midas NFX

Total Solutions for True Analysis-driven Design

TOTAL SOLUTION for

TRUE ANALYSIS-DRIVEN DESIGN

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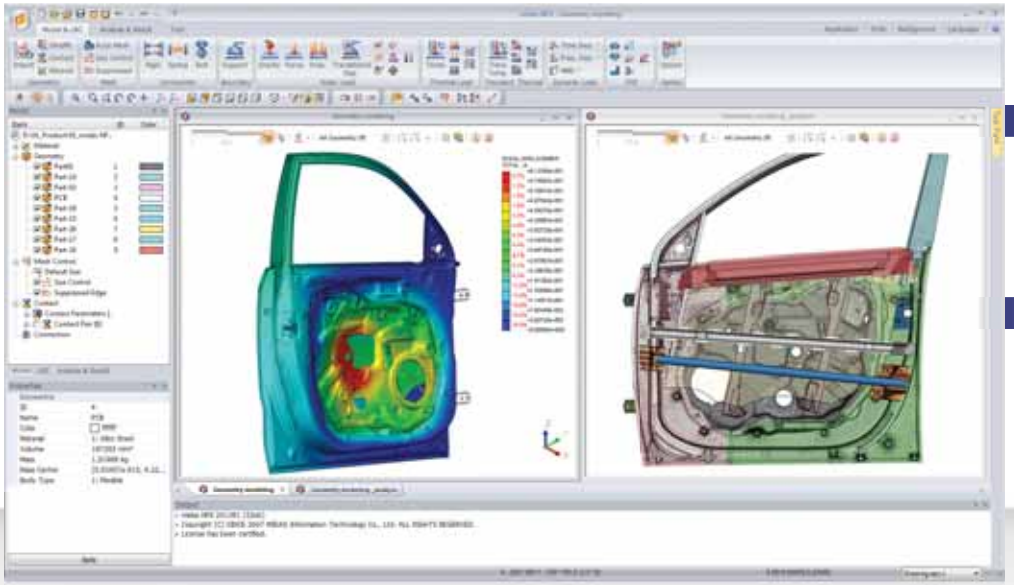
Total Solutions for True Analysis-driven Design

In the era of global competition, the demands on the use of CAE are growing faster than ever in the process of product design simulations. **For design productivity and product competitiveness, the CAE tool must be capable enough for sophisticated analyses and yet sufficiently easy enough for the product designers to use**.

Total Analysis Solutions for Optimum Design in Multi-disciplines

midas NFX provides total analysis solutions in a very user-friendly work environment and produces highly reliable results.
midas NFX empowers the designers to effectively carry out various structural, heat transfer and computational fluid analyses required in the process of product design.
midas NFX enables the designers to attain optimum product design through high quality and speedy simulations.



Pre/Post-processing for Designers

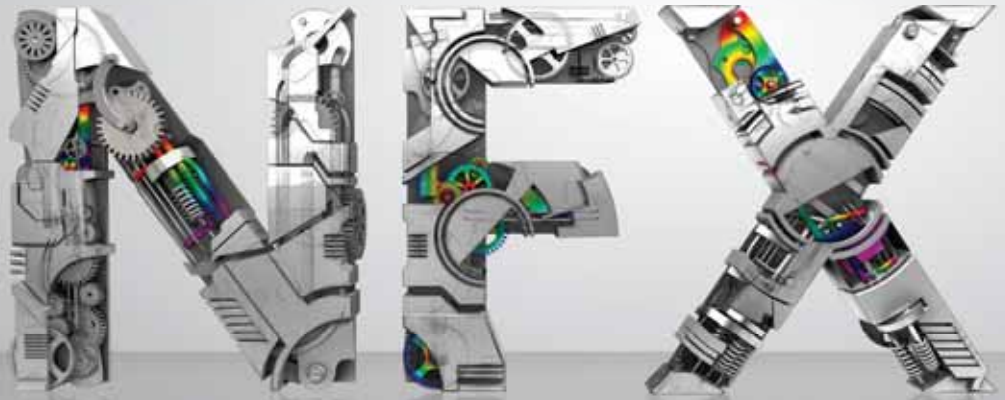
- CAD modeling based operational method for general designers and novice analysts
- Solid modeling supported
- Fast and simple analyses for design with minimum input through various automation functions

Pre/Post–processing for General Analysts & Experts

- CAD modeling based & finite element modeling based operational method for experts and experienced analysts
- Hybrid models of various elements such as solid, shell and frame supported
- Accurate modeling, analysis and results evaluation using the built-in geometric modeling and various mesh generation functions

Linear Static Analysis
Modal / Buckling Analysis
Heat Transfer / Thermal Stress Analysis
Nonlinear Static Analysis
Explicit / Implicit Dynamic Analysis
Fatigue Analysis / Composite Material Analysis
Topology / Size Optimization
CFD Analysis
High Performance Parallel Solvers

Part I. Concept and Applications of CAE

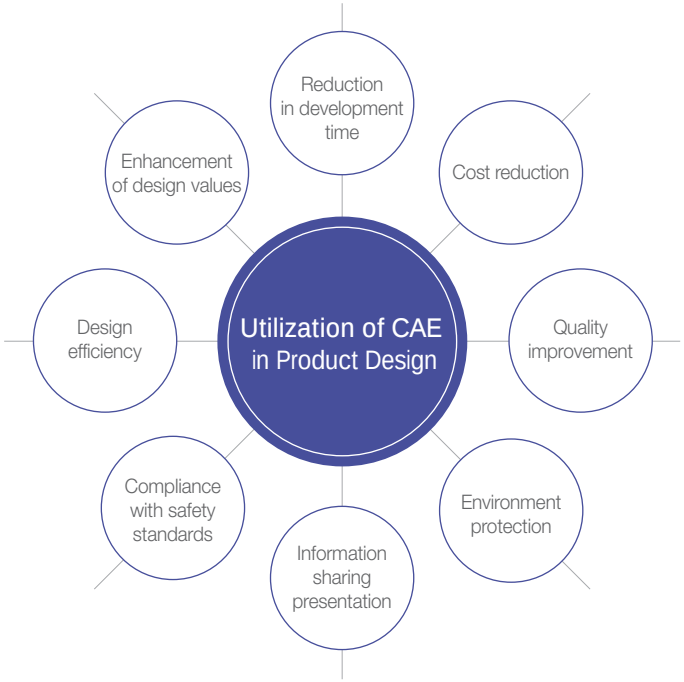


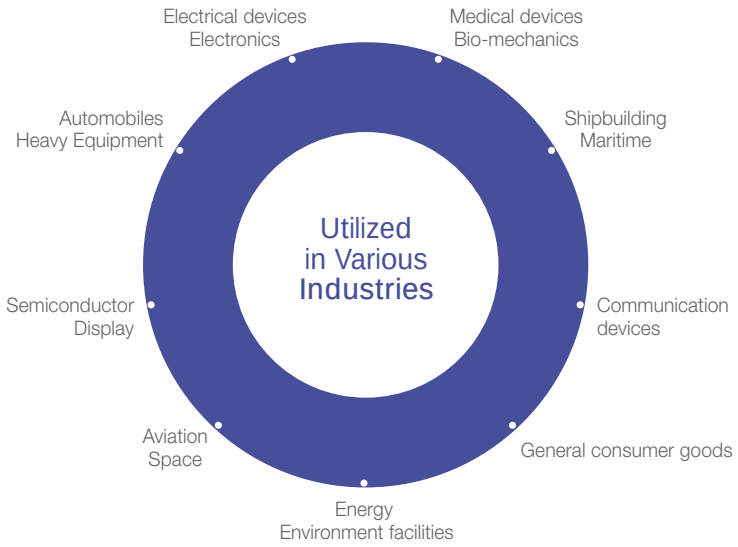
What is CAE?

CAE (Computer Aided Engineering)

CAE is synonymous with technology by which performance of a design model is examined and improved through a series of simulations using a computer.

Fabricating physical prototypes can be very costly and time consuming for product development. Product design needs to be optimized for efficiency and productivity while being innovative. All potential defects and errors must be eliminated prior to actual production.





Ideal for Efficiency, Productivity & Innovations

CAE enables the designer to examine the performance of a design model and use the analytical results to modify and enhance the model prior to manufacturing and testing prototypes. In actual engineering analysis and design involving various shapes and materials, CAE continuously helps the designer shorten the development time and strengthen the competitiveness of products and technology.

Applied to various industries beyond traditional engineering

Being able to evaluate the performance of a product or a system prior to manufacturing a prototype is so important that CAE has become a strong and effective tool not only in its traditional fields of engineering but also in other areas such as the medical, communication, electrical, electronics and semiconductor engineering fields.

Internationally Accepted CAE Standard Process

Product Development Process & CAE

Utilizing CAE at the design stage offers an innovative process, which will lead to securing initial product quality, a decrease in product development time and reduced costs.

With the increase in the number of simulations, the need for producing physical prototypes will significantly decrease.

Standard process adopted worldwide

A traditional product development process evolves around repetitive manufacture of prototypes and testing, leading to an increase in time and costs. Product design can be checked and improved through analytical simulations at the initial stage while reflecting many design parameters and conditions. Such a new process will lead to a significant reduction in design changes downstream.

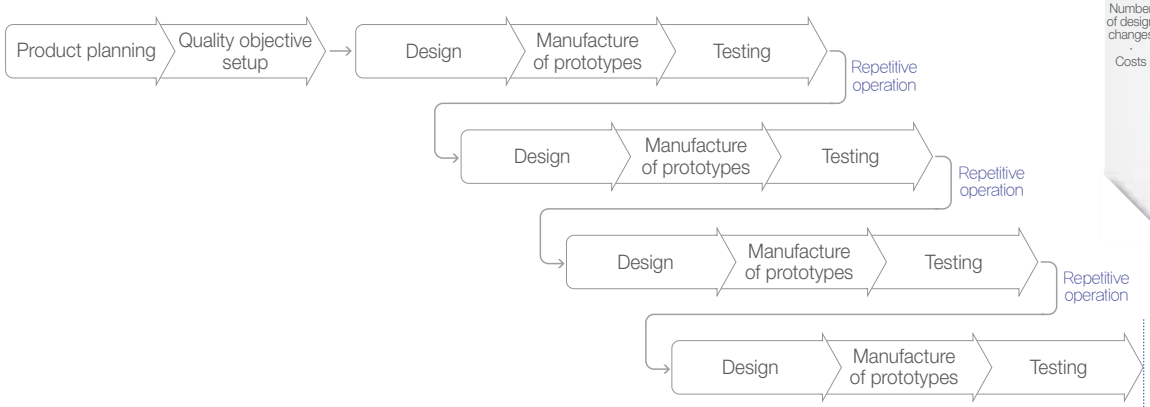
Innovative Product Development Process

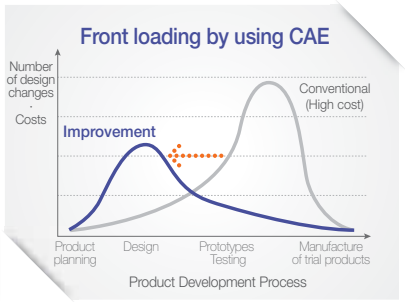
Introducing and utilizing CAE from the initial stage of product development will lead to the following advantages:

- Possibility to evaluate product design prior to manufacturing prototypes
- Tremendous flexibility in design changes
- Significant reduction in time and costs

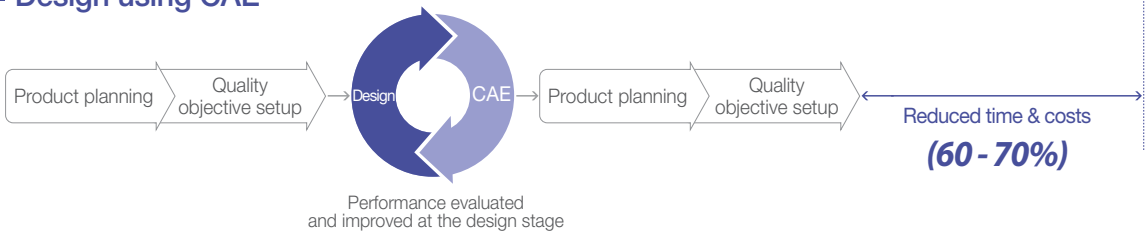
"What if CAE is introduced and utilized during the initial stage of product development ?"

▪ Traditional Design





▪ Design using CAE



Change in CAE Paradigm from Technological Advancement

Why must CAE be utilized?

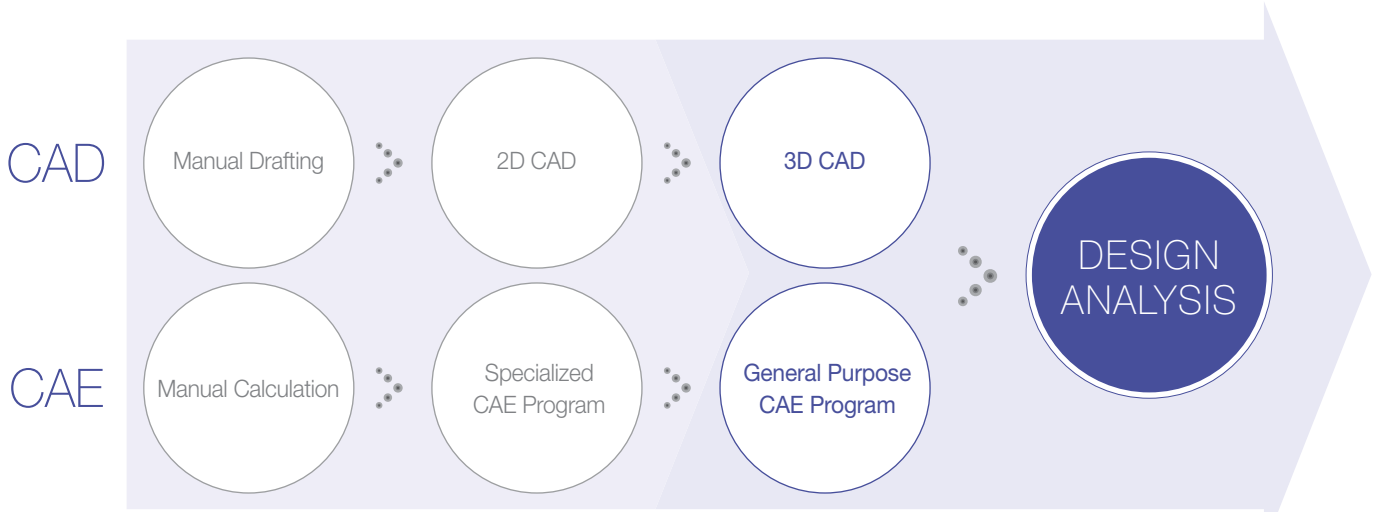
Advancement of CAD/CAE Technology

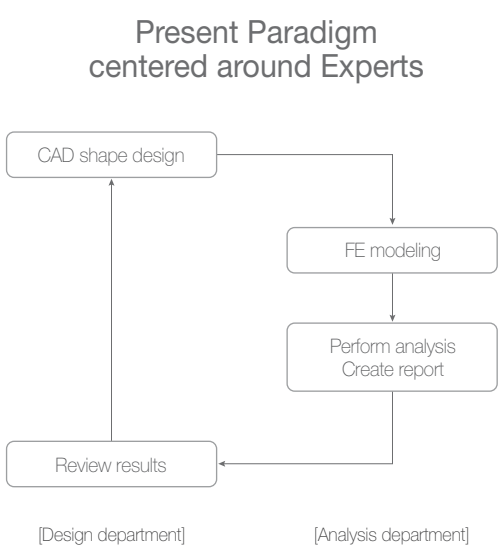
With the advancement in technology, manual work once performed by a few experts is now being shifted to **a large number of designers** with digital-based technology.

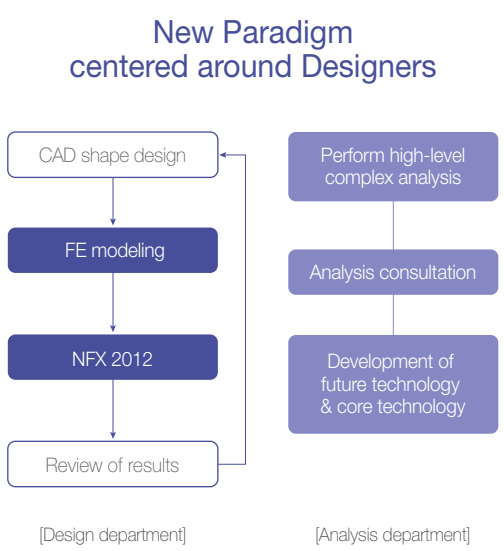
CAD/CAE has enabled the engineers and designers easily create digital prototypes while considering more complex and diverse materials. Time has come for **the designers to easily verify and predict the product performance through optimized simulations prior to mass production**.

Change in Paradigm

The CAE technology has advanced from a point where only the experts could operate CAE to a point now that even the designers can use it for product design as common technology. **More design workforce can analyze the characteristics of products from various angles at the product development stage**. And the group of experts can now focus on and dedicate their time to high-level analyses and development of future technology and core technology securing a competitive edge for their products.

