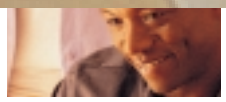
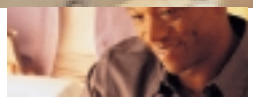
# Femap®: Affordable, real FEA solutions for the engineering desktop

www.eds.com/products/plm/femap/





Femap® digital simulation solutions

Developing exceptional products that meet strict quality and performance criteria cannot be left to chance. PLM Solutions from EDS takes the guesswork and worry out of your product development process with a comprehensive suite of world-class digital simulation solutions.

NX
PLM Solutions

EDS

**EDS PLM Solutions digital simulation solutions**

Product lifecycle management (PLM) is the ability of extended enterprises – consisting of dispersed users and diverse data types – to effectively plan, execute, monitor, and optimize all of the stages in a product lifecycle via a digital product development environment. Within an integrated digital environment you can conceive, engineer, design and analyze digital 3D models of products and the processes required to manufacture, deliver and support them.

EDS PLM Solutions provides a comprehensive yet easy to use suite of scalable capabilities for total product performance evaluation – from concept design through to prototype evaluation. EDS is uniquely positioned as a single source provider of a complete range of world-class digital simulation solutions. These include design-integrated process-centric simulation tools in Unigraphics® NX and I-deas® NX Series, as well as CAD-independent digital prototyping and simulation tools such as Femap.

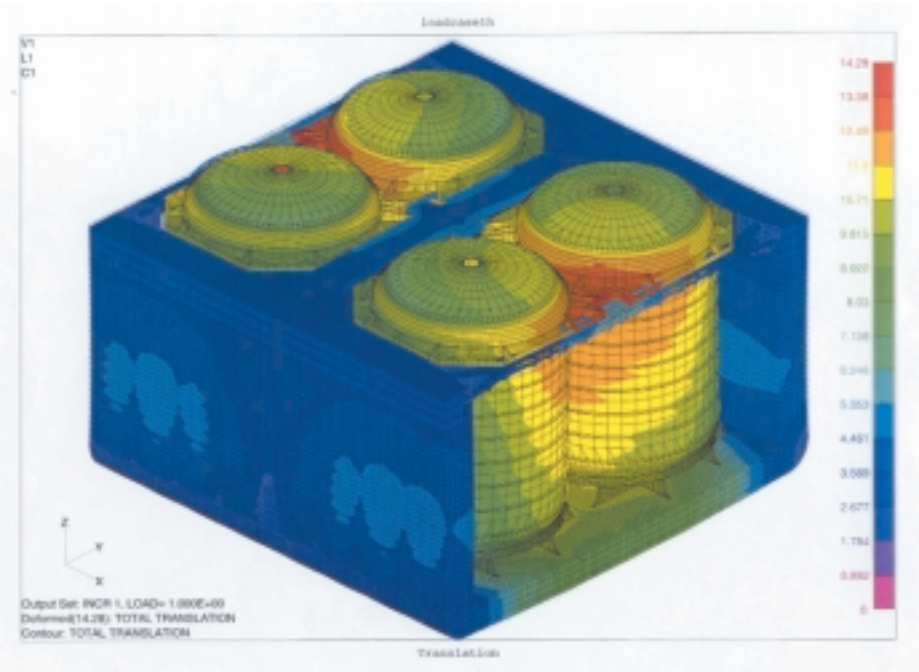
A market-leading component of the EDS PLM Solutions family, Windows-native Femap also provides a CAD-independent backbone to other industry-leading simulation products. Examples are MSC.Visual Nastran for Windows from MSC.Software, Sinda/G from Network Analysis Inc., and the American Bureau of Shipping's SafeHull package which is widely used within the shipbuilding industry. Based on an advanced set of open desktop technologies, Femap works easily within all types of customer engineering environments. Femap is also based on the Parasolid® modeling kernel, which ensures direct access to more than 35 percent of the world's digital product definition data.

You too can achieve the global competitive advantages of digital prototyping and simulation by integrating your engineering best practices with advanced CAE software and services from EDS.

