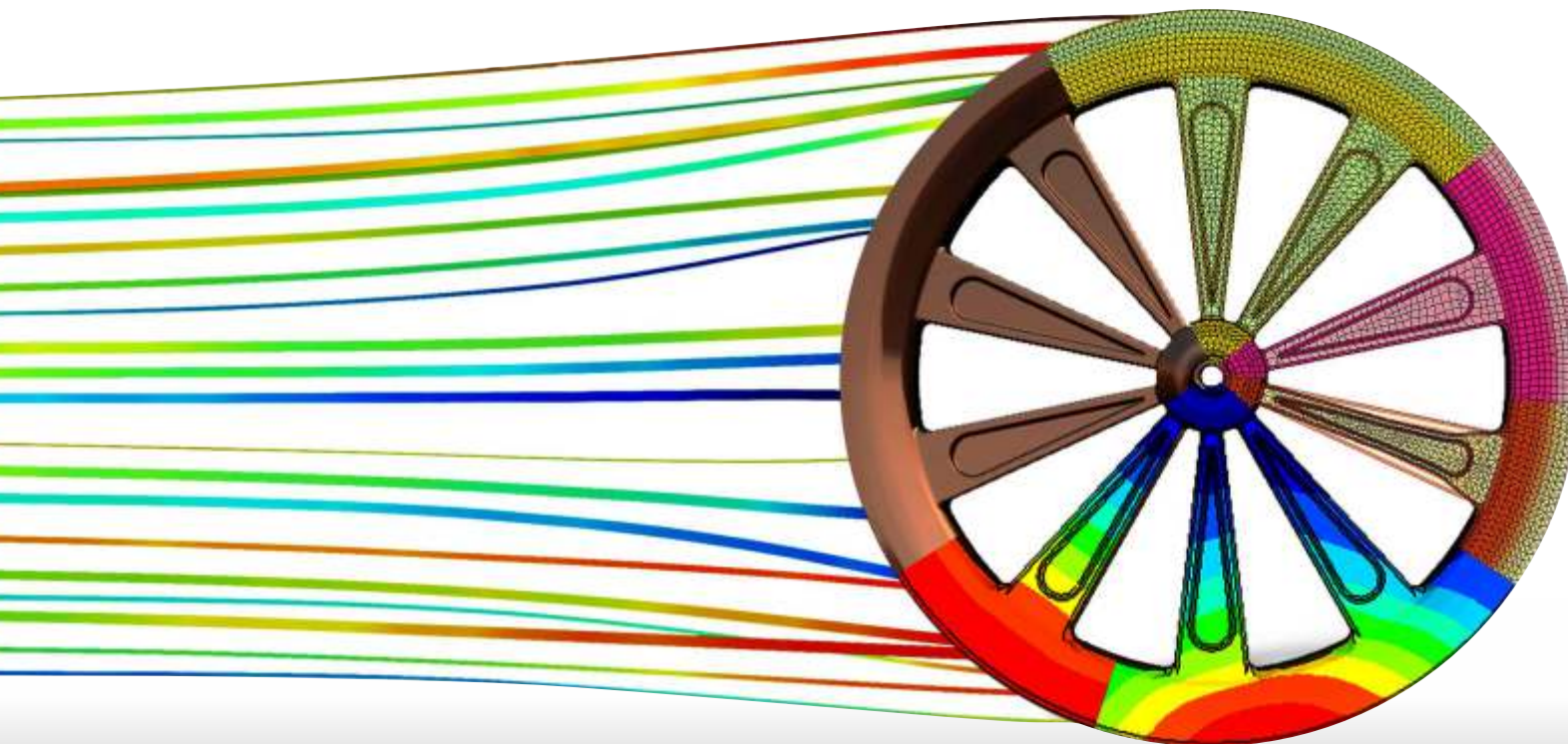


# DEP MeshWorks

POWER TO ACCELERATE PRODUCT DEVELOPMENT



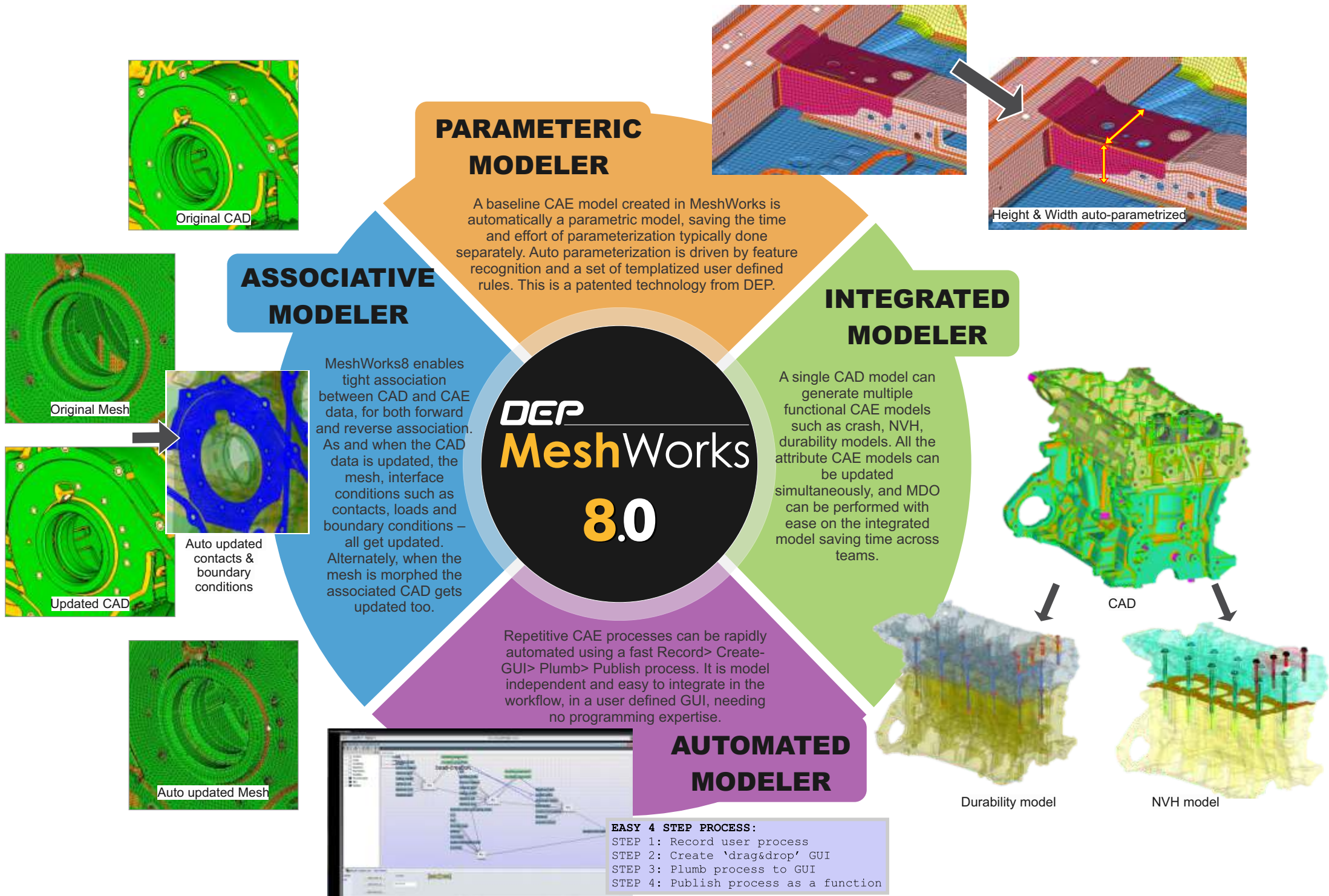
PRE/ POST PROCESSING

CAE/ CAD MORPHING

PROCESS AUTOMATION

MULTI- DISCIPLINARY OPTIMIZATION

CAE PARAMETRIZATION



**AN INTEGRATED CAE PLATFORM THAT TRANSFORMS THE PRODUCT DEVELOPMENT PROCESS**



# Meshing

MeshWorks has a powerful CAE meshing engine that allows users to create 2D and 3D meshes rapidly from complex CAD data.

Highly automated meshing functions available allow users to create exceptional quality meshes with minimal user intervention in the shortest time possible, with minimal to virtually no CAD clean-up.

Template based meshing allows users to set-up templates for feature recognition, mesh size requirements and quality criteria.

Highly automated mesh quality improvement functions robotically correct meshes to meet user specified quality templates and constraint criteria.

Wide variety of CAD interfaces are supported to import geometries from all well known CAD packages and generic formats such as STEP & Parasolid.

Even though CAD clean-up requirement is minimal to nil, MeshWorks offers a CAD engine with an extensive set of CAD functions for curve, surface and solid editing and manipulation.

Batch meshing capability allows users to assign meshing templates to entire model assemblies and mesh them in a batch mode across multiple processors – either on workstations or in the HPC environment.

## TRIAMESHING:

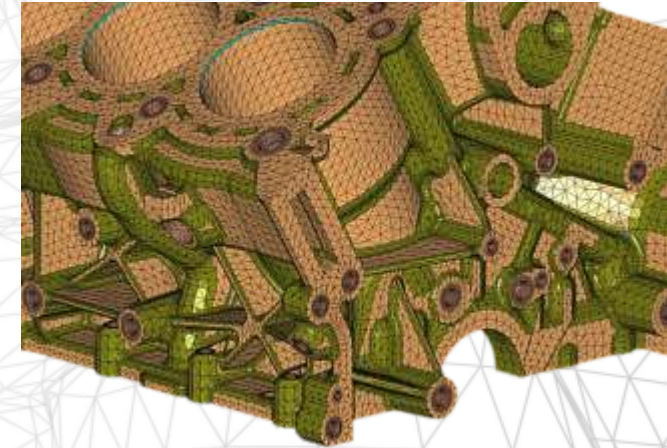
The automated tria mesher generates meshes that meet element quality requirements and mesh flow conditions in regular regions and special regions such as fillets, holes etc. Structural & CFD meshes are generated efficiently with flexibility of using several control parameters to generate meshes to suit the CAE engineers' specialized requirements.

