FE Design

the optimization company

proven partner for better products

FE-DESIGN – proven partner for industrial manufacturers and suppliers

Demands for state-of-the-art product development are stronger than ever. Nowadays all industries are subject to accelerating changes in production and development and increasing aggressive competition. Complex demands can be fulfilled by applying simulation and optimization technologies in a virtual product development process.
The use of structural optimization in the early design phase leads to optimal design proposals that eliminate the need to perform numerous design variations. The FE-DESIGN approach goes beyond the usual analysis of single engineering problems. Therefore customers are able to make better product development decisions in the earlier design phase using a multi-disciplinary approach which includes the combination of static and dynamic FE analyses with MBD simulations, FEA simulations with durability analysis, or non-linear FEA calculations with life cycle predictions.

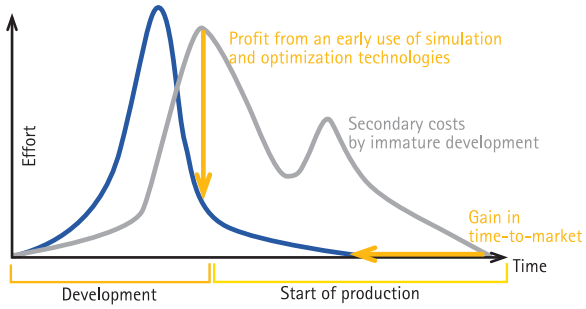


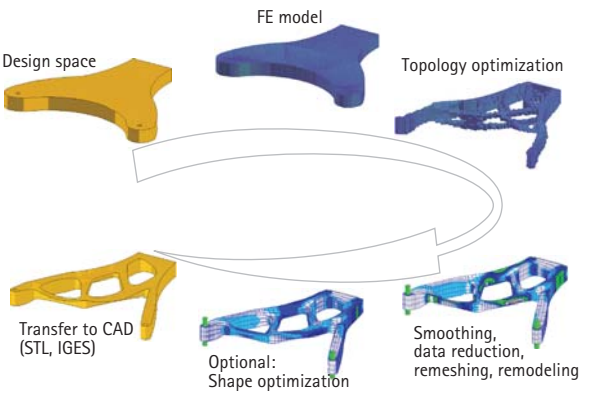
Figure courtesy of Prof. A. Albers, University of Karlsruhe, IPEK

"It is our intention to integrate the proven optimization technology as a standard methodology into the design and product development process.
Many clients already benefit from our valued engineering services and the open architecture of the optimization system TOSCA."
Dr. Juergen Sauter, Founder and CEO of FE-DESIGN

FE-DESIGN – the service and engineering approach

- Complete development projects from design space to CAD model
- Optimization of existing FE models
- Management of cross-disciplinary simulation projects for industry and research & development applications
- On-site CAE consulting and the transfer of knowledge and expertise in optimization technologies
- Training and coaching of designers, engineers and technical executive management staff
- Customization to integrate TOSCA into an existing enterprise-individual design and analysis environment

TOSCA



Integration of topology and shape optimization into the design process

TOSCA - the modular optimization system

TOSCA´s open architecture and seamless integration into nearly all major CAD/CAE systems allow engineers to leverage existing simulation expertise and in-house developments.

- TOSCA.topology proposes an optimal design from a given design space for all specified loads and boundary conditions. Various manufacturing restrictions (e.g. casting constraints) can be included.
- TOSCA.shape improves an existing design or component by modifying the surface to achieve homogenized stress or an increase of the natural frequencies.
- TOSCA.bead calculates the optimal layout of beads for sheet-metal components.
- TOSCA.smooth prepares, smooths and allows a data reduction of results as well as the transfer of results into different CAD systems using different file formats.

TOSCA supports all industry standard FE solvers (ABAQUS, ANSYS, I-DEAS, MSC.Marc, Nastran, PERMAS), durability codes (FALANCS, FEMFAT, MSC.Fatigue), and most pre- and postprocessors with native interfaces (ABAQUS/CAE and ABAQUS/Viewer, ANSYS, FEMAP, I-DEAS, MEDINA, MSC.Patran) and others with standard file formats.