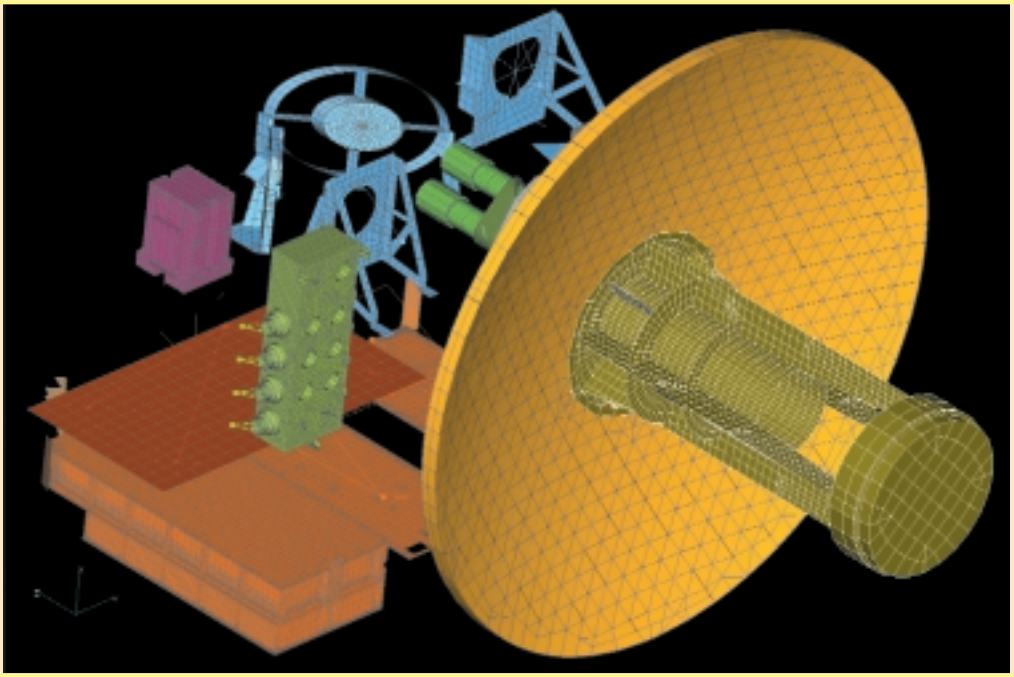
# High-performance FEA modeling with Windows-native ease of use

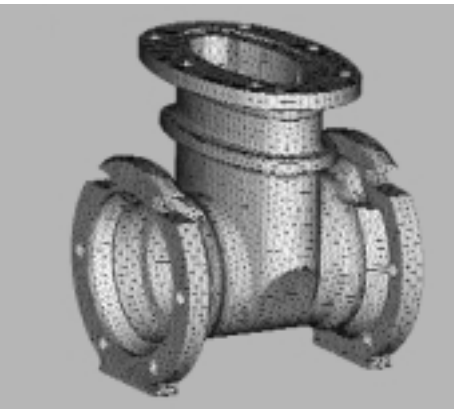
Femap is the world's leading Windows-based pre- and post-processor for advanced engineering finite element analysis (FEA). Femap provides engineers and analysts with an FEA modeling solution to handle complex tasks easily, accurately and affordably. With an emphasis on power and simplicity in finite element modeling for more than 15 years, Femap continues that focus today with integration to a wide range of industry-standard structural and thermal solvers such as Nastran, Ansys, Abaqus, LS-Dyna, TMG and Sinda. As an engineer or manager responsible for finite element analysis, you demand software that is easy to use, but with the power to model the toughest analyses. Femap delivers just that — affordable high-performance FEA modeling for the engineering desktop with Windows-native ease of use.

Femap is widely used by the world's leading engineering organizations and consultants to model complex products, systems, and processes, including satellites, aircraft, heavy construction equipment, marine vessels and process equipment. From advanced beam modeling, mid-surface extraction and hex meshing, to robust CAD import and idealization, Femap gives you unparalleled model control and flexibility. And with a broad range of loads, materials, analysis types and visualization options, Femap is a solid investment for those committed to excellence in the use of finite element analysis technologies.



