In the conventional development process, the standard procedure is to use computer technologies in design (CAD) and in engineering simulation (CAE).

The Problem
In the conceptual phase, which plays a crucial role in the efficiency of the entire development process, technology and downstream product stakeholders are typically not involved or available.

The Solution
Through computer-assisted conceptualization using OptiStruct, the development engineer receives valuable assistance in this important phase of the development process.

Altair OptiStruct is a design tool based on the finite element method, which generates concept design proposals from supplied packaging information.

Upon defining the loads, constraints and required product performance, OptiStruct establishes a component shape that satisfies the requirements which in turn defines the arrangement of ribs, beads and stamping patterns even before the initial design layout. This type of OptiStruct design proposal helps the designer when developing completely new component designs. The use of this technology frequently brings improvements in components’ design performance and lets you reach your goal considerably faster than conventional development methods.

Quality Benefit
With OptiStruct, product designers and engineers define targets, such as maximum stiffness, highest possible natural frequency, minimum weight and maximum allowable stress. In addition, designers have the opportunity to define any number of other design and manufacturability requirements. OptiStruct then draws up a design proposal based on your design specifications. The result is an optimal product concept that takes into account complex load situations.

Time Benefit
There are often numerous design iterations and concessions that are made throughout the stages of product design. Determining a design that meets stakeholder requirements at the beginning of the design cycle substantially reduces the number of iteration loops, thus providing more time for product innovation and shorter time-to-market.

OptiStruct - New Paths in the Development Process
OptiStruct - Simple to Integrate into

1. CAD Data Easily Imported

The OptiStruct user has at his disposal every possibility for importing CAD geometry. Both CAD direct interfaces and neutral exchange formats exist; direct readers are available for CATIA and UG. IGES, VDA and STL formats are also available for data transfer.

Examples of different applications
- Conceptual determination of optimal component geometries, frame structures or arrangements of ribs
- Material removal in unimportant (under-stressed) component areas

2. Topology Optimization

A method of determining optimal material distribution within a given package space.

Examples of different applications
- Conceptual determination of optimal component geometries, frame structures or arrangements of ribs
- Material removal in unimportant (under-stressed) component areas

3. Topography Optimization

Method of determining stamping patterns in thin-walled components.

Example of different applications
- Establishing a concept for bead configurations that meet requirements

4. Shape Optimization

Method for modifying the shape of existing components.

Examples of different applications
- Establishing ideal component shapes for detailed improvements to existing component concepts
- Reduction of notch stresses in critical component areas

5. Parameter Optimization

Process for defining ideal component parameters.

Example of different applications
- Defining ideal wall thicknesses, spring, beam or cross section sizes

6. Comprehensive Modeling Capabilities

The construction of the optimization model can be carried out with the integrated pre-processing capabilities of Altair® HyperMesh®. All the capabilities of the HyperMesh FE modeling system are available. Tasks such as automated meshing and the application of loads and constraints can be performed very simply.

- Strain energy for describing stiffness (definable locally and globally)
- Any number of natural frequencies
- Shear strain/torsion at any points on the component
- Stresses
- Weight or volumes (definable locally and globally)
- Buckling factors

Combinations of these variables are also possible. By means of equations they can be put in any relation to each other and weighted.

A typical OptiStruct design assignment could be described as follows:

Minimize component weight, but...
+ the first natural frequency shall be at least 200 Hz and the second at least 300 Hz
+ maximum deflection for static load 1 shall be 0.3 mm
+ the distance between point A and point B for static load 2 shall not exceed 0.2 mm

7. Product Performance Specifications Directly Translatable

OptiStruct offers great flexibility in describing the development objective. The following variables can be incorporated when writing the requirements:

- Strain energy for describing stiffness (definable locally and globally)
- Any number of natural frequencies
- Shear strain/torsion at any points on the component
- Stresses
- Weight or volumes (definable locally and globally)
- Buckling factors

Manufacturable Design Proposals that take into Account Numerous Manufacturing Constraints

The design proposal from an optimization process is only usable if the features contained in it can be translated into a manufacturable component.