## QUAD DOMINANT MESHING:

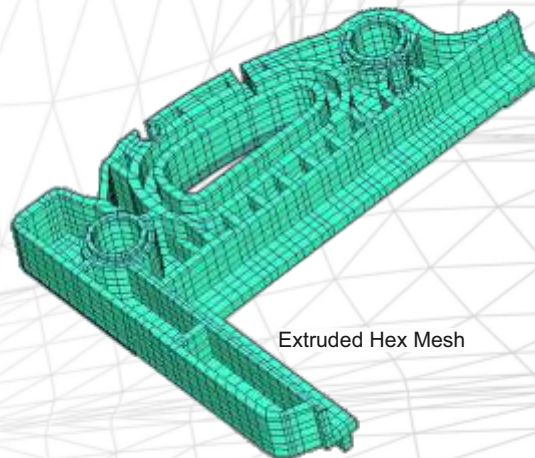
The automated quad dominant mesher generates quad dominant meshes with minimal triangles meeting element quality requirements, providing good mesh flow, meeting specialized meshing requirements around holes, fillets, flanges, beads etc. and excellent control over element size requirements.

## MID-PLANE MESHING:

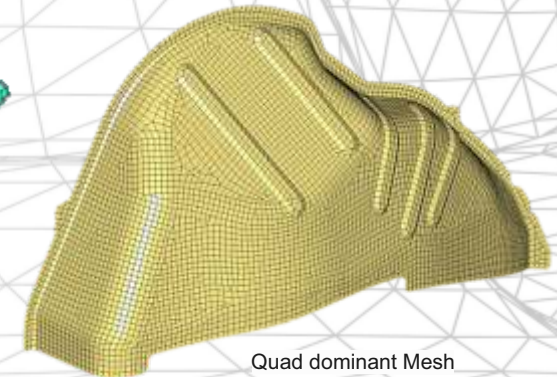
A set of automated and powerful interactive meshing functions allow users to create mid-plane meshes of complex plastic and casting parts with ribs and other intersecting features. Variable thicknesses as driven by the CAD geometry are automatically assigned to the mesh.



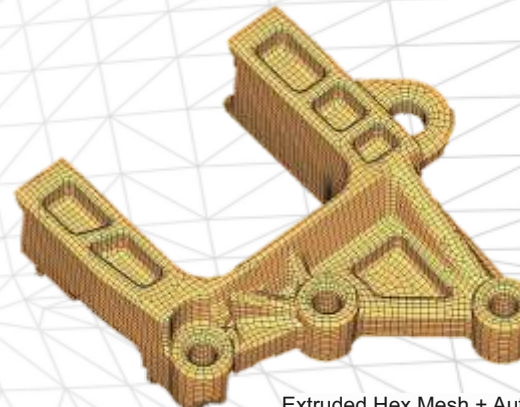
Tetra Mesh



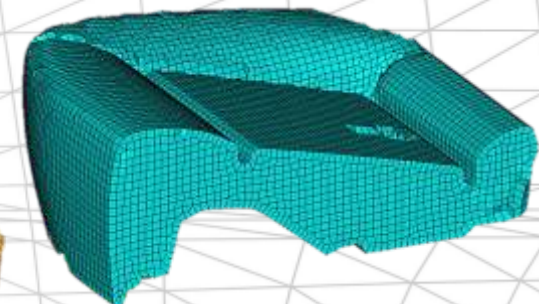
Extruded Hex Mesh



Quad dominant Mesh



Extruded Hex Mesh + Auto-hex



Auto-hex mesh - Cartesian



### TETRAMESHING:

MeshWorks provides several methods for getting tetrahedral mesh. Tetra mesh can be controlled by a variety of factors such as gradation factor, layered tetra mesh, growth rate etc.

### HEXAMESHING:

The automated cartesian hexa mesher allows users to create 100% hexa meshes of complex parts that have a high volume to surface ratio ('chunky' parts). The extruded hex mesher can rapidly generate hex dominant meshes for parts whose features are aligned in a specific direction. The 'thin-wall-hex-mesher' can rapidly convert a mid-plane quad dominant mesh to a hex-dominant mesh. Users can combine all of the hex mesher functions to generate a geometry hugging hex dominant mesh with minimal number of penta elements.