## Scalable CAE solutions to fit your needs





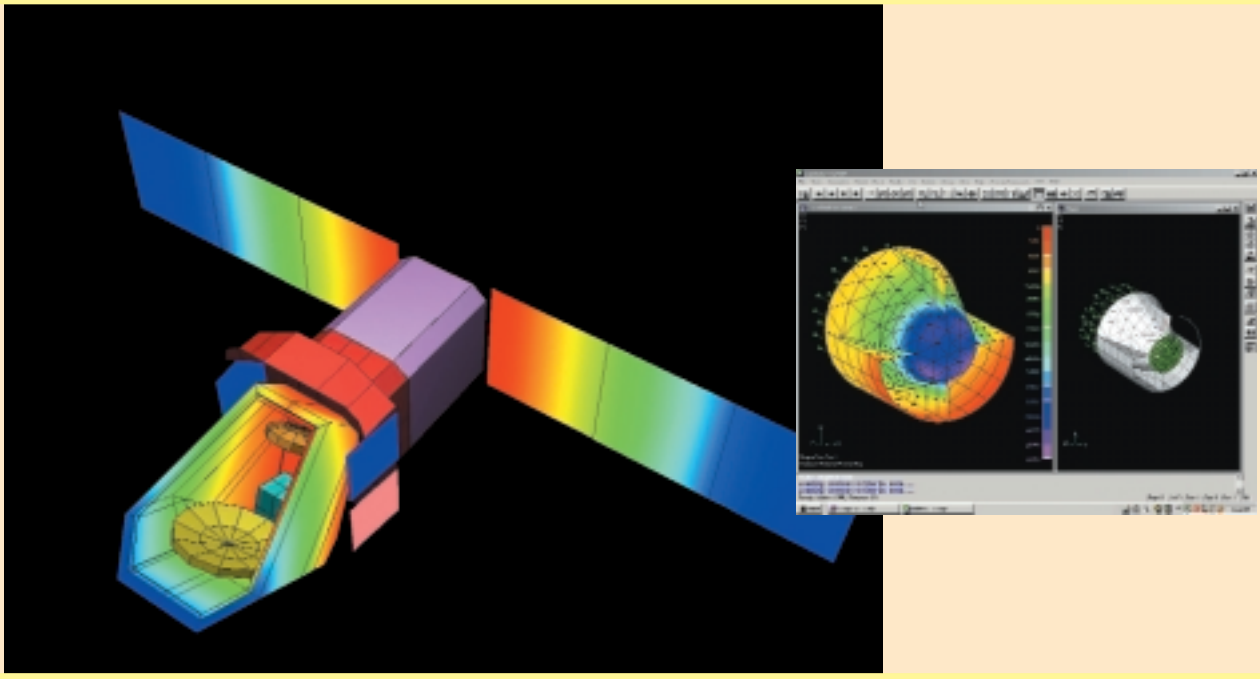
Femap is scalable for a broad range of analysis applications — not with a series of confusing options and modules, but with a wide array of functionality. For customers who primarily exchange and modify existing finite element models, Femap provides exceptional value and performance. With basic tools for manipulating finite elements models at the node and element level, and FEA model readers for importing existing models from many FEA solvers, Femap is a nuts-and-bolts, "bottoms up" finite element pre- and post-processing solution.

If your product data begins with surfaces and solids, Femap supports CAD geometry transfer via many formats, including IGES, STEP, VDAFS, ACIS (includes AutoCAD), Unigraphics NX and I-deas NX Series, CATIA v4, Pro/E, and Parasolid (includes Solid Edge® and SolidWorks). Once you import CAD geometry, Femap can modify it with a full suite of solid and surface modeling and editing tools.

Femap goes beyond the capabilities of most CAD-embedded or CAD-centric designer FEA tools. To effectively model the structural, dynamic and thermal behavior of complex systems and assemblies, solid FEA models cannot always do the job. Femap also delivers analyst-centric tools for idealizing solid CAD geometry to fully represent the behavior of today's engineered parts and systems and obtain accurate answers.

### Femap Structural

Femap Structural combines the Femap advanced pre- and post-processor with the proven solver technology from EDS' high-performance NX Model Solution. Femap Structural provides solution capabilities for statics, normal mode dynamics, buckling and steady-state heat transfer, and includes state-of-the-art sparse matrix and iterative solvers for fast analysis turnaround times of large solves on desktop computers.



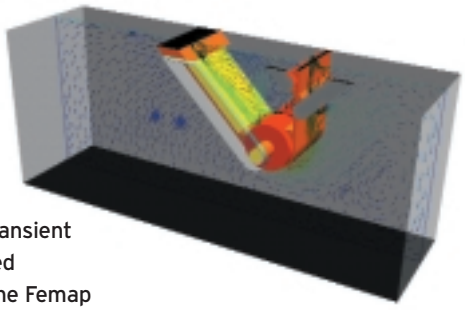
## Femap Advanced Thermal

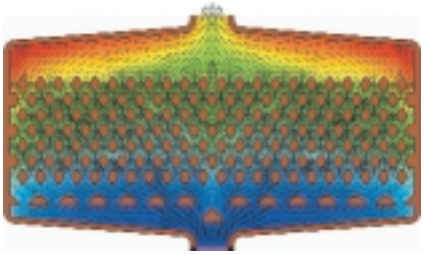
Femap Advanced Thermal includes the fundamental simulation capabilities needed for most transient and steady state thermal analysis engineering applications. It includes modeling of conduction, convection, radiation and phase change and provides a range of thermal boundary conditions and solver controls. Femap Advanced Thermal also provides a powerful thermal modeling tool for assemblies called thermal couplings, which allows you to create paths for heat to flow between parts in large, complex assemblies.

