Tire Hexa Meshing for Off Road Applications

DEP MeshWorks | Application sheet

Hex mesh creation procedure along with process automation, reduces more than 20-30% time in building high quality complex tread patterns.

Challenges in Concept studies

- The tread and carcass portion in the Off Road Application Tires has intricate geometry. It basically includes the fillet region areas which are very complex and makes the meshing & modeling a tedious and time-consuming process. Given the composite nature of the treads, building a good Quality Hexa mesh is one of the strenuous task for Tire Design teams.

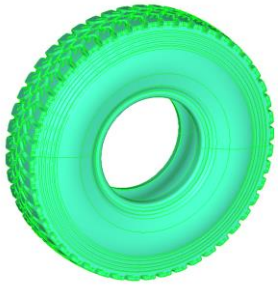
The Solution

- Using the highly automated toolsets users having even less technical expertise can mesh complex geometries in MeshWorks. The Hexa meshing tools in the MeshWorks, designed specifically for off-road tire applications makes this task easy to execute. MeshWorks also provides the 'Extruded Parametric Hexa Mesh' approach which enables creating good quality mesh with minimal inputs from the user.

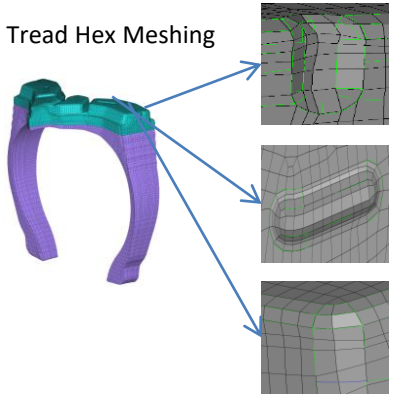
Value

	Process Using Other Tools	Process Using DEP MeshWorks
Time Taken for the Task of Hex Meshing	45-50 hours	12-15 Hours
Expertise Needed	Highly Experienced Engineer	Regular Engineer
Additional Hex Meshing Features	None	Automated tools for better mesh flow, targeted mesh size/pattern modeling, etc.

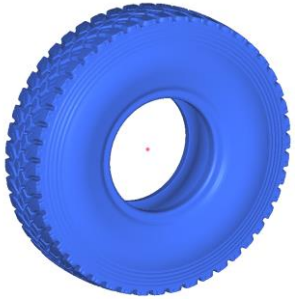
Tire CAD Input Data



Single Tread Hex Meshing



Complete Hex Meshing



Work Flow - Driven by MeshWorks

Complete Pre & Post Processor

- Comprehensive FE/CFD pre & post processor with powerful tools for CAD clean-up, meshing (shell, tetra, hexa, hybrid, etc.), highly automated model assembly and results processing.
- Complex FE/CFD can be generated 30% faster and with better quality than other competitor products.

Customized Engineering Process Automation

- Customer CAE processes can be rapidly automated using a fast Record>Create-GUI>Plumb>Publish process.
- 2X to 10X time reduction can be expected for processes that are repeatable.

CAD & CAE Morphing Technology

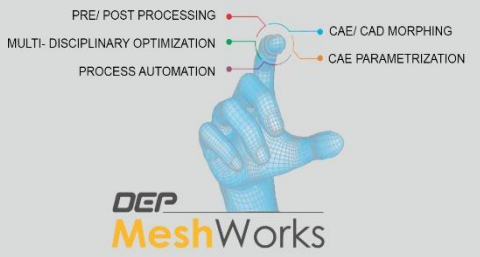
- Reduces Finite Element (FE) & Computational Fluid Dynamics (CFD) model building time by 50% to 80%.
- Generated morphed CAD models representing optimized designs very rapidly and form the main link between CAE & Design teams.

Parametric CAE Technology

- Rapidly converts FE & CFD models to intelligent parametric CAE models, enabling fast design iterations & Design of Experiment (DoE) studies.
- Most comprehensive parametrization engine addressing several categories of parameters such as shape, gage, material, spot welds, seam welds, adhesives, design features, etc.

Multi-Disciplinary Optimization (MDO)

- Enables Multi-Disciplinary Optimization to meet design targets, minimize product weight, and minimize manufacturing cost using parameteric CAE models.



Tire Meshing for 2D Cross Section

DEP MeshWorks | Application sheet

Develop accurate models in order to optimize performance and model complex Rebar layers at reduced time for 2D Tire Sections

Major features of the tire are modeled in detail → Appropriate material models are created for accuracy → Interactions between the different materials are modeled for optimized design

Work Flow - Driven by MeshWorks

Challenges in Concept studies

- The carcass and belt components of a tire are rubber-cord composites, which are simulated by Rebar materials. Compared with tire matrix material, Rebar layer has stronger material rigidity and in a tire cross section the curves are made with various Rebar Layer features. Building a pure Quad Mesh & Rebar layer splitting for tires is a challenging task and requires expertise in modeling.