### ASSOCIATIVITY:

The mesh generated is highly associative to the CAD geometry. This allows for highly automated update of the mesh as and when the CAD geometry changes and vice versa.

### INTEGRATED MESHING:

Meshing templates corresponding to different attributes such as stress/durability, stiffness/NVH etc. can be assigned to the CAD data. As a result meshes corresponding to all the different attributes can be generated from one single model eliminating the need for duplicated effort.

### PARAMETRIC MESHING:

A patented parametrization methodology generates parametric meshes during the meshing process itself. The parametrization is driven by CAD features and user provided rules & templates.

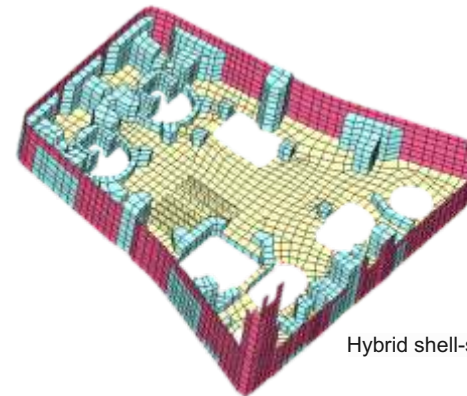
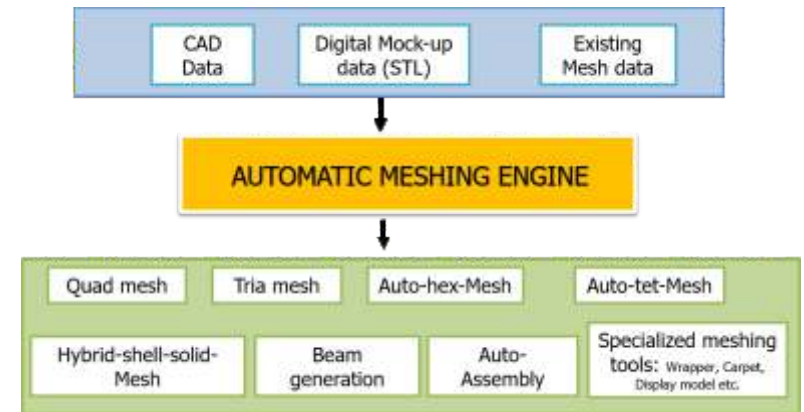
## Modeling

The Modeling module within MeshWorks comprises of a set of interactive and highly automated model assembly, model connection, materials, loads and boundary condition assignment functions that will allow users to create complex full system level models such as that of automotive vehicles, IC engines, airplanes, ships etc. in a highly condensed time frame.

### SPOT WELDING:

For spot-welded structures (such as automotive bodies) the weld elements can be generated automatically for various types of attributes such as crash, NVH, durability etc. Specialized features such as weld force failure, heat affected zone modeling around the spot welds etc. are available for more in-depth modeling of the welds.

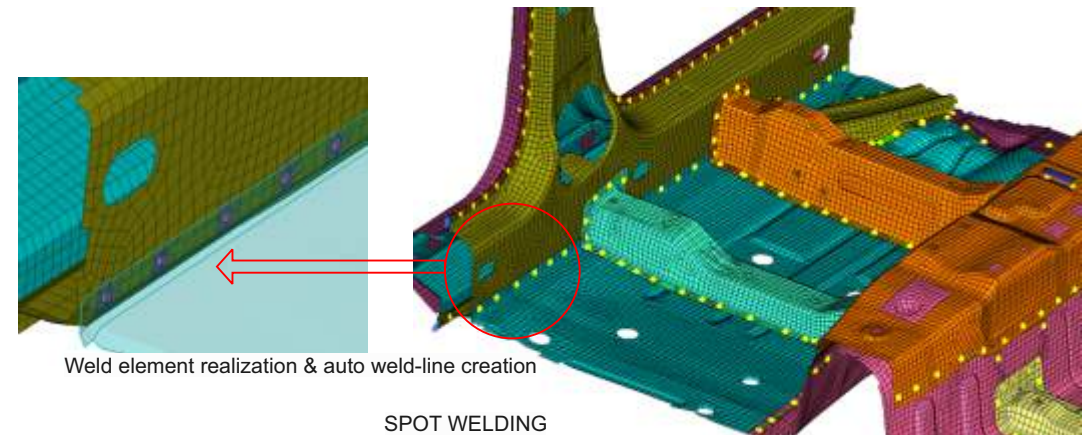
During early stages of the product development spot weld lines and spot weld points can be automatically generated using the part meshes.



Hybrid shell-solid Mesh



Midplane Mesh





## SEAM WELDING:

For fabricated structures involving seam welds the weld elements can be generated using a wide variety of configurations such as quad, beam, solid, rigid elements etc. For detailed modeling of the weldments using solid elements, options are available to automatically create the weldments and have node-to-node matching connection to the surrounding parts.

## ADHESIVE BONDING:

In locations where adhesive bonds are required solid bond elements will be generated automatically and connected to the surrounding part meshes through connection equations, contacts etc.

## BOLTED CONNECTIONS:

A wide variety of bolted assembly connection elements can be automatically created. These involve a) through bolts, b) screws, c) detailed metric bolt modeling, d) bolt connections with beams/rigids etc.

