PACCAR E-Truck: Retrofit Packaging & Optimization

STUDENTS: Dane Bowman-Weston, Kyle Jiang, Kamiar Pousti, Sakar Shakya, Cameron Urquhart, John Viacrucis

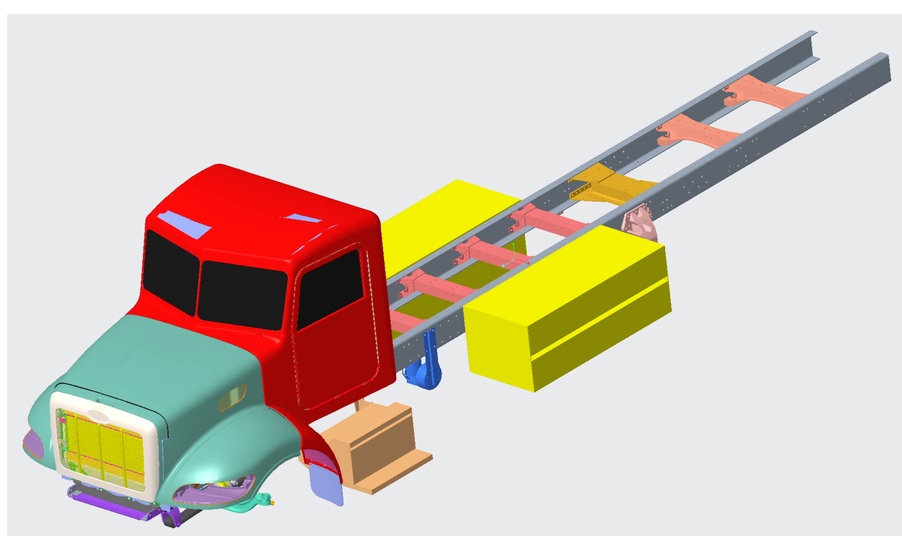
SUMMARY

Introduction:

- The goal of this 4-year project is to convert a Class 7 Peterbilt 337 ICE truck into a fully battery electric vehicle.
- We are working closely with 3 other E-Truck capstone teams: **Controls** Architecture, **Electrical** Architecture, and **Systems** Definition & Modeling.
- We also collaborate with the E-Truck Registered Student Organization (RSO).

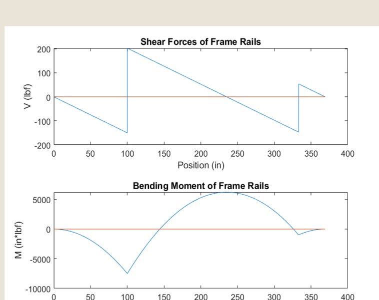
Objective:

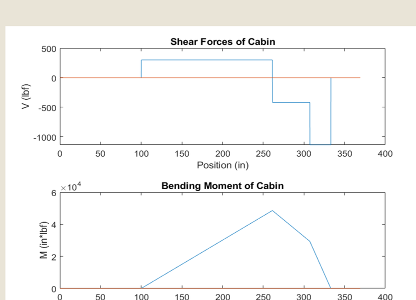
- Select appropriate components based on industry performance metrics using Market Research, Six Sigma Decision tools, and Supplier consultations.
- Ensure structural integrity and safe mounting of electrical components through Static Beam Analysis and Finite Element Analysis (FEA), including Modal Analysis.
- Modify CAD model to package battery-electric powerplant into the ladder chassis.
- Modify auxiliary systems to operate without ICE power

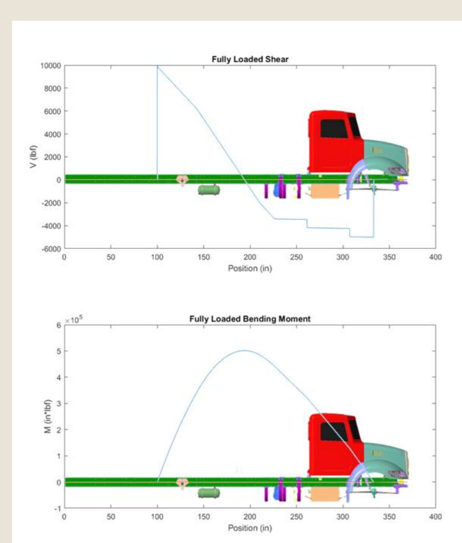


STRUCTURAL ANALYSIS

- Breaking truck into parts to find axle loads
- Max front load: ***12,000 lbs*** / Max rear load: ***21,000 lbs***
- Add payload to bring gross weight to ***33,000 lb*** (Class 7 Max)
- Maximum shear (per frame rail): ***~9,868 lbs***
- Maximum bending moment (per frame rail): ***~501,400 in-lb***

