



# InDepth

Engineering Solutions

EV/HEV  
SERVICES

DESIGN

ANALYZE

ENGINEER



## WHAT WE DO

InDepth Engineering solutions is a mechanical engineering consulting firm recognized for its commitment to providing the highest level of quality service.

Founded in 2006, with focus on automotive industry, we have since spread our wings to provide innovative solutions to amusement park, medical device, alternative energy, consumer products and aerospace industry.

Our integrated design and development services cover all key aspects of a project, such as design (CAD), engineering and drafting, load development using multi-body dynamics (MBD), computer aided engineering (FEA/CFD). Through extensive detailing and rigorous root cause analyses, we explore creative ways to problem-solve and overcome difficult design challenges.

We approach every challenge with a passion for professionalism and excellence, which enables us to continuously exceed the expectations of our customers.

## CONVERSION FROM CONVENTIONAL TO HYBRID VEHICLE

### CRASHWORTHINESS

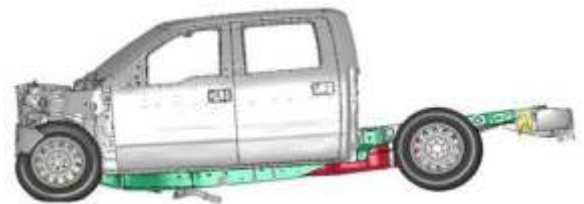
- Conventional vehicle FE model build, validation against public domain test data
- Model update to reflect intended design updates to convert it to Hybrid Vehicle
- Design direction to ensure no degradation in safety performance of the hybrid vehicle

### DURABILITY

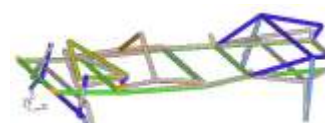
- Durability assessment of frame, hybrid powertrain mount brackets
- Durability of motor, generator housing, battery cradle and various new systems
- Structural and thermal performance evaluation of high voltage battery system

### NOISE, VIBRATION & HARSHNESS (NVH)

- Base model validated against four poster test data
- NVH assessment of Hybrid design to manage modal map
- Dynamic stiffness analysis of powertrain mounts
- Designing the mount and bushing rates to obtain best performance



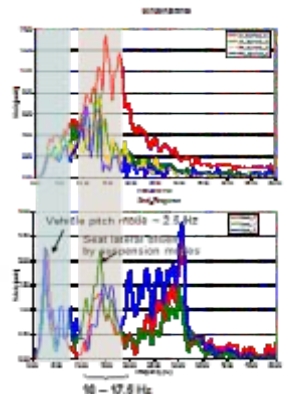
### Four-poster test data analysis



Suspension Modes



Powertrain Modes

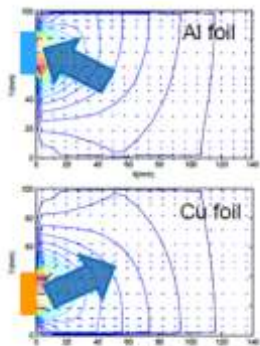




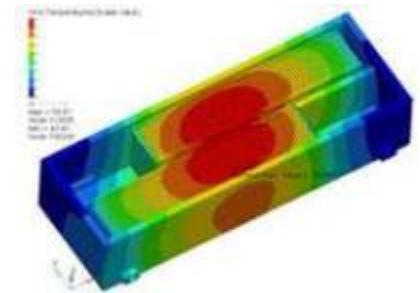
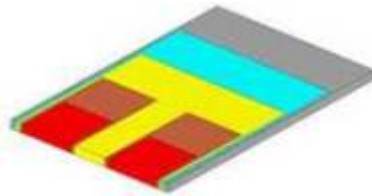


## THERMAL MANAGEMENT OF BATTERY PACK

- Thermal management from cell to module to pack level.
- Heat generation based on internal resistance and duty cycle.
- Hand calculations and CFD for flow optimization
- Temperature variation in cells per NREL
- Transient and steady state heat transfer analysis to minimize the temperature and increase battery life

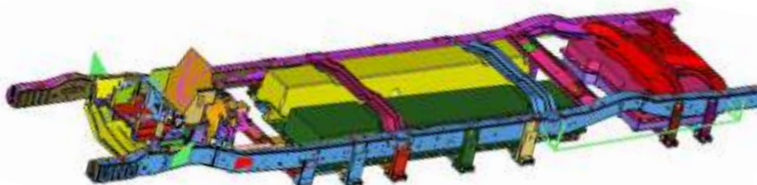


\*Source: [NREL](#)



## ELECTRIC AND HYBRID PICKUP TRUCK

- Durability evaluation of battery cradle design for heavy battery packs as per SAE requirements.
- Crucial design decisions such as the number of mounts, mount spacing etc. for the bolt-on cradle made with accurate engineering calculations.
- Performance of the design under several loading scenarios, as per SAE is verified.
- All the fastener and adhesive bond evaluation with adequate conservative measures performed.
- Modal performance of the design also evaluated.