## CONTACT MODELING:

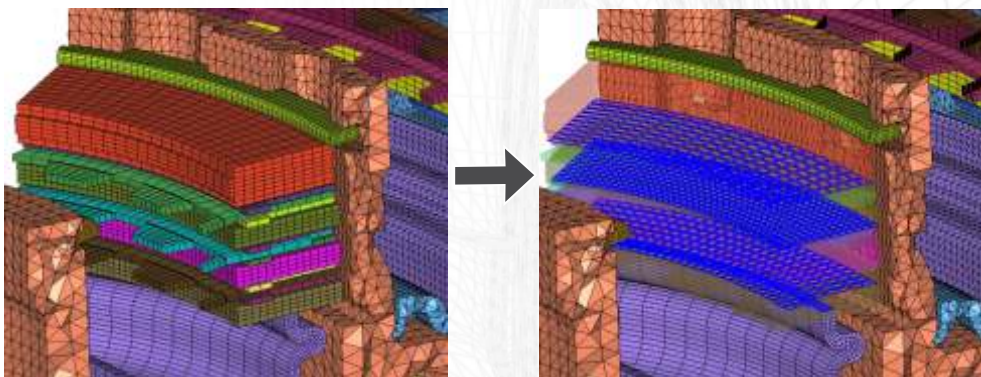
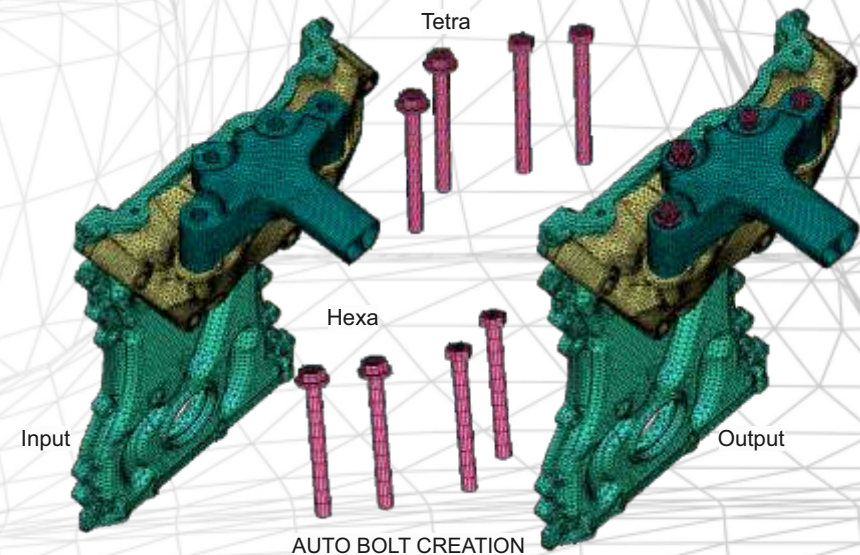
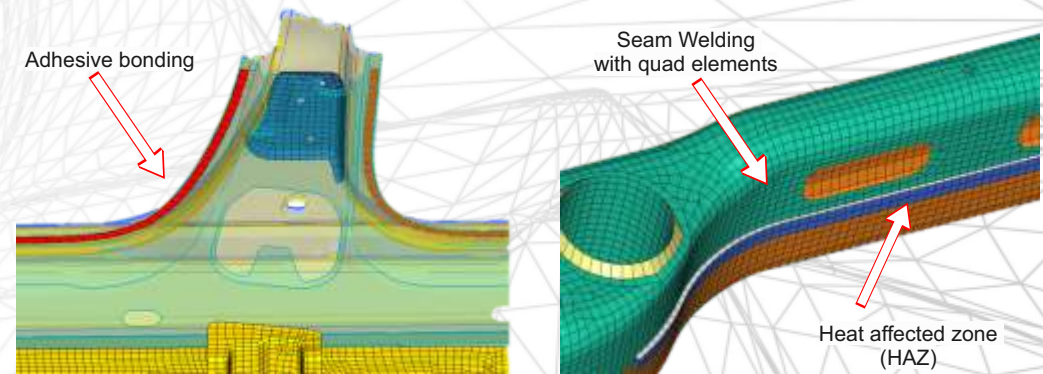
Extensive contact modeling is available with automatic contact surface creation between all components of an assembly. The contact pairs can also be generated between the contact surfaces with appropriate interface conditions such as friction, thermal properties etc.

## LOADS & BOUNDARY CONDITIONS:

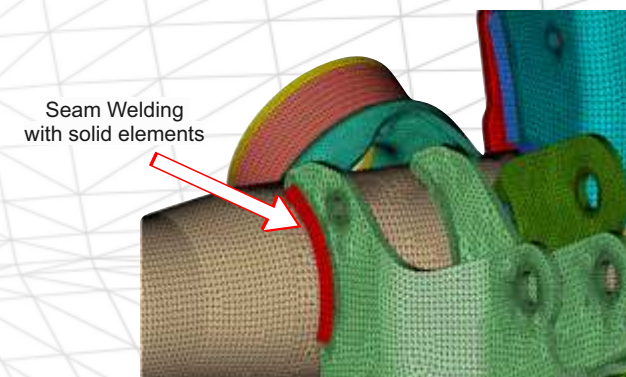
A wide variety of loads and boundary conditions for various types of problems can be applied in a quick and efficient manner.

## INCLUDE FILE MANAGEMENT:

For very large scale system models an include file management system has been provided. Users can organize sub-assembly data into include files and perform data manipulation operations across different include files.



AUTOMATIC CONTACT CREATION



AUTOMATIC WELDMENT CREATION



# Post-processing

MeshWorks is a multi-disciplinary post-processor for viewing and publishing the results of analysis. It allows for loading and viewing the result files obtained from various solvers.

A rich set of post processing features such as animations, contouring, cut section results, iso plotting of results, querying of results values node-by-node or element-by-element etc. are all supported.

Interactive post-processing features in MW8 allow users to have rich insight into the results and hence the behavior of mechanical systems under operational loads.

Several automated post-processing utilities are available for robotic extraction of 'hot-spot' results such as peak stress values, max vibration amplitudes etc.

Multi-window post processing of results allows users to easily compare the results of several load cases or several design iterations side by side.

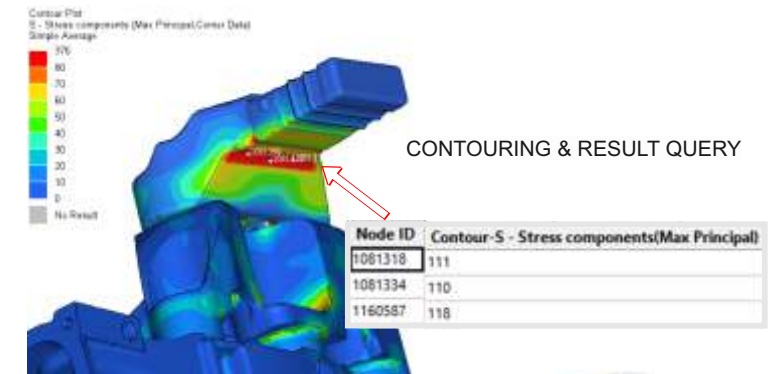
Multi-page post processing of results allows users to organize different types of output responses into different pages for easy viewing and navigation.

## FUNCTIONS

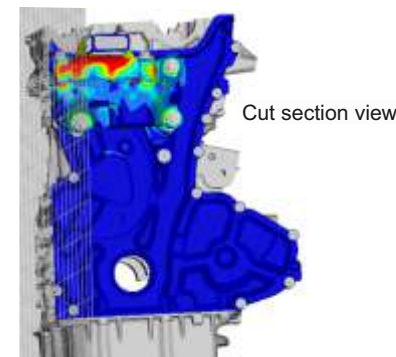
- Contour: Allows to create contour plots of a model and visualize the analysis results.
- ISO: Allows to display iso(or same value) results of the model.
- Animation: Transient, Linear and Modal animation options are supported.
- Model Info : Annotations display the model details and users can include notes for additional information as and when needed.
- Query: Allows users to view and export results of queried nodes, elements & components.
- Cut Section: Allows user to cut planar sections through a model to view results on internal details of the model.
- Utilities: Several utilities are used for highly automated post processing of results for Design of Experiments (DOE) and optimization studies.