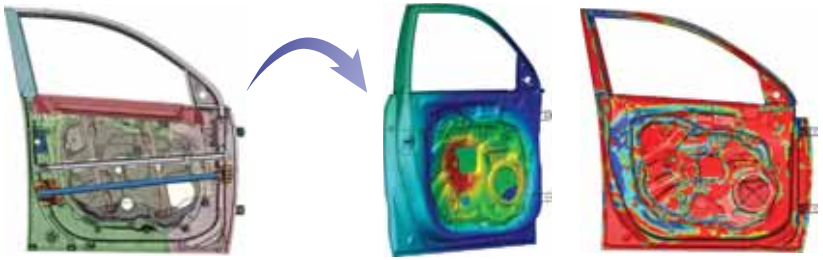






Proven to be practical and reliable through various project applications

Automotive

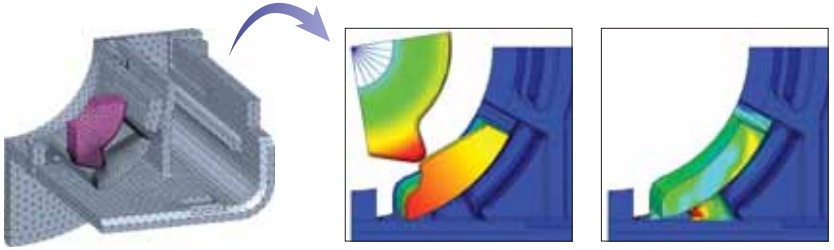


Car door FE model | Stress distribution | Fatigue life cycle

Analysis for strength and durability
(material/geometric nonlinear, linear transient response & fatigue analyses)

1st Front bending mode | Rear torsional mode

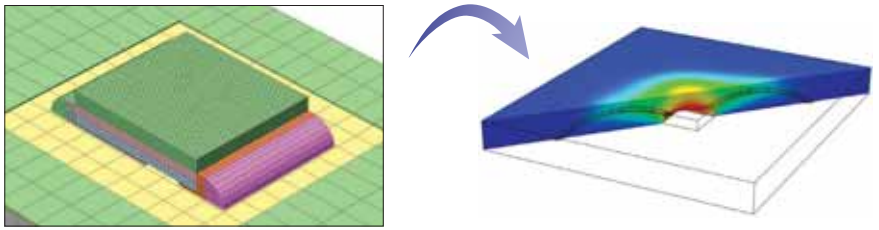
Dynamic analysis of a car body



FE model of a door lock | Deformed shape | Stress distribution

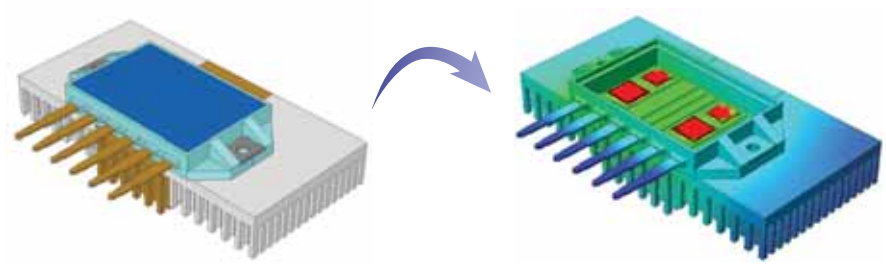
Nonlinear contact analysis of car's door lock

Electronics / Electrical



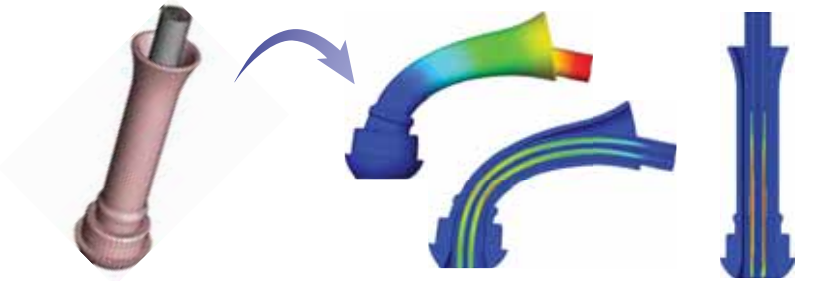
BLU chip FE model | Temperature distribution

BLU chip's heat transfer analysis
(Thermal contact using mixed hexa/tetra mesh)



MOSFET with heat sink | Temperature distribution

MOSFET's heat transfer analysis using heat sink



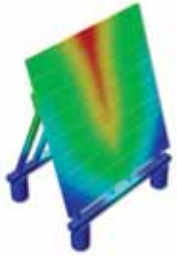
Cord assembly's FE model | Deformed shape & stress distribution | Fatigue life cycle

Cord assembly's durability check
(material/geometric nonlinear & fatigue analyses)

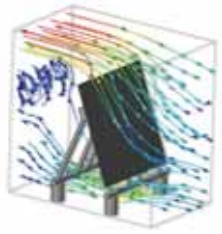
Proven to be practical and reliable through various project applications

Plant & manufacture

FE model

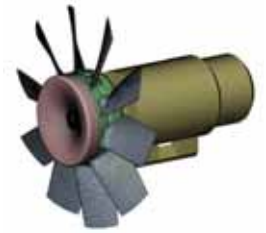


Frame panel's deformation



Wind pressure

Photovoltaic power generation's frame analysis



FE model

FAN's Stress distribution

Dynamic analysis of plant equipment

Machinery / heavy equipment

Crawler drill FE model

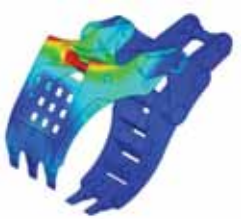
Deformation shape

Stress distribution

Construction equipment
(contact auto-search & remote loading functions used)

Geometry model

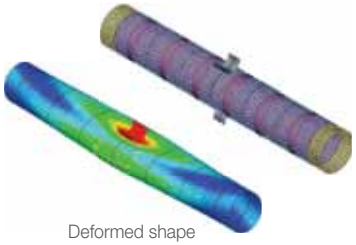
FE model



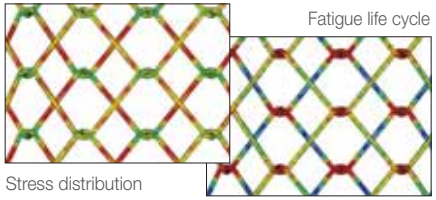
Stress distribution

Multi-Grapple strength analysis

Medical equipment

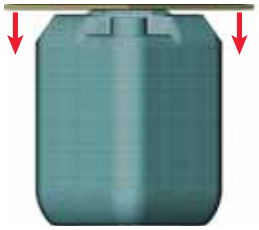


Deformed shape



Static analysis using auto contact and fatigue life evaluation of medical stent

Consumer products



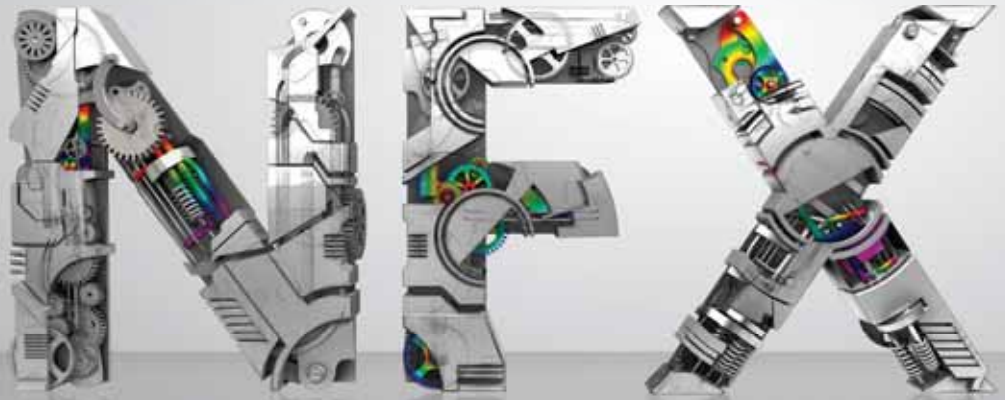
Geometry Model

Static analysis result

Nonlinear analysis result

Buckling analysis of polyethylene box

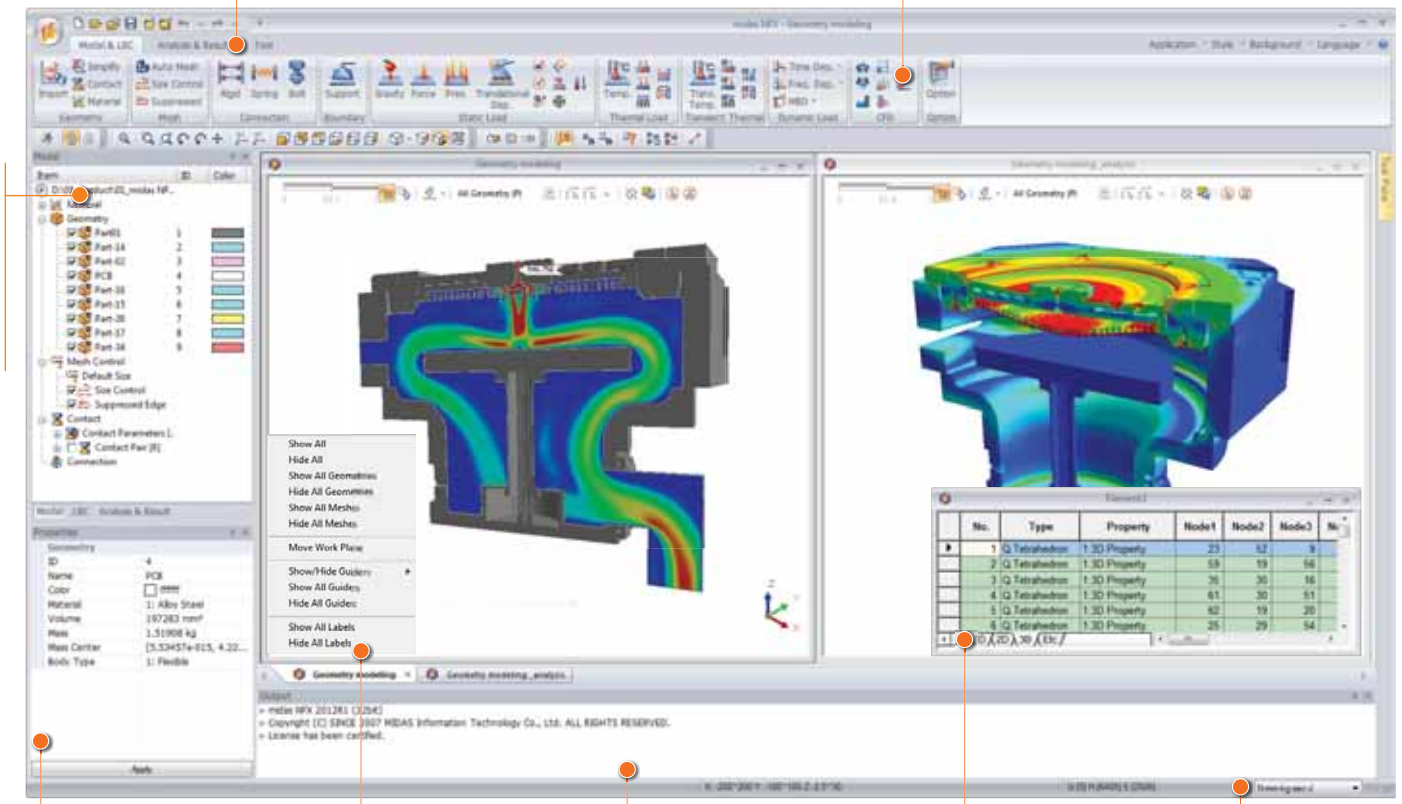
Part II. midas NFX (Pre/Post)



Simplified framework focused on easy user interface

Operation Environment

A quantum leap in operational environment can be experienced in midas NFX. The user interface is simpler, lighter and more intuitive for design analysis in practice for from general designers and beginners to expert analysts.



Intuitive Workflow possible with minimum mouse operation

Workflow

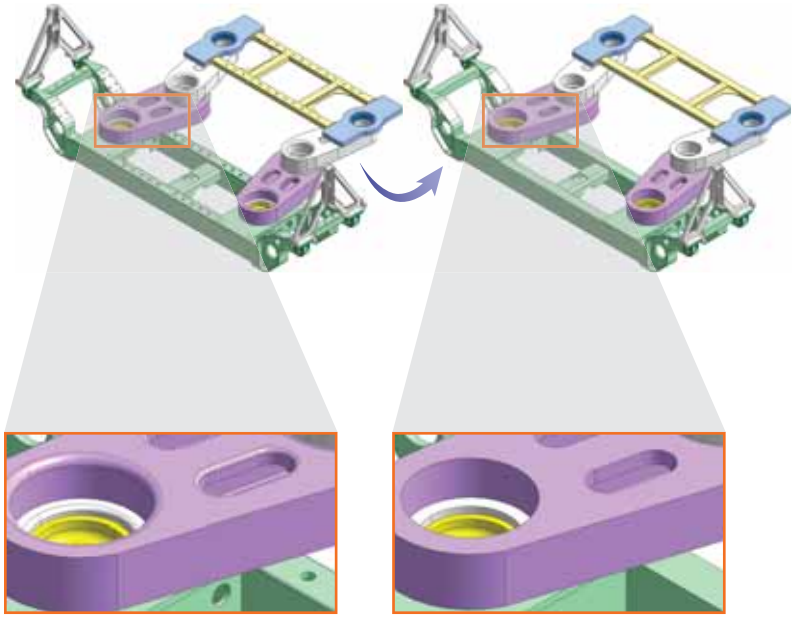
A typical workflow in midas NFX consists of the following six steps:

(1) Import a CAD file
(2) Define materials
(3) Assign loads and boundary conditions
(4) Create finite element mesh and perform analysis
(5) Check main analysis results
(6) Auto-generate analysis report

Through a series of steps from generating an analysis model using a CAD model to analyzing and generating an automatic report, midas NFX guides the user to effectively conduct the entire process of analysis and evaluation of results.

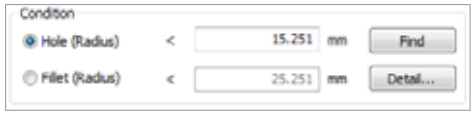
Step 01

Import a CAD model targeted for analysis
(Auto-processing functions for contact & feature removal)



CAD model targeted for analysis

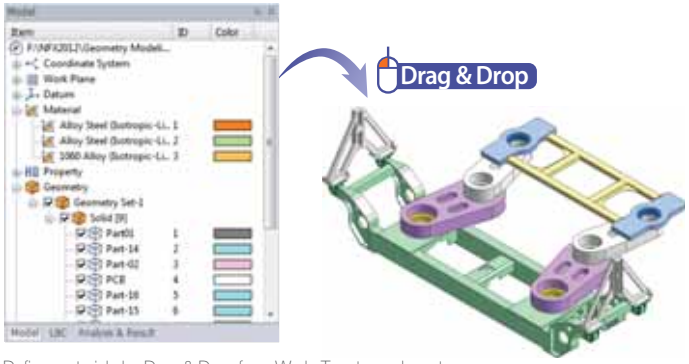
Model after automatically removing features and defining contacts



Automatic removal option for features including holes & fillets

Step 02

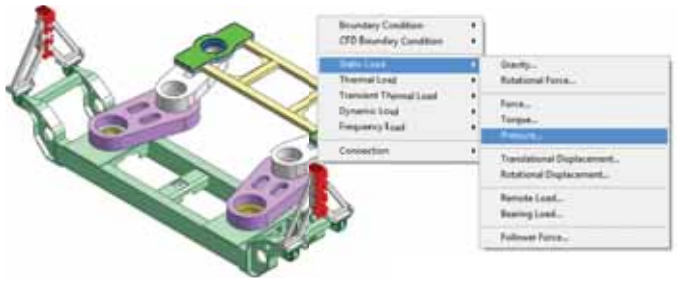
Define materials (Database + Drag & Drop)



Define materials by Drag & Drop from WorksTree to each part
(built-in material database supplied)

Step 03

Assign loads/boundary conditions
(Directly to the geometric shapes)

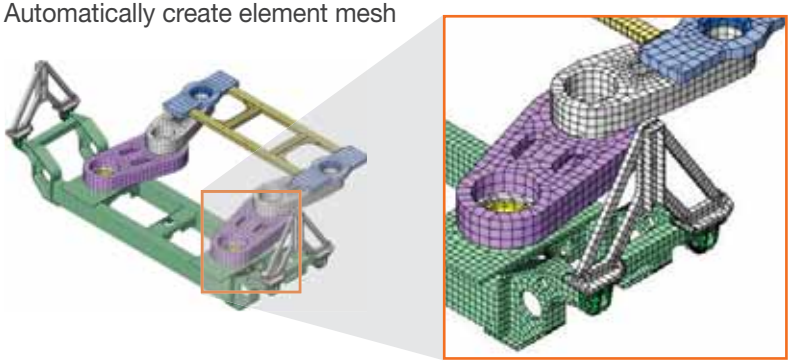


Diverse and automated high-class functions to conveniently obtain best results

Workflow

Step 04

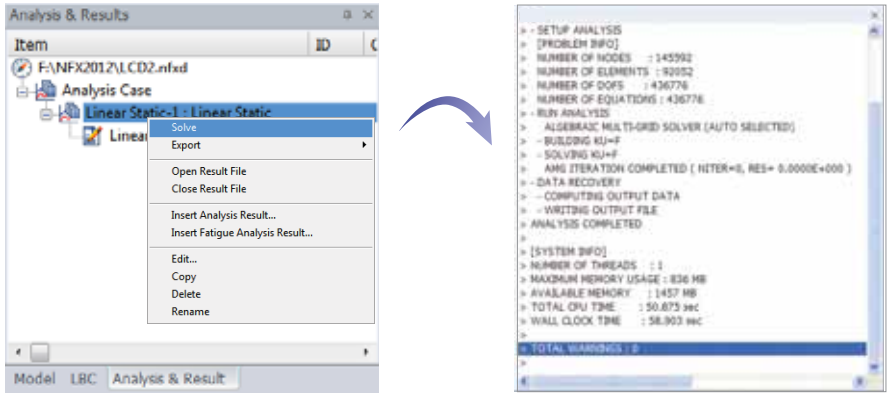
Automatically create element mesh



Automatic generation of element mesh for analysis
(Hexahedron-tetrahedron hybrid mesh)

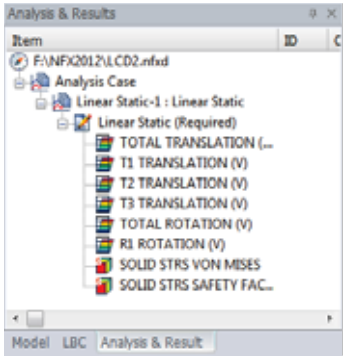
Step 05

Define analysis case(s) and perform analysis

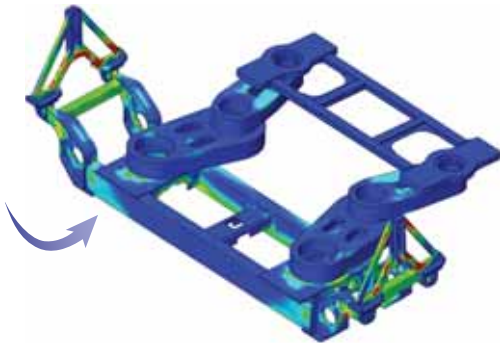


Step 06

Check main analysis results



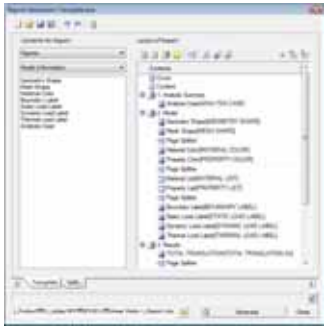
Double-click in Results Works Tree



Stress results and deformed shape

Step 07

Auto-generate analysis report
(Customizable MS-Word format)



Prepare analysis report

Generated report (MS Word format)

Mid-range of CAD modeling functions for a variety of practical geometric modeling

Geometric modeling

midas NFX provides various practical surface and solid modeling functions at the mid-range CAD level enabling both bottom-up and top-down modeling methods.