Successful optimization applications by FE-DESIGN´s expertise

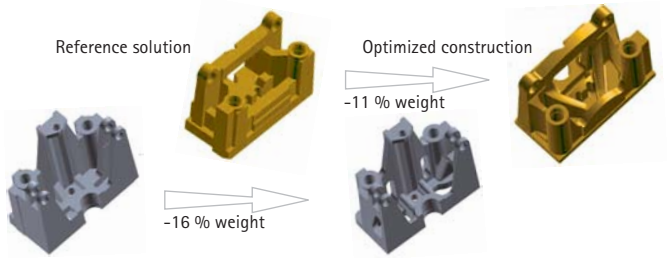
AUDI AG, one of the leading automobile manufacturers worldwide defines its success under the guiding principles of "enthusiasm, creativity and readiness". The desires and demands of the customers determine the direction of marketing helping AUDI become a leader in business innovation. AUDI applies new standards.
The automobile industry today is confronted with radical changes in competitive conditions. Even though customer demands in regards to product quality and short time-to-market are constantly increasing, the efficiency of development processes should not be impaired. As a result, the necessity of using simulation tools as early as possible in the process chain is growing.
The traditional development process is one in which CAE simulations begin after a CAD draft has been completed. Usually information from the simulation are obtained so late that the design phase of a part can hardly be influenced, which has a negative impact on the efficiency of the component in question. Topology optimization is brought into play at this point in time in the process chain. Already in the design phase, information is provided regarding loads and optimal weight of the component geometry in the available design space.

Example:
Topology optimization of an engine support for the new AUDI A8 with the following results: Acceleration of the development process, 45 % stress reduction, 10 % weight reduction. The first prototype fulfills all mechanical tests.

"Topology and shape optimization are now being used by AUDI as standard methods in the development of castings and forgings."
Thomas Binder, Peter Haffner, Peter Hougardy, Development Engineers, Functional Design of Lightweight Structures, AUDI AG

Roemheld & Moelle GmbH was established as a family company in 1859. With a workforce of 200 people the company has its headquarters in Mainz, Germany. Roemheld & Moelle specializes in the manufacturing of castings according to orders and requests of customers.
Strategies of light-weight construction are not only of interest for the aviation, aeronautical and automotive industry, but also in the field of traditional mechanical engineering. An example is the optimization of an end plate and a clamping plate of a plastic injection moulding machine. Based on the modified draft of a conventional design which served as a reference solution, a design was developed with consistent use of topology optimization and a noteworthy quantity of material could be saved: After being implemented as a CAD design, about 15 % less material was used than before.
The interdisciplinary cooperation in the present design process among the experts of structural optimization, the foundry and the machine manufacturer proved to be very worthwhile. The optimized design suggestion could be transferred in a very short time to a new CAD-draft while taking all design and manufacturing conditions into consideration.

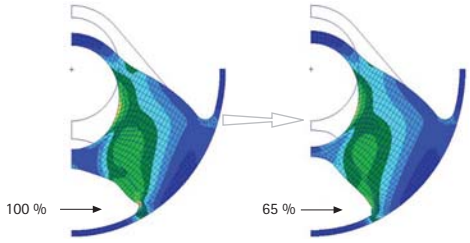
Example:
Optimization of an end plate and a clamping plate of a plastic injection moulding machine taking foundry-technical restrictions into consideration (drawing directions). The requirements regarding the maximum deflection of the clamping plate and the equivalent stresses were met well with the new design.



"The newly designed machine components could be manufactured within a period of only 3 months using topology optimization with TOSCA. A cost reduction of 7 % for the end plate and 10 % of the clamping plate could be achieved with a weight reduction."
Matthias Moelle, Managing Director, Roemheld & Moelle GmbH

The **Freudenberg Group** is a family company with diversified activities, its major one being seals & vibration control, e.g. as supplier for the automotive industry. In 2002 the Freudenberg Group employed a workforce of 28,000 employees in 44 countries and posted sales of 4 billion Euro. The Freudenberg Research Services KG is responsible for research and development within the whole group.
Elastomer components have to be analyzed nonlinearly, therefore the aim was to obtain fast and robust methods available for topology and shape optimization with interface to ABAQUS.
In cooperation with the Vibracoustic GmbH & Co. KG, a joint venture of the vibration and technical areas of the companies Phoenix and Freudenberg, a range of typical components were improved with respect to weight, stiffness and life-span using TOSCA. These components included: elastomer supporting structures of a suspension and engine mount, an engine bracket and a gear bracket, torsional vibration dampers and a camshaft absorber. Topology and shape optimization with TOSCA and ABAQUS in conjunction with the self-developed material laws of Freudenberg are now regarded as being highly effective tools in product development.