## BENEFITS

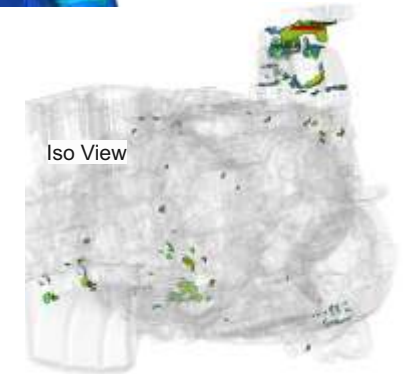
- Integrated post-processing user interface within MeshWorks environment.
- Inclusive of Post Processing results from Abaqus & Nastran solver outputs.
- Large scale models are handled with ease.
- Multi- page and multi- window post processing of results with easy 'cut, copy, paste, apply' from one window/page to another.
- Automated 'Score Card' module helps in extracting various key results and provides in a user friendly tabular format.
- XML based session file saving.



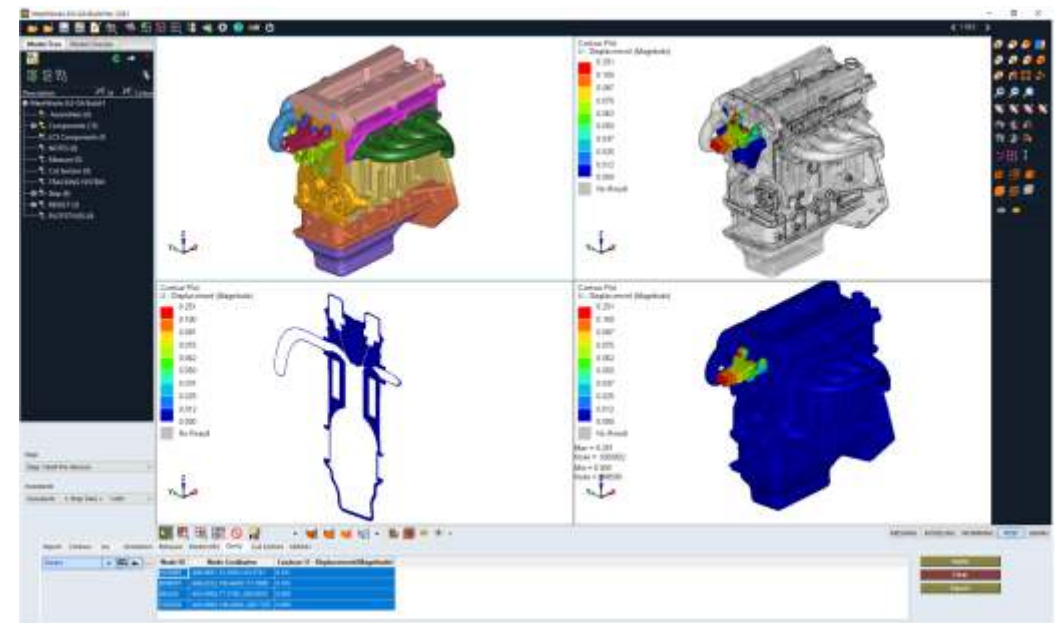
CONTOURING & RESULT QUERY



Cut section view



Iso View



Multi-window Postprocessing

# Graphing

DEP MeshWorks graph is a powerful plotting and data analysis tool. It has a rich set of plotting features, a user friendly interface, easy navigation from function to function, and is fully integrated within the MeshWorks interface.

Inbuilt math functions are available in the tool, which makes it easy to process mathematical expressions for the plotting of CAE simulation results.

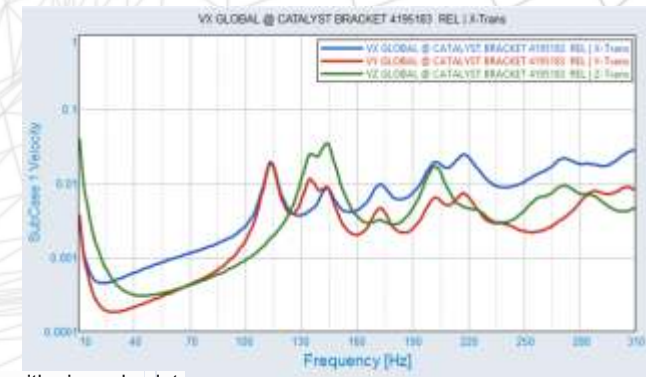
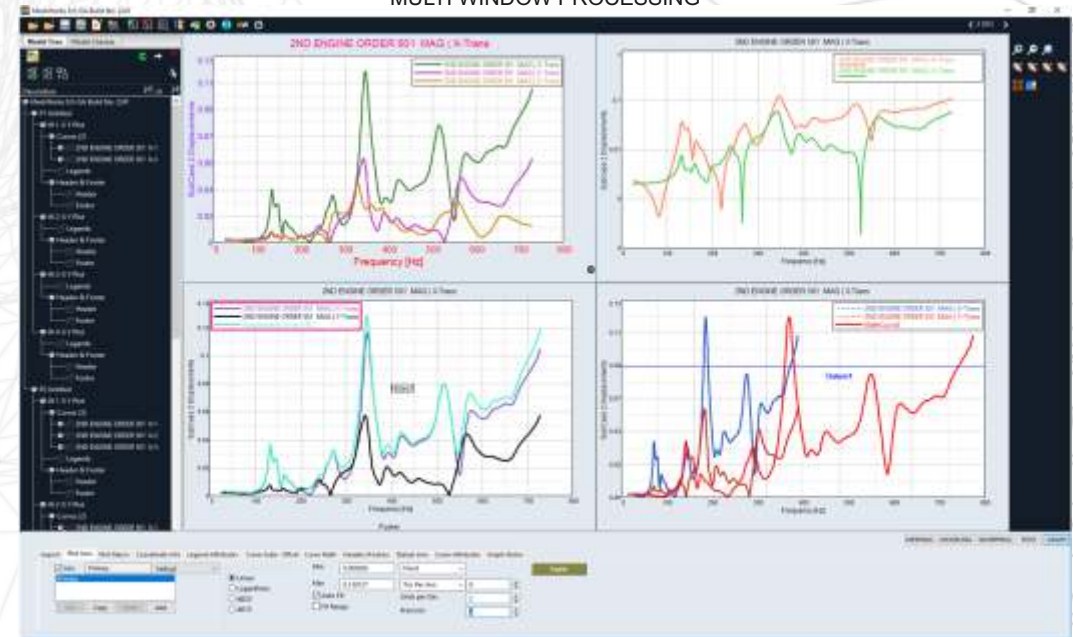
## FUNCTIONS

- Plot Axes: Allows the user to change linear scale to logarithmic scale.
- Plot Macro: Allows the user to plot the resultant curve.
- Coordinate info: Allows user to see the maximum and minimum points of the curves.
- Legend Attributes: Displays the curve details. The user is then able to change attributes like line style, color, weight.
- Curve Scale Offset: Allows the user to perform curve scaling, offsets can be applied to multiple curves.
- Curve Math: Allows the user to create new curves using expressions and values.
- Header/Footers: Allows user to edit header/footers.
- Datum Line: Allows user to create line in user defined location in both horizontal and vertical axes.
- Curve Attributes: Allows the user to define attributes like line style, color, weight, symbol style and color.
- Graph-Notes: Annotations display the curve details. The user can add notes to provide extra information if needed.

