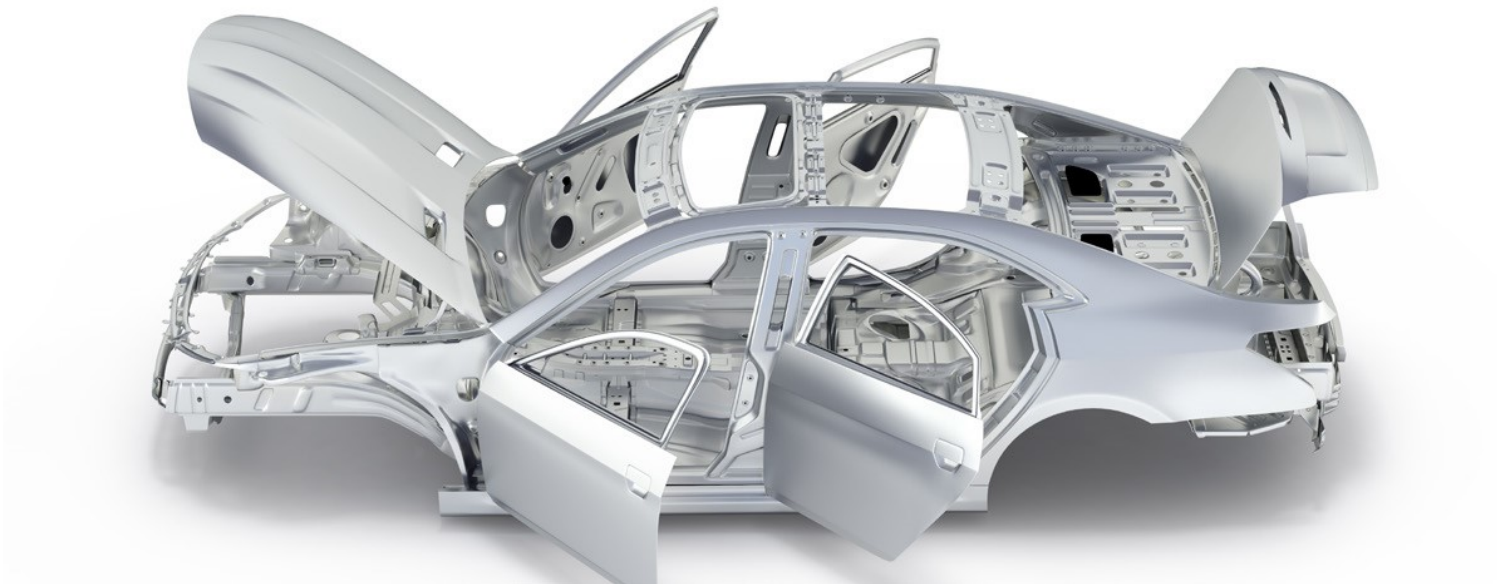
HEXAGON | MSC Software

Case study

AI/ML based trimmed body NTF & global modes prediction & optimization using ODYSSEE CAE

ODYSSEE CAE helps Satven reduce the time required for trimmed body NVH simulations and optimization from multiple days to a few minutes



Satven was established in the year 2000 with a singular focus & objective – to cater to the varied & complex design & engineering needs of the automotive industry. The company has today grown multifold to become one of India's leading automotive engineering bureaus.

Skilled human resources, consistent quality, broad knowledge base, strategic partner alliances, domain & subject matter expertise, and strong customer relationships have been continuously propelling Satven's growth into higher orbits.

Satven provides comprehensive solutions to the automotive industry that cover a wide range of engineering activities, including but not limited to Concept Design, Product Design, Value Engineering/ Value Analysis (VA/VE), Dimensional Management, Sourcing, Knowledge Based Engineering (KBE), myriad non-linear and linear FEA, full vehicle crash, NVH, durability, Computational Fluid Dynamics (CFD), and Multi-Body Dynamics (MBD).

Satven is a global organization with engineering centers in Germany (Munich) and India (Hyderabad & Chennai) in addition to offices in Detroit, Munich, Shanghai, and Hiroshima and its corporate offices in Hyderabad.