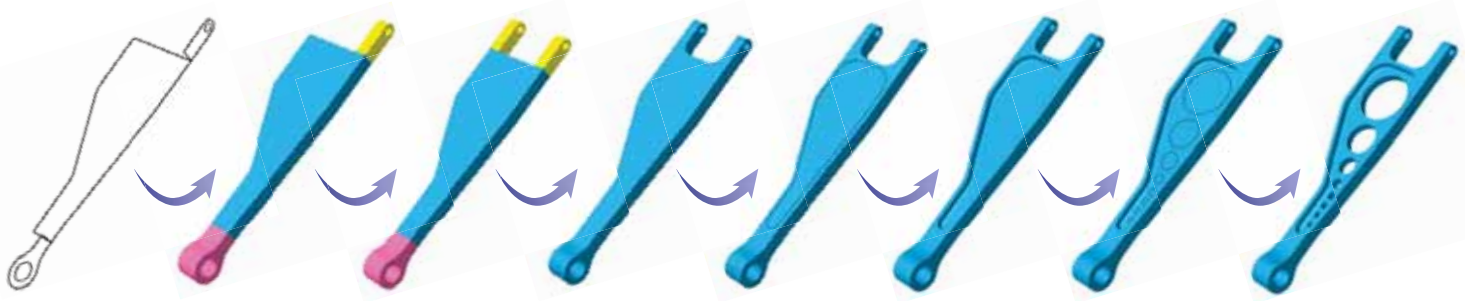
Surface
- Surface: plane, Coons, NURBS, point interpolation
- Extrude, revolve, sweep, loft
- Fillet, chamfer, offset
- Fuse, sew (end-connect, mid-intersect, approximate)
- Trim, extend, imprint of point/curve on surface
- Trim by surface/curve

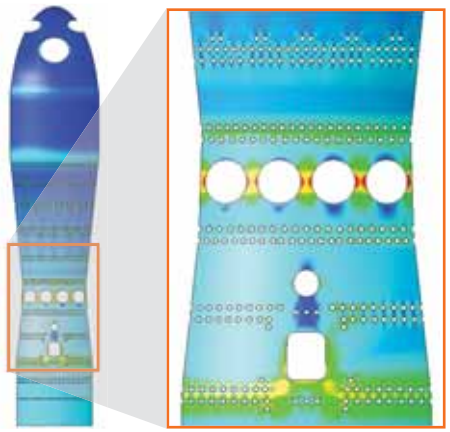
Solid
- Primitive: box, cylinder, sphere, torus, cone
- Boolean operations: fuse, cut, common
- Extrude, revolve, sweep, loft
- Trim, divide, draft, shell
- Fillet, chamfer, create hole

Curve
- Line, polyline, arc, circle
- Rectangle, polyline
- Spline, profile, spiral
- On-face curve
- Intersect line on surface, shortest line, tangent
- Trim, extend, fillet, chamfer, offset
- Merge, divide, make wire (grouping)

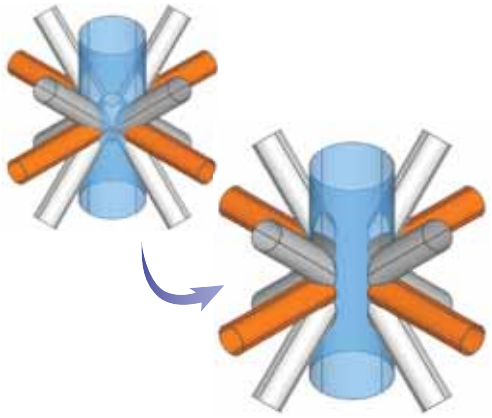
Geometry manipulation
- Explode, compound
- Model check: topology, overlap
- Search/delete small surface/curve
- Measure: area, length, distance, angle
- Move: translate, rotate, mirror, scale
- Remove: hole, interior (imprint) point/line

Solid Modeling Example

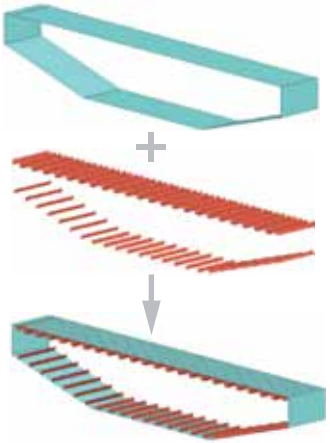




Various shapes and hole sizes by trim and surface split by line



Trim 2 surfaces based on intersection line



Connection of stiffners using sew and fuse functions of surface (Non-manifold Surface creation)

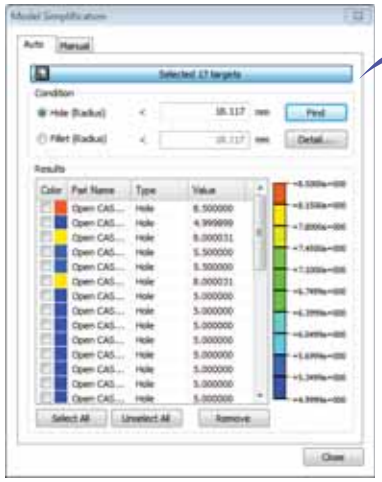
Intuitive and powerful cleanup for effectively creating an analysis model

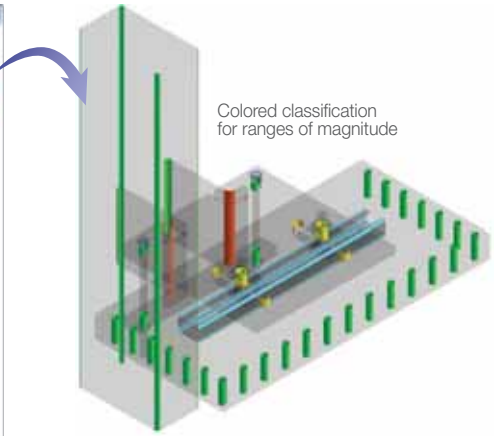
Automatic Cleanup

The automatic cleanup function of midas NFX can conveniently clean up features such as small holes and fillets that are not essential for analysis.

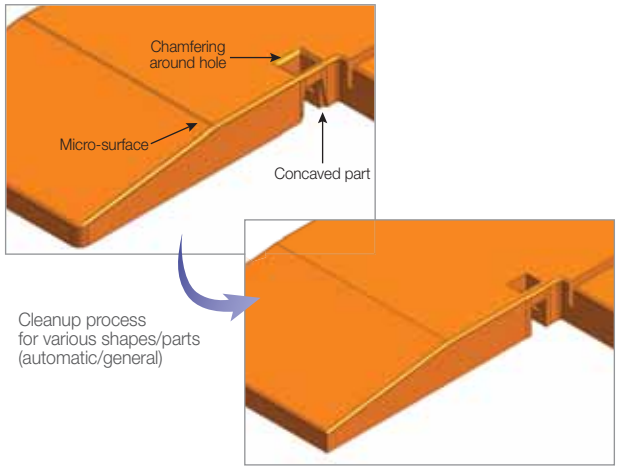
The cleanup function can be applied automatically when importing a CAD model. Or features can be conveniently searched, checked and deleted in the cleanup wizard without any complicated manual work.

- **Main automatic cleanup functions**
  - Remove holes, fillets, projections
  - Remove/merge micro-surfaces
  - Check and modify topology

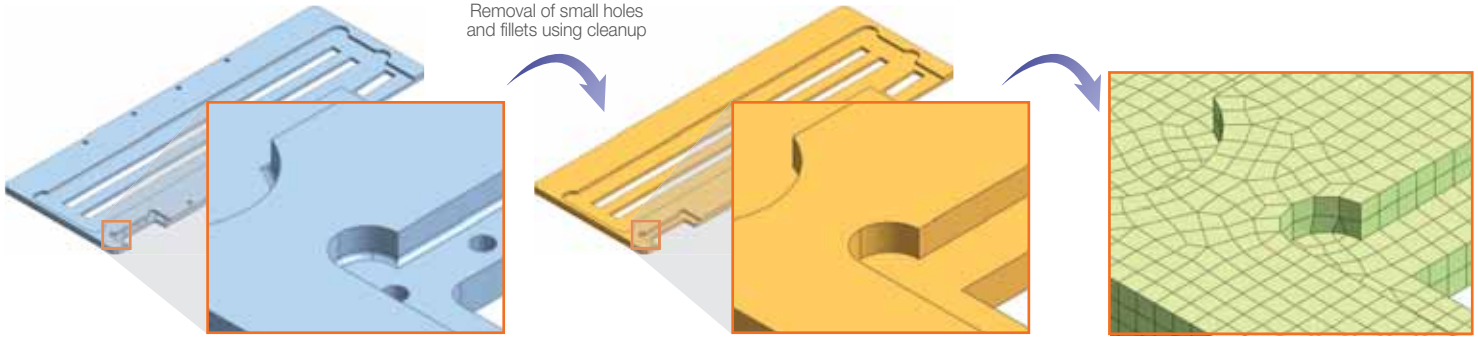




Intuitive interface for searching
and distinguishing objects to be removed



Cleanup process
for various shapes/parts
(automatic/general)



Hybrid mesh created after cleanup
(reduction in the numbers of elements/nodes
and improvement of element mesh quality)

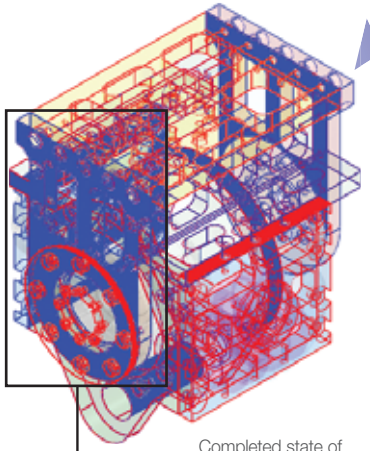
Automated contact definition suitable for complex, large scale assemblies and convenient visualization and management

Definition of Contact

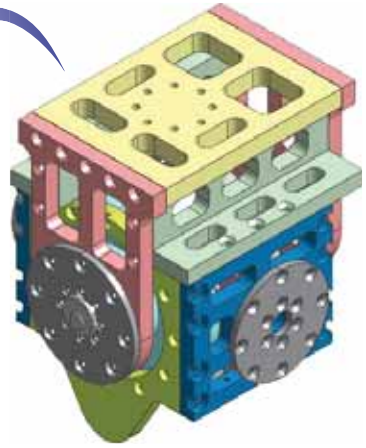
midas NFX automatically defines contacts for assembly models and allows the user to conveniently check and manage the definitions.

Even for a complex assembly model, contacts are established by automatic calculation of distances between the parts without having to check every contact condition between the parts. The defined contacts can be clearly checked through visual representations.

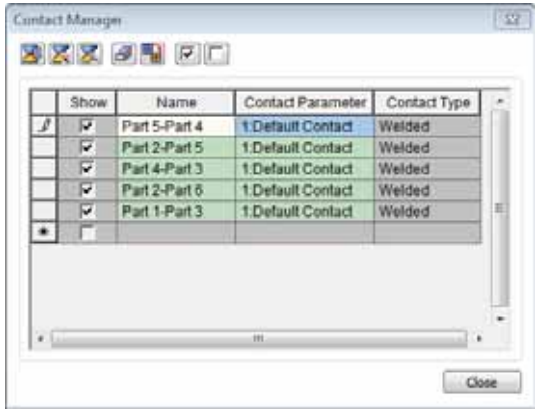
Also, by using the contact manager function, the essential information of the defined contacts can be readily checked and simply revised.



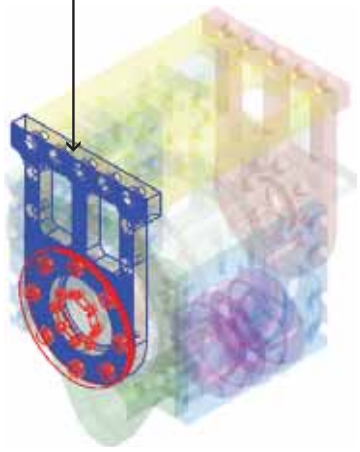
Completed state of automatic contact assignment (total model check)



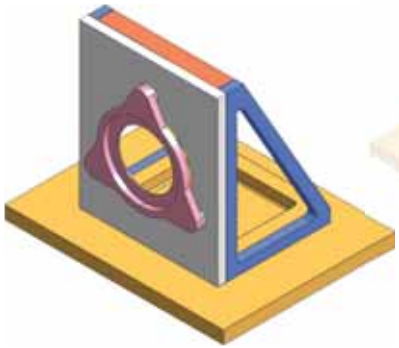
Assembly model

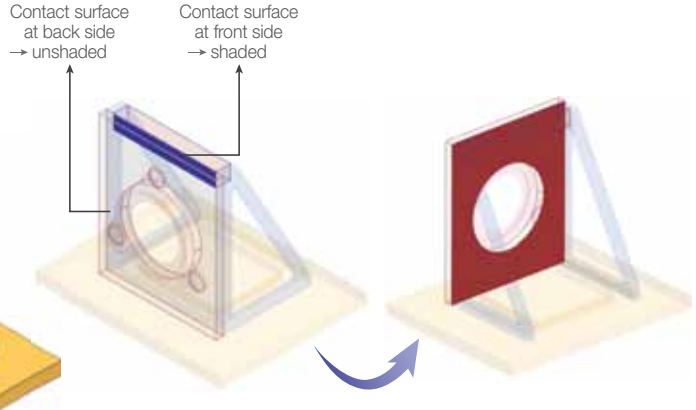


Contact manager to conveniently check, revise and manage contact definitions



Individually check each contact definition





Depending on the viewpoints of the contact surface, the shaded surface changes, which allows the user to easily check the location of the contact surface.

Various mesh generation methods for optimum element meshing

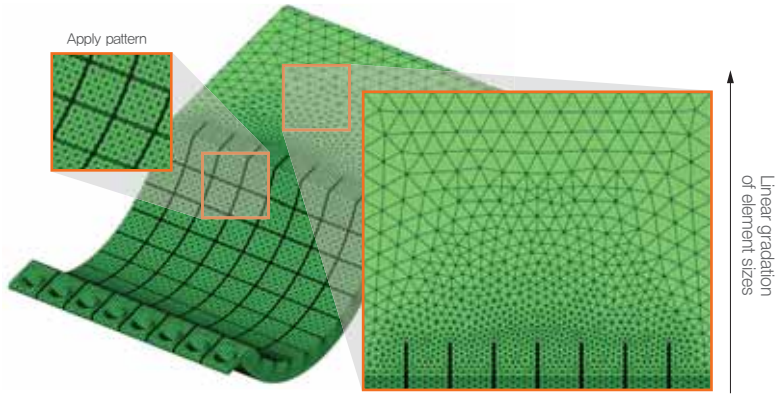
Mesh Generation

midas NFX enables both expert and novice users to easily generate optimum mesh for analysis through a number of mesh generation options.

- Surface Auto-Mesher
- Solid Auto-Mesher
- Map-Mesher
- Manual extraction of higher order element mesh
- Element based mesh regeneration
- Element mesh generation including internal points and curves
- Assignment of mesh densities to internal element meshes
- Offset element creation around internal holes
- Adaptive analysis reflecting geometric shapes

midas NFX contains practical functions to improve and manipulate element mesh of high quality. midas NFX also provides various management and checking functions to conveniently manage complex models.