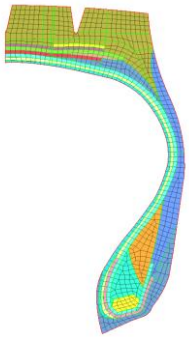
The Solution

- MeshWorks comes with inbuilt tools that helps meshing the 2D structure for tires, which is then used for analysis. The 'Mesher' tool in the MeshWorks provides the 'Pure' Quad Mesh Pattern around the tire cross section curves. Also the functions are designed in a way for easy execution, saving time and effort. MeshWorks delivers maximum quality model with minimal user efforts enabled by 'Automatic Quality' options. MeshWorks also provides the 'Element Splitting' tools which is useful for isolating and managing the Rebar layers as per the requirement.

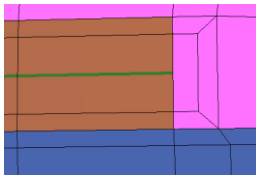
Value

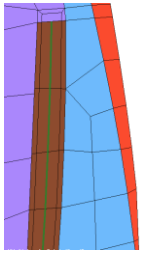
- Each geometric feature have a significant impact on the overall tire design. Without an accurate representation of the 2-D cross section of the tire, the simulation results will lose the necessary quality inputs for design decisions. By using the 'Mesher' & 'Editing' tools in the MeshWorks users can create a concrete 2D foundation for an optimized tire design. This results in reduction of 30-40% time in the Modelling Process compared to other tools.

Tire Cross Section



Tire Cross Section Output





Mesh Pattern

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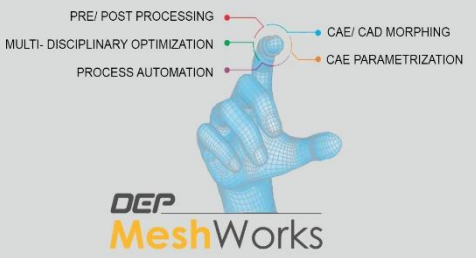


Tire Parametrization for 2D Cross Section

DEP MeshWorks | Application sheet

Local features of tire cross section are parametrized for durability, NVH, DOE studies, 'Response Surface Model' based optimization etc. deriving at new models rapidly.

All Local features of tire are captured in 2D cross-section → Features are parametrized for shape changes → Usage of parametric models for detailed engineering studies

Work Flow - Driven by MeshWorks

Challenges in Concept studies

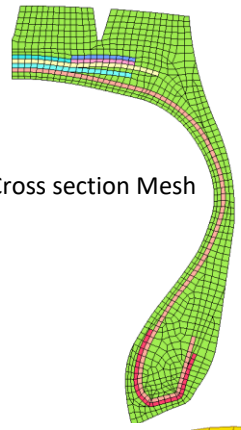
- Accurate meshing of Tire Cross Section Curves, along with the required dimensional modifications is necessary for optimizing tires that positively impacts vehicle performance. From dimension perspective, tire cross section meshing process needs to consider the Inner & Outer Width Changes as well as Rebar Layer thickness changes. For a Tire 2D Cross Sectional Mesh, compounding the above factors, desired skills are need-of-the-hour.

The Solution

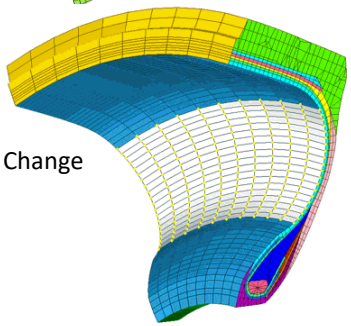
- The Morphing & Parameterization tools from MeshWorks makes this task automated and easy to execute. User can easily derive new FE/CFD models or modify the shape of tire FE/CFD models using MeshWorks. Unique modeling solutions are available in MeshWorks, where user can create the parameter for any particular design change with less time and effort. All major dimensions and feature of an existing tire FE model can be parametrized and new models can be generated from the parametric model rapidly.