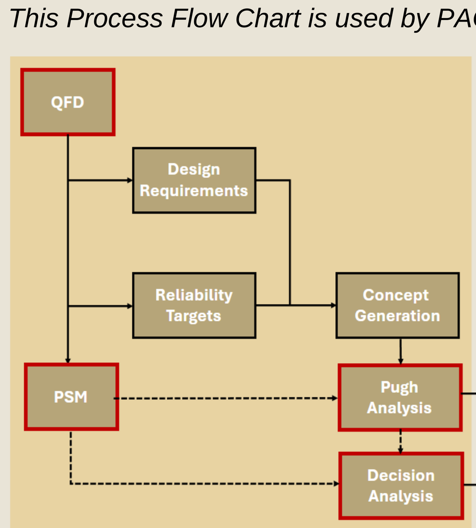


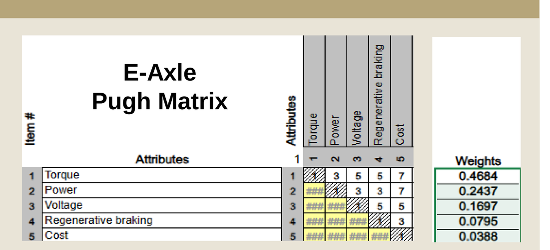


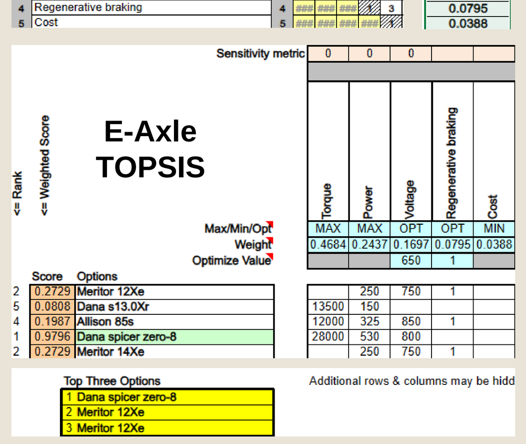


DECISION ANALYSIS

This Process Flow Chart is used by PACCAR for Design Selection

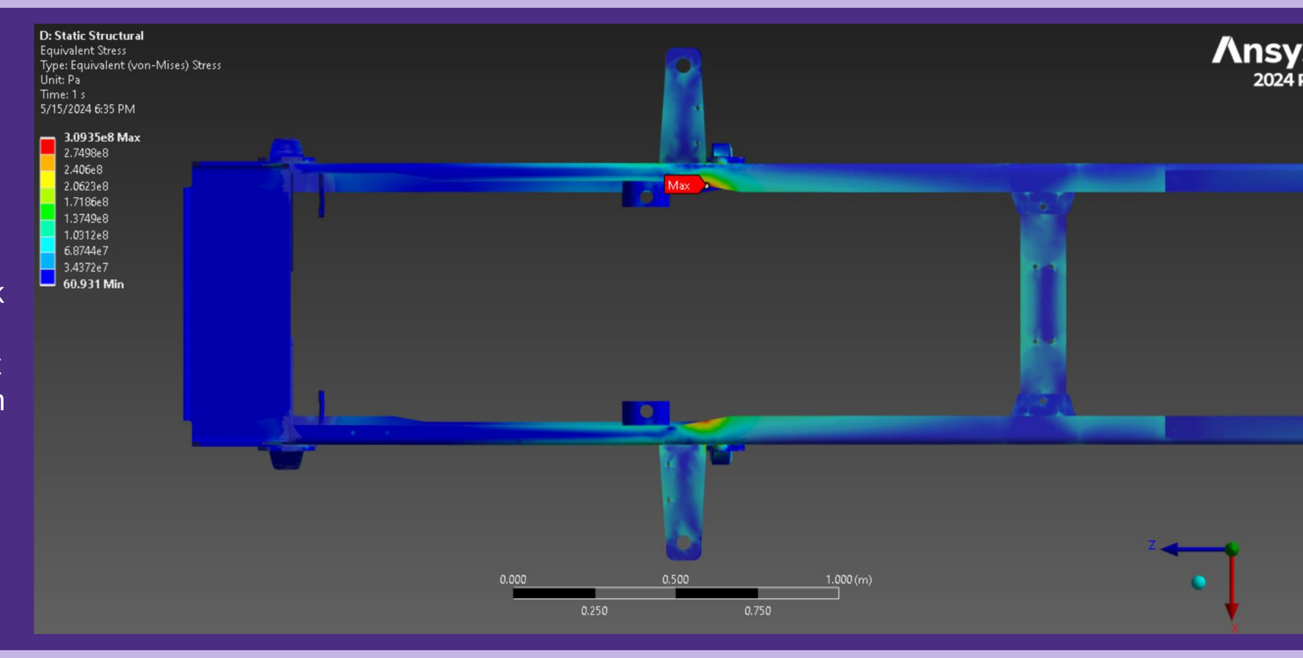