- Automatic group creation by parts
- Element mesh check
- Element mesh quality testing
- Checking and aligning element coordinate systems
- Division of element patterns
- Renumbering nodes/elements



Symmetrical mesh generation

Automatic Generation

- Auto-mesh generation
  : Surface, solid & plane domains
  : 2D->3D. Element based regeneration
  : Densification including internal points/curves
- Mapped mesh generation
  : Surface, solid, 4-nodes
  : Curve/surface defined volume

Density Control

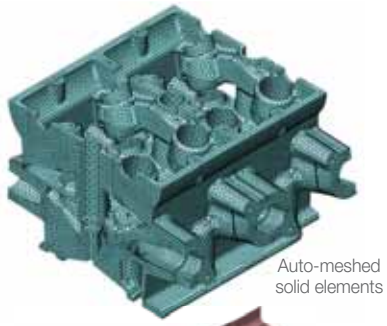
- Density Control
  : Element length, number of divisions, length ratio
  : Linear gradation, symmetrical distribution
  : Mouse click assignment, table input, matching
- Property assignment and check
- Default value assignment and use
- Division of patterns and density control

Protruded Generation

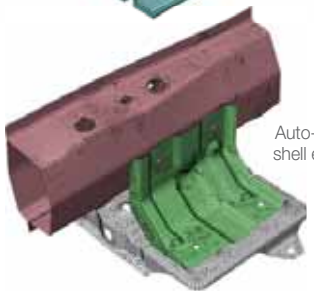
- Extrude, revolve, sweep project, offset, fill
- Node → 1D element extrusion
  Curve → 2D element extrusion
  2D element/solid element surface → 3D extrusion
- Equal, unequal interval extrusion
- Extrusion based on geometric entities, nodes and elements

Manipulation Function

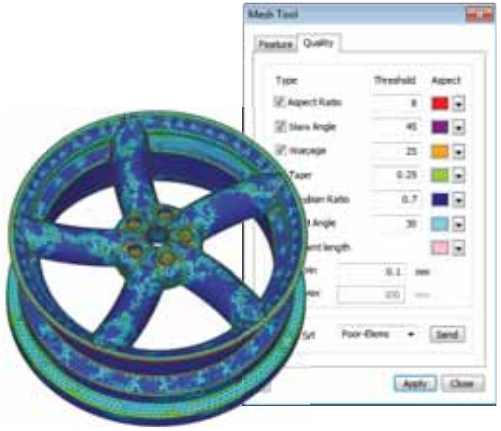
- Node/element table
- Node/element group
  : Definition, name change, Boolean operation
- Change in element parameters (order, etc.)
- Check : connection condition, element quality
- Move : translate, rotate, mirror-copy, scale
- Group calculation : union, intersection, difference of sets, XOR



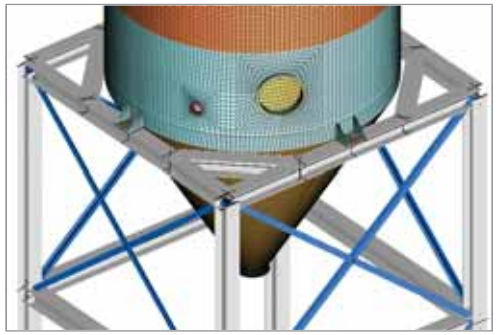
Auto-meshed solid elements



Auto-meshed shell elements



Graphics based convenient element mesh quality check and group classification



Freedom of combining of solid, shell and frame elements (frame cross-sections displayed)

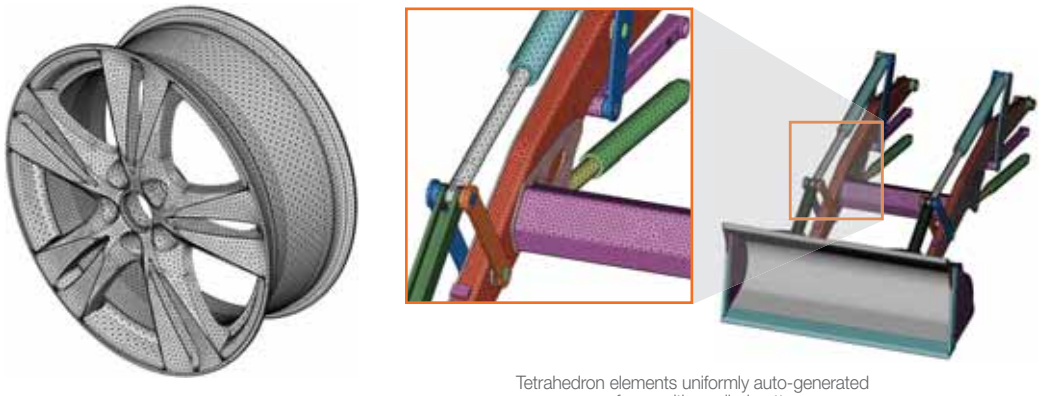
High-performance, high-quality auto-mesh generation for optimum finite element mesh

Solid Automatic Mesh

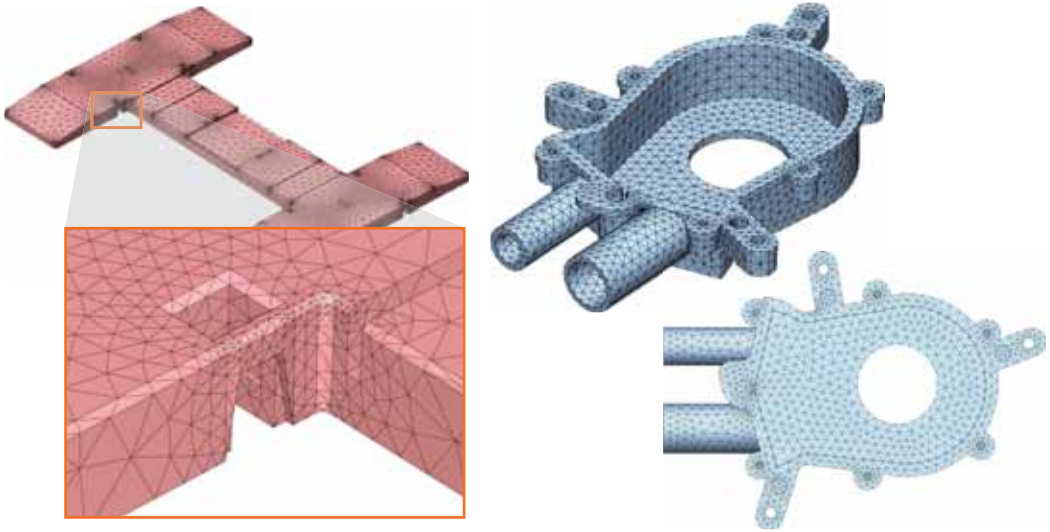
midas NFX generates optimum element mesh using the automatic mesh generation function for hexahedron-tetrahedron hybrid mesh.

midas NFX generates high-quality, hexahedron dominant element mesh even for solid models of complex shapes. As such, the number of nodes and hence the analysis time become significantly reduced. Especially the boundaries generally consist mostly of hexahedra, the results of which are superior to other element types.

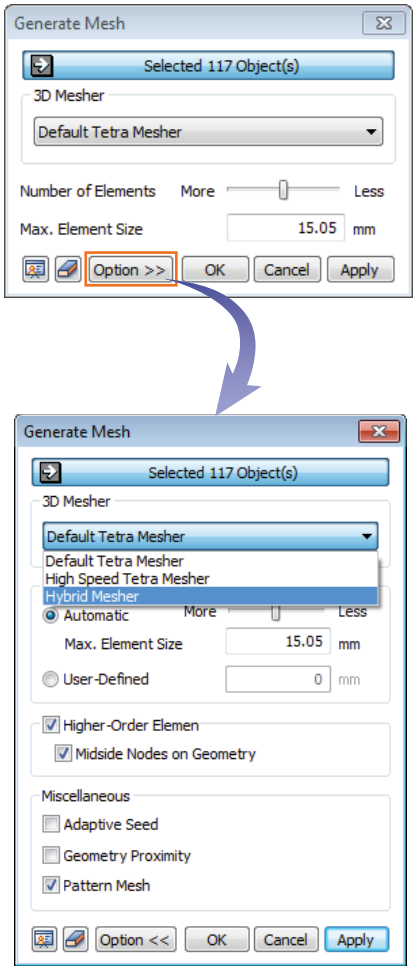
midas NFX supports parallel processing that utilizes multi-cores during mesh generation. Even for a large scale assembly model consisted of tens and hundreds of parts, many parts are simultaneously meshed, which results in a significant reduction in the total mesh generation time.



Tetrahedron elements uniformly auto-generated on surfaces with applied patterns



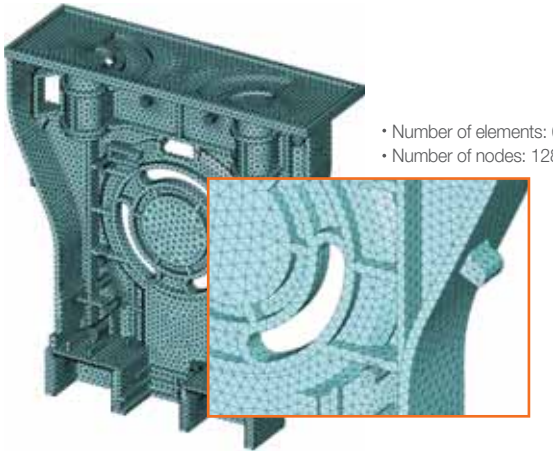
Auto-generated tetrahedron mesh with the automatic control of mesh density reflecting the shape characteristics such as curvature and proximity to holes



Various practical control options for element mesh density and shape

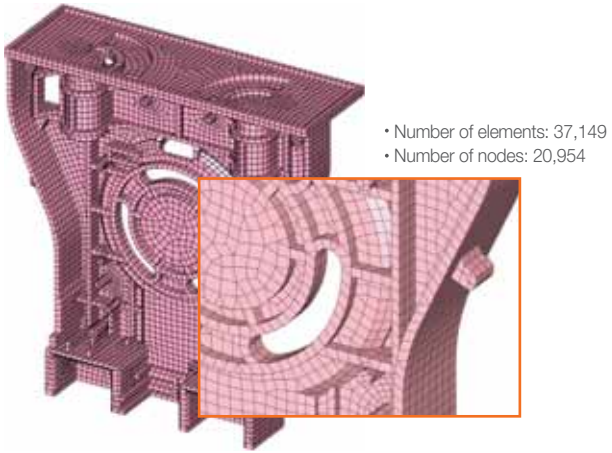
Latest hybrid element mesh generator leading to efficient analysis and superb results

Hybrid Element Mesh (hexahedron-tetrahedron hybrid element mesh)



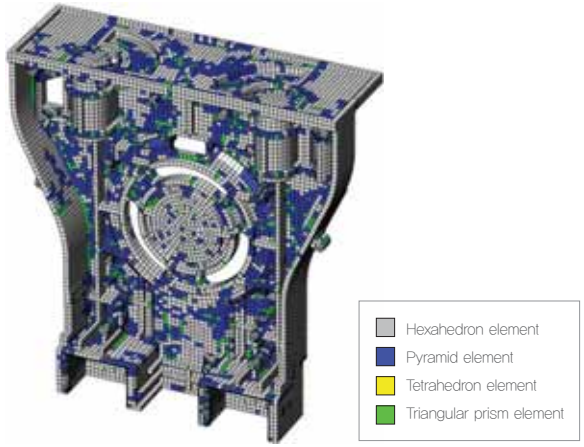
• Number of elements: 69,496
• Number of nodes: 128,907

Tetrahedron element mesh model generated by Tetra Mesher

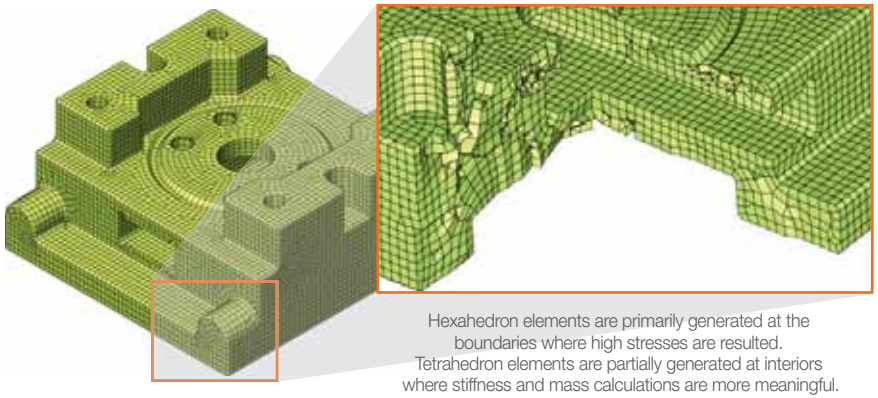


• Number of elements: 37,149
• Number of nodes: 20,954

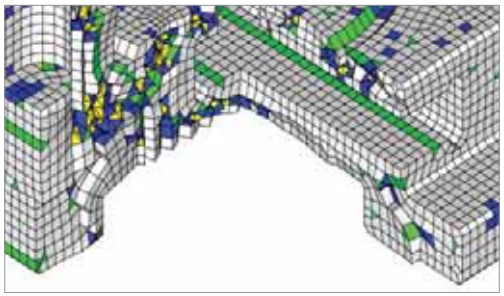
Hexahedron-tetrahedron hybrid element mesh model generated by Hybrid Mesher (50% reduction in the number of elements & 80% reduction in the number of nodes compared to traditional mesh of similar element sizes)



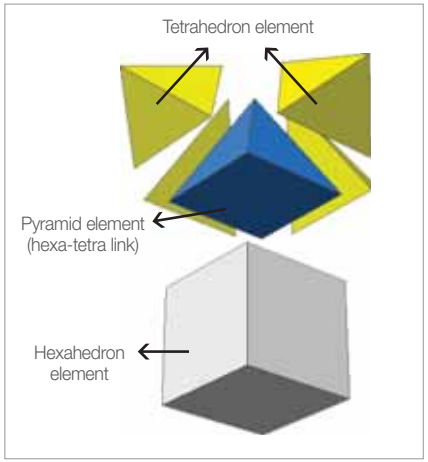
Distribution of hexahedron-tetrahedron hybrid elements (colored display based on element types)



Hexahedron elements are primarily generated at the boundaries where high stresses are resulted.
Tetrahedron elements are partially generated at interiors where stiffness and mass calculations are more meaningful.



Element distribution in hexahedron-tetrahedron hybrid element mesh (colored display based on element types)



Composition of hybrid element mesh

Analysis wizards help designers and beginners produce results in a short period of time

Analysis Wizard

midas NFX provides the analysis wizard so that designers and beginners may quickly and conveniently execute the seven primary practical analysis steps.

Analysis Types

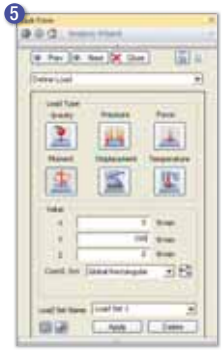
- Linear static, modal, buckling, heat transfer, and drop analyses.

Select analysis type

Import CAD data

Define and assign materials

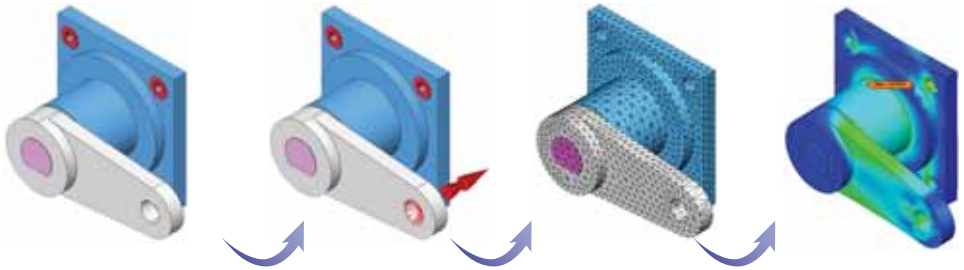
Define boundary conditions



Define loads

Assign analysis case and execute analysis (mesh density, contact, iterative analysis, etc.)

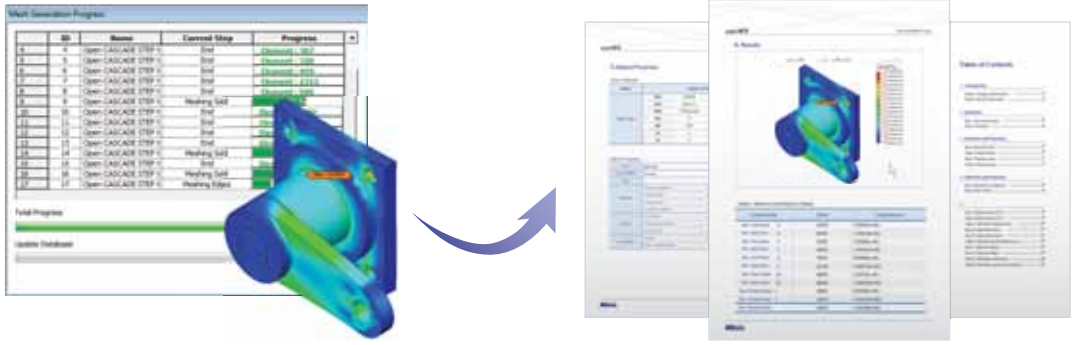
Main results verification (displacement, stress, factor of safety, etc.)


Assembly model import
Define boundary condition on fixed part

Define load

Auto mesh & Auto-contact between parts

Result evaluation


Analysis report in the MS-Word format (can be customized for in-house purposes)

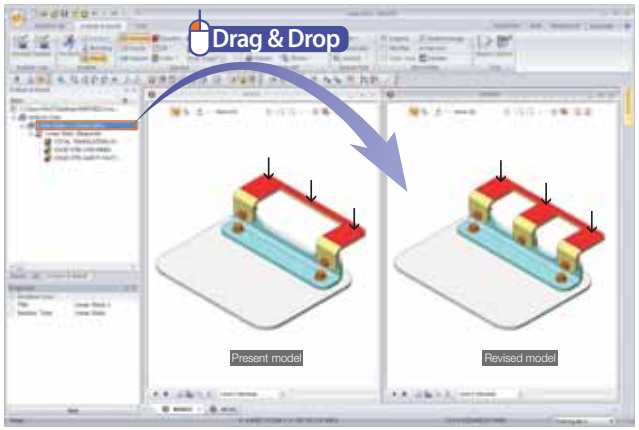
Simple re-analysis using analysis model update without additional work despite changes in the model

Analysis Model Update (Replacing CAD model)

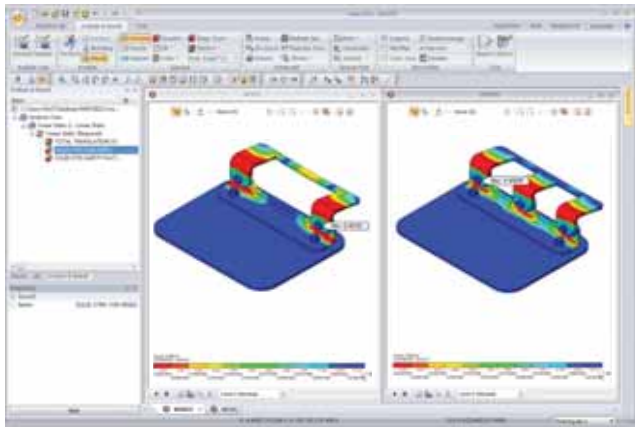
The analysis model update function of midas NFX is used to eliminate the need for additional repetitive work related to model changes, which occur frequently in the design process. Re-analysis can be performed immediately after simply updating the CAD model. Parametric studies for various geometric dimensions can be also effectively performed.

midas NFX supports various references for analysis model update such as IDs of geometric objects, coordinates and colors of geometric surfaces, which enable the user to update even after the topology of the CAD model has been changed.