Value

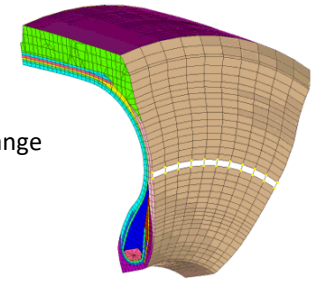
- By using the MeshWorks Morphing approach, during early stages of development, new FE models of tires can be very rapidly derived from existing models. Large proportion changes such as inner and outer radius change, wall thickness change etc. can be swiftly done to existing FE models. Overall, the users can reduce 60-70% time compared to other tools & save a lot of manual efforts in optimizing the tire design.



Tire Cross section Mesh



Inner Skin Change



Outer Skin Change

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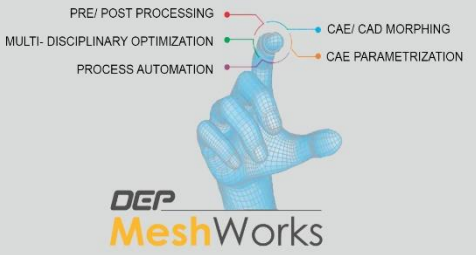


Tire 2D Cross Section Mapping

DEP MeshWorks | Application sheet

Rapid changes to Tire 2D cross section while modeling for analysis of dynamic behavior in extended range of operating conditions.

Challenges in Concept studies

- Because of the various geometric shapes of different parts of the tire such as the tread and the sidewall 2D-cross sectional geometry details of the tire are very crucial in modeling. The tire cross section curves are designed with Quad Mesh elements which requires additional modifications while meshing for a new design. Meshing the cross section for the new geometry requires lot of manual efforts. It is tedious and time consuming, to project & map the source mesh to the target cross section curves.

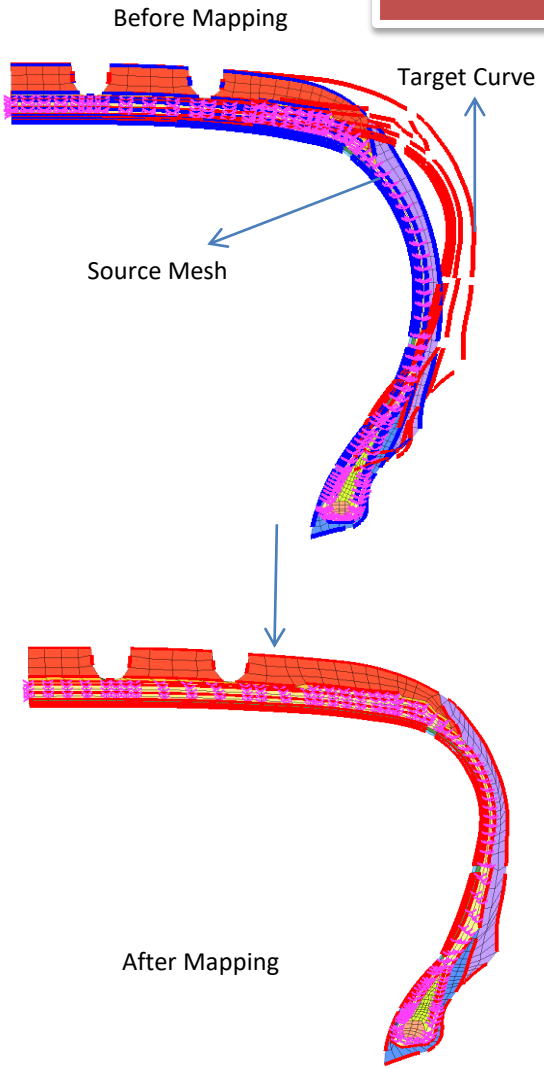
The Solution

- Since tires have significant influence over the vehicle performance, characteristic shape factors of tire are iterated for more accuracy. The Mapping Tool from the MeshWorks makes this incremental modeling task automated & easy to execute from user end. With increasing need for model accuracy at all given conditions, mapping tools provide complete automation approach to capture the necessary design changes quickly. User can select the source mesh & map it to the target location without deviating the Mesh Pattern & Quality of the tire model.

Value

- Tire model development for analysis of dynamic behavior of vehicle components happens in various stages. With the dynamic responses, modifications in tire models is handled accurately by using 'Mapping Tool' in MeshWorks. It reduces more than 40-50% of tire modeling time compared to the other tools without compromising the quality. Also, the manual efforts are saved by applying the automated processes for the developmental progress in tire modelling and its application.

Morph Set-up Creation → Mapping the Global Regions → Mapping the Local Regions



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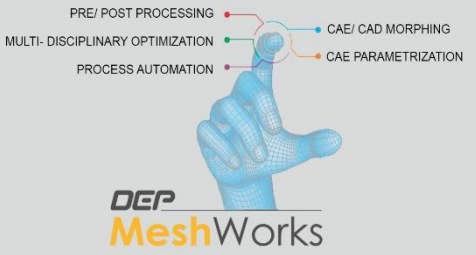


Tire Treads Parametrization

DEP MeshWorks | Application sheet

Parameterization tools that directly help study the sensitivity of tread pattern for optimized output and hydroplaning considerations.