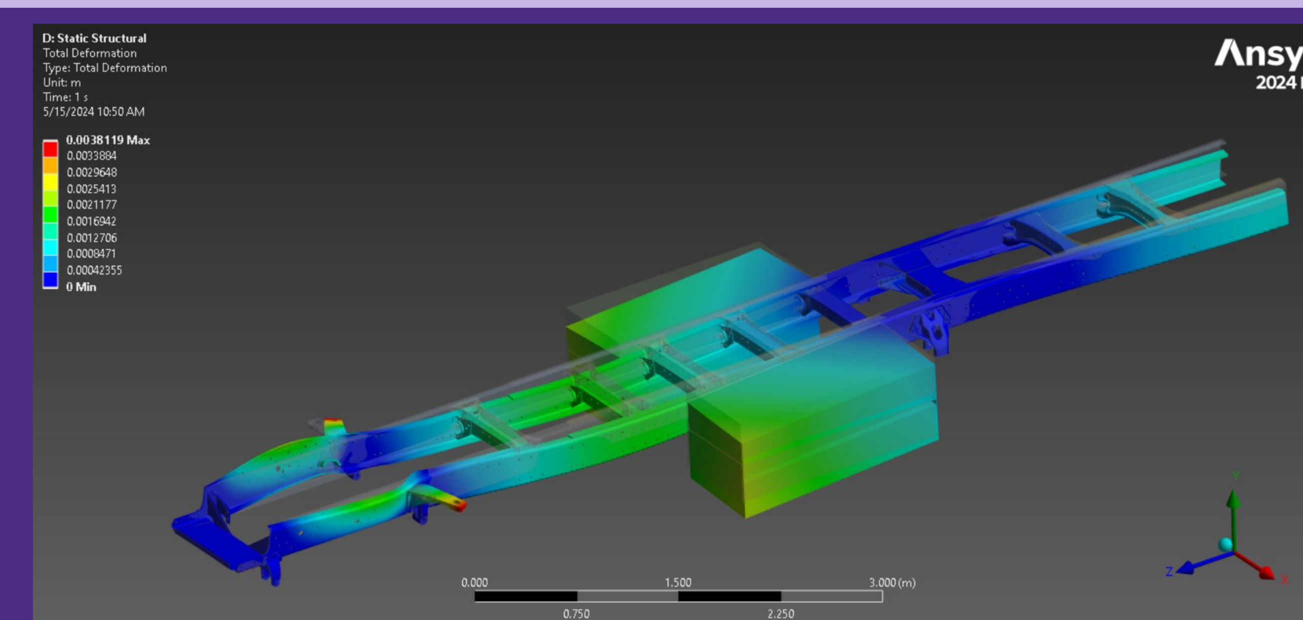
6G CABIN STRESS

Stress incurred at the site of the truck cabin due to a scenario in which the driver reverses into a loading dock at 6G's (dock strike). Maximum stress in this area is ~ 309 MPa