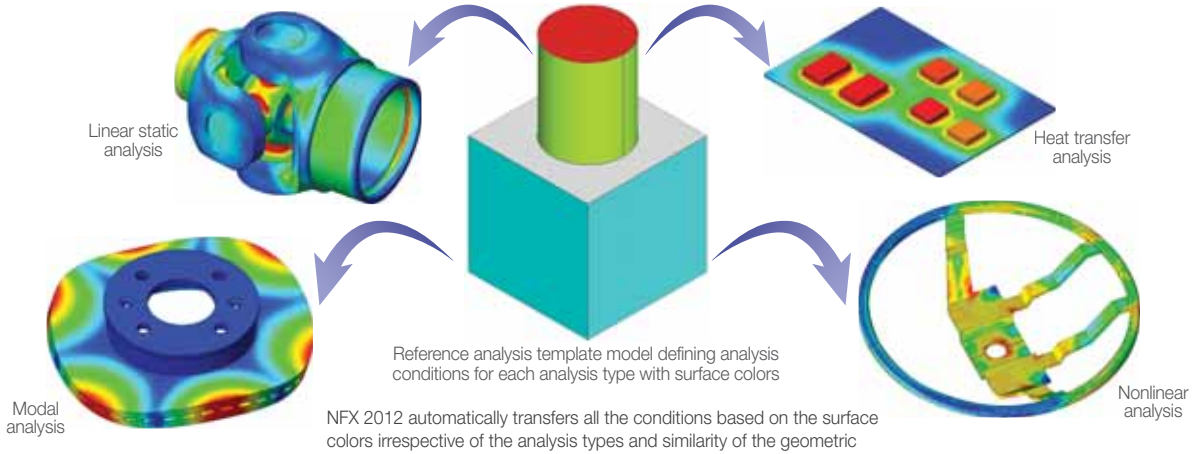
This function can be especially used to apply a standard analysis template model to a number of CAD models. So it is very convenient to propagate standardized design analyses to designers.



By simple Drag & Drop of the analysis cases of the present model to the revised model, all the loads, boundary conditions, analysis types and conditions are automatically transferred to the revised model.



After re-analyzing the revised model, the results before and after the revision can be conveniently checked and compared in a multi-window view.

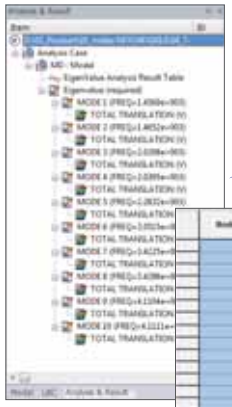


NFX 2012 automatically transfers all the conditions based on the surface colors irrespective of the analysis types and similarity of the geometric shapes of models, allowing the user to simply define analysis conditions to any other models by Drag & Drop.

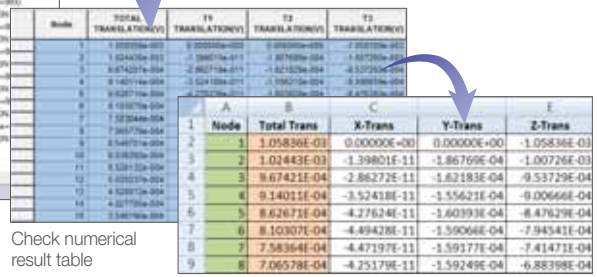
Results organization function and graphs for practical analysis of results

Post-processing Result Analysis and Organization

The practical result analysis and organization function of midas NFX allows the user to effectively carry out secondary tasks after analysis such as report writing.

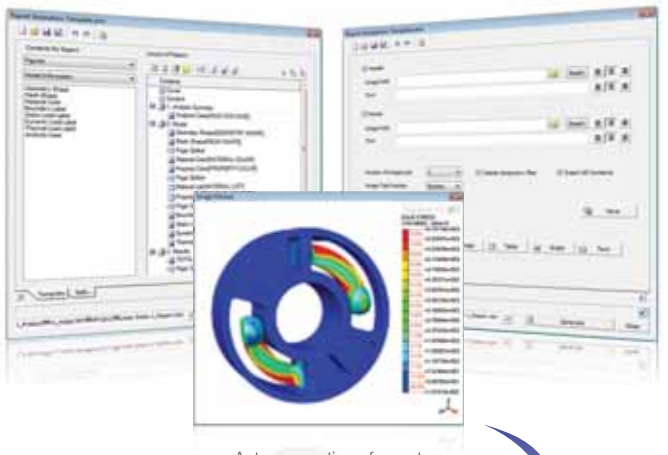


Post-processing ResultsTree

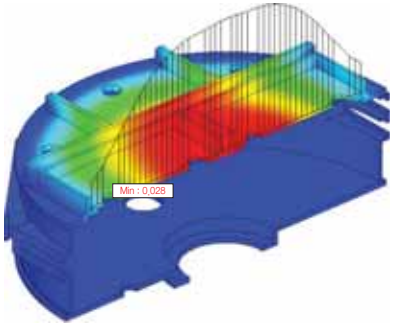


Check numerical result table

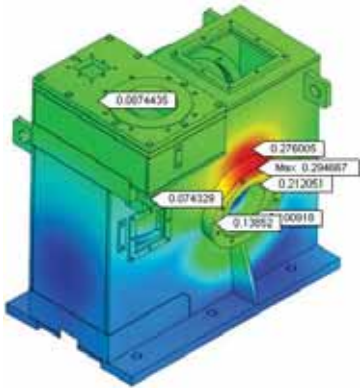
Linked operation with MS-Excel



Auto-generation of report



Result distribution graph along any specific line

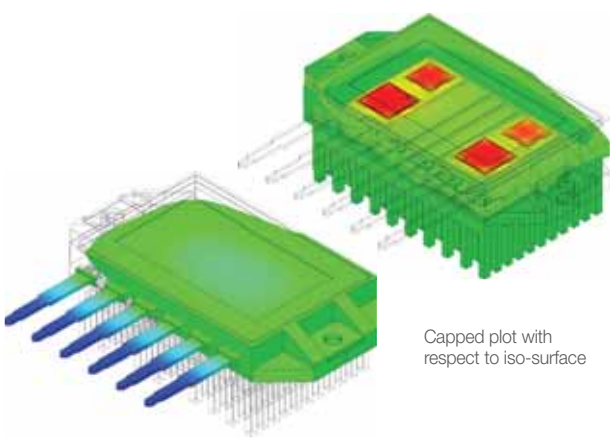


Result inquiry at any location (tags displayed)

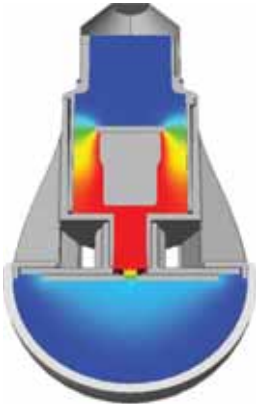
Analysis report in the MS-Word format (can be customized for in-house purposes)

Diverse and sophisticated post-processing graphics enabling swift results checking and comprehensive report

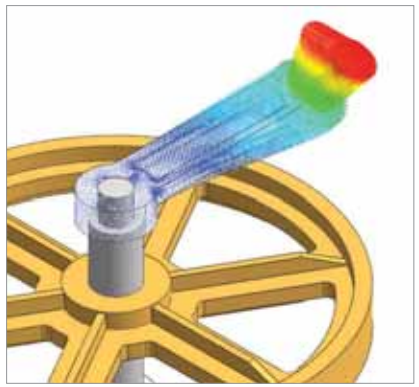
Post-processing Graphics



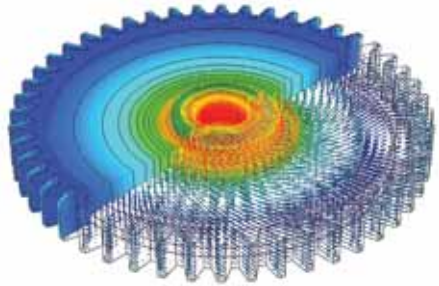
Capped plot with respect to iso-surface



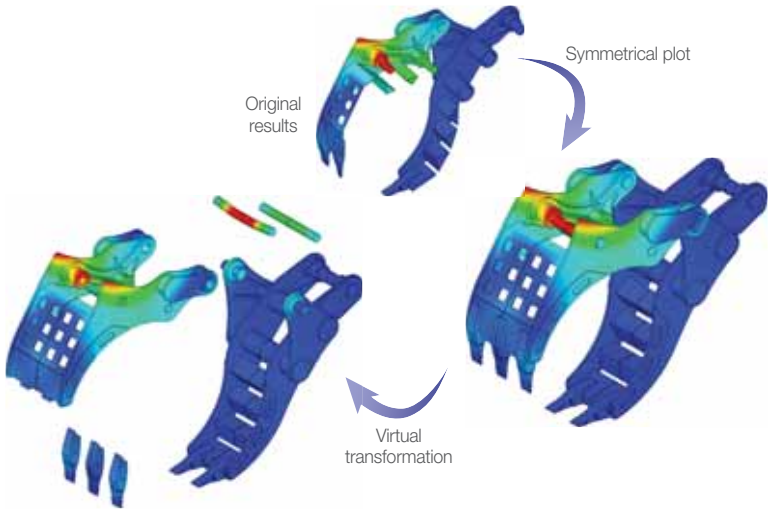
Slice plot of a specific plane



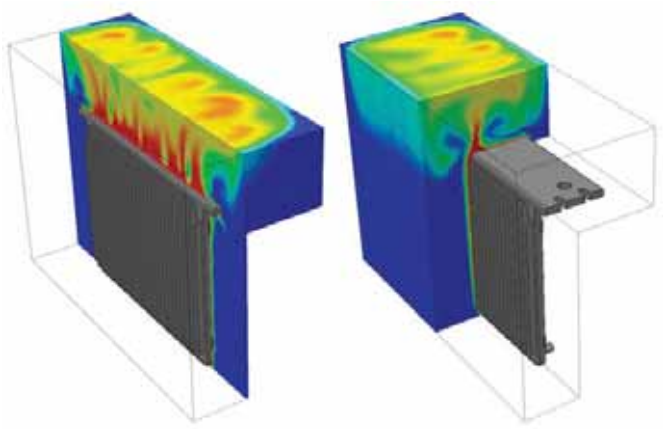
Vector plot



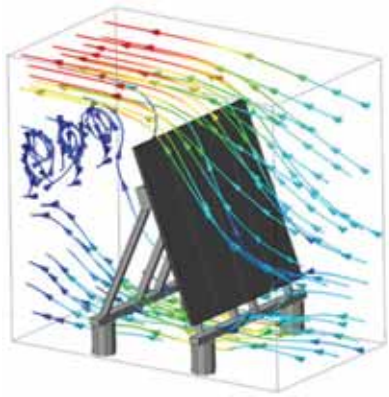
Example of a simultaneous plot of clipped contours and vectors



Segregating an assembly by individual parts for analyzing results

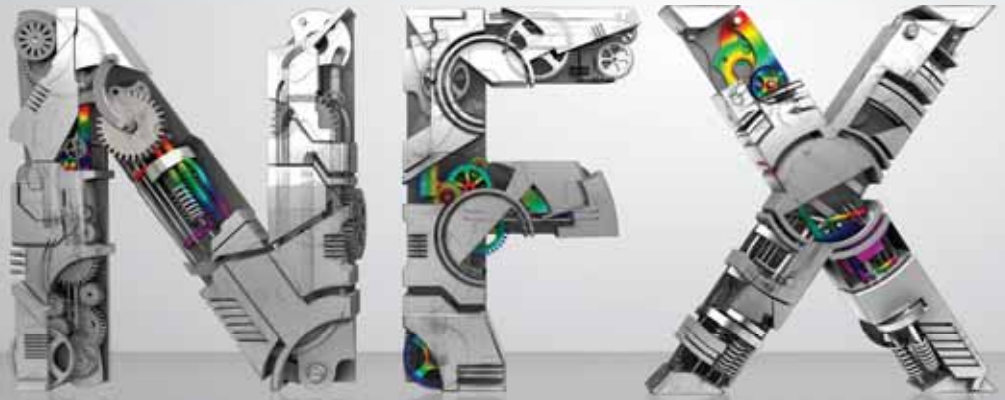


Checking changes in temperature using clipping at a specific plane



Stream line results to evaluate fluid flows

Part III. midas NFX (Solvers)



Integrated multi-field analysis solutions for optimum design

Composition of Analysis Functions

midas NFX provides total solutions from high-end structural analysis functions such as contact analysis, nonlinear analysis, explicit dynamic analysis and fatigue analysis in addition to high-end fluid analysis functions such as moving mesh, free surface analysis and mass transfer analysis.

The user can now benefit from significantly reduced analysis time through the implementation of high-performance parallel multifrontal and AMG solvers.

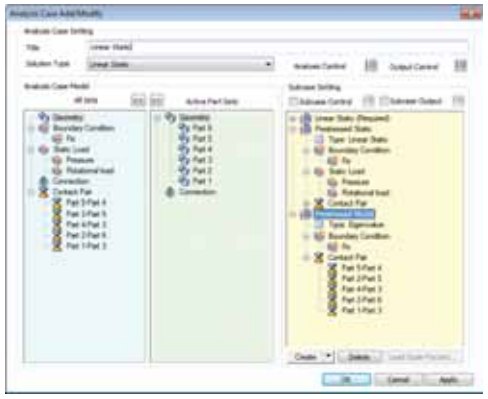
midas NFX provides highly reliable results even for complex practical analyses and aims at providing optimum design for effective design work.

Fast & accurate linear analysis and various results tailored to design using the latest element algorithms and high performance solvers

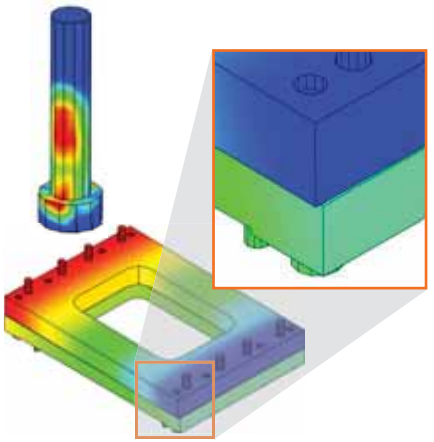
Linear Static Analysis

Using the superb analysis performance and the linear contact function of the high performance parallel processing solvers (multifrontal & AMG), models of any complexity can be analyzed quickly and accurately.

- Linear stress, displacement and safety factor calculations
- Linear contacts: single-body motion, sliding, interpolation link
- Prestress function
- Diverse and yet practical loads and boundary conditions
  - Loads: self-weight, centrifugal force, concentrated load, moment, temperature, pressure, beam load, pipe internal pressure, remote load, bolt load, etc.
  - Boundary conditions: constraint condition, symmetrical condition, MPC condition, etc.
- GUI based subcase definition, calculation of results and transformation of result coordinate system
- Outstanding analysis speed due to high performance parallel solvers
  - Direct method: multifrontal solver
  - Iterative method: AMG solver
- Checking practical analysis results (convergence error caused by mesh density, etc.)
- Extraction of stress results using surface elements



Multiple number of analysis cases for a single project model and the results of the analysis cases compared after analyses (Intuitive user interface consisted of a tree structure and Drag & Drop method)



Relative deformation and bolt stress analysis using linear sliding contact

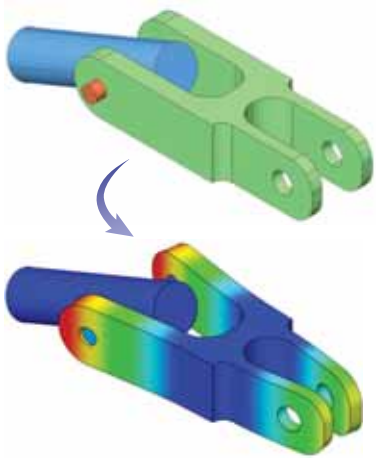
Modal/Buckling Analysis

Using the Block Lanczos solver, fast eigenvalue analysis becomes possible for a large scale model. In a complex assembly model, the modes of behavior can be effectively calculated using the linear contact function reflecting the relative motions between the parts.

- Natural frequency, mode shape, mode participation factor, effective mass results and calculation error check
- Define the range of eigenvalues to be calculated
- Sturm Sequence check (check for missing eigenvalues)
- Linear contact function: single-body motion, sliding, interpolation link
- Prestress considered (prestress modal)
- Mode Assurance Criterion (MAC)
- Consistent mass, lumped mass
- Results check identical to that of linear analysis (stress, strain, etc.)
- Buckling analysis possible for all the elements including composite material solids

Modal analysis of an automobile axle (7th mode, Free-Free condition)

Example of numerical results table and graph for a modal analysis



Modal analysis of an assembly using sliding contact

midas NFX

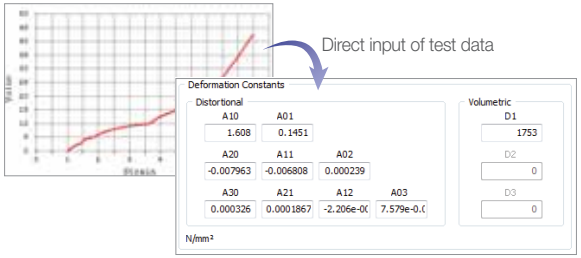
High-quality material, geometric and contact nonlinear analyses providing excellent convergence and practicality

Nonlinear Analysis

midas NFX provides excellent convergence and effectively undertakes material, geometric and contact nonlinear analyses.

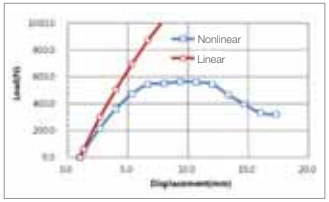
- Material nonlinearity
  - Material models: elastoplastic, hyperelastic
  - Hardening behaviors: isotropic, kinematic, combined
  - Hyperelastic material models: Mooney-Rivlin, Neo-Hookean, Polymoial, Ogden, Blatz-Ko, etc.
- Geometric nonlinearity
  - Large displacement and large rotation considered using the Updated Lagrangian method
  - Follower force: pressure, gravity force, concentrated load, etc.
- Contact nonlinearity
  - Three-dimensional surface-surface contact, single surface contact
  - Contact behaviors: single-body motion, sliding, rough contact, general contact, interpolation link, friction
- Various load increments
  - Automatic load increments
  - Quasi-static load increments using functions
- Various iterative methods, stiffness update method and convergence criterion method
- Composition of continuous/independent load conditions
- Status of convergence and interim results during analysis, re-analysis (restart)

Nonlinear contact analysis of steel frame



Test results

NFX 2013 analysis results

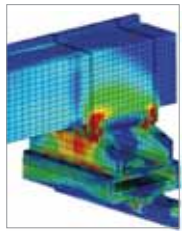


Comparison with linear analysis

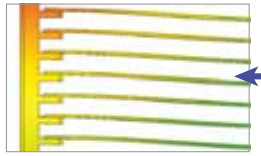
Contact Analysis

midas NFX uses the latest contact analysis function to analyze complex assembly models and nonlinear contact motions. Contact surfaces are auto-searched from which contact conditions are subsequently defined in an assembly model of any complexity.