# HYBRID CARGO VAN DEVELOPMENT

- Parallel Hybrid vehicle – front wheel driven by IC engine, rear wheel driven by motor
- All aluminum uni-body construction with underbody power-tub
- Front rail and bumper development for best energy absorption to weight ratio
- Engine box packaging for maximum utilization of crush space
- Body development – optimized pillar and roof rail sections for roof crush, body torsion and bending modes and stiffness
- Power-tub development – enclosure design meeting side impact and various SAE requirement

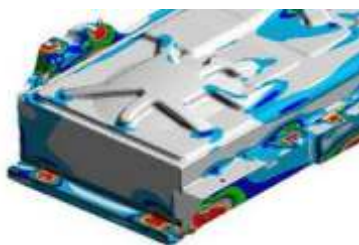


## DESIGN OF BATTERY ENCLOSURES FOR ELECTRIC AND HYBRID VEHICLES

InDepth has successfully executed design, validation, and optimization of the battery enclosures meeting all the performance and mass targets.

### BATTERY BOX DESIGN FOR ELECTRIC CAR

- Various durability, modal, shock and impact load cases analyzed to ensure structural integrity of the battery pack and battery box.
- Thermal Management of battery packs from cell level to module to pack level. Water and air cooled packs- CFD and heat transfer simulations.
- Design recommendations made and implemented to protect battery terminals from contacting the enclosure during various loading, avoid module mount adhesive failure and electrical connection failure.
- Significant cost saving achieved by minimizing usage of adhesive, optimizing weld placement and count.
- Significant weight saving achieved by proper bead placement, getting proper joint stiffness, introducing lightening holes where material was not needed, and sheet metal optimization.
- Excellent correlation of PSD durability simulations with test failures.
- Enclosure design changed significantly to eliminate all failures.
- Final design tested to meet the required life.



Baseline Design



Final Design



## WHY PARTNER WITH US??

Our advanced CAE capabilities and familiarity with the industry standards, have helped our customers achieve significant cost and mass savings with robust designs.

We assess each project individually, based on its objectives, parameters and drivers to develop specific methodologies that will add value and de-risk the project.

At InDepth, we bring advanced technologies for design synthesis, structural optimization, reliable manufacturing feasibility studies and innovative ways to meet even the most critical needs of our customer, at a cost effective and lower time development time.

Our engineers take personal pride in their work. We understand the nuances of the business and careful thought is put in to individual project by our experts. Thus, creating an excellent relationship that makes our clients come back to us, again and again.

InDepth Engineering is your one stop solution to all challenges.

## OUR TOOLS

 **SOLIDWORKS**



**Altair**

**HyperWorks**

 **SIMULIA**  
**ABAQUS**



**MSC Nastran**

**SAP2000**



**RISA-3D**

 **AUTODESK**  
**INVENTOR**




 **AUTODESK**  
**MOLDFLOW**



**LS Dyna**



**AUTODESK**  
**REVIT**

 **AUTODESK**  
**AUTOCAD**



**AUTODESK**  
**ALIAS**

**ANSYS**



**SIEMENS**  
**NX**



## CAPABILITIES

Computer Aided Engineering (FEA/CFD)  
Product Design and Development  
Design Optimization  
Mechanical System Design  
Systems Integration  
Reverse Engineering  
Program Management

## CAE EXPERTISE

Durability & Fatigue  
Crash Analysis  
Noise and Vibration  
Computer Aided Optimization  
Composite Material Simulations  
Thermo - Mechanical Analysis  
Computational Fluid Dynamics  
Manufacturing Simulations

## STANDARDS

FMVSS, NCAP, IIHS, SAE Guidelines,  
ECE, FMCSR

## INDUSTRIES SERVED

Automotive  
Amusement Park  
Aerospace  
Alternative Energy  
Medical Device  
Consumer Products

## AUTOMOTIVE EXPERTISE

Full Vehicle  
Body Structure  
Chassis and Suspension  
Seating Systems  
Interior Trims  
Powertrain  
EV / HEV

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## CONTACT US

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