Femap Advanced Thermal also provides many advanced thermal and fluid flow modeling capabilities for the thermal analyst, including fluid duct flow modeling with coupled convection and fluid flow analysis. The Advanced Thermal package delivers an extensive set of tools for advanced radiation and spacecraft modeling, including solar and orbital heating, orbit modeling and display, specular reflections with ray tracing, and articulating structures. It also includes advanced solver features such as custom user subroutines, model simplification, sub-structuring and interfaces to industry thermal codes.

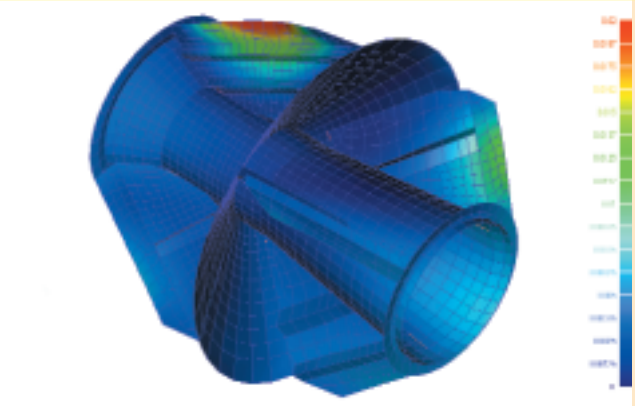
## Femap Flow

Femap Flow provides a comprehensive 3D computational fluid dynamics (CFD) solution fully integrated with Femap. Combined with Femap Advanced Thermal, it solves a wide range of multi-physics problems involving fluid flow and heat transfer. Femap Flow models 3D fluid velocity, temperature and pressure by solving the Navier-Stokes equations for both steady state and transient applications. Low-speed and high-speed compressible flows can be modeled. The Femap Flow solver uses an efficient and robust element-based finite volume, multi-grid solver for fast and reliable solutions. Forced flow, natural convection and mixed flows can be modeled and can include multiple inlets, outlets and internal flow boundary conditions. For electronics-cooling applications, the package easily models fan curves, inlet and outlet resistances as well as convection from thin structures. Rotating systems, moving walls, flow turbulence models, humidity and other features are available for the most advanced fluid flow modeling requirements.





# Femap increases your analysis productivity

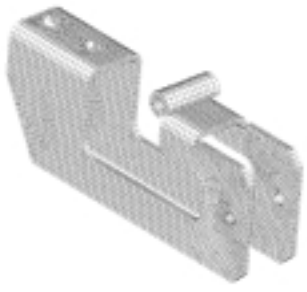


## Serious engineering on Windows

With powerful tools for geometry import, geometry creation, meshing, materials and properties, loads and boundary conditions, Femap delivers a depth of functionality typically found in more expensive, high-end UNIX-based solutions but often lacking in the mid-range designer CAE packages. Femap makes it possible to quickly create models that accurately predict the structural, dynamic and thermal performance of single components or complex systems.

## The right geometry for analysis

Engineers often encounter geometry that is not ideal for analysis model definition. Femap provides geometry creation and editing tools for curves, surfaces and solids, feature suppression, and mid-surface extraction. Solids can be subdivided and automatically connected to represent dissimilar materials for semi-automatic hexahedral mesh generation. Engineers can combine multiple surfaces to improve meshing areas for higher quality shell meshes.



