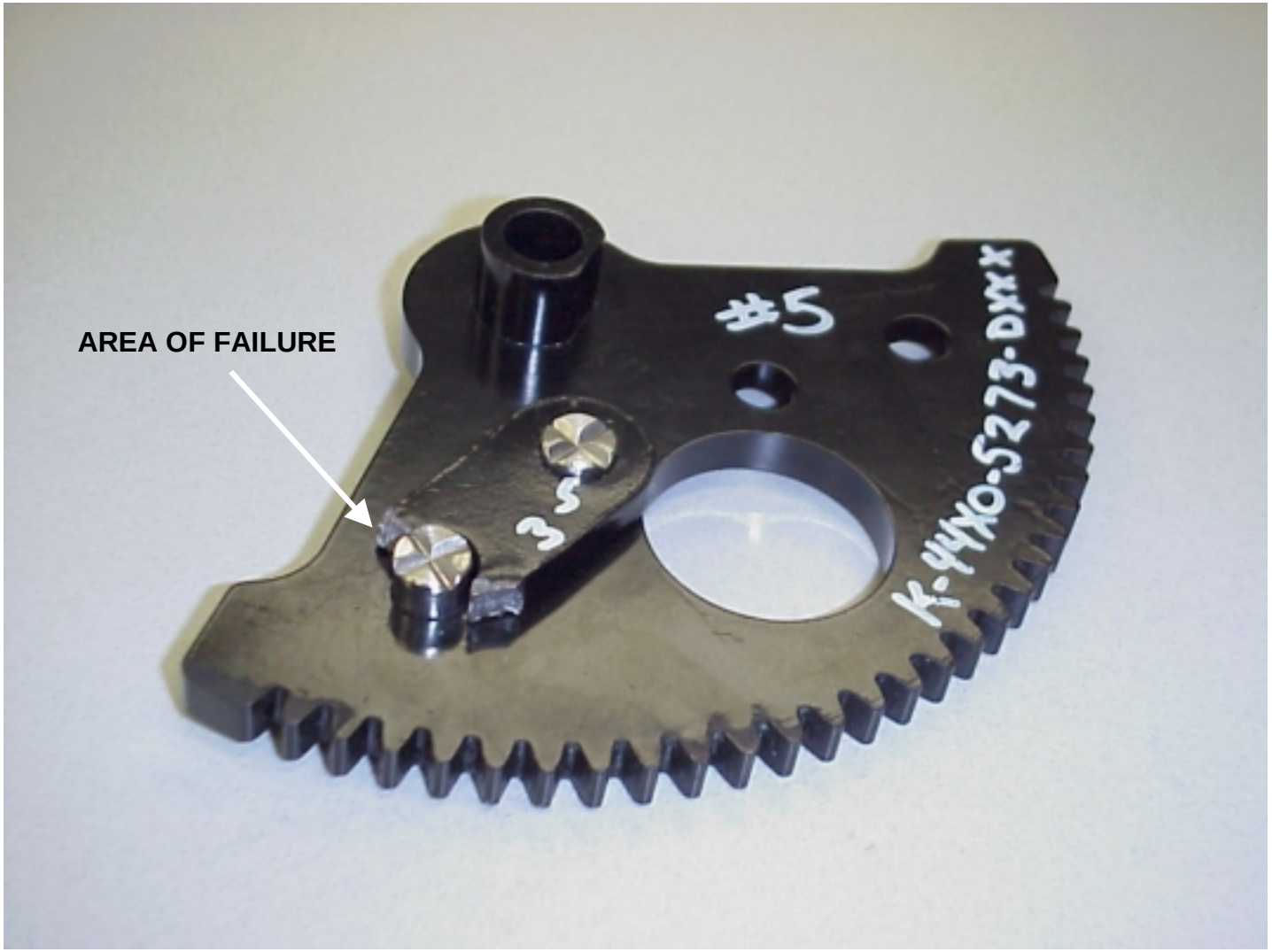
Failed drive link



Objectives of analysis

- Analyze load vectors using CAT/ADAMS
- Use results in finite element analysis
- Determine root cause of failed drive link
- Analyze modified design

