TOTAL SOLUTION 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.
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
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.

Utilization of CAE in Product Design

- Reduction in development time
- Design efficiency
- Compliance with safety standards
- Information sharing presentation
- Environment protection
- Quality improvement
- Cost reduction
- Enhancement of design values

Utilized in Various Industries

- Medical devices
- Bio-mechanics
- Electrical devices
- Electronics
- Automobiles
- Heavy Equipment
- Shipbuilding
- Maritime
- Communication devices
- Semiconductor Display
- Aviation
- Space
- Energy
- Environment facilities
- General consumer goods
- Electronics
- Electrical devices
- Energy
- Environment facilities
- Communication devices
- Shipbuilding
- Maritime
- Aviation
- Space
- General consumer goods
- Electronics
- Electrical devices
- Energy
- Environment facilities
- Communication devices
- Shipbuilding
- Maritime
- Aviation
- Space
- General consumer goods

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.
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

**Product Development Process & CAE**

- **Product planning** → **Design** → **Manufacture of prototypes** → **Testing** → **Repetitive operation**

- **Design** → **Manufacture of prototypes** → **Testing** → **Repetitive operation**

- **Design** → **Manufacture of prototypes** → **Testing**

Design using CAE

- **Product planning** → **Quality objective setup** → **Design**

- **Product planning** → **Quality objective setup** → **Design** → **CAE**

Reduced time & costs (60 - 70%)
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.

**Present Paradigm centered around Experts**

- CAD shape design
- FE modeling
- Perform analysis
- Create report
- Review results

[Design department] [Analysis department]

**New Paradigm centered around Designers**

- CAD shape design
- FE modeling
- Perform high-level complex analysis
- Analysis consultation
- Development of future technology & core technology
- Review of results

[Design department] [Analysis department]
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)
- Dynamic analysis of a car body
- 1st Front bending mode
- Rear torsional mode
- 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**

- Photovoltaic power generation’s frame analysis
- Dynamic analysis of plant equipment

**Machinery / heavy equipment**

- Construction equipment (contact auto-search & remote loading functions used)
- Multi-Grapple strength analysis

**Medical equipment**

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

**Consumer products**

- Buckling analysis of polyethylene box

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*www.midasNFX.com*
Part II. midas NFX (Pre/Post)
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.

**Ribbon Menu**
Provides related works in panel type

**Tabbed Toolbar**
Provides categorized toolbar icons

**Works Tree**
Provides model data in a tree structure and useful functions for data management and modeling

**Properties Window**
Provides various information and an editing function

**Context Menu**
Provides frequently used menus depending on selected entities

**Message Window**
Provides various information and operation results in modeling

**Table Window**
Provides input data and result values in Excel-like tables

**Unit Manager**
Provides real-time unit conversion
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.

**Workflow**

**Step 01**
Import a CAD model targeted for analysis
(Auto-processing functions for contact & feature removal)

**Step 02**
Define materials (Database + Drag & Drop)

**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

Step 05
Define analysis case(s) and perform analysis

Step 06
Check main analysis results

Step 07
Auto-generate analysis report (Customizable MS-Word format)
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

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

**Geometric modeling**

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**Solid Modeling Example**

- Create profile
- Extrude solid
- Copy solid
- Boolean operation
- Create profile
- Create holes (Defined depth)
- Draw profile
- Create holes (Through-all)

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

**Trim 2 surfaces based on intersection line**

**Connection of stiffeners 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, and projections
  - Remove/merge micro-surfaces
  - Check and modify topology

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

Intuitive interface for searching and distinguishing objects to be removed

Colored classification for ranges of magnitude

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

www.midasNFX.com
Automated contact definition suitable for complex, large scale assemblies and convenient visualization and management

Definition of Contact

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.

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.

Completed state of automatic contact assignment (total model check)

Individually check each contact definition

Contact surface at front side shaded

Contact surface at back side unshaded

Contact manager to conveniently check, revise and manage contact definitions
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

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
- 3D 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

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

Hybrid Element Mesh (hexahedron-tetrahedron hybrid element mesh)

- Tetrahedron element mesh model generated by Tetra Mesher
- Number of elements: 69,496
- Number of nodes: 128,907

- Hexahedron-tetrahedron hybrid element mesh model generated by Hybrid Mesher
  - Number of elements: 37,149
  - Number of nodes: 20,954

- 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.

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

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

- Composition of hybrid element mesh

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

Analysis Wizard

1. Select analysis type
2. Import CAD data
3. Define boundary conditions
4. Define and assign materials
5. Assembly model import
6. Define load
7. Auto mesh & Auto-contact between parts
8. Define loads
9. Assign analysis case and execute analysis (mesh density, contact, iterative analysis, etc.)
10. Main results verification (displacement, stress, factor of safety, etc.)