## A better mesh, faster than ever

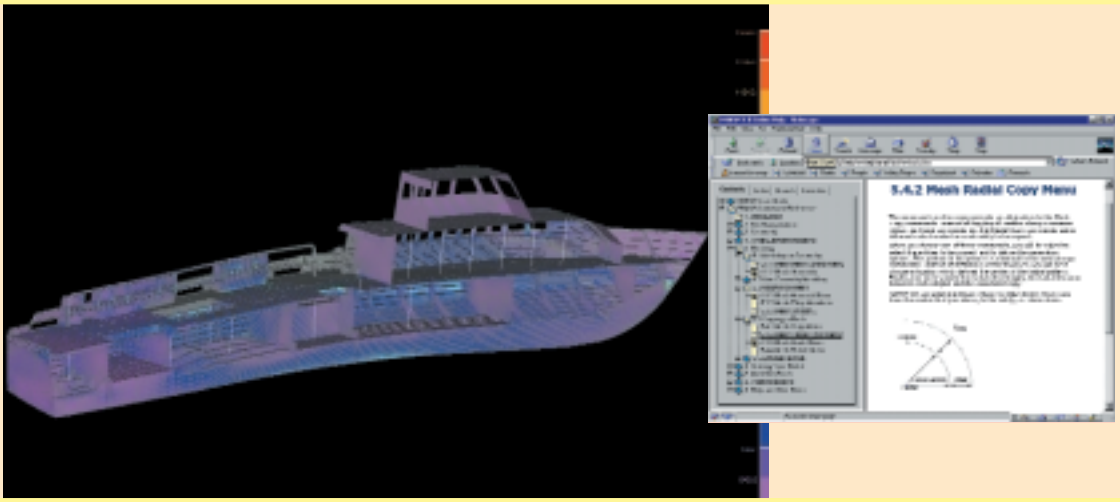
With intelligent default mesh sizing, Femap anticipates your meshing requirements. Femap also provides flexible mesh controls on points, curves and surfaces, with extensive options for biasing and mesh topology, plus fully automatic, high-speed tetrahedral solid meshing and quad-dominant surface meshing.

## CAD independent

Femap offers seamless geometry access with major CAD systems, and extensive geometry creation tools including standard wireframe lines, arcs, circles and splines and surface modeling. Using either the ACIS or Parasolid geometry engines, Femap can create complex solid and surface models. Powerful shelling, blending, Boolean operations, surface imprinting, and lofting combine to make Femap extremely effective at creating geometry for analysis.

## Analysis set manager

The analysis set manager in Femap allows you to store solver setup data with your models, so you don't need to complete numerous dialog boxes each time you edit your model and create a new analysis input file. The sets can also be saved in a library for use with other models.



### HTML help system

To make Femap even easier to use, its on-line documentation is published in HTML format, allowing you to access the help system with Netscape Navigator or Internet Explorer Web browsers. You can access the help system through context sensitive help, the help menu, or from outside Femap. The help system includes a collapsible table of contents, full-text search, index, and favorites (bookmarks).

### Integrating analysis technologies

Leading firms recognize that a single analysis technology seldom meets all their requirements. By integrating multiple analysis technologies in a single modeling and visualization environment with Femap, they can make better designs faster.

### Multiple solver support

Femap provides in-depth, high-quality support for industry standard solvers, including the popular and proven Nastran, Abaqus, Ansys, LS-Dyna and NX Model Solution. Femap provides the ability to reuse and integrate analysis models from legacy data, and from customers and suppliers. Femap's complete element library, with comprehensive support of physical and material definitions, takes full advantage of the advanced capabilities of these solvers, including dynamic, geometric and material nonlinear applications.

Leading third-party solvers use Femap to perform CFD, soil modeling, advanced thermal analysis and electromagnetic simulations.

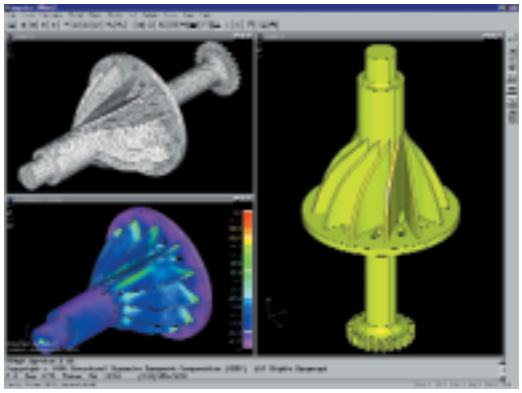
### FE Structural solvers and analysis results types supported

| Analyses | Abaqus | Ansys | Femap Structural | LS Dyna | MSC Marc | MSC Nastran |
|---|---|---|---|---|---|---|
| Static | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Modal | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Buckling | ✓ | ✓ | ✓ | | | ✓ |
| Heat transfer | ✓ | ✓ | ✓ | | | ✓ |
| Nonlinear | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Transient response | ✓ | ✓ | | ✓ | | ✓ |
| Frequency response | ✓ | ✓ | | | | ✓ |
| Random response | | ✓ | | | | ✓ |
| Explicit dynamics | ✓ | | | ✓ | | |
| Post process | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