- Three-dimensional surface-surface, point-surface, single face contacts
- Various methods to define contacts
  - Automatic definition for each analysis case
  - Contact definition wizard, manual definition
- Contact behaviors suitable for practical work
  - Single-body motion, sliding, general and rough contacts, interpolation link
- Coefficient of friction, modulus of rigidity, possible to define shell thickness to simulate contact on both sides of shells
- Various results including contact force and contact stress
- Heat contact to simulate heat conduction between discontinuous parts

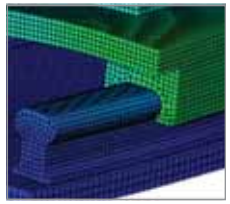


Analysis of a complex assembly model using the automatic contact definition function

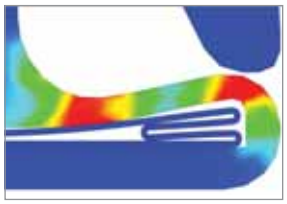


Linear contact (single-body motion)

Nonlinear rough contact (separation)

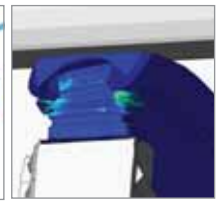


Automatic connection of free end using automatic contact



Nonlinear contact analysis of a car's door lock sensor

Nonlinear contact analysis of a door's weather strip



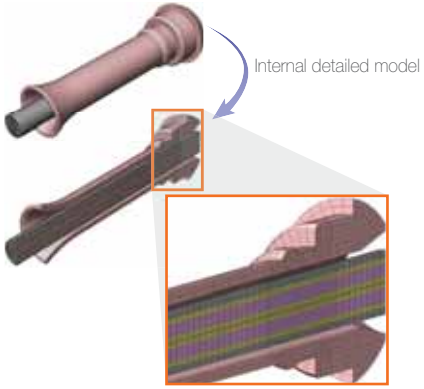
A cars' front bumper crash

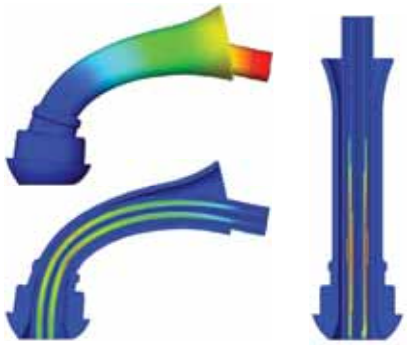
Convenient evaluation of fatigue & durability by absolute minimum input data

Fatigue Analysis

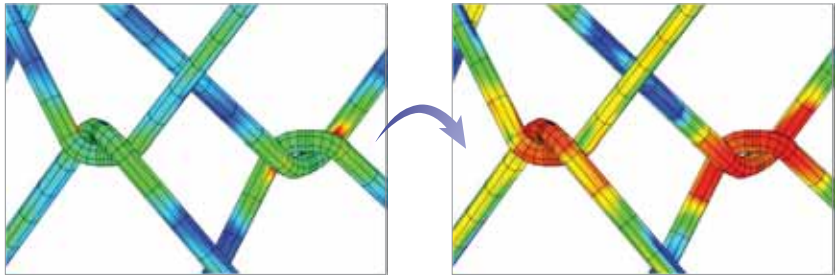
midas NFX can conveniently examine fatigue and durability using an independent post-processing function. Fatigue analysis can be conveniently performed with only minimally required input data. The structural analysis domain can now extend from traditional strength checks to durability checks.

- Fatigue analysis in time domain (fatigue analysis by time-dependent load and stress history)
- Damage level, fatigue life results
- Analysis objects designated (boundary, global, user-defined, etc.)
- Rainflow Counting, Mean Stress Correction options
- Selection of evaluation stress (Signed von-Mises, absolute maximum principal stress)
- Linear/multi-linear S-N curve





Deformation/strength and service life analysis of cord assembly

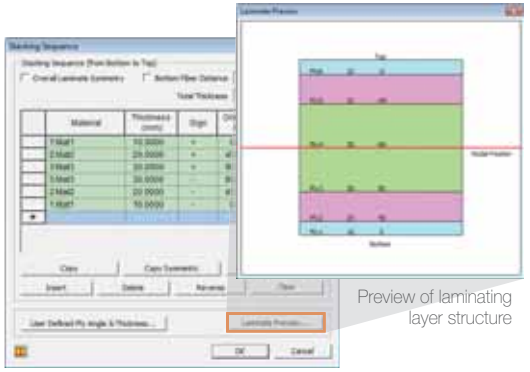


Static analysis using automatic contact function and examination of fatigue life of a medical stent using the static analysis results

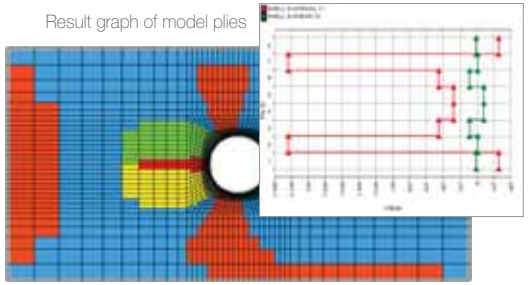
Composite Material Analysis

midas NFX can check 2D and 3D composite material elements together with an intuitive GUI for defining composite materials.

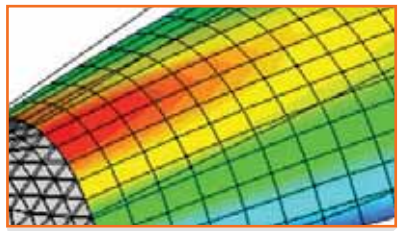
- Failure theory
  - Hill, Hoffman, Tsai-Wu, maximum stress, maximum strain, NASA LaRC02
- Failure index
  Failure Index, FE Failure Index, Strength Ratio
- 3D composite material solids and nonlinear materials supported
- Global Ply ID supported and material property matrices (A, B and D) calculated
- Top/bottom fiber results per ply produced
- Various ways to define material directions (angle, coordinate system, vector, etc.)

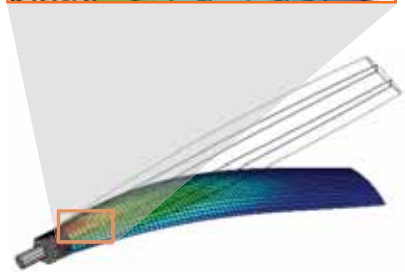


Intuitive GUI for defining a laminated layer structure (compatible with MS-Excel)



Ply maximum/minimum results (Contour, Iso-line)





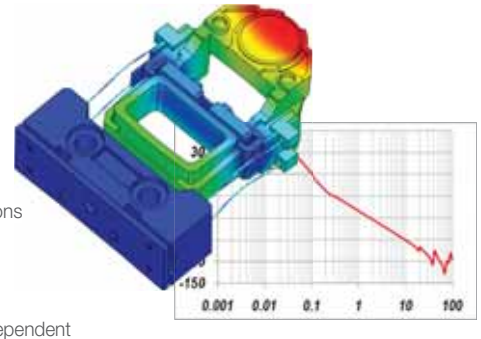
Structural analysis of a composite wing of a wind turbine

Explicit dynamic - high-quality nonlinear, drop and impact analyses

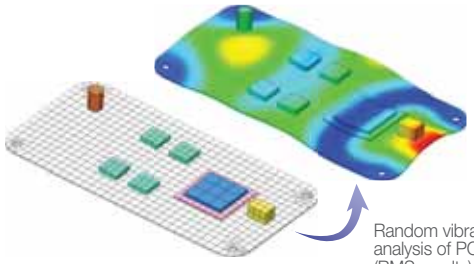
Linear Dynamic Analysis

midas NFX can perform practically the most excellent and reliable dynamic analysis. Both direct integration and modal methods are provided with reliability and efficiency.

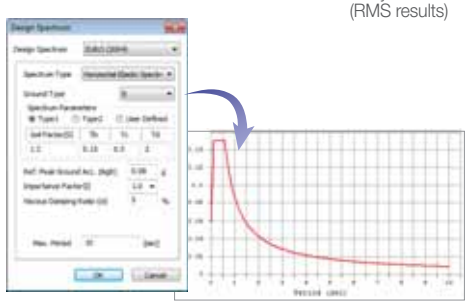
- Direct method and mode method
  - Transient response analysis
  - Frequency response analysis
  - Random vibration analysis
  - Response spectrum analysis
  - Enforced motion analysis
- Conversion function from static to dynamic loads
  - Analysis function considering various load conditions
- Automatic time increments
- Analysis function considering prestress
- Various damping effects
  - Modal, structural, material, Rayleigh, frequency-dependent
- Design spectrum database implemented



Response analysis of DVD-ROM due to magnetic force (frequency response analysis)

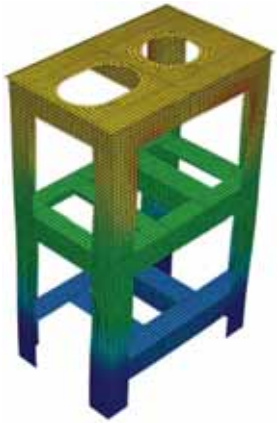


Random vibration analysis of PCB (RMS results)



Selection/definition of design spectrum

Automatic generation of response spectrum



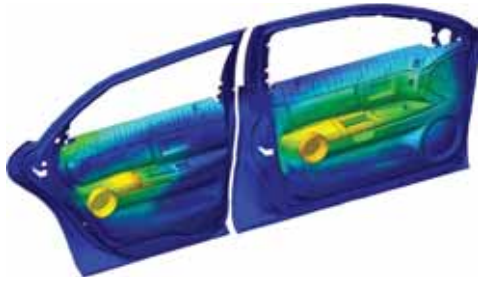
Seismic analysis

Explicit Dynamic Analysis

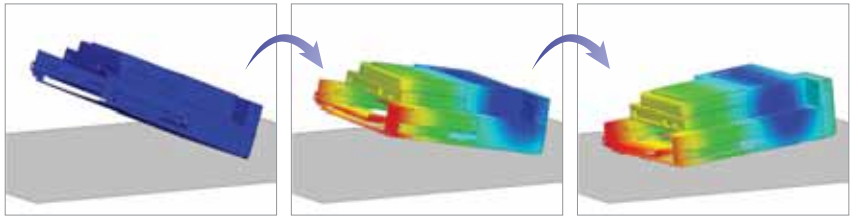
By using explicit time integration, midas NFX effectively calculates complex material, geometric and contact nonlinear phenomena of large scale assembly models. Accurate analysis can be conveniently carried out using various element types including hexahedron elements, pyramid elements and higher-order tetrahedron elements.

- Diverse nonlinearity
  - Material nonlinearity: elastoplastic, hyperelastic (Mooney-Rivlin, Neo-Hookean, Polymoial, Ogden, Blatz-Ko, etc.) models
  - Geometric nonlinearity: large displacement, large rotation, follower force
  - Contact nonlinearity: various contact behaviors considering three-dimensional contact and friction
- Mass scale
  - Scaling by individual element groups
  - Time step based mass adjustment
- Automatic calculation of safe time step by elements
- Checking the status of convergence and results in the interim steps during analysis
- Restart function using subcases and parallel processing function using multi-cores

Seat belt anchorage analysis



Door trim impact analysis



Hard Disk Drop Test

midas NFX

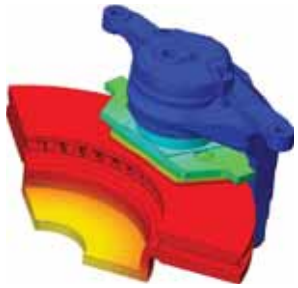
Total Solutions for True Analysis-driven Design

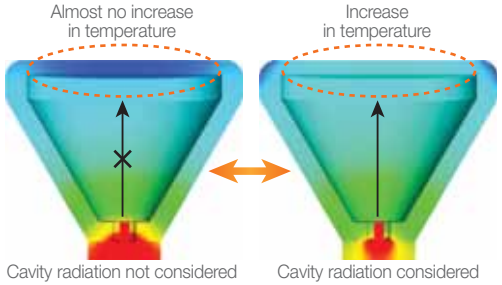
Heat transfer and fluid analysis

Heat Transfer/Heat Stress Analysis

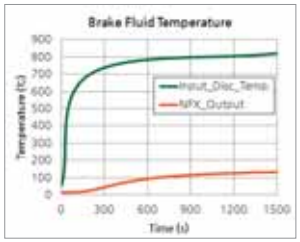
midas NFX offers practical heat transfer and heat stress analysis capabilities. Especially heat stress analysis is provided as an independent analysis case. As such, a single analysis can produce temperature results by heat transfer and thermal deformation/thermal stress results.

- Steady and transient heat transfer analyses
- Nonlinear heat transfer analysis function considering temperature-dependent materials and conditions
- Various load conditions
  - Heat generation, conduction, convection, radiation, heat flux, initial temperature, fixed temperature conditions
- Thermal contact function to simulate heat conduction between discontinuous parts
- Heat transfer analysis function considering cavity radiation
  - Open/closed conditions
  - Radiation shape factor calculation
- Effective transient heat transfer analysis using sensor
  - Automatic termination of analysis based on standards
  - Minimum/maximum/average temperatures in a selected domain defined under the sensor conditions

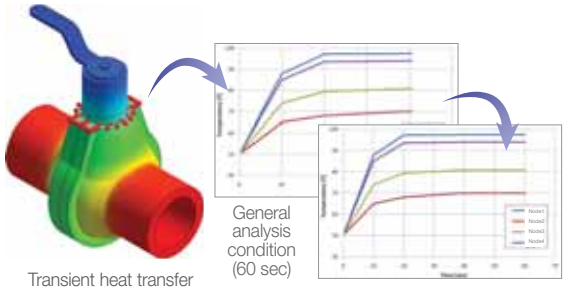




Heat transfer and temperature distribution by heat cavity radiation inside an LED lamp



Heat capacity analysis of a brake system (transient heat transfer, heat contact applied)



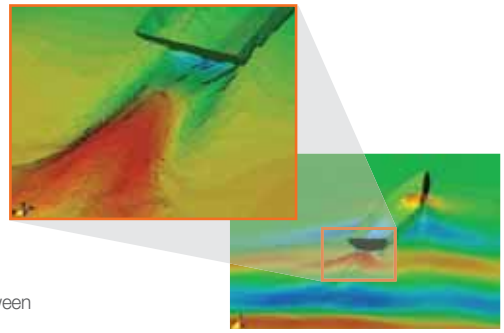
Transient heat transfer analysis of a ball valve (using sensors)

Termination of results at 40.5 sec when using sensors

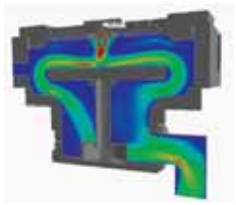
Fluid Analysis

midas NFX provides a finite element based CFD analysis function, which allows all fluid analyses in the flow velocity domain, various heat transfer analyses and free surface analyses. A single work environment combines both structural and fluid analyses in the same geometric analysis model.

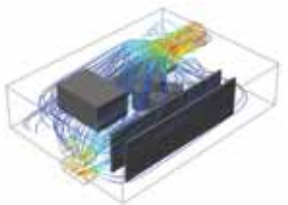
- Heat transfer and flow analysis
  - Two- and three-dimensional, two-dimensional axisymmetric analysis
  - Steady and transient state analyses
  - Heat transfer and multi-phase fluid analysis
- All fluid analyses in the flow velocity domain
  - Compressible and incompressible fluid analyses
  - Applications of various types of turbulence models
  - k-ε, k-ω, k-ω-SST, etc.
  - LES model, etc.
- Moving mesh and deformation supported
- Analysis function of noncontiguous mesh contacts between fluid and solid or fluid and fluid
- Free surface analysis and mass diffusion analysis functions
- High performance parallel solver functions



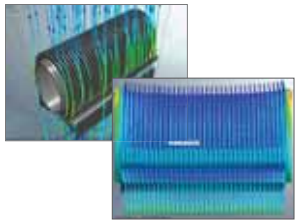
Free surface analysis (Transpiration technique)



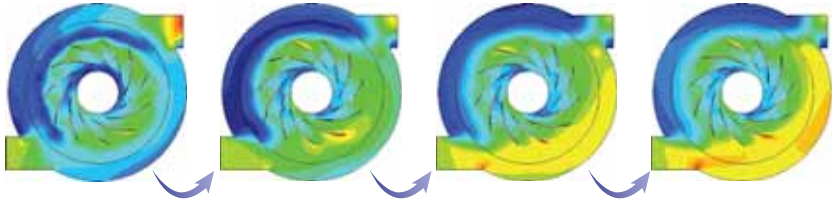
Evaluation of Gas flow distribution uniformity in CVD Semiconductor equipment considering turbulence behavior



Cooling capacity evaluation of electronics equipment using thermal flow analysis



Thermal flow analysis and thermal expansion analysis of heat sink of a boiler system



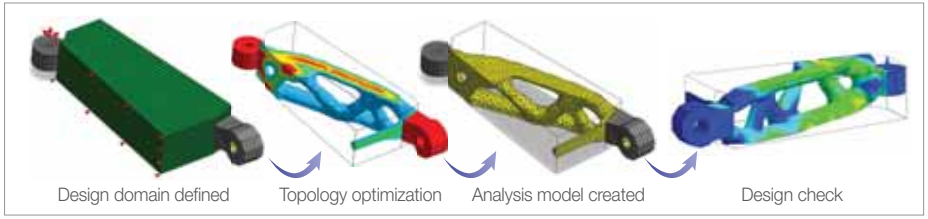
Evaluation of rotary pump's discharge capacity considering blade rotation

Topology optimization and adaptive mesh analysis to secure economy, reliability and safety

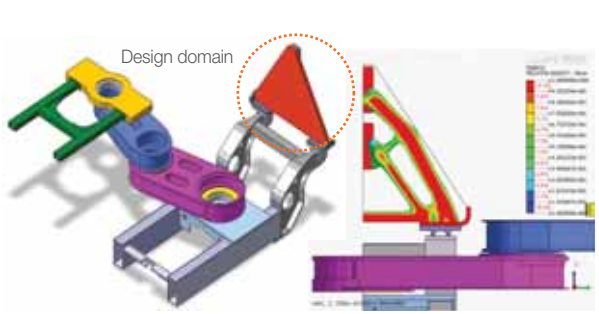
Topology Optimization Design

midas NFX provides practical topology optimization analysis considering static/dynamic analyses and manufacturing processes. By linking linear static, modal and frequency response analyses, all of which are widely used in practice, optimization analysis is performed considering structural safety and economy.