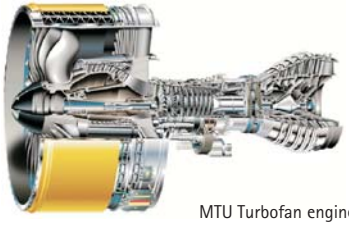
Example:
Shape optimization of an elastomer spring of a torque support under compression resulting in the reduction of the maximum equivalent stress by 35 % as well as the avoidance of fold-overs.



"It is really amazing to see what great strides have been made within the last two years in regards to structural optimization of non-linear problem definitions with the use of TOSCA. As forerunners in the business, the flexible approach and adaptability of FE-DESIGN made it possible for us to coordinate our processes in such an optimal way that we are able to stay one step ahead of our competitors."
Mark Boggasch, Project Manager CAE, Freudenberg Research Services KG

MTU Aero Engines GmbH is a strong international player in the development, manufacture and maintenance and repair of commercial and military engines. The main business areas include: development and manufacture of government orders, commercial engine manufacture, maintenance and repair of military and civil engines; manufacture and maintenance of industrial gas turbines. In its globalization efforts, MTU continues to expand its leading-edge position through worldwide cooperative efforts and joint ventures.
Interstage (Inner) Air Seals (IAS) of aircraft engine turbines are designed to carry sealing features between flow path cavities and to prevent hot gas injection on driving rotor structures. Therefore, the IAS's are not only loaded with static pressure differences and rotational forces but also with high temperature gradients in a radial and axial direction. The resulting stresses have to be evaluated according to their Low Cycle Fatigue (LCF) behaviour as a requirement of the rules for aircraft engine certification ("Type Certificate") which are set by aviation regulation authorities, e.g. Federal Aviation Administration (FAA) or Luftfahrtbundesamt (LBA, Germany).

Example:
An engine thrust increase development program revealed high bending stresses resulting in an IAS missing the LCF life target. Parameter based optimization could not resolve the stress situation. Using TOSCA the existing MSC.Marc model has been optimized within 4 iterations to fulfill the requirements.



MTU Turbofan engine

"Shape optimization of components is a key issue in the developing process of rotating parts. It was possible to fulfill the Low Cycle Fatique life requirements by using TOSCA by introducing only small changes in the air seal geometry as required by various boundary conditions."
Martin Fischer, Walter Huber, Dept. TPEH, MTU Aero Engines GmbH

FE-DESIGN –
the established optimization technology partner

Since 1992: Research on advanced structural optimization methodology by Dr. Juergen Sauter and his team at the Technical University of Karlsruhe.

1994: European Academic Software Award.

1998: Foundation of FE-DESIGN GmbH and start of the development of a commercial code.

1999: Conclusion of a worldwide agreement with MSC.Software Corp. distributing FE-DESIGN´s topology and shape optimization technology with an interface to MSC.Nastran as product MSC.Construct.

2000: Establishment of the FE-DESIGN engineering service department and continuous expansion of the software development department.

2001: Launch of own software product TOSCA with additional interface to ABAQUS and direct TOSCA distribution in Germany.

2002: Initiation of strategic partnerships with further major CAE solution providers and TOSCA interfaces to ANSYS and I-DEAS.

2003: Release of additional solver interfaces on the market (PERMAS and MSC.Marc) and start to establish a worldwide TOSCA reseller and support network.

2004: Launch of the major release TOSCA 5.0 with enhanced capabilities for topology, shape and bead optimization while taking manufacturing restrictions into consideration, a better CAD integration, and the interactive presentation of the optimization results.

In close cooperation with its clients TOSCA has being continuously improved by FE-DESIGN to allow for more ease-to-use capabilities, system integration and interoperative activities, increased functionalities such as coupling to multi-body systems or life-cycle prediction and higher performance.
Beyond the use of TOSCA, the clients of FE-DESIGN's engineering services benefit from an intensive transfer of knowledge through CAE services and consulting, research & development projects, as well as a leverage of optimization knowledge for their specific requirements.

FE-DESIGN
in strategic partnerships

- ABAQUS Inc.
- ANSYS Inc.
- CAD-FEM GmbH
- Ceetron ASA
- INTES GmbH
- LMS International
- Magma GmbH
- MAGNA STEYR Engineering Center Steyr GmbH & Co. KG
- MSC.Software Corporation
- T-Systems International GmbH
- UGS PLM Solutions

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