Bionic Optimization
Overview

- SinusPro
- Optimization methods
- Topology Optimization
- Bionic Optimization
- Optimization procedure
- Optimization of a retainer
- Optimization of a truss bridge
The Fields of Expertise

Forging Engineering
- Forming-Simulations
- Material-Models
- Process-Optimization
- Part-Tests

Bearing Engineering
- EHD-Simulations
- Component-Tests
- Part-Layout
- Supplier-Management

Bionic Optimization
- Topology-Optimization
- Shape-Optimization
- Parameter-Optimization
- 3D-Print

Base Engineering
- FEM
- MKS
- CFD
Know-how Software

FEM
- Abaqus Standard / Explizit (Solver + Pre/Post)
- Medina (Pre/Post)
- MSC Nastran (Solver)
- Marc/SimuFact (Solver + Pre/Post)

MBS
- AVL Excite (Solver, inkl. Akustik und EHD)

CFD
- Ansys CFX (mehrzahlig, Partikel, transient)
- Ansys FLUENT (mehrzahlig, Partikel, transient)
- Converge (Solver, Verbrennung)
- Flowmaster (1D)

Add-on
- C++, Python
- Mathcad
- Matlab
- Abaqus (Multiphysics)
- Simufact (Umform- und Schmiedesimulation)
- Hexagon
SinusPro / Software

- **SinusPro / TorVib**
  Simulating Torsional Vibrations, also for branched systems

- **SinusPro / Safety3D**
  Post processor for calculating HCF and LCF Safety Factors

- **SinusPro / BondCheck**
  Welding Seam Evaluation acc. to DIN 13001

- **SinusPro / Optimizer**
  Topology Optimization based on ABAQUS GUI

- **SinusPro / HeatFlow**
  Transient 1D – Heat Flow Simulation (Wall Interaction included)

- **SinusPro / Mapper / FiberForge**
  Datatransfer from one Tool to another (e.g. local Materialdata)

- **SinusPro / VFD (Video-Fluid-Dynamik)**
  Evaluation Tool to assess Video-based Flow
Optimization

Reasons for optimization:

✓ Identification of the optimum any number of loading situations
   Enormous increase of load cases (aviation and automotive industry)
✓ Improvement of target properties
   Target properties: weight, stress, deflection, characteristic frequency, stiffness in terms of acoustic impact, etc.
✓ Different procedures are developed
Optimization Methods

- Parameter Optimization
- Material Optimization
- Shape Optimization
- Topography Optimization
- Topology Optimization
Topology Optimization

- Procedure to gain an idea of the optimum design
- Optimization of a defined installation space
- Reduction of the volume based on the restrictions and targets of the optimization
- Definition of restrictions and targets
  - Weight, stiffness
- Procedures:
  - Pixel Method
  - Bubble Method
Workflow – Optimization

1. **Analysis of the original structure**
2. **Definition of the design space and the target properties**
3. **Acting load**
4. **Calculation of the optimum structure based on the inputs**
5. **Derivation of the design under consideration of production requirements**
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- Increase of volume, where there is an overload
- Decrease of volume, where load leads to situations under defined limits
- Standard growth procedure of the nature
- Deduction of natural structures for the development of mechanical structures
  - Example: Splitted winglets
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Optimization of the retainer of a press

Aim: Reduction of material input
Model & Loads
Workflow – Topologie Optimization

1. Analysis of the original structure
2. Definition of the design space and the target properties
3. Derivation of the design under consideration of production requirements
4. Calculation of the optimum structure based on the inputs

Load of the press & equipment
Comparison of Result to the Initial Design

Reduction of the weight: >20%
Deflection remains the same

Initial design

Optimized design
Bionic Optimization

Optimization of a truss bridge
Aim: Reduction of material input
Initial Design

Design consists of I-profiles for the main frames and L-profiles for the diagonal frames.
Model & Loads

Load case I: Mass of the transported goods (5xDWT)

Load case II: Mass of the transported goods (5xDWT) + cross wind (3xDWT)

Load case III: Mass of the transported goods (5xDWT) + cross wind (3xDWT)

Load cases
Workflow – Topologie Optimization

- Analysis of the original structure
- Definition of the design space and the target properties
- Load due to weight & cross wind
- Derivation of the design under consideration of production requirements
- Calculation of the optimum structure based on the inputs
Optimized Structure

Green areas give an idea for the framework design.
Bionic Lightweight Construction

Optimized Structure

Initial design

Proposed volume distribution

Optimized design – Version I
Bionic Lightweight Construction

Optimized Structure

Version 1

Version 2

Increase of stiffener cross section to reduce vertical deflection

Version 3

Increase of stiffener cross section to reduce vertical deflection
Bionic Lightweight Construction

Comparison of Result to the Initial Design

The weight reduction to the final version 3 amounts to 18%.
The deflection for load case I is reduced by 15% and the deflection for load case II & III is the same.
What distinguishes SinusPro GmbH from others is that we offer all 3 major types of numerical simulation including software engineering comprehensively under one roof. Do not hesitate to contact us.