# Femap pre- and post processing tools

## Geometry import

- CATIA import – reads CATIA model files (CATIA v4.1x or v4.2)
- IGES import – in addition to a basic IGES interface, an advanced IGES interface that supports many additional entity types is included in Femap. This supports IGES standards 4.0 to 5.3.
- IGES export – in addition to advanced IGES import this interface exports Parasolid geometry to IGES format
- VDA import – provides direct access to VDA files up to v2.0
- I-deas import – provides access to IDI files generated by I-deas 8 and I-deas 9
- Pro/ENGINEER import – provides direct access to model files from Pro/E v17 to 2000i2
- Solid Edge import – provides direct access to Parasolid geometry in solid and sheet metal part files
- Unigraphics import – provides direct access to geometry from Unigraphics v11 through v18 CAD models and Parasolid geometry exported from all Unigraphics versions
- ACIS and Parasolid import – each of these interfaces converts imported geometry to the other's solid modeling kernel format. If you normally work with Parasolid, but need to use ACIS geometry, you can convert it to Parasolid so that it can fully interact with your other geometry.

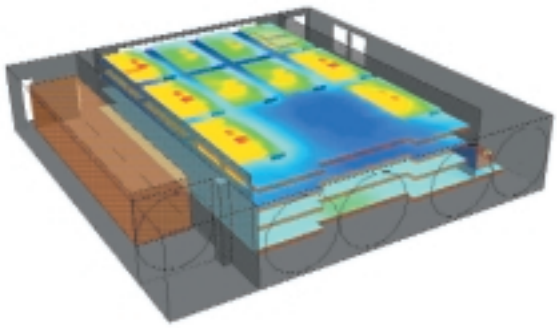


## Geometry creation

- Create points, lines, arcs, circles and splines
- Break, trim, extend, join, fillet, offset and copy
- Import DXF and IGES points, curves, trimmed surfaces and solids
- Import or export stereolithography (SLA) STL data
- Direct import and export of ACIS (.sat) and Parasolid (.x_t) parts or assemblies
- Boolean and extrude/revolve solid modeling
- Midsurface extraction
- Project curves onto surfaces
- Intersect surfaces to create curves
- Define regions by projecting curves on solid
- Create curves based on U-V space on surfaces
- Shell solids, with constant thickness
- Rule, revolve, extrude and loft surfaces
- Stitch surfaces into solids

## Meshing

- Subdivision and semi-automatic meshing of solids
- Automatic solid meshing with tetrahedral elements
- Global and local controls with default sizing
- Define element size or spacing with bias
- Free surface meshing, quads or triangles only
- Mapped meshing with quads or bricks
- Direct generation of line, shell and solid elements
- Extrude and revolve – geometric curves or line elements can be extruded/revolved into shell elements. Shell elements can be extruded or revolved to form solid elements.
- Connected shell elements can be extruded normal to themselves to turn thin-shell models into solid ones.
- Mesh refinement and smoothing
- Full associativity between geometry and mesh
- Interactive mesh editing



## Element library

- 1D – rod, tube, bar, beam, spring, gap. Full support of arbitrary and standard cross-sections including all property calculations
- 2D planar – plane strain or stress, axisymmetric 3D surface or solid
- 2D axisymmetric – shells and solids
- 3D surface – plate, laminate, shear panel, membrane, quads or triangles
- 3D solid – tetra, wedge and brick
- All 2D and 3D elements: linear or parabolic
- Mass and general stiffness matrices
- Contact lines and surfaces, and slide lines
- Rigid and interpolation elements

## Materials

- Isotropic, orthotropic and anisotropic
- Nonlinear elastic, bilinear and plastic
- Hardening – isotropic or kinematic
- Hyperelasticity, creep and composites
- Temperature and strain rate dependence
- User extensible library with thousands of material properties included

## Loads and constraints

- Geometry or finite element based
- Associativity between geometry and mesh
- Load case definition and management
- Fixed (non-zero) displacements and rotations
- Constraint equations (MPCs)
- Nodal forces and moments
- Distributed loads on line elements
- Constant or variable pressure
- Velocities and accelerations
- Transient dynamic, frequency and random vibration
- Temperatures, heat generation or flux
- Convection and radiation

## Customization

- Record, edit and playback macros
- Basic Scripting Language – full featured, object oriented, OLE/COM-based programming API
- Fully documented ASCII neutral file format