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

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

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.
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.
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
- Original results
- Symmetrical plot
- Virtual transformation
- 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)
Integraded 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

**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

- Modelling of a complex assembly model
- Modes of behavior calculated using the linear contact function

Example of a complex model and results analysis using linear sliding contact.
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, Polynomial, 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)

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 car’s front bumper crash

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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

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.)
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

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

Selection/definition of design spectrum
Automatic generation of response spectrum
Seismic analysis
Response analysis of DVD-ROM due to magnetic force (frequency response analysis)
Random vibration analysis of PCB (RMS results)
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

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: $k-\epsilon$, $k-\omega$, $k-\omega$-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
Topologies 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

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

Process of using topology optimization design

- Design domain defined
- Topology optimization
- Analysis model created
- Design check

Sample drawing and analysis

Approximate model generation, Approximate model size optimization design process

Capacity estimation/verification & Optimized model generation

Assign Design Zone

Topology Optimization

Approximate Modeling

Size Optimization

Size optimal design using topology optimization

www.midasNFX.com
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.

### High Performance Parallel Solvers

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

#### World class high performance parallel solvers catered to large scale models

#### Linear static analysis

<table>
<thead>
<tr>
<th>Solver</th>
<th>Nodes</th>
<th>Degrees of freedom</th>
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</thead>
<tbody>
<tr>
<td>Solid elements</td>
<td>(156,862)</td>
<td>(817,791)</td>
</tr>
<tr>
<td>Shell/beam elements</td>
<td>(163,143)</td>
<td>(916,890)</td>
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<tr>
<td>Solid elements</td>
<td>(170,123)</td>
<td>(874,346)</td>
</tr>
<tr>
<td>Shell elements</td>
<td>(154,320)</td>
<td>(840,180)</td>
</tr>
</tbody>
</table>

#### Modal analysis

<table>
<thead>
<tr>
<th>Modes</th>
<th>Solver</th>
<th>Nodes</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Shell elements</td>
<td>(156,862)</td>
<td>(817,791)</td>
</tr>
<tr>
<td>50</td>
<td>Shell elements</td>
<td>(170,123)</td>
<td>(874,346)</td>
</tr>
<tr>
<td>50</td>
<td>Solid elements</td>
<td>(154,320)</td>
<td>(840,180)</td>
</tr>
<tr>
<td>50</td>
<td>Shell/beam elements</td>
<td>(163,143)</td>
<td>(916,890)</td>
</tr>
</tbody>
</table>

#### Nonlinear static analysis

<table>
<thead>
<tr>
<th>Degrees of freedom</th>
<th>Solver</th>
<th>Nodes</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Shell elements</td>
<td>(170,123)</td>
<td>(874,346)</td>
</tr>
<tr>
<td>Contact</td>
<td>Shell elements</td>
<td>(154,320)</td>
<td>(840,180)</td>
</tr>
<tr>
<td>Contact</td>
<td>Solid elements</td>
<td>(154,320)</td>
<td>(840,180)</td>
</tr>
</tbody>
</table>

#### 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

---

31 Part III: NFX 2013 (Solvers)
Reliable & excellent analysis results with the latest elements and analysis algorithms

Verifications & Benchmarking Tests

<table>
<thead>
<tr>
<th>Element</th>
<th>Collapse Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUAD4 HYB</td>
<td>2638,142</td>
</tr>
<tr>
<td>QUAD8 HYB</td>
<td>2517,7</td>
</tr>
<tr>
<td>QUAD4 RED</td>
<td>2084,625</td>
</tr>
<tr>
<td>QUAD8 RED</td>
<td>2594,725</td>
</tr>
<tr>
<td>QUAD4 FULL</td>
<td>2746,794</td>
</tr>
<tr>
<td>QUAD8 FULL</td>
<td>2676,172</td>
</tr>
<tr>
<td>TRA3 HYB</td>
<td>2899,387</td>
</tr>
<tr>
<td>TRA6 HYB</td>
<td>2508,51</td>
</tr>
</tbody>
</table>

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

Pinched cylinder with rigid diaphragms (K.Y.Sze, W.K.Chan & T.H.H.Pan, 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
Part IV. Enhancements in midas NFX 2017
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.

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

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

Model with hidden cross-section

Displayed cross-section

Application example – Leaf spring
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.

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.

<table>
<thead>
<tr>
<th>Volume</th>
<th>40% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraint 1</td>
<td>0.296mm</td>
</tr>
<tr>
<td>Constraint 1</td>
<td>5060Hz</td>
</tr>
</tbody>
</table>

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

Case 1
Topology Optimization based on Linear Static analysis

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

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

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.

Two-way FSI (Fluid Structure Interaction)

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

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.

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

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

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.
Total Solutions for True Analysis-driven Design

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

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

Arbitrary Surface/Solid Average window
Application example – average output pressure on Face

Flow Path command window
Streamlines generated from selected faces
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.

Technical Support System for Customer Satisfaction

- 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

End-User Training

- 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

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.

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