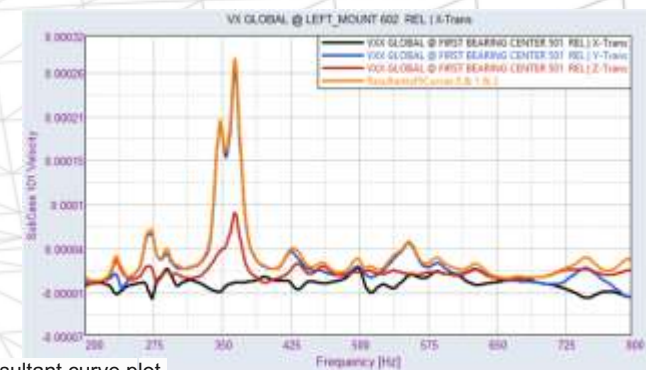
## BENEFITS

- Integrated graphing user interface within MeshWorks Pre/Post.
- Inclusive of Post Processing results from Nastran(\*pch) solver output.
- Multiple Punch files can be appended and used for plotting curves.
- Multi- page and multi- window post processing of results with easy transfer of settings from one window/page to another.
- XML based session file saving. Session files can be replayed.

## MULTI WINDOW PROCESSING



Logarithmic scale plot



Resultant curve plot



# Customized Engineering Process Automation

Customer CAE processes can be rapidly automated using a fast Record > Create-GUI > Plumb > Publish process.

Very complicated geometry and mesh creation processes can be automated with virtually no scripting or programming expertise.

Processes that could be automated include a) CAD, b) Meshing, c) Model Assembly, d) Morphing, e) Parametrization, f) Postprocessing etc.

Significant time reduction of 2X to 10X is possible once processes are automated.

Published process could be shared with all users in the organization as a simple resource file – no need for any new software releases.

External exes and scripts (Python, Java etc.) can be integrated into the process.

Simple 'drag&drop' functionality to create GUI and plumb it to the recorded process.

Automatic conversion of recorded process to a data flow chart which can be plumbed to the GUI.

## FUNCTIONS

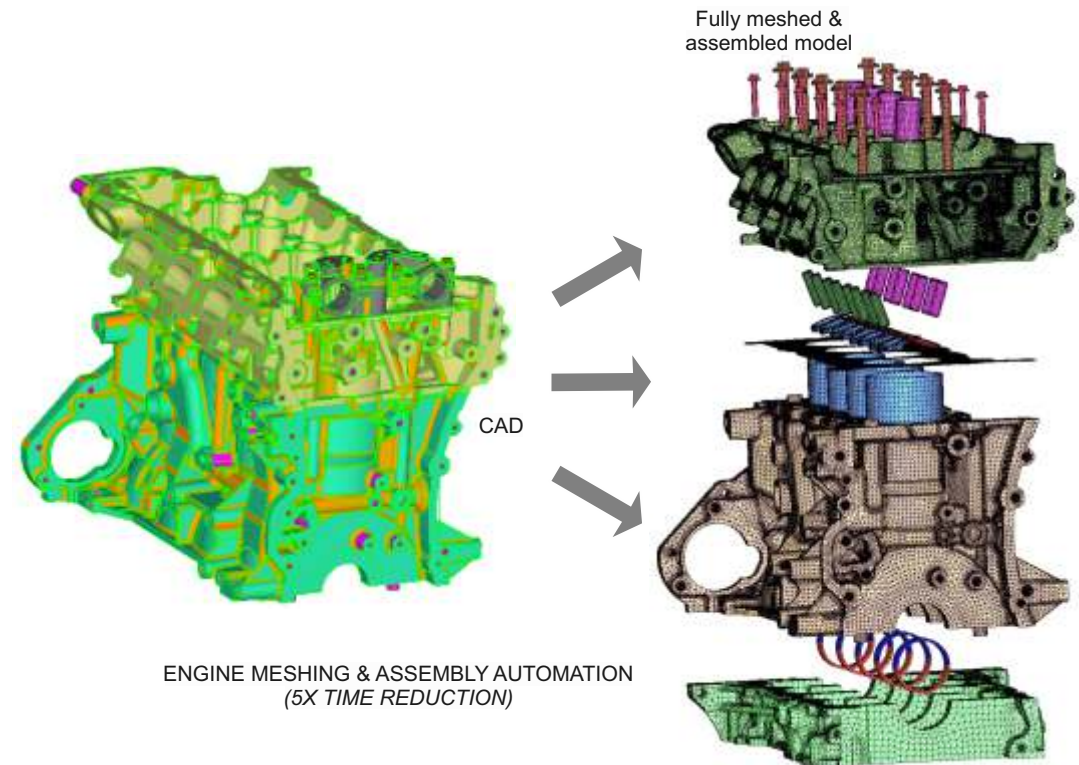
- Customizable process templates.
- Process automation possible for a wide variety of models.
- Recording of the entire process with 'on/off' recording options.
- Drag & drop GUI creation options for quick/easy function interface creation.
- Automatic conversion of recorded processes into data flow charts.
- Direct drag & drop options to plumb GUI to process data flow.
- Logical operators, conditional statements, process loops etc. can be included into the process flow for decision making and directing processes accordingly.
- Multiple process automation functions can be linked under a single GUI.
- Process can be linked with external scripts and executables.

## BENEFITS

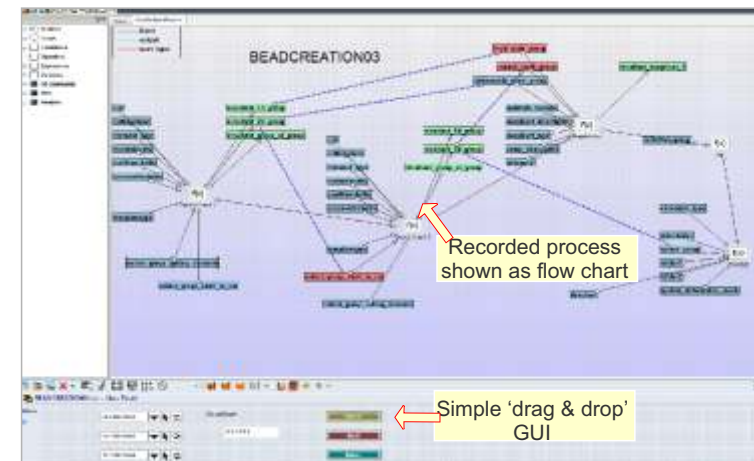
- Significant time reduction in CAE processes – 2X to 10X.
- All the pre-processing steps can be performed as integrated work flow as per user's own ideas and requirements.
- Even the most complicated process can be made simple with the help of process automation in MeshWorks.
- Faster results while ensuring consistency and quality.
- Processes can be standardized and institutionalized across the entire organization.

### TYPICAL PROCESSES THAT CAN BE AUTOMATED:

1. CAD geometry creation & manipulation
  2. Complex meshing & assembly
  3. Load case set-up, results recovery & auto report
  4. Automated parametrization
- Etc.



