MAHLE

*Driven by performance*

# MAHLE's Switch to HyperWorks

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# Agenda

- Introduction – MAHLE

- Background of Internal Combustion Engine

- MAHLE's FEA history

- Switch to HyperMesh

- Advantages

- Challenges

- Future Tools

# MAHLE - Background

- Founded in 1920 in Germany

- MAHLE ranks among the top three systems suppliers worldwide

  - Piston systems, cylinder components, valve train systems, air and liquid management systems.

- One of the 30 largest companies in the automotive supply industry worldwide

- The leading global development partner of the automotive and engine industry

- Roughly 48,000 employees worldwide

  - 110 production plants

  - 7 research and development centers

- The Group has an on-site presence in all important world markets

# MAHLE - Products

Piston Systems

Air Management Systems

Cylinder Components

Valve Train Systems

Liquid Management Systems

# Internal Combustion Engines

- Invented over 100 years ago

- Transfers chemical energy to mechanical power

    - Piston

    - Connecting Rod

- Compression Ignition / Spark Ignition

- Market Trends

    - Efficiency / Friction Reduction

    - Smaller / Lighter

    - Turbo Charging / Super Charging

        - Higher Compression

# MAHLE's FEA History

- FEAs first performed in the 1970's

- First FEAs were very crude

  - Used a punch-card system for creating mesh

  - 2D simulations

  - Took several weeks to perform

  - Nodes limited to 2,000

- Level of sophistication has increased over the years

  - Pre-processors help create meshes quickly

  - 3D simulations

  - Can be performed in a few days

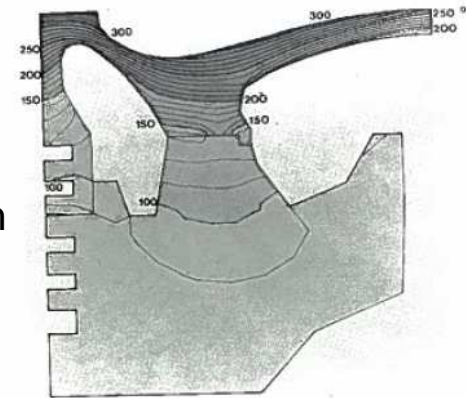  - Virtually no limit to number of nodes

  - Many components considered



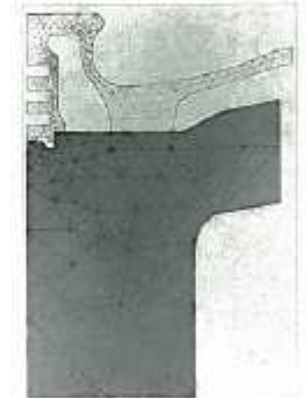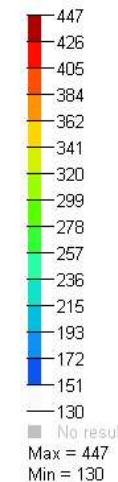Bild 3  Errechnetes Temperaturfeld mit T_max = 325 °C

Bild 8  Element-Idealisierung eines gebauten Kolbens

# Switch to HyperMesh

- MAHLE interested in switching pre-processors for several years

  - Looked into several different programs

  - HyperMesh looked most appealing

    - Offered a lot of capability

    - Floating points system

- Granted a trial license for HyperMesh in 2008

- Tested by two of the Simulation Engineers at MAHLE

- Benefits for meshing noticed immediately

- Full switch-over summer 2009

# HyperMesh's Advantages

→ Easy to use

- Support

- Defeature

- Line suppress

- Automesh

- Selection tools

- Element cleanup

- Model tree

# Easy to Use

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- Panels

  - Straight forward

  - Customizable

- Icons

- Shortcut keys

  - Jump between pages

- Model Tree

- Geometry Editing
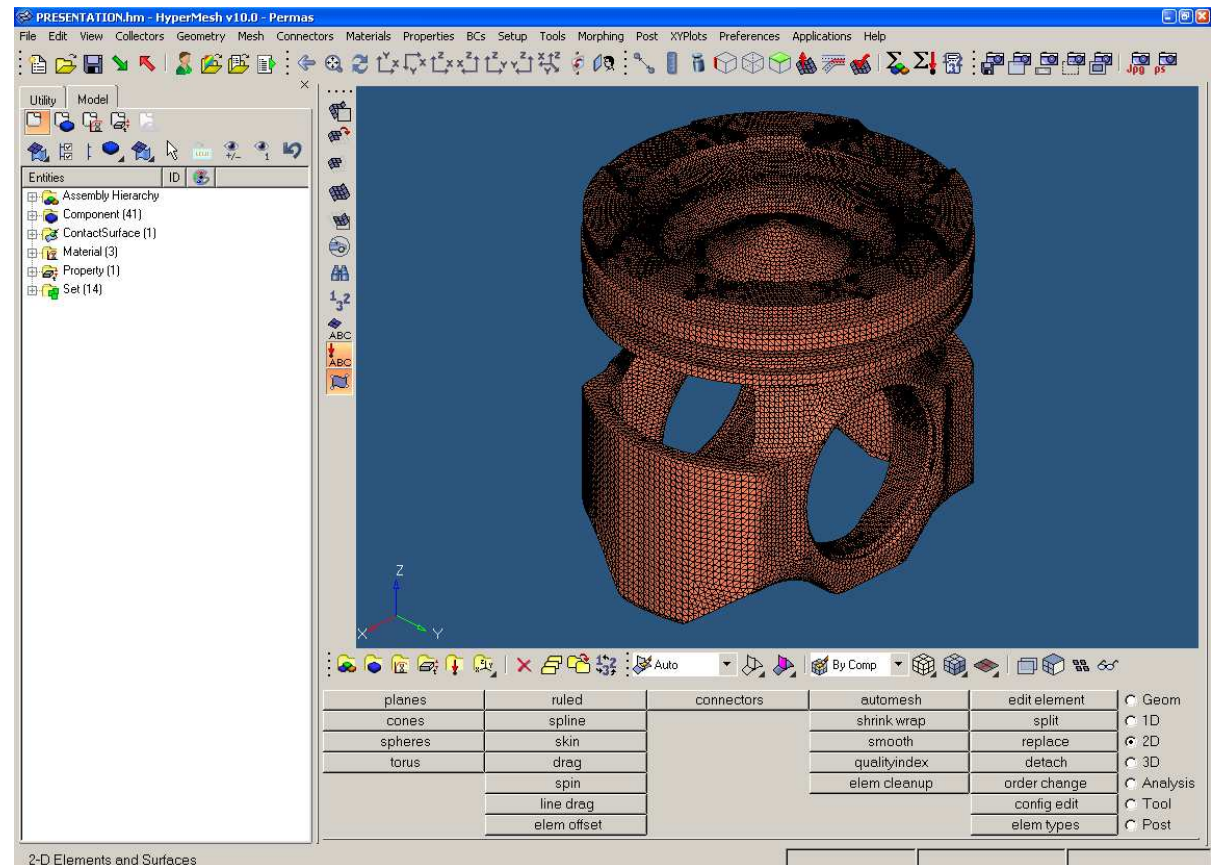
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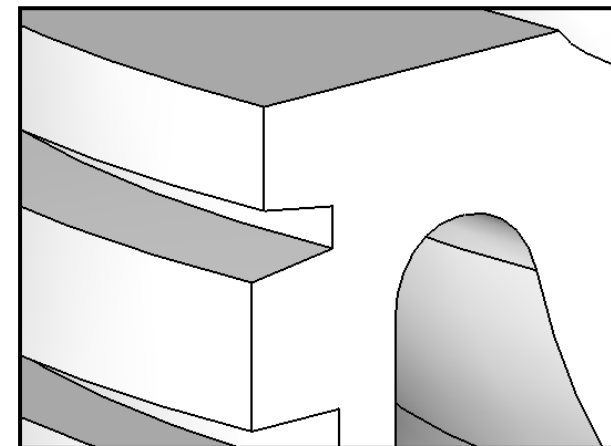- Element cleanup

- Model tree

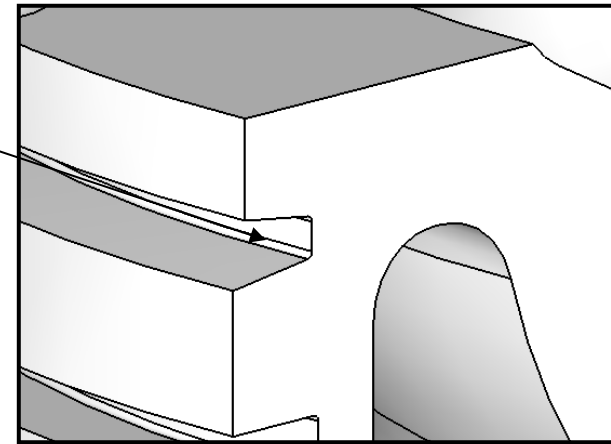# Support

- Altair is very willing to help

  - Application Engineer

    - Regular Visits

    - Very Motivated

  - Support Hotline

    - Quick response

- World Headquarters located less than 1 hour away

- Training Sessions

# HyperMesh's Advantages

- Easy to use

- Support

→ Defeature

- Line suppress

- Automesh

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- Model tree

# Defeature

- Many CAD model have small fillets

- Small fillets cause bad elements and have little effect on fatigue calculation

- Easy to remove without creating new surfaces using *defeature*

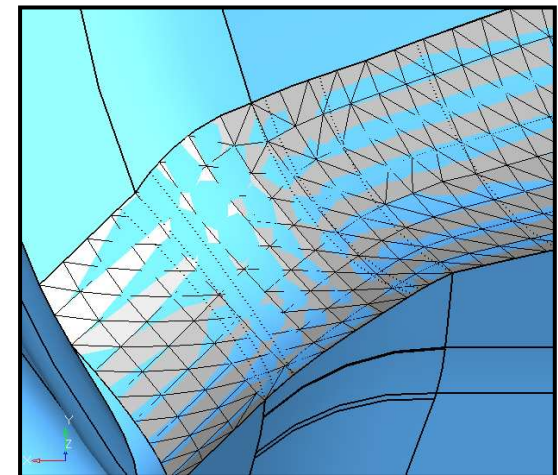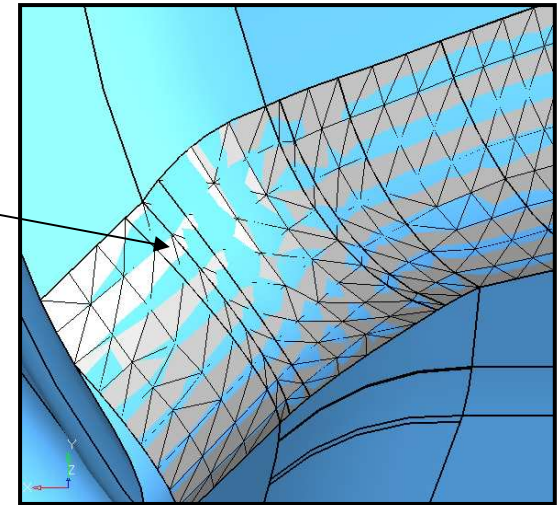- Allowed MAHLE to eliminate an expensive license for external geometry cleanup tool

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© MAHLE

# Line Suppress

- Many CAD models have many small lines and surfaces due to many contours of the geometry



- Many can be ignored in FEA
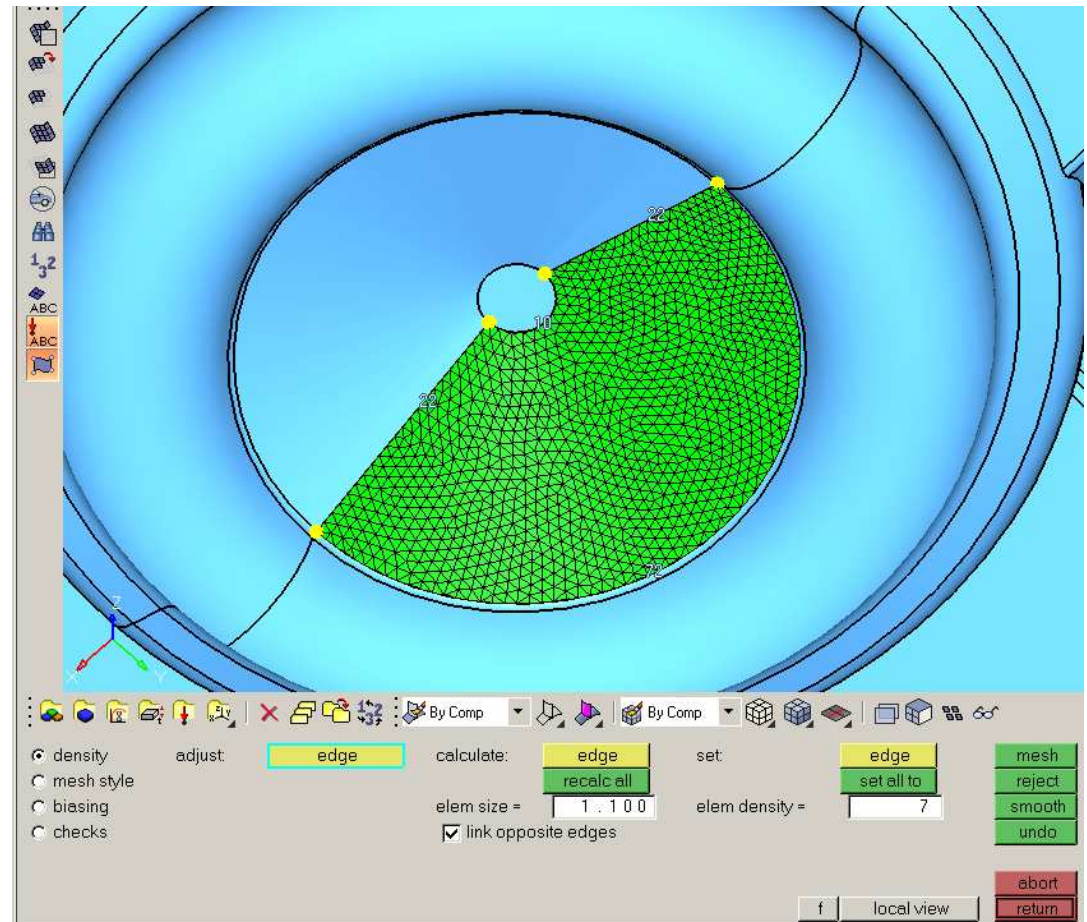
- Helps to create better elements

# HyperMesh's Advantages

- Easy to use

- Support

- Defeature

- Line suppress

→ Automesh

- Selection tools

- Element cleanup

- Model tree

# Automesh

- Easy to use

- Interactive page

  – Mesh density

  – Mesh style

  – Quality

- Undo meshing

  – Reject

  – Remesh surface

© **MAHLE**

# HyperMesh's Advantages

- Easy to use

- Support

- Defeature

- Line suppress

- Automesh

→ Selection tools

- Element cleanup

- Model tree

# Selection Tools

- Many options for selecting objects

  - by face

  - reverse

  - by collector

- Speeds up virtually every step of pre-processing

- Transfer selection between panels

| by window | on plane | by width | by geoms | by domains |
|---|---|---|---|---|
| displayed | retrieve | by group | by adjacent | by handles |
| all | save | duplicate | by attached | by block |
| reverse | by id | by config | by face | by path |
| by collector | by assems | by sets | by outputblock | by include |

# HyperMesh's Advantages

- Easy to use

- Support

- Defeature

- Line suppress

- Automesh

- Selection tools

→ Element cleanup

- Model tree

# Element Cleanup

- Quality Index

  – Easy to move nodes

- Element Checks

  – Many different checks

- Automesh – Remesh Elements

- Manual Editing
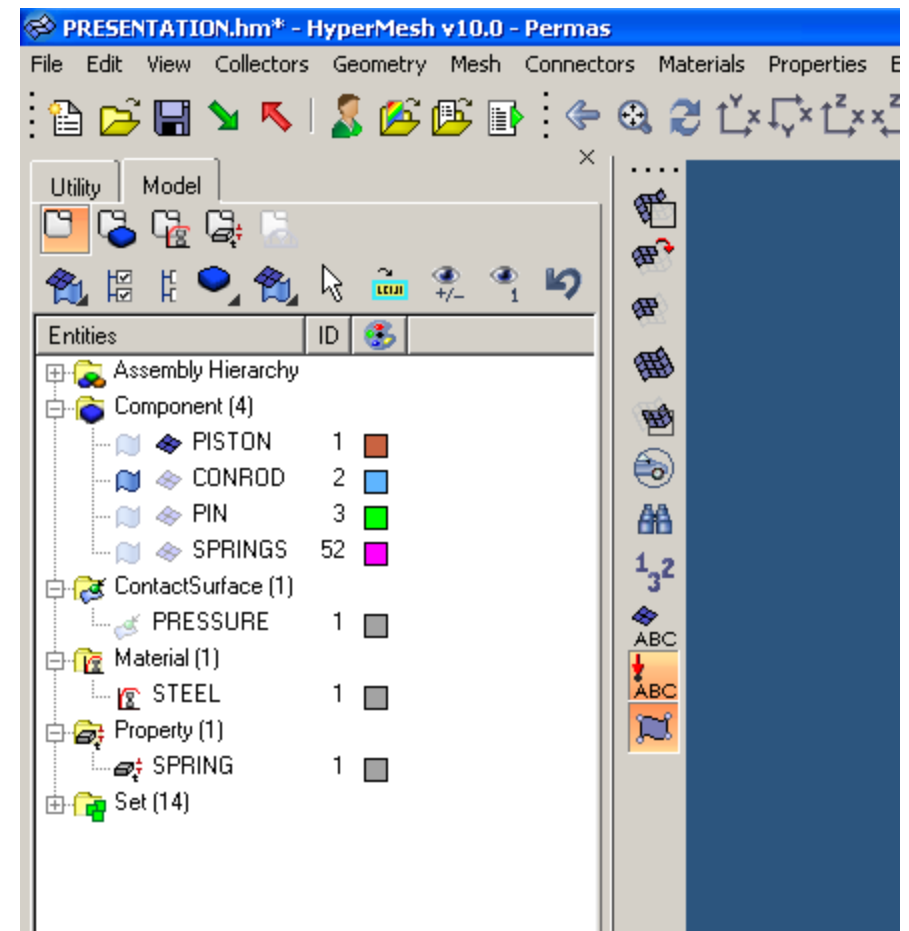
  – Can create / split elements
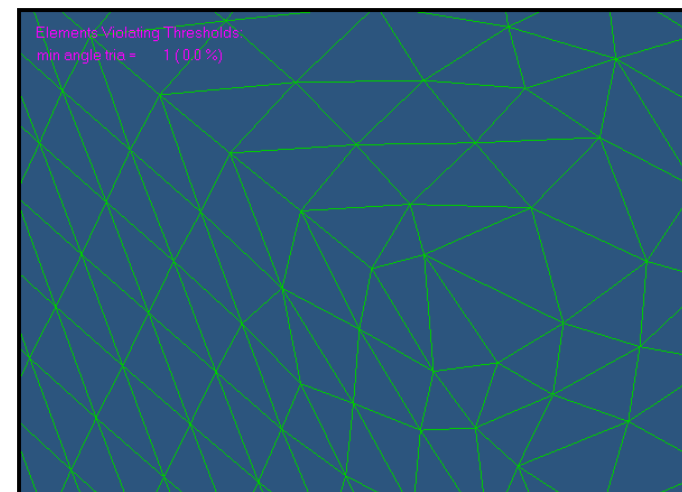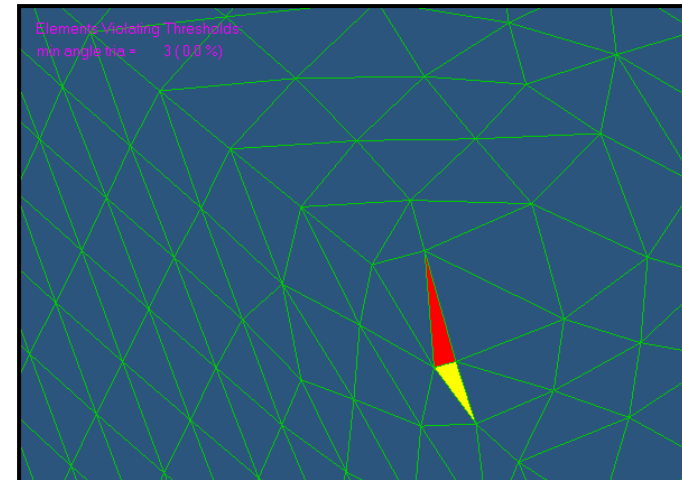
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→ Model tree

MAHLE Industries, Incorporated, RDNS,  Scott Janowiak,  15-April-2010
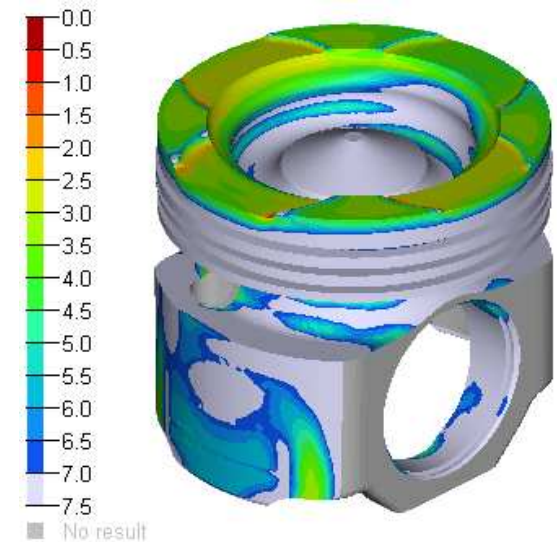
© MAHLE

# Model Tree

- Allows user to visualize everything easily

- Turn mesh / solids on or off quickly

- Delete objects

# Challenges

- MAHLE uses the Permas solver

  - Interface fairly new in HyperMesh

- Reading results from MAHLE programs into HyperView

  - Fatigue factor calculator

  - Pressure results

  - Solved by translation program (Altair support)

- Picture creation quality

- Query results

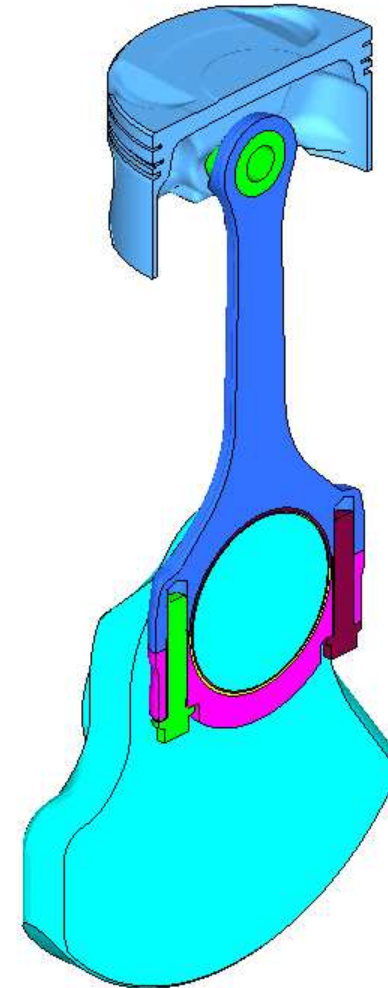- Interpolate results from one mesh to another

# Future Tools

- Optimization

- Multi-Body Dynamic Simulations for PCU

- Writing .h3d files from MAHLE programs

- Standardized reports from HyperView

# THANK YOU!