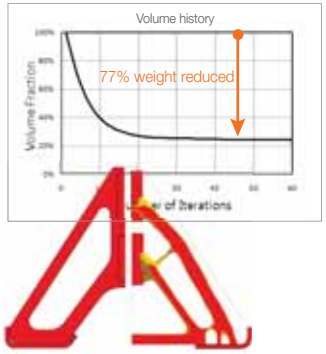
- Optimization analysis function linked with static and dynamic analyses
  - Linear static analysis
  - Modal analysis
  - Frequency response analysis
- Analysis function considering conditions of manufacturing processes
  - Setting design limit/constraint conditions such as stress, displacement, volume, draw direction and symmetrical conditions
- Simultaneous optimization analysis considering various operation and load conditions
- Automatic regeneration of analysis model without separate CAD work and mesh smoothing function
- Other practical convenience functions
  - Mode trace, definition of design/non-design domains, automatic initial value setup



Process of using topology optimization design



Conceptual design using topology optimization
(linear static analysis, weight reduction through minimizing volume)



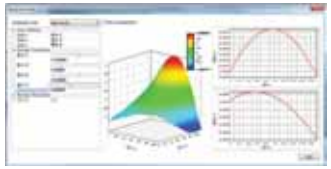
Review against original design

Size Optimization

midas NFX provides size optimization analysis based on estimation and verification of each material and property's influence. midas NFX can determine an optimal material/property composition to minimize stress, volume or weight of the designed model.

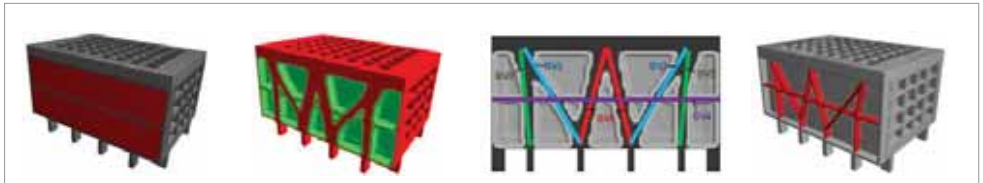
- Size optimization for all types of thermal/structural analysis
- Property and material design variables
  - Intuitive assignment of variables for size optimization
  - Section size and thickness, composite material lamination thicknesses and angles, spring stiffness, damping, mass, modulus of elasticity, etc.
- Design Sampling
  - Various Methods (FFD, CCD, OA, LHD) & 1D Parameter Study
  - Correlation between Design variables & Analysis Response
- Size optimization design based on approximate models
  - Approximate modeling techniques (Kriging model, Polynomial Regression model)
  - 2D/3D Graphic tool for approximate model analysis
  - Optimization design estimation and analysis result verification
  - Automatic optimized model generation

Sample drawing and analysis



Approximate model generation,
Approximate model size optimization
design process

Capacity estimation/verification
& Optimized model generation



Size optimal design using topology optimization

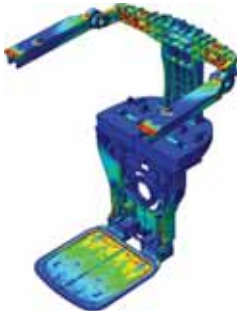
World class high performance parallel solvers catered to large scale models

High Performance Parallel Solvers

midas NFX has been implemented with both multifrontal solver and AMG (Algebraic Multigrid) solver, which are considered to be among the most efficient solvers in existence.

midas NFX supports the direct multifrontal solver and the iterative AMG solver, out of which a suitable solver can be selected depending on the analysis type and model size. Through the efficient parallel processing in a multi-core system, high performance calculations can be realized.

A large scale model can be efficiently analyzed even in a 32-bit environment of limited memories. In case a 64-bit is used, extremely large scale problems can be analyzed fast.



Linear static analysis			Linear static analysis	Linear static analysis	Modal analysis (50 modes)	Linear static analysis	Nonlinear static analysis (contact)
Solid elements (156,862) Nodes (272,597) Degrees of freedom (817,791)			Solid elements (163,143) Nodes (303,347) Degrees of freedom (916,890)	Shell/beam elements (156,862) Nodes (272,597) Degrees of freedom (951,378)	Shell elements (170,123) Nodes (162,391) Degrees of freedom (974,346)	Solid elements (154,320) Nodes (280,060) Degrees of freedom (840,180)	
32bit	64bit		32bit	32bit	64bit	64bit	
AMG	MFS	AMG	AMG	AMG	MFS	MFS	
273 sec	185 sec	167 sec	548 sec	364 sec	1.65 hr	110 sec	2,210 sec (iterated 18 times) → 123 sec each time

AMG (Algebraic Multigrid), MFS (Multi-Frontal Solver)

System specs:
- 32bit: Intel Core 2 Duo 2.66Hz 2GB RAM, Windows XP
- 64bit: Intel Xeon 2.27Hz 12GB RAM, Windows Vista

Multi-frontal Solver

- Direct method solver
- Excellent performance up to 500,000 to 600,000 degrees of freedom in a 32-bit system
- Exceptionally outstanding performance in a 64-bit system of no restrictions in memory capacity
- Improved performance if the Constant Stiffness option is used, which does not update stiffness in nonlinear analysis

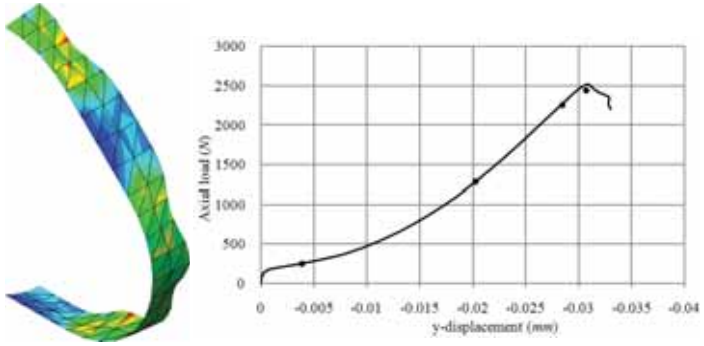
Algebraic Multigrid Solver

- Iterative solver
- Superior performance over 500,000 to 1,000,000 degrees of freedom in a 32-bit system
- Especially outstanding performance in a thick solid model
- For a shell model, stable convergence offered unlike other iterative solvers
- Consistent performance offered irrespective of the stiffness update method used in nonlinear analysis

※ midas NFX automatically selects an optimum solver based on the type of analysis and the type and size of the model.

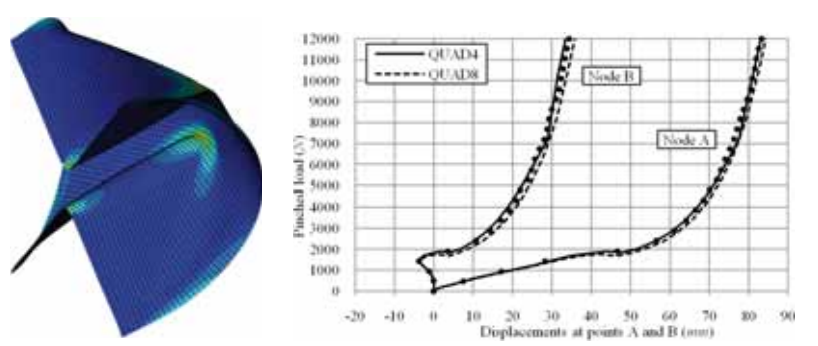
Reliable & excellent analysis results with the latest elements and analysis algorithms

Verifications & Benchmarking Tests

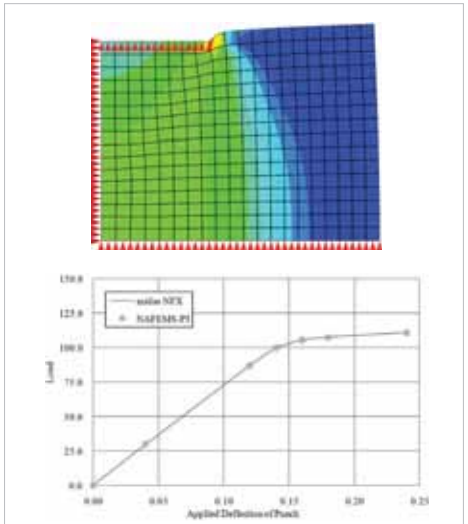


Element		Collapse Load
QUAD4	HYB	2638.142
QUAD8	HYB	2517.7
QUAD4	RED	2984.625
QUAD8	RED	2594.725
QUAD4	FUL	2746.794
QUAD8	FUL	2676.172
TRIA3	HYB	2899.387
TRIA6	HYB	2506.51

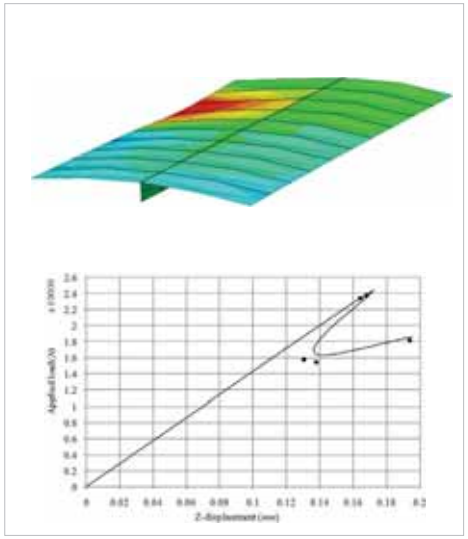
Pear-shaped cylinder under end shortening (NAFEMS, Geometric nonlinearity)



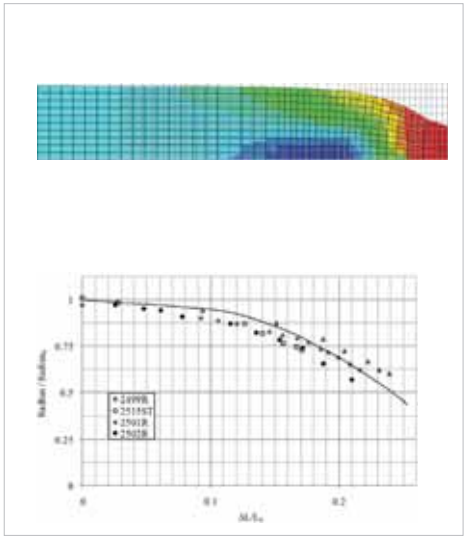
Pinched cylinder with rigid diaphragms
(K.Y.Sze, W.K.Chan & T.H.H.Pian, Geometric nonlinearity)



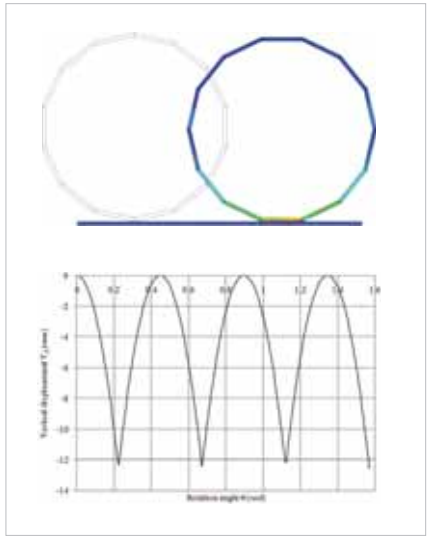
Rigid punch plasticity (NAFEMS, Material nonlinearity)



Stiffened cylindrical panel
(NAFEMS, Material / Geometric nonlinearity)



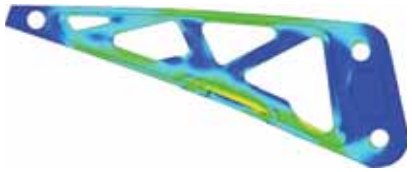
Necking of a circular bar
(J.C.Simo, T.J.R.Hughes, Material / Geometric nonlinearity)



Sliding and rolling of a ring on a rigid surface
(NAFEMS, Boundary nonlinearity)

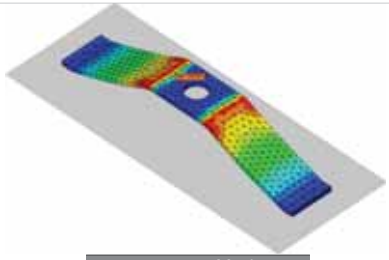
Reliable & excellent analysis results with the latest elements and analysis algorithms

Verifications & Benchmarking Tests



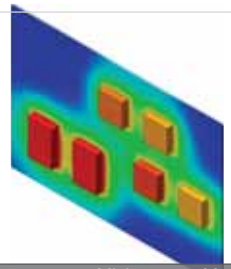
Software	Maximum displacement	Maximum stress
midas NFX	0.206 mm	98.6 MPa
N Software	0.206 mm	98.6 MPa

Linear static analysis
(solid element, rigid link, concentrated load)



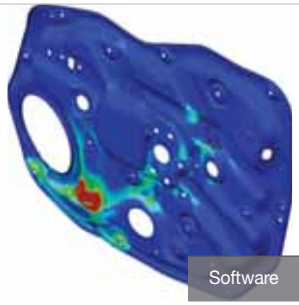
Software	Maximum stress
midas NFX	1.348 MPa
A Software	1.354 MPa

Nonlinear contact analysis
(solid element, shell element, imposed displacement)



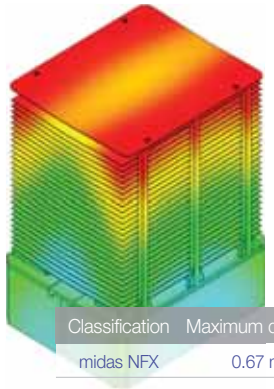
Software	Minimum temperature	Maximum temperature
midas NFX	20.33℃	104.21℃
A Software	20.30℃	103.61℃

Heat transfer analysis
(solid element, thermal contact, thermal fluid inlet, convection gradient)



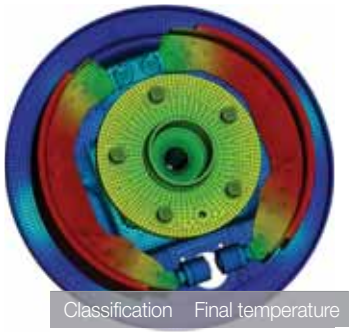
Software	Maximum stress
midas NFX	0.156 GPa
A Software	0.157 GPa

Material/geometric nonlinear analysis
(Shell element, large deformation, distributed load)



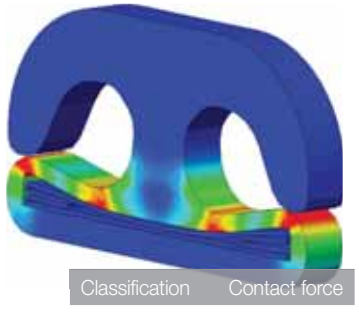
Classification	Maximum deflection
midas NFX	0.67 mm
N program	0.66 mm

Linear static analysis
(solid element, linear contact,
temperature load, self-weight)



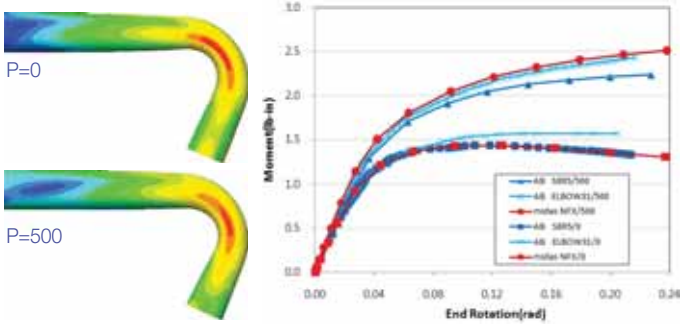
Classification	Final temperature
midas NFX	118.0
N program	117.6

Heat transfer analysis
(solid element, thermal contact,
influx of heat, convection)



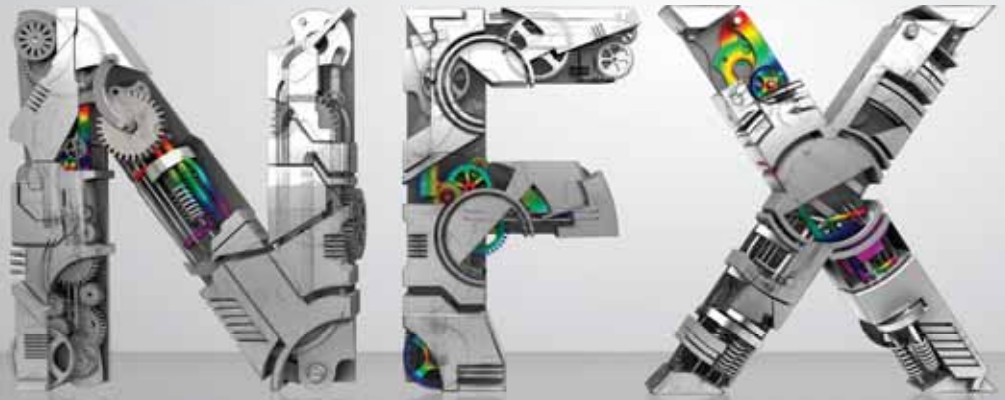
Classification	Contact force
midas NFX	10.88 N
N program	10.87 N

Nonlinear contact analysis
(solid element, enforced displacement)



Material/geometric nonlinear analysis
(shell element, pressure load, moment load)

Part Ⅳ. Enhancements in midas NFX 2017

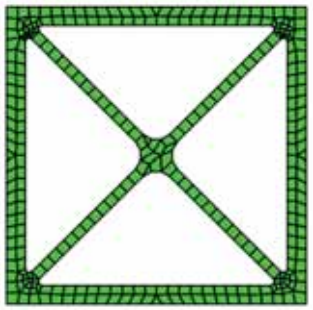


What is new in midas NFX 2017?
Most interesting features and enhancements

Modeling Enhancements

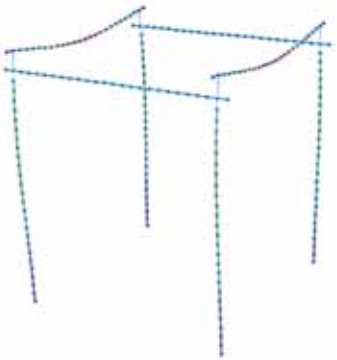
Complex Cross-Section

- This feature is related with 1D elements and can automatically compute cross-section properties for arbitrary shapes.