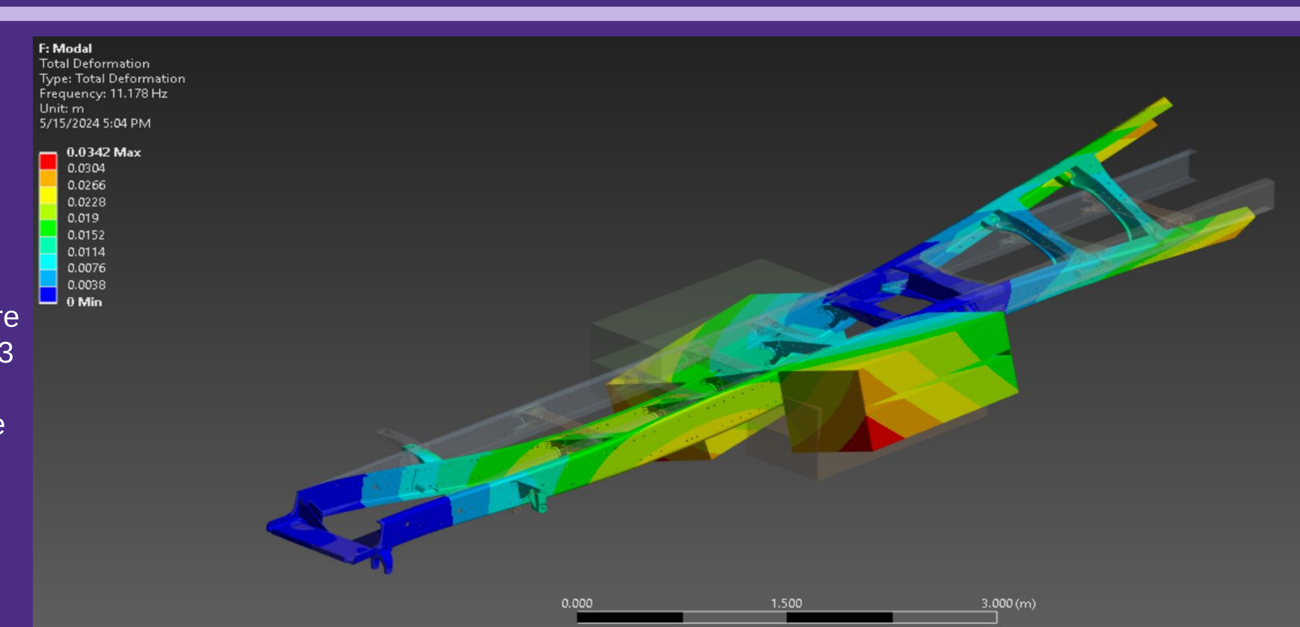
6G DEFORMATION

Image is an exaggeration of the deformation in the frame due to 6G dock strike. Max deformation is ~ 3.8 mm