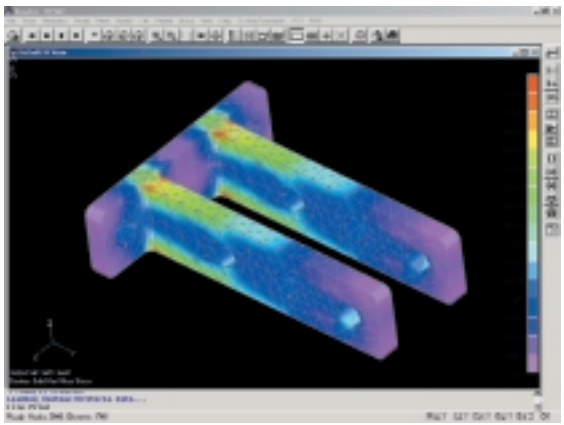
## Groups and layers

With Femap you can easily subdivide your model for visualization or post-processing purposes. Group by:

- Coordinate clipping
- Automatically add new entities to active or user-specified group
- ID
- Associativity
- Material
- Property
- Type
- Automatic group creation based on properties, materials, and geometric constraints

## Results visualization and reporting

- Deformations, animations, and vector displays
- Single- and multi-load step animations
- Filled color contours and criteria displays
- Iso-surface and cutting planes, with dynamic control
- Shear and bending moment diagrams
- Error estimates
- Results across composite laminates
- Extensive result sorting capabilities
- X-Y plots with multiple curves
- Text reports – standard and user-customizable
- Interactive data query with mouse
- Free-body displays, including grid point force balance support for grouped entities
- Import/export in comma-separated tables
- Internet publishing with VRML support
- Save animations with AVI support

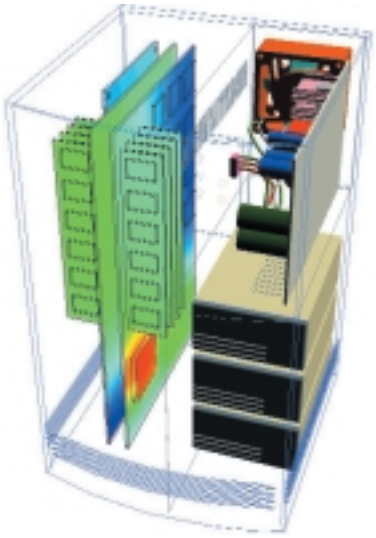


### User interface

- Native Windows look and feel
- Multiple graphics windows
- Full, multi-level undo/redo
- Online help with hypertext links
- Toolbars to access frequently used commands
- Cut and paste images into Windows applications
- Dynamic highlight during selection operations
- Box, circle, polygon, front, depth and query picking of geometric and FEA entities
- Select entities by associativity (all elements connected to specified nodes or surfaces, all elements of a specified property)

### Graphics

- OpenGL support
- 3D dynamic pan, zoom and rotation
- Hidden line and wireframe display
- Free edge and free face display
- Light source shading and transparency
- Element displays: orientation, axes and offsets
- High-quality output – vector-based printing



## Integrated solvers for Femap

### Femap Structural

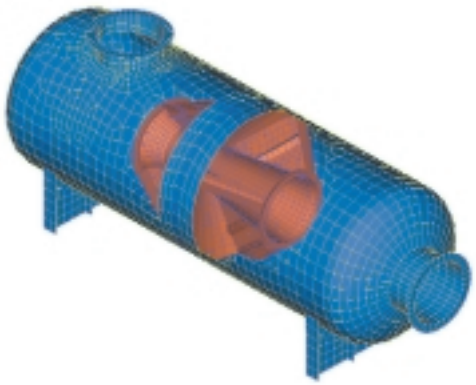
- A general-purpose finite element analysis program.
- Integral part of Femap; no additional input files need to be created for the analysis. All analysis control parameters are controlled by the analysis set manager.
- Offers a comprehensive set of finite elements to model a wide variety of structures, all with evolving state-of-the-art mathematical formulations to minimize computer time and maximize accuracy.
- Includes the following solution methods:

  Static analysis – stress stiffening effects can be included. Normal mode dynamic analysis – Lanczos,

  Simultaneous Vector Iteration (SVI) and Guyan reduction methods available. Stress stiffening and spin soft ening effects can be included.