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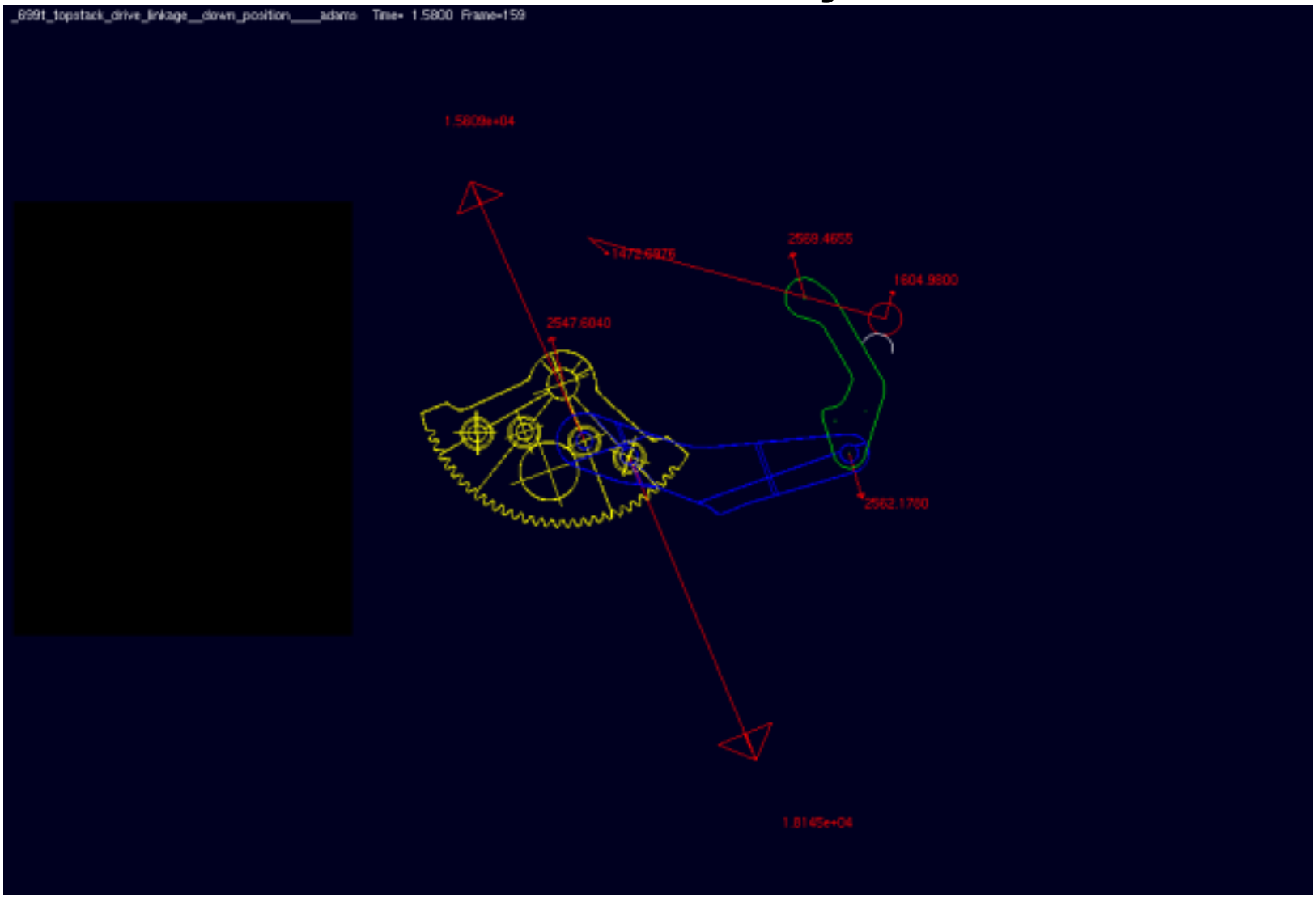
Load vector analysis