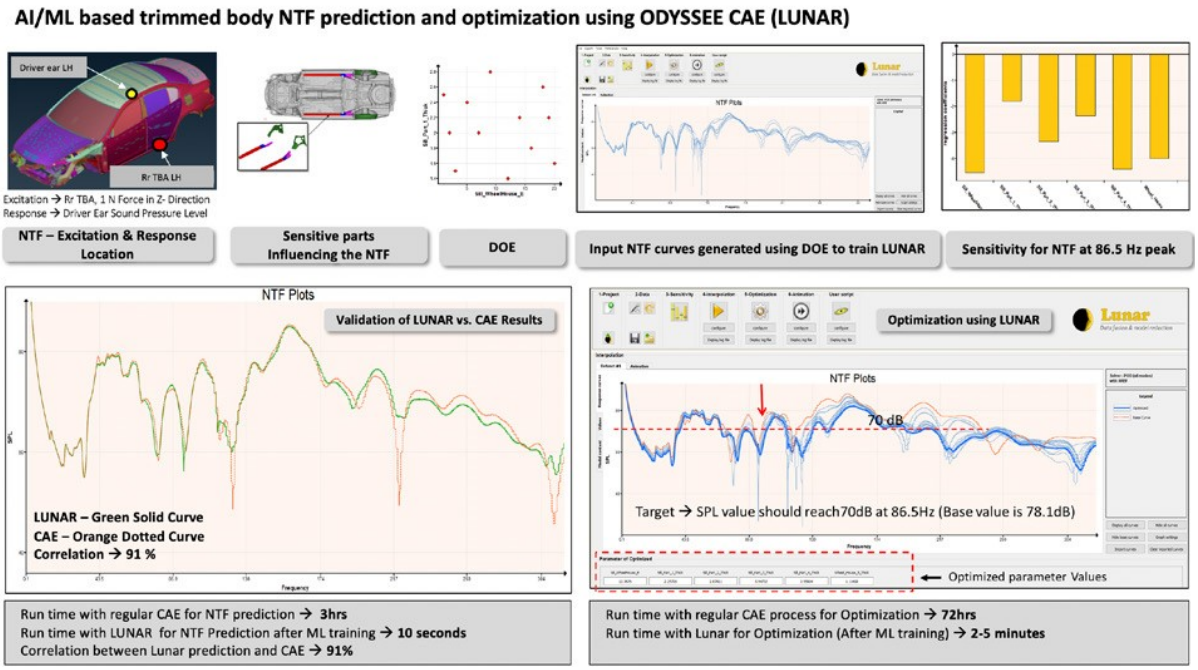


Fig 1: AI/ML based trimmed body NTF prediction and optimization using ODYSSEE CAE

Challenge

The emergence of AI and ML in vehicle development promises to transform the automotive industry and spur innovation. As a leading engineering solutions provider to the automotive industry, Satven was keen to leverage the advantages of AI and ML to ensure superior services and deliver a definite competitive advantage to its customers.

To this end, Satven embarked on a competency development project to strengthen its capabilities in delivering AI/ML-based solutions to its customers. The team decided to explore an AI/ML approach for quick predictions and optimization. In particular, the effect of BIW Panel Thickness and Young's "E" modulus on Trimmed Body NTF/VTF/Global Modes was studied and accordingly optimized.

Solution

The Satven team was keen to use ML techniques available in the ODYSSEE CAE software from Hexagon (see https://www.mscsoftware.com/product/odyssee). The ODYSSEE CAE optimization package is an innovative tool built by exploiting machine learning and reduced order modelling (ROM) techniques to replace traditional response surface solutions by ROMs, thus allowing for predicting of arbitrary time dependent and non-linear physical phenomena. Satven decided to use open source Honda Accord 'Body in White' FE model for the evaluation (https://www.nhtsa.gov/crash-simulation-vehicle-models).

The evaluation had following objectives –

1. **Noise Transfer Function (NTF) –**
    a. Study of BIW component thickness & material sensitivity on NTF
    b. NTF predictions using ML approach (without actual CAE simulations)
    c. NTF optimization using ML approach (without actual CAE simulations)
2. **Global Modes –**
    a. Study of BIW component thickness & material sensitivity on front end lateral bending mode
    b. BIW front end lateral bending mode prediction using ML approach (without actual CAE simulations)
    c. BIW front end lateral bending mode optimization using ML approach (without actual CAE simulations)

Satven team identified a few sensitive components for the NTF and Global Modes study based on initial set of runs. The thickness & Young's Modulus of these components were considered as variables for generating the initial Design of Experiments (DOE) which is used for training the ML model. The DOE is generated using ODYSSEE CAE. Subsequently, the NTF and Normal Modes analysis decks were generated using the Parser