2D mesh is required
to define arbitrary shape

Complex Cross-Section
Property window

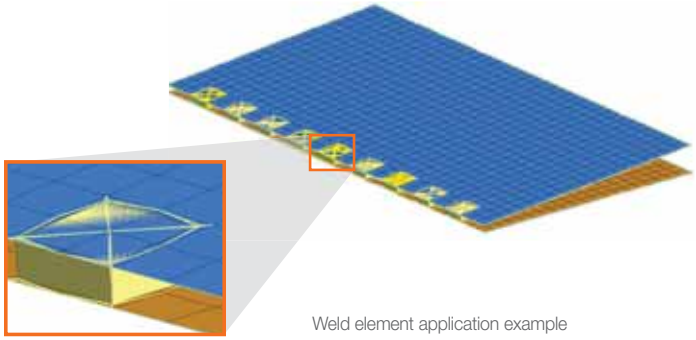


Model with hidden cross-section

Displayed cross-section

Weld Element

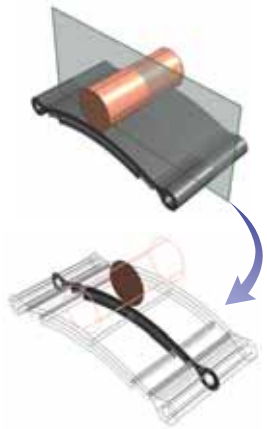
- Creating weld element is much more easier now and can be done by few mouse clicks.



Weld element application example

Line Contact

- Line Contact has been added to allow modeling of assemblies which are in plane strain state or axisymmetric models.



Application example – Leaf spring

2D section used for modeling

Created contact pairs

2D line contact results

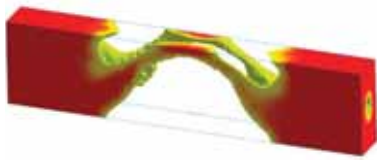
Less computational effort due to less number of elements,
same accuracy as in 3D

What is new in midas NFX 2017?
Most interesting features and enhancements

Analysis Enhancements

Topology Optimization – Multi Subcase support

- The Topology Optimization has got new capability to simultaneous consideration of multiple types of analysis cases. New feature is supported by Linear Static and Eigenvalue analysis to optimize structure based on volume minimization. Thus all Design Constraints (Stress, Displacement, Fatigue) can be used in the same time.



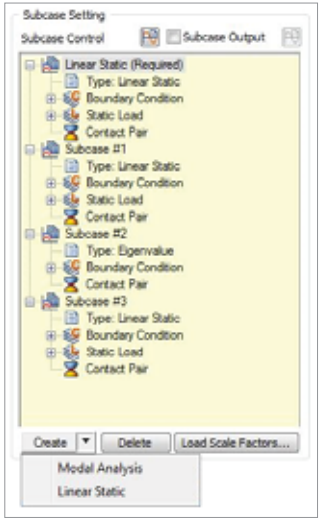
Volume	40% Reduction
Constraint 1	0,296mm
Constraint 1	5080Hz

Constraint 1 : Displacement ≤ 0.3mm
Constraint 2 : Natural Frequency ≥ 5000Hz

Multi-Subcase analysis can be done through the following way:

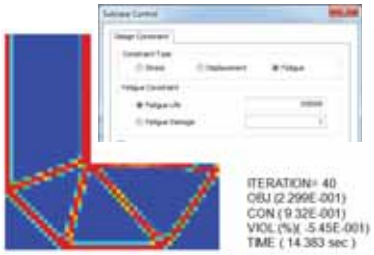
Case 1
Topology Optimization based on Linear Static analysis
> min. Volume

Case 2
Add "Modal Analysis" through the Create button
at the bottom of the subset case

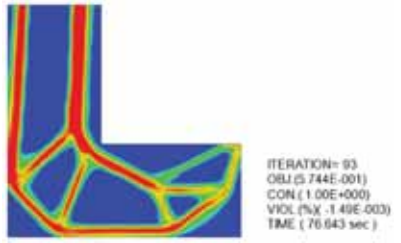


Topology Optimization – Fatigue Design Constraint

- Topology optimization of structures subjected to repeated loading conditions can be handled. Fatigue constraints are introduced in order to find a light weight design that is dimensioned by the critical fatigue stress and that avoids stress concentrations.



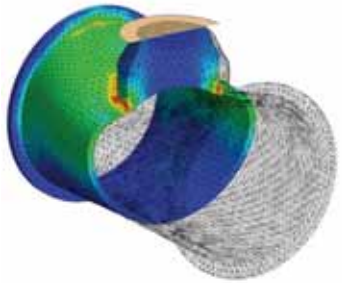
L-beam problem: optimization result
with fatigue constraint (Compliance-based)



L-beam problem: optimization result
with fatigue constraint (with Sensitivity)

Tetrahedral element – Rubber Property

- The formulation of lower order tetrahedral elements for incompressible material has been improved. Models with rubber property can be modeled with less number of DOF, keeping the same level of accuracy.



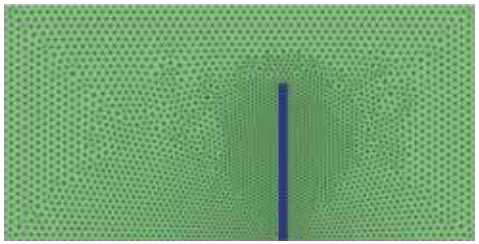
Model with rubber property

What is new in midas NFX 2017?
Most interesting features and enhancements

Analysis Enhancements

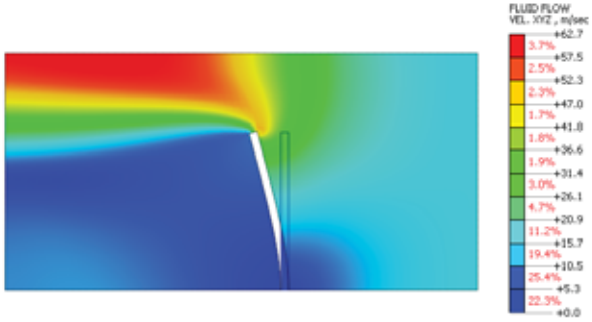
2-way FSI (Fluid Structure Interaction)

- Two-way-coupling calculations are now supported. The structural response of the structure can be transferred to the fluid solver. Process is being performed in iterative loop.

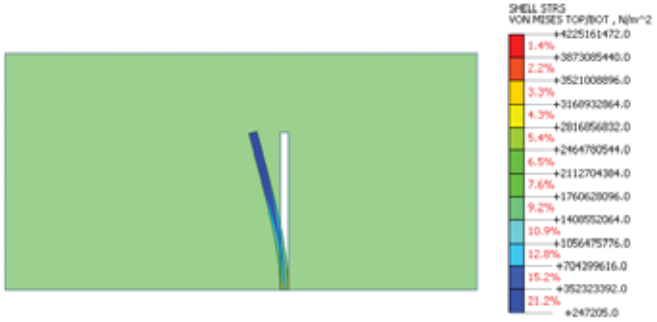


Application example – 2D Flow over obstacle

Pressure distribution
around the deformed structure



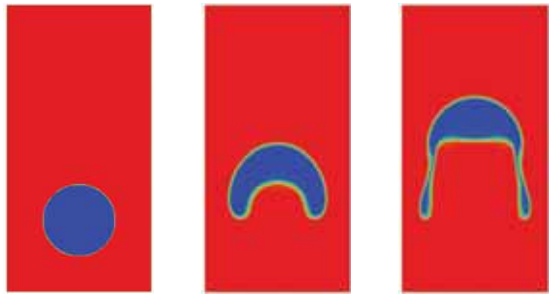
Velocity distribution
around the deformed structure



Stress distribution on deformed structure

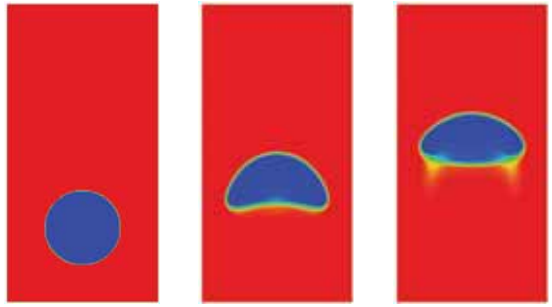
2 Phase Flow (VOF: Volume of Fluid)

- Volume of Fluid (VOF) feature is designed for two immiscible fluids, where the position of the interface between the fluids is of interest.



0 sec 1.5 sec 3.0 sec

The bubbles rise with the passage of time
(Small difference in phase densities)



0 sec 1.5 sec 3.0 sec

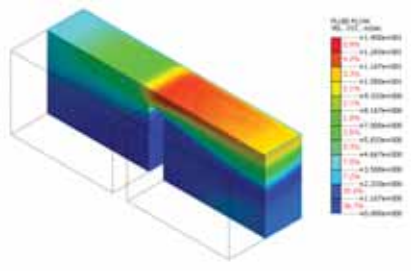
The bubbles rise with the passage of time
(Big difference in phase densities)

What is new in midas NFX 2017?
Most interesting features and enhancements

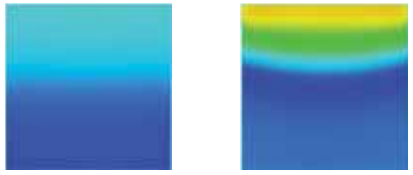
Analysis Enhancements

Translational Periodic/Symmetry BC

- Translational periodicity and symmetry boundary can be created. In many cases it is possible to use periodic boundary conditions, where what flows out through one boundary reappears flowing in through the opposite boundary.



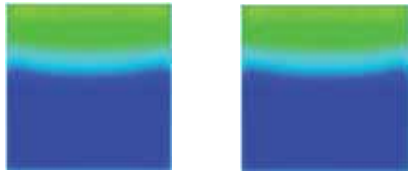
Model with applied Periodic BC



Inlet velocity distribution

Outlet velocity distribution

Model without applied Periodic BC

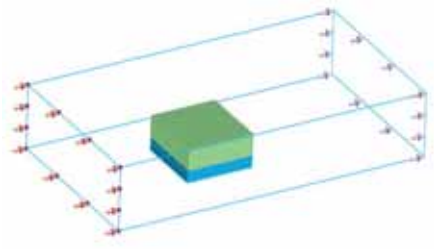


Inlet velocity distribution

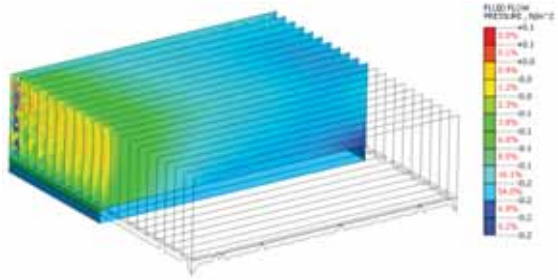
Outlet velocity distribution

Thin Wall - Conductivity

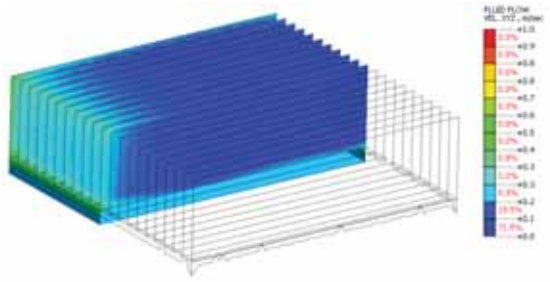
- Thin Wall BC has got 2 new inputs, the thickness of the layer and its thermal conductivity. This is used to calculate the effective thermal conductivity with the assumption that the heat flux across the thin wall is continuous.



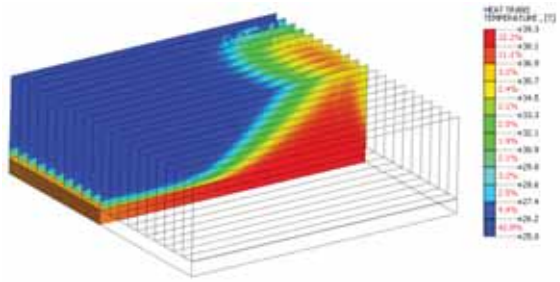
Model with applied Thin Wall condition



Pressure distribution



Velocity distribution



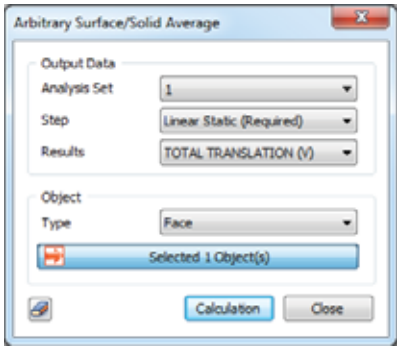
Lamination temperature distribution

What is new in midas NFX 2017?
Most interesting features and enhancements

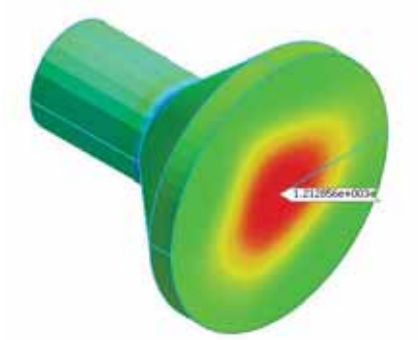
Results Post-Processing

Arbitrary Surface/Solid Average

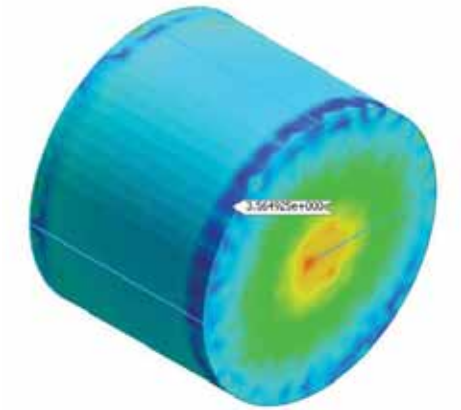
- New post-processing tool for averaging result data from surfaces or volumes



Arbitrary Surface/Solid Average window



Application example – average output pressure on Face

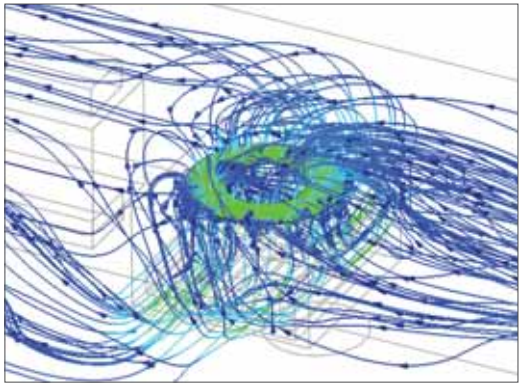


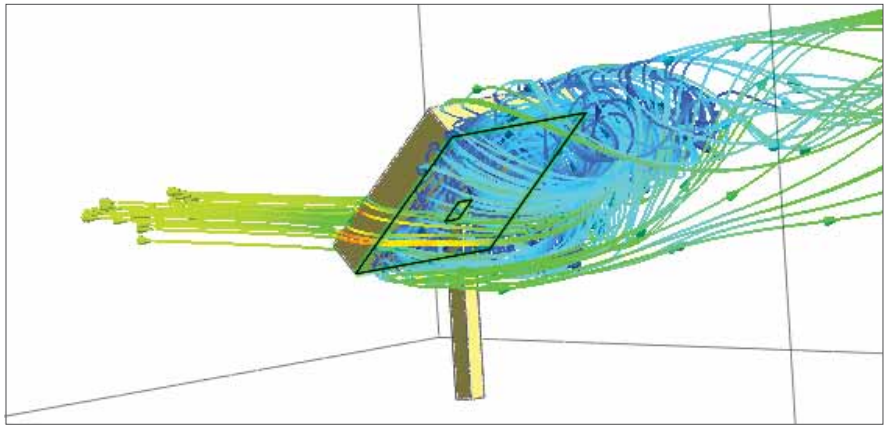
Application example – average velocity from Solid

Flow Streamline

- Streamlines can be displayed from selected faces or nodes individually.

Flow Path command window





Streamlines generated from selected faces

Systematical-technical support system to promptly respond to the needs of the users

Technical Support System for Customer Satisfaction

MIDAS operates a technical support system to promptly respond to the needs of the customers. MIDAS strives to help the customers successfully complete their projects. MIDAS builds its success on customers' success.

Q&A Service

The NFX Q&A service provides a prompt reply to the customer's inquiry related to the technical matters associated with the use of the program within 24 hours. Any information that the technical support staff receives is kept confidential.

Remote Technical Support Service

The NFX remote technical support service actively responds to the customer's inquiry by sharing a customer's PC screen in real-time with the technical support representative to resolve the inquired problems. It is the MIDAS' differentiated technical support service.

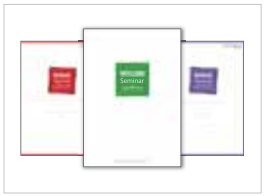
End-User Training

Various online/offline technical training services are available for the customers wishing to maximize their benefits from the efficient use of NFX 2012.

- Prompt product updates tailored to the customer's request
- Free training system (on/offline, customized training)
- Technical support for initial practical application
  - Customized tutorials and training support for practical models
- Web-based remote technical support system
- Various manuals, technical documents and practical case tutorials
- Practical CAE training for beginners (Educational and Professional)
- Free technical courses in the topics of interest
- Various training/research support system for academia and educational institutes

Online training

Practical Case Tutorials



Regular technical seminars and technical course materials

midas NFX

Total Solutions for True Analysis-driven Design