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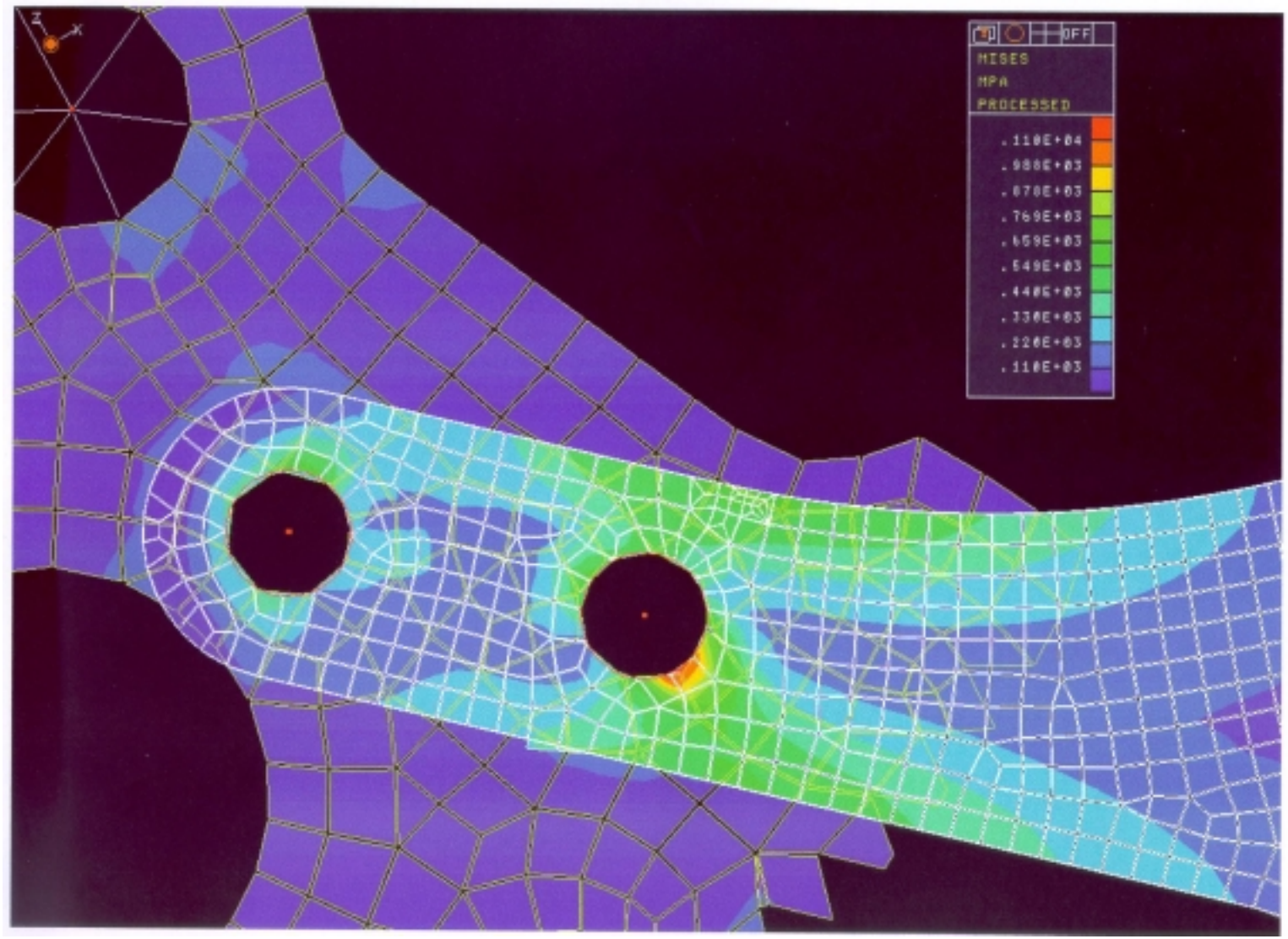
Finite element analysis results