Challenges in Concept studies

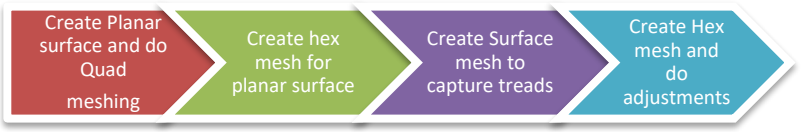
- A detailed tire tread that consists of rubber blocks and grooves along with the material composition is required for accurate prediction of tires' running performance. Usually tread patterns are meshed with 'Hexa' elements and requires modification for optimized results. The required revisions mainly includes converting the tread pattern into variable pitches, modified tread profiles, tire materials thickness change etc. All these chores requires a lot of engineering expertise & manual intervention which impacts the modeling time.

The Solution

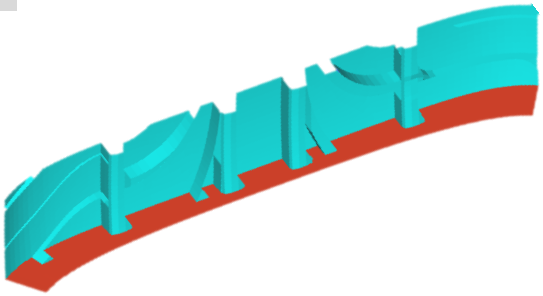
- Tire treads are mostly complex patterns filled with groves and blocks. Effective mesh generation procedure for tires needs to fully consider the detailed tread blocks with variable anti-skid depths that impacts the tire performance in varied use case scenarios. Morphing & Parameterization tools from MeshWorks makes this task easy to execute with its automated modules. There are unique solutions for tire modeling where user can easily modify the geometry by creating the parameter for particular design changes. User can also automatically generate the design models based on the various analysis results.

Value

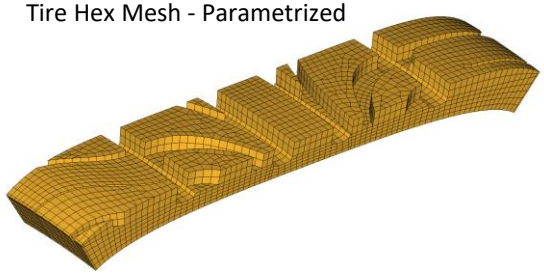
- Detailed tread modeling is implicit for better analysis and optimized results. By using MeshWorks tire treads can be modelled in required way for tire performance studies. Parametrization features can help simplify the detailing of the tire tread models in myriad ways. And with Morphing capabilities user can reduce over 60-70% time compared to the conventional tools. Also, a significant amount of manual efforts is saved with automation support in tire tread modeling.

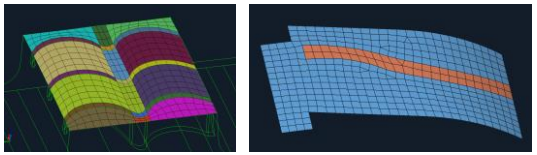


Work Flow - Driven by MeshWorks



Tire Hex Mesh - Parametrized





Surface mesh to capture the Tire tread features

Complete Pre & Post Processor

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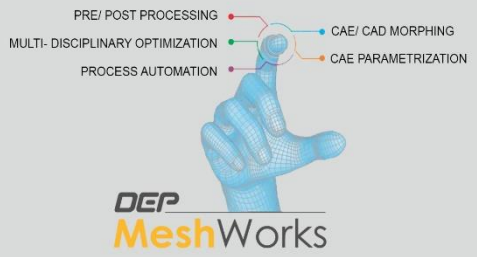


Tire Analysis – Post Processing

DEP MeshWorks | Application sheet

Comprehensive analysis of tire characteristics and responses for hydroplaning considerations.

Challenges in Concept studies

- For various loads & applications, different tire models respond in diverse ways. Tire analysis provides better understanding of road-tire interaction and help improve the designs accordingly. The 2D & 3D tire model builds supports in major prediction on hydroplaning behaviour of tires. Different tire tread pattern & carcass cross section-2D Mesh are enablers in hydroplaning analysis and tire patterns are optimized based on the results. But this analysis requires numerous iterations added with more manual efforts to arrive at any design conclusion.