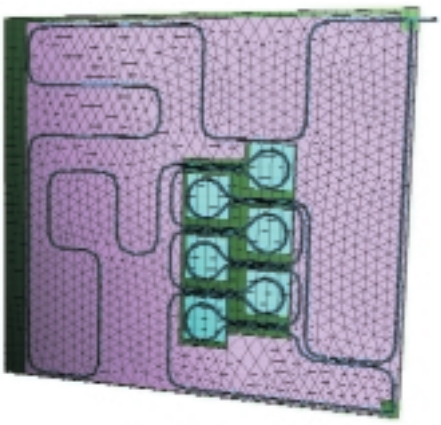
  Buckling analysis – predicts the loads at which the onset of structural instability will occur

  Steady-state heat transfer analysis – solves for the steady-state temperatures due to convection, conduction and heat generation. Material properties can be temperature dependent.
- Uses a direct matrix solver based on an advanced sparse matrix strategy which minimizes solution time and disk space by taking maximum advantage of matrix sparsity. An alternative is an iterative solver that is especially effective for large models.
- Based on the popular NX Model Solution, in production use at thousands of sites worldwide. EDS tests Femap Structural against internationally recognized standards (e.g., NAFEMS, Soc. Francais de Mecanicians). An extensive suite of test problems, some with closed-form solutions, is used to verify the accuracy of the results.



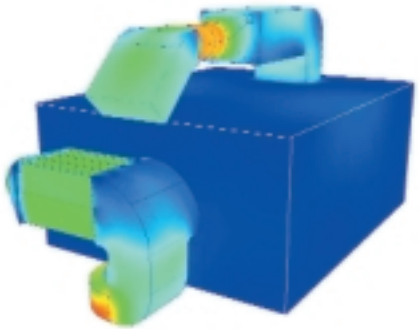
## Femap Advanced Thermal

- Transient and steady-state solutions, linear and non-linear.
- Thermal boundary conditions including temperatures, heat loads, fluxes, initial conditions and thermostats.
- Thermal couplings to create thermal assemblies of disconnected FE models including couplings between surfaces, edges and points.
- Conduction including isotropic and orthotropic properties, radial heat flow, phase change and time, temperature and direction dependent properties.
- Radiation including the calculation of view factors with shadowing effects for diffuse surfaces, variable surface properties, axisymmetric radiation modeling, and multiple radiation enclosures.
- Convection by specifying boundary conditions using tabular data or formulae.
- Additional solver features including axisymmetric modeling, table dependent parameters, non-geometric modeling, and solution monitor.
- Duct fluid flow network modeling with coupled forced and free convection simulation for multiple fluids and modeling both incompressible and compressible flows.
- Solar and orbital (spacecraft), diurnal and radiative heating including orbit modeling and interactive orbit display.
- Specular and hemicube radiation modeling with ray tracing and modeling of transmissive surfaces.
- Articulating structures for radiation modeling including translating and rotating joints and spinning spacecraft.
- Joule heating simulating electric resistance circuits
- Interfaces to industry thermal codes including SINDA, ESATAN, TRASYS and NEVADA
- Advanced solver features including model simplification, sub-structuring and user written subroutines, batch solutions and editable input files



## Femap Flow

- Transient and steady-state solutions for Newtonian fluids
- Surface convection, natural, forced and mixed flows
- Air flow turbulence modeling including K-E, fixed viscosity and mixing length models
- Complete coupling with Femap Advanced Thermal for complete thermal and fluid flow modeling including advanced radiation modeling
- Internal and external fans and vent openings including fan/pump curves
- High-speed and compressible flows
- Rotating and translating surfaces
- Rotating frames of reference for rotating machinery
- Model symmetry and slip conditions
- Support for unstructured mesh including tetrahedral, wedge and brick elements
- Volume porosity and flow resistances
- Disjoint meshing, support for flow across disconnected mesh-to-mesh volumes
- High order advection schemes
- Humidity and general scalars
- Thin wall modeling using shell elements for conduction, convection and radiation



## About EDS

EDS, the leading global services company, provides strategy, implementation, business transformation and operational solutions for clients managing the business and technology complexities of the digital economy. EDS brings together the world's best technologies to address critical client business imperatives. It helps clients eliminate boundaries, collaborate in new ways, establish their customers' trust and continuously seek improvement. EDS, with its management consulting subsidiary, A.T. Kearney, serves the world's leading companies and governments in 60 countries. EDS reported revenues of $21.5 billion in 2002. The company's stock is traded on the New York Stock Exchange (NYSE: EDS) and the London Stock Exchange. Learn more at **eds.com**.

## About product lifecycle management solutions

EDS is the market leader in product lifecycle management (PLM), providing solutions to the global 1000. Product lifecycle management enables all the people who participate in a manufacturer's product lifecycle to work in concert to develop, deliver, and support best-in-class products. As the only single-source provider of PLM software and services, EDS can transform the product lifecycle process into true competitive advantage, delivering leadership improvements in product innovation, quality, time to market, and end-customer value. Learn more at **eds.com/plm**.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