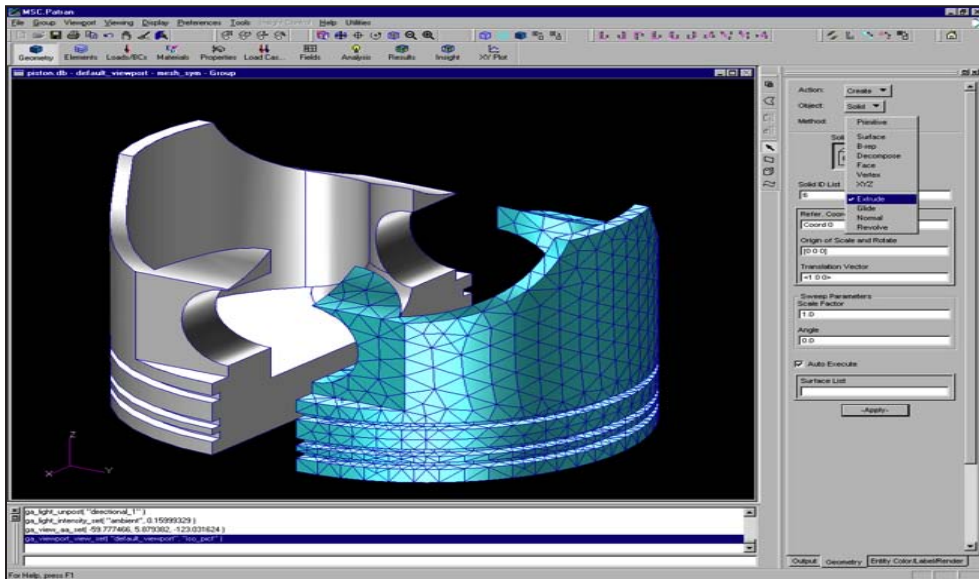


# MSC.Patran®

## The industry's leading finite element modeling environment



### Overview

MSC.Patran™ 2004 is an open-architecture, general purpose, 3-D mechanical computer aided-engineering (MCAE) software package with interactive graphics providing a complete CAE environment for linking engineering design, analysis, and results evaluation functions. In manufacturing companies throughout industry, MSC.Patran is the acknowledged leading finite element modeler, enabling the user to conceptualize, develop and test a product through computer-based simulation prior to making manufacturing and material commitments. MSC.Patran brings the full power of mechanical simulation to the design process for reduced cost, increased productivity and faster time-to-market.

### Direct Access of CAD Geometry

#### DESCRIPTION

MSC.Patran enables direct access to geometry from leading CAD systems for creating finite element models. With direct access, geometry remains intact in the CAD format and is imported into MSC.Patran database without any translation or modification. Support for many industry-standard geometry exchange formats is provided. An option is also available for direct import into Parasolid format for several CAD systems and exchange formats. All finite elements, loads, boundary conditions, and material properties can be associated to the geometry

#### GEOMETRY ACCESS FEATURES

- Direct access of CAD part files
  - Available interfaces include:
    - CADDS 5
    - CATIA
    - EUCLID 3
    - I-DEAS
    - Pro/ENGINEER
    - Unigraphics

### Capabilities

- Intuitive graphical interface with direct access of CAD geometry
- Complete integration with MSC.Software's analysis solvers and third-party solvers
- Automatic/Interactive Feature Recognition
- Robust automatic surface and solid mesh generation
- Advanced mesh-on-mesh capability
- Comprehensive results postprocessing
- Results standardization through results templates
- MSC.Patran Command Language (PCL) and optional MSC.Acumen™ toolkit for customization

### Benefits

- Increase productivity of your design and development process
- Reduce development costs through increased use of simulation technologies
- Enable better collaboration through MSC.Patran's tight integration with CAD packages and analysis solvers

- Entity types that can be accessed include points, curves, surfaces, and solids. In addition, for Unigraphics, solid features, parameters and attribute data can be directly accessed and manipulated.
- Direct Access of Parasolid files
  - Access geometry from any Parasolid-based CAD system
  - Entity types that can be accessed include wire, sheet and solid bodies
- Direct Access of ACIS files
  - Access geometry from any ACIS-based CAD system
  - Entity types that can be accessed include curves, surfacing, and solids.
- √ – Support ACIS Version 11.0
- Direct access of IGES files from any CAD system:
  - Geometric entity types that can be accessed include points, curves, surfaces, and B-rep Solids.
  - Finite element entity types that can be accessed include nodes, elements, and coordinate frames.
- Direct Access of VDA files
  - Entity types that can be accessed include points, curves, and surfaces
- Support of STEP Application Protocols (AP203 and AP209) data exchange standards. AP203 provides geometry and configuration controlled design data, and AP209 extends this to include analysis (FEM/FEA) and composites.
  - AP203 IMPORT
- All AP203 Conformance Class representations (1-6) are supported
- Only the agreed upon minimum subset of Conformance Class 1 entities are supported
- Group based geometry import is supported
- AP203 assembly is supported
- Assembly is imported in MSC.Patran and all the assembly instances are duplicated
- Group based Assembly import is supported
- Name of Geometric Entities preserved using CATIA cad association
  - AP203 EXPORT
- Curves, surfaces, and solids Name of imported Geometric Entities preserved using CATIA cad association
- Exports MSC.Patran Geometry entities as either Class 2: Geometrically bounded surface shape representation, or Class 6: Advanced B-Rep shape representation.
  - AP209 IMPORT/EