An Integrated Optimization System for ANSYS Workbench Based on ACT

Manfred Fritsch, Business Development
FE-DESIGN GmbH Germany
FE-DESIGN Optimization Inc Chicago USA
AGENDA

- FE-DESIGN “the optimization company”
- What is non-parametric Topology Optimization?
- What are the Differences between parametric and non-parametric Methods?
- Product Development Values by using TOSCA and ANSYS Mechanical
- Integration of TOSCA Structure into the ANSYS Environment
- **NEW:** TOSCA Workbench Extension (based on ACT)
- Optimization of Chassis and Engines components in Automotive Industry
FE-DESIGN Your Partner for Structural and CFD optimization

FE-DESIGN combines development and engineering of optimization methods.

FE-DESIGN has the ability to deliver best solutions for our customers, benefiting from many years of experience.

Our customers improve their optimization processes continuously due to knowledge transfer with FE-DESIGN.

Customers leverage FE-DESIGN’s knowledge, with long-term business relationships.
FE-DESIGN: Locations and ANSYS Partners
FE-DESIGN Optimization Inc

- Located in Des Plaines, IL (Chicago)
- An Affiliate of FE-DESIGN GmbH, Germany
- Dedicated to supporting our US customers
- Ron Banchak (General Manager), Mark Miller (Senior Technical Consultant)
Product Development Values by Using TOSCA and ANSYS Mechanical

- Virtual prototypes accelerate the product development cycle
- Numerical simulation increases product quality
- Economy of energy and resources
- Higher efficiency through lower masses, higher accelerations, shorter cycle times
- Lower stresses increase durability
- Savings of material at ensured product quality
- Early product launch due to shorter development times
FE-DESIGN: Customers (extract)
What is Non-Parametric Topology Optimization?

**Theory:**
Given a predefined design domain in the 2D/3D space with structural boundary conditions and load definitions. Distribute a given mass such that a global measure takes a minimum (maximum) value.

**Example:**
Find the design with maximum stiffness or minimum weight!

Courtesy of AUDI AG
What are the Differences between the two Methods?

Non-Parametric Methods
- Structural Topology
- Fluid Topology
- Non-par. Shape
- Bead

Parametric Methods
- Sizing & par. Shape
- Geometric Parameter
- DOE & RSM
- Robustness
- Reliability
- MDO

Combination of both Groups

Both groups have their strengths. The right method depends on the given optimization task.
Structural & Fluid Optimization using TOSCA

**TOSCA Structure.topology**
- Find the design with maximum stiffness or minimum weight!

**TOSCA Structure.shape**
- Reduce local stresses and increase the durability!

**TOSCA Fluid.topology**
- Topology optimization of channel flow to minimize pressure drop!

**TOSCA Structure.bead**
- Increase the stiffness or eigenfrequency of sheet metal structures!
Examples of Topology optimized Components

Sony Electronics: TV Plastic/Metal Plate

Suzlon: Mainframe

Boeing: Landing Gear

Audi: Traverse Link

McLaren: Compliant Beam
Integration of TOSCA Structure into the ANSYS Environment

- Design space modelling
- FEA-Preprocessing
- Validation of FE-Analysis

GUI realized with ANSYS ACT
- Optimization Preprocessing
- Start the RUN

Batch - Solver

Optimization Module
- Postprocessing of smoothed optimization results

- Result transfer to CAD Systems using TOSCA Structure transfer functionality
TOSCA Workbench Extension

Setup and run your analysis

- Define your „design space“ model
- Setup the analysis
- Validate the results
TOSCA Workbench Extension

Integrate the TOSCA Extension

- Select the TOSCA Optimizer
- Share the model with a new optimization box
Setup the optimization

- Define the design area and frozen areas
- Define the boundary condition for the optimization
TOSCA Workbench Extension

Run the optimization and view the results

- Run the optimization
- View the new density distribution in the design area
- View the smooth result
TOSCA Workbench Extension

Run the validation

- Automatically remesh the smooth result
- Apply the load and boundary conditions
- View the results of the validation run
New TOSCA Extension for ANSYS WB
Comparison with the current Loop

Existing loop

New loop
Optimization of Chassis Parts

- Topology Optimization of a Transverse Link
- Topology and Shape Optimization of a Control Arm
- Topology and Shape Optimization of a Forged Control Arm with Elastic-Plastic Material Behavior
- Optimization of Chassis arms to reach buckling loads
- Shape Optimization of a Rear Wheel Carrier
- Multi Disciplinary Optimization of a Rear Axle Wheel Carrier
Optimization of **Chassis Parts** for Automotive

- Many types of optimization tasks can be performed with TOSCA
  - Topology optimization for a basic design proposal
  - Complete loop (topology/shape) for forged components
  - Optimization of **fatigue behavior in combination with plastic strain** for static misuse loadcases
  - Modifying stiffnesses, stresses/strains and load-deflection curve for static misuse
  -...

- Advanced options can be included
  - **Nonlinearities** like plasticity, nonlinear material behavior, and nonlinear boundary conditions
  - **Fatigue**
  - Combined responses
Optimization of Engine Components

- Shape Optimization of a Cylinder Head
- Shape Optimization of a Turbo Charger
- Topology Optimization for Lightweight Crankcase Design of Medium-Speed Diesel Engines
- Topology Optimization of a Crankshaft
- Shape Optimization of an Exhaust Manifold with Plastic Strain as Response
- Weight Reduction of a highly-loaded Gasoline Piston

1.27 2.1 1.88 2.16 1.28
Optimization of **Engine Components** in Automotive

- TOSCA optimization has a wide range of applications in many different areas and industries
- There are many engine applications available
  - TOSCA can be used for “real world applications“ in the customer’s environment
    - Very large models
    - Nonlinearities
    - Fatigue integration
    - Solver independent
- CFD Optimization with the latest technology available
Structural Optimization – Design Process with ANSYS Workbench and TOSCA Structure

- Initial Design Space Geometry
- Finite Element Model
- Topology Optimization
- Smoothing and Generation of Validation File
- Shape Optimization
- Optimization Model
- Validation Run

Optimized Design Geometry

ANSYS Workbench

TOSCA Structure
Thank you for your attention

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