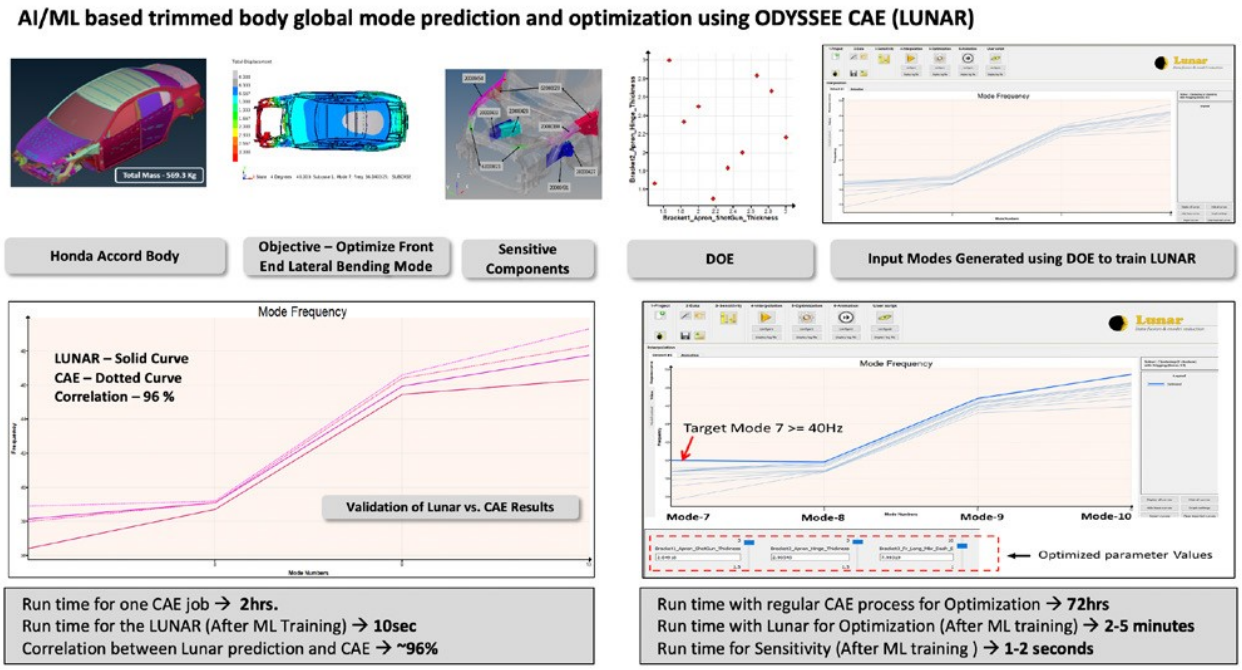


Fig 2 : AI/ML based trimmed body global mode prediction and optimization using ODYSSEE CAE

Tool in ODYSSEE CAE with MSC Nastran as a solver. The decks were then solved using the MSC Nastran solver to generate the NTF & Normal Modes output.

In the next step, the DOE parameters (X-Input) and NTF/ Modes (Y-output) are fed to the ODYSSEE CAE tool to generate a Reduced Order Model (ROM). The sanity of this ROM model is checked by comparing the ODYSSEE CAE predicted results (ML results) against results predicted by MSC Nastran (CAE results). Once validation is done, the ROM model is used to predict the sensitivity of the input parameters to the NTF/Modes results. In the next step targets and constraints are set for NTF + Modes and Optimization is carried out using the ROM model to arrive at optimum design parameters.

Key highlights:
Product: ODYSSEE CAE, MSC Nastran
Industry: Automotive
Benefits:
ODYSSEE AI/ML helps Satyam Ventures significantly reduces time required for Trimmed Body NVH simulation and optimization.

Results

The correlation between ODYSSEE CAE (ML) and MSC Nastran (CAE) results was found to be 91 % considering major peaks. Also, where the traditional FEM simulation takes about three hours, ODYSSEE CAE simulation takes only a few seconds. Identifying the sensitivity of the parts could be achieved in just a few seconds and given that there are multiple simulations required, the total time could be several hours/days or even weeks with traditional CAE, which makes it practically impossible to try out a variety of iterations. Whereas the ODYSSEE CAE Reduced Order Model simulation takes only a few seconds which is very helpful in identifying sensitive parameters, trying out a large number of design iterations in very short time spans, leading to better and faster decisions and the development of better vehicle designs. Based on the results and the massive advantages that automation with AI/ML provides, the Satven team is keen to explore the use of these tools in actual vehicle development for their customers.

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Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

MSC Software, part of Hexagon's Manufacturing Intelligence division, is one of the ten original software companies and a global leader in helping product manufacturers to advance their engineering methods with simulation software and services. Learn more at mscsoftware.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

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