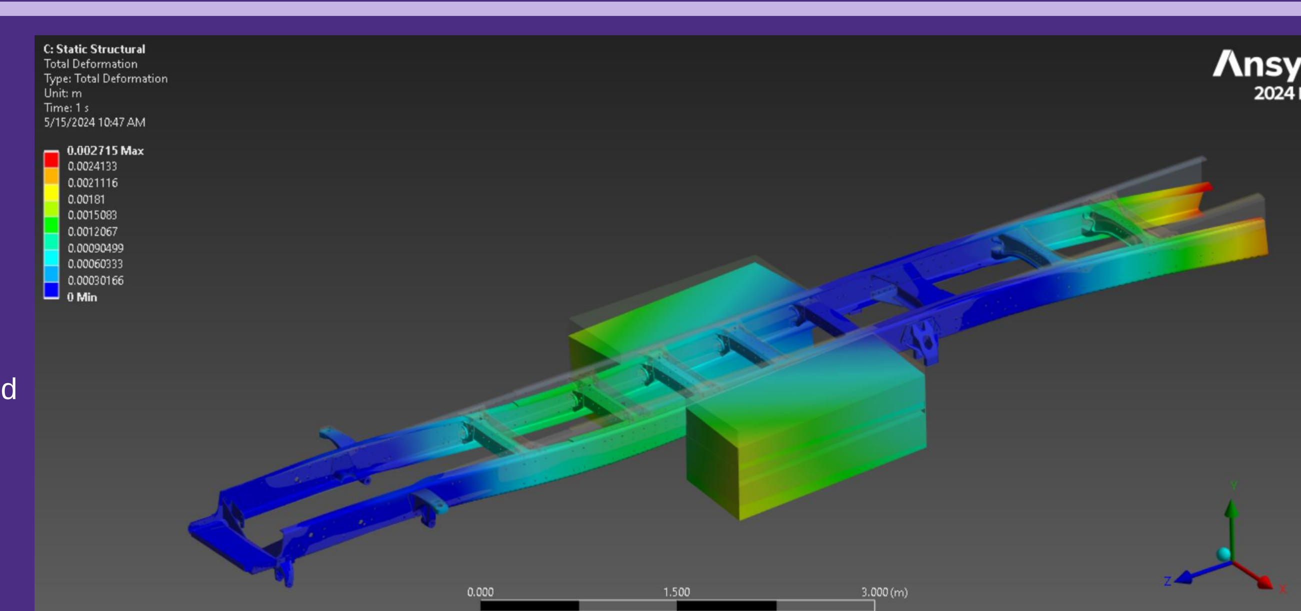
MODAL ANALYSIS

In Modal ANSYS, the first 6 natural frequencies (modes) of the frame were found and ranged from 11.18 to 25.33 Hz. Harmonic Response analysis suggests the frame reaches extreme amplitudes at 11.18 Hz

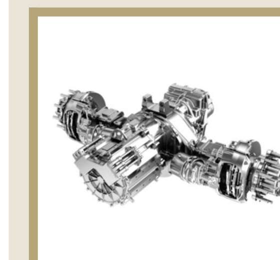


2G FATIGUE

Image is an exaggeration of the deformation in the frame due to fatigue as a result of bottoming the suspension at 2G bump and a rebound of 1.5G. Current model suggests infinite life in the ladder chassis with batteries mounted

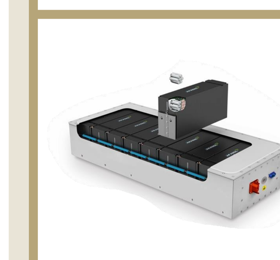


COMPONENT SELECTION



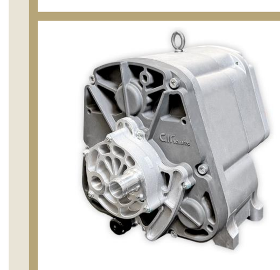
DANA—Spicer Zero-8 E-Axle & Inverter

Power:	530 kW	Voltage:	400-800 V
Torque:	28,000-130,000 Nm	GCW:	16,000-70,000 kg



AKASOL—9 AKM 150 CYC HV Battery (x4)

Energy:	98 kWh	Weight:	560 kg
Voltage:	665 V	Cycles:	4,000



AirSquared—P17H043D-BLDC-LC Air Compressor

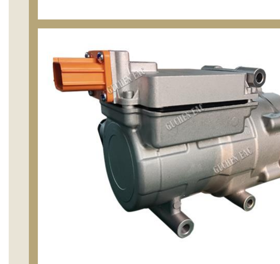
Pressure:	190 psi	Flow:	425 L/min
Displacement:	134.5 cm^3/rev	Weight:	18 kg

Bell Intercoolers—EWP130 Water Pump

Pressure:	72.5 psi	Flow:	130 L/min
Speed:	600-1200 rpm	Weight:	1.226 kg

DC Airco—DC 6001 Heat Pump

Power:	3.4 kW	Voltage:	400-850 V
Flow:	25-40 L/min	Weight:	21.5 kg



GUCHEN—Electric Truck AC Compressor

Power:	2.82 kW	Cooling:	3.175 kW
Displacement:	34 cm^3/rev	Weight:	6.1 kg

CONCLUSION

Summary:

Throughout the two quarters, our team made substantial progress. We conducted comprehensive market research based on the requirements developed in collaboration with the 3 other capstone teams. Through supplier consultations and the application of Six Sigma tools like the Decision Analysis and the Pugh Matrix, we generated rankings for all components. We successfully analyzed the chassis structure to ensure structural integrity and safe mounting of the high voltage batteries. Our team also modified the CAD model to incorporate the selected high-voltage batteries.

Future Work:

- Finalize the selection of all components and maintain ongoing supplier engagement
- Conduct a Decision Analysis to affirm the High Voltage Battery selection
- Confirm decisions regarding the necessarily auxiliary components for the cooling system
- Refine FEA, including Modal analysis with all components selected
- Update the CAD model to incorporate the E-axle, auxiliary components, and component mounting brackets

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MECHANICAL ENGINEERING
UNIVERSITY of WASHINGTON

ADVISERS: John Hartley, Raeef Barsoum, Per Reinhall

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