Different manufacturing constraints can be defined in OptiStruct. This ensures that the resulting design proposal can be fully detailed in CAD and manufactured.
3. Integrated FE Solver

Besides its extensive optimization capabilities, OptiStruct contains a modern finite element solver. OptiStruct can be used to solve for linear, natural frequency or linear buckling problems. The input format conforms to the NASTRAN format. This enables compatibility with a large number of third-party commercial software packages.

4. Extensive Post-Processing Capabilities

Leveraging HyperMesh and HyperView® integrated post-processing and visualization capabilities, OptiStruct has extensive capabilities for evaluating and interpreting the optimization results. Contour and ISO surface representations make it possible to graphically visualize and understand the design proposals. Informative XY graphs are available for reviewing the optimization process.

Minimal Structural Dimensions

OptiStruct offers the opportunity to specify minimal structural dimensions from the start. OptiStruct thereby avoids frail structures and, as an example, takes minimal wall thicknesses for casting into consideration.

Numerous Specifications for Beads and Stamping Patterns

Using OptiStruct, it is possible to have thin-walled components “beaded” automatically to achieve greater component stiffness. Within OptiStruct, numerous specifications for direction and shape can be set so that bead patterns, which cannot be produced or do not satisfy other requirements, are not created.

Die Draw Directions

Die draw directions can be specified in OptiStruct to create a design which is suitable for casting or forging. This additional constraint information prevents hollow profiles or undercuts in the resulting design. Specifying die draw directions is perfectly suited for automating rib placement on die-cast and injection-molded components.

Symmetry Specifications

With both topology and topography optimization, up to three planes of symmetry can be specified. With symmetry specifications defined, the resulting design proposals will be symmetrical despite asymmetrical component loading.

Results Conveniently Shared with CAD Systems

Besides reviewing the design proposals in a post-processor such as Altair HyperMesh or Altair HyperView, OptiStruct concept designs can also be exported as IGES CAD geometry. This geometry is generated by means of advanced smoothing and surface reduction algorithms and thus allows the results to be directly imported into all CAD systems.

This “geometry creation” functionality, in conjunction with the inclusion of manufacturability requirements, provides the designer with a concrete concept design for the component, very early in the product design process.
Numerous companies from a variety of industries are successfully using Altair OptiStruct in their development process to bring better products to market in a shorter amount of time.

OptiStruct’s customers include:
- Airbus
- Alcoa
- Audi
- BAE Systems
- Bayer
- Benteler
- Bertrandt
- CAT
- Delphi
- Daimler
- DaimlerChrysler
- Dana Corporation
- Delphi
- DSM Engineering Plastics
- Dyson
- Faurecia
- FIAT
- Fisher-Price
- Ford Motor Company
- GE
- General Motors
- Hayes Lemmerz
- Honda
- Honeywell
- ISUZU
- Jaguar Cars
- Johnson Controls
- John Deere
- Lear
- Opel
- PACCAR
- TECOSIM GmbH
- Tenneco Automotive
- The Budd Company
- Tower Automotive
- Toyota
- Trelleborg Automotive
- TRW
- Visteon
- Volkswagen
- Volvo
- ZF Friedrichshafen AG

Examples of different applications

### Topology Optimization Applied to a Transmission Cover

OptiStruct was able to determine a new, effective rib configuration that increased stiffness while simultaneously reducing the weight.

Until now, we needed two or three design cycles to reach our target of 200 Hz for the first natural frequency of oil pans. With the help of Altair OptiStruct topography optimization, we often achieve 300 Hz with the first design.

Arnulf Deschler, ZF Friedrichshafen AG

### Topography Optimization Applied to an Oil Pan

OptiStruct identified a new stamp bead layout resulting in an increase of the first natural frequency to 40 Hz.

### Topology Optimization Applied to a Radiator Module Bracket

By applying OptiStruct, it was possible to improve the stress level and component stiffness substantially, and at the same time, reduce material use.

### Topology Optimization Applied to an Air-Conditioner Compressor Bracket

Implementing the OptiStruct design proposal resulted immediately in a part with outstanding stress and stiffness properties exceeding the required limit for the first natural frequency by 37%.

As one of the world-wide leading companies in the area of virtual product development, Altair Engineering provides software solutions and services to shorten and enhance development processes.

Altair Engineering
1820 E. Big Beaver
Troy, MI 48083-2031
Telephone: 248-614-2400
Fax: 248-614-2411

www.altair.com · info@altair.com