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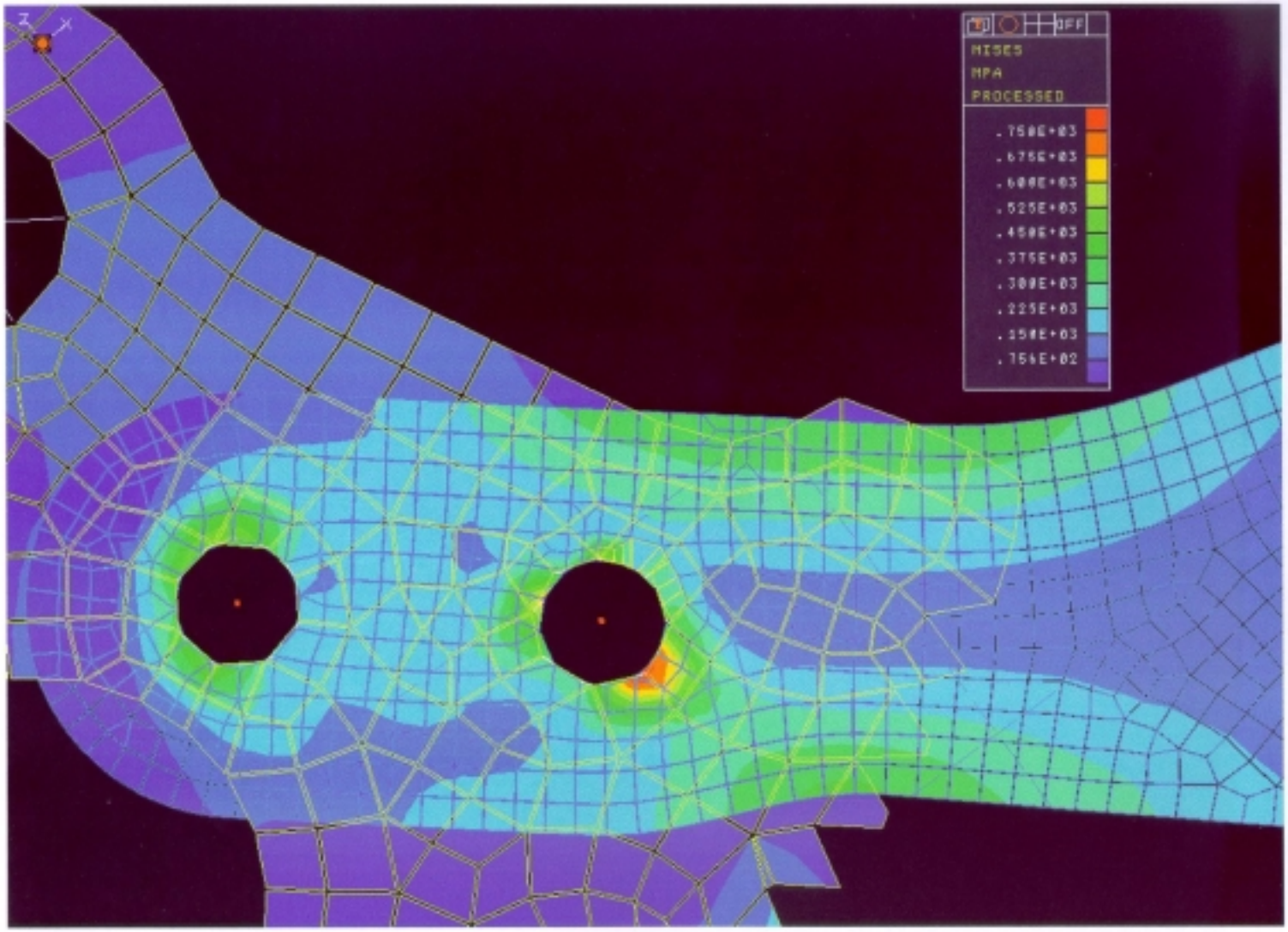
Finite element analysis results - Modified design



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Next steps at ASC

- Model additional existing mechanisms & correlate with test results (ideally use for failure analysis)
- Begin to use CAT/ADAMS to model concept stage mechanisms
- Gain management confidence and make CAT/ADAMS analysis a standard task in our design process

Question & Answer Period