The Solution

- The most demanding performance questions regarding tires are usually answered by analysis. DEP MeshWorks provides wide range of optimization tools and complete package of Post-Processing features that characterizes the aspects of tire performance under consideration. Especially we can use these tools to study the different tire profiles for evaluating the hydroplaning in given set of designs. MeshWorks also provide the 'Latin Hypercube' sampling DOE creation which is an automated process where user can generate the multiple optimal designs matrix in one-go.

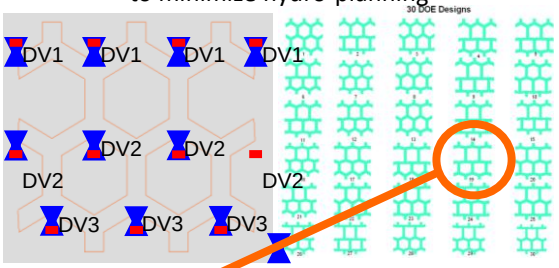
Value

- Analyses are performed to give more insight in to the tires dynamic behaviours. The results help make better educated design decisions during the development phase of a new tire. With MeshWorks and its easy to automate CAE analysis process users can yield 2X to 5X time savings in the development. MeshWorks assists in tire data analysis and tire modeling in a faster and more accurate way.

Build detailed 2d & 3D CFD models → Baseline Analysis for study of best behaviour for hydro-planning → Comparison of baseline, DOE best and Optimum designs

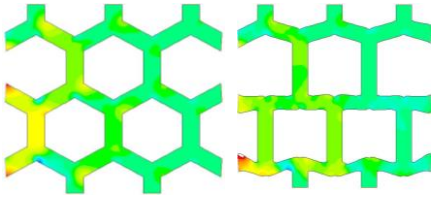
Work Flow - Driven by MeshWorks

Tire tread pattern optimization to minimize hydro-planning

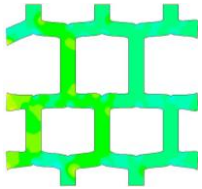


Baseline design | DOE best design | Optimum design Derived from Response Surface Model

Static Pressure Contour



Baseline Design | DOE Best Design



Optimum Design using RSM

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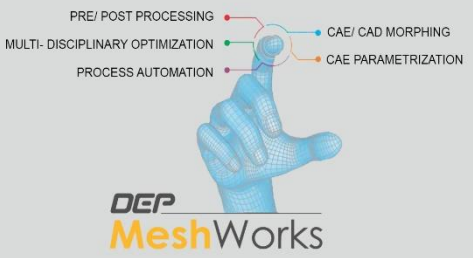


Rapid Hex Mesh for Tire Modeling

DEP MeshWorks | Application sheet

100% Hex Mesh Modeling for TIRE tread & full Tire model.

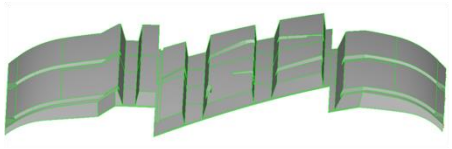
Challenges in Concept Studies

- Tire tread are made with grooves & ribs feature with different height and width, due to which building hex mesh is a challenging task, which requires expertise in modeling.

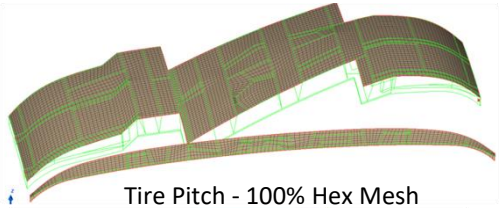
Solution

- The process automation tool from MeshWorks makes this task automated and easy to execute. MeshWorks enables rapid hex mesh modeling with a high level of automation. It can generate a good quality mesh, with minimal user inputs, and the task can be performed by any engineer, and doesn't require a meshing expert.

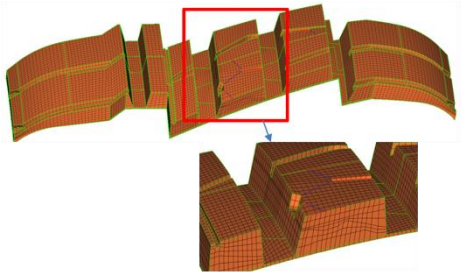
Tire Pitch - CAD Data



Tire Pitch - 100% Quad Mesh



Tire Pitch - 100% Hex Mesh



Value

	Process using Other Tools	Process using DEP MeshWorks
Time taken for the task	1 Day	1 Hour
Expertise Needed	Highly experienced engineer	Regular engineer
Auto parameterization of features for further optimization	None	Excellent

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