### EASY 4 STEP PROCESS: RECORD > CREATE GUI > PLUMB > PUBLISH



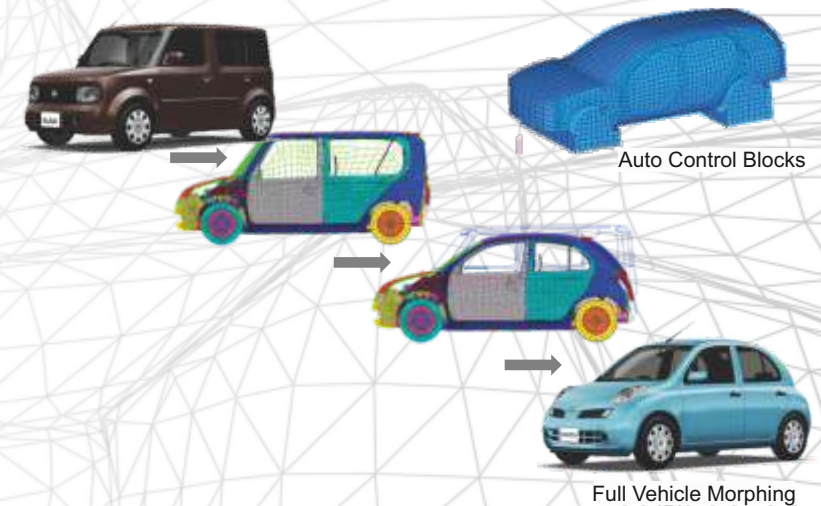


## CAE Morphing

MeshWorks is a feature based morphing tool that can rapidly morph existing FE & CFD models to match new geometry and/or to new proportions

Component and full system level FE/CFD models (such as automotive vehicle Crash, NVH & Durability models) can be morphed to fit target design features such as styling lines, sections, proportions etc. precisely.

A wide variety of morphing techniques such as control block (lower & higher order), direct parabolic, spherical, polycube and field based morphing are available to address varied applications. An extensive set of automated and interactive tools to create 'control blocks' for assembly level morphing is available.

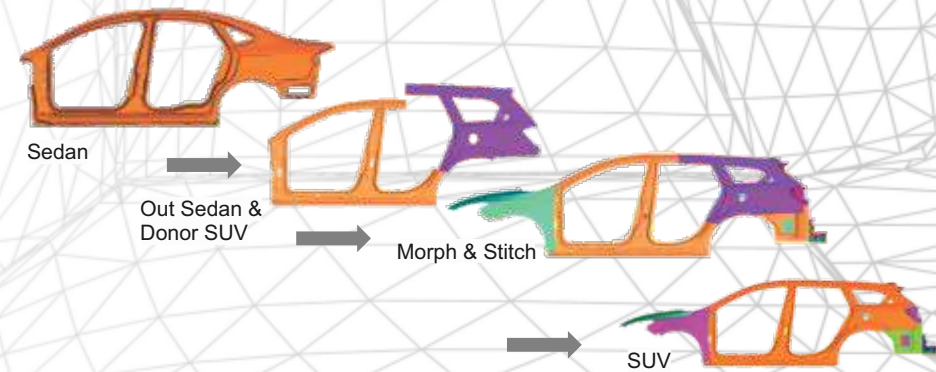


## Concept Modeling

MeshWorks has advanced cutting, blending and stitching functions to create early stage concept FE and CFD models very rapidly.

Local regions from the donor FE or CFD model can be cut, morphed and stitched to the target FE/CFD model resulting in a new concept quickly.

Concept FE components can be created using sections and director lines. Concept FE features such as ribs, gussets, holes etc. can be created rapidly on existing models.



## CAE Parameterization

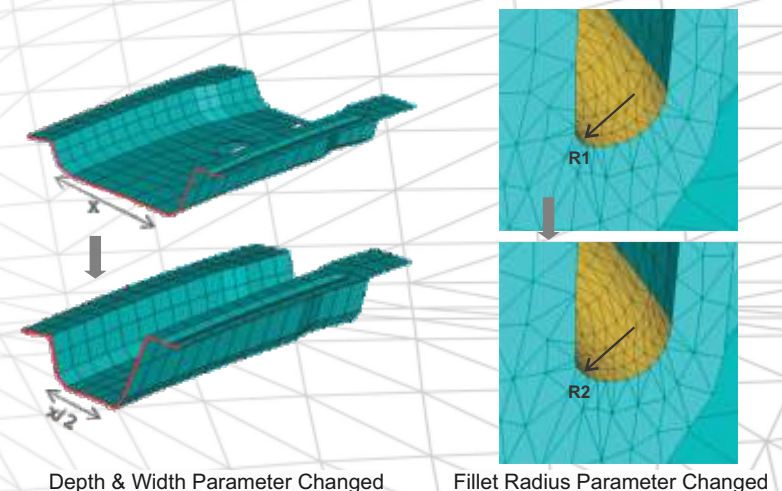
MeshWorks is a comprehensive CAE model parameterization engine with a broad range of categories of parameters that can be used at all stages of product development.

Categories of parameters include: gauge, shape, sections, spot weld pitch, seam-weld-spacing, adhesive length, topology (member repositioning), features (number of holes, ribs, bulkheads, crush-initiators etc. in a given space) and general parameters.

Regular FE/CFD models can be converted to intelligent parametric FE/CFD models.

The parameters can be exercised as one-time execution or linked to Design of Experiments (DOE) and Multi-Disciplinary Optimization (MDO) schemes.

Multiple runnable CAE models (literally hundreds of them) can be generated automatically by exercising the parametric CAE models.



## Design Enablers

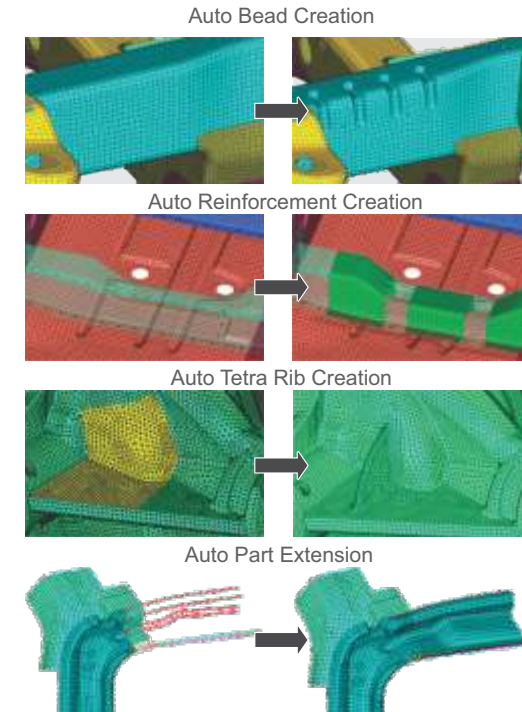
MeshWorks has a powerful Design Enablers module that will allow users to automatically create typical design solutions required to improve Structural and CFD performance and reduce weight.

Typical Design Enablers available as automated 'ready-to-use' CAE solutions include: a) Beads, b) Darts, c) Bulk-Heads, d) Reinforcements, e) Holes/Slots, f) Part Extension/Contraction, g) Shell Rib, h) Tetra-Rib, i) Tailor Welded & Rolled Blank – TWB/TRB etc.

All of the above can be created very easily without the user having to manually create geometry, mesh or connections – sufficient to provide inputs at a high level as if a design engineer would do.

The Design Enablers can be executed as an integrated solution complete with properties, materials, connectors etc.

The Design Enablers can be executed as a single instance or as a parameter with multiple instances.

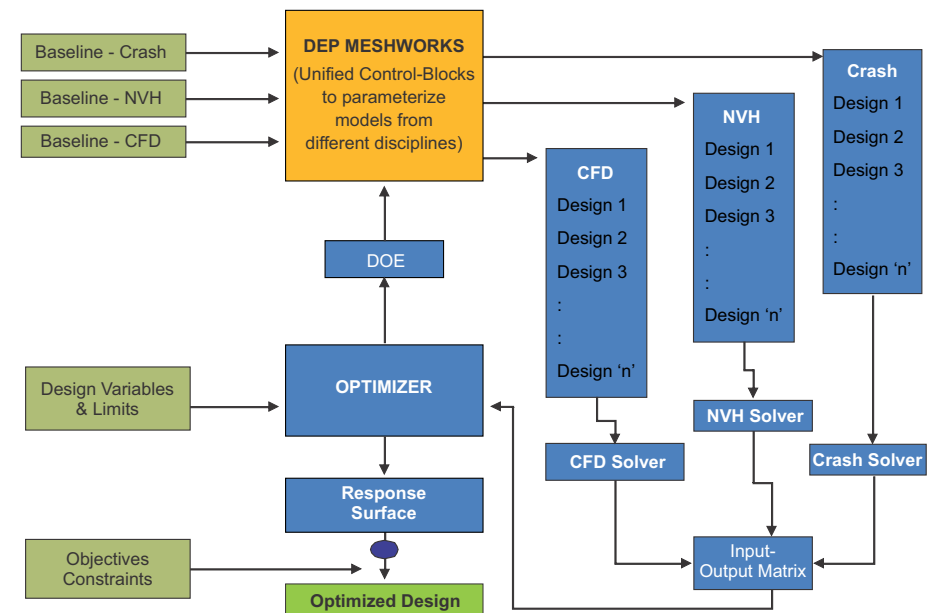


## Multi- Disciplinary Optimization

DEP MeshWorks based Parametric and Non-Parametric CAE models enable Multi-Disciplinary Optimization to meet design targets, minimize product weight and minimize manufacturing cost.

Meshworks parametric models can robustly generate multiple runnable analysis data sets given a Design of Experiments (DOE) matrix. It can be executed in a batch mode and can be integrated within automated work flows.

Ready interface is available to major optimization software such as Isight, ModeFrontier, Heeds, Optimus, LSOPT, etc.





## CAD Morphing

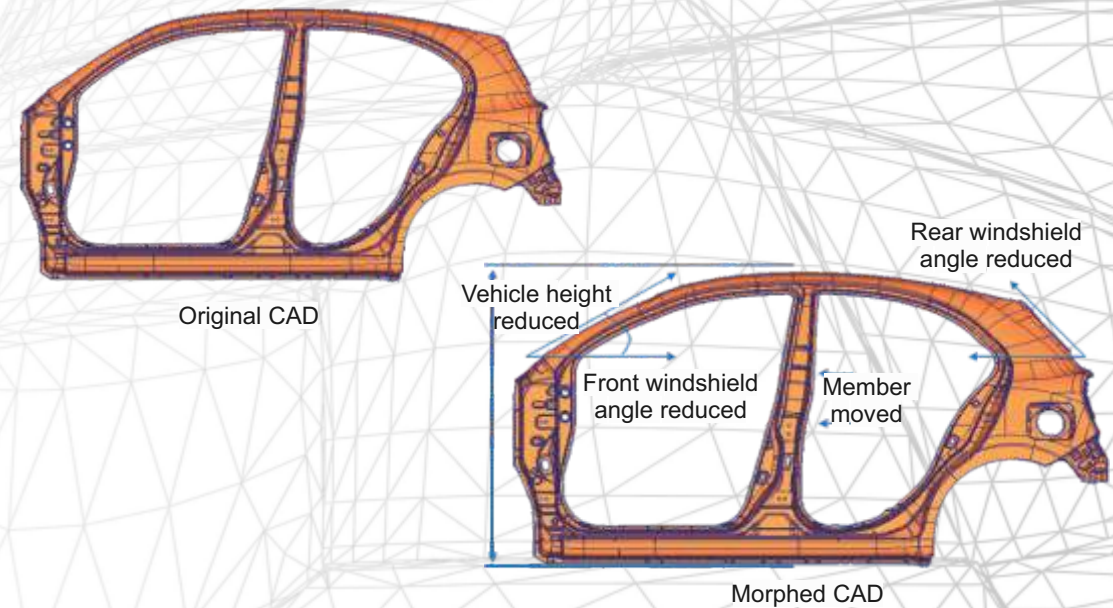
CAD Morpher is a transformational software from DEP which allows users to morph existing CAD data (Body structures, Powertrain and Chassis parts) directly to new shapes rapidly.

For example, the complete BIW CAD data of an existing production vehicle can be morphed and made to fit a new vehicle's styling data and/or proportions. Several months of CAD development can be reduced using DEP's patented CAD morphing technology.

CAD morphing can be carried out at all different stages of product development:

- A) Early concept stage: Existing donor CAD data can be morphed to target new styling data and vehicle proportions
- B) Vehicle architecture development: Existing BIW CAD data can be automatically updated to fit new sections as determined by architecture team
- C) Vehicle optimization: Existing CAD data can be updated to match optimized results obtained by the CAE team

Morphed CAD data thus obtained can be used for studies involving packaging, formability, styling, human factors, ergonomics, CAE, supplier sourcing etc. very early on in the program.



## Supporting Platforms

- Windows 64 bit (7,8,10)
- Windows Servers
- Red Hat and SUSE Enterprise Linux 64 bit (Workstation & HPC)

## CAD Interfaces

- Parasolid (text & binary)
- STEP
- IGES
- CATIA V4 & V5
- JT
- UG/NX

## FE Interfaces:

- STL (ASCII & Binary)
- MSC Nastran
- Abaqus FEA
- ANSYS
- LS-DYNA
- Pam-Crash
- RADIOSS
- Fluent
- SC/Tetra
- STAR-CD
- MADYMO
- OptiStruct
- GENESIS
- CONVERGE CFD



Smarter Solutions. Realized.

Detroit Engineered Products (DEP) is an Engineering Solutions and Product Development company. Since its inception in 1998 in Troy, Michigan, USA, DEP is now a global company with footprint in Europe, China, Korea, Japan and India. DEP uses the accelerated and transformed product development process, accomplished by utilizing our proprietary platform, DEP MeshWorks, which rapidly reduces the development time of products for all segments.

Rapid time to market of new products across several industry sectors such as automotive, defense, aerospace, energy, oil & gas, consumer products and heavy equipment is a unique value proposition delivered to clients via DEPs world class engineers and the DEP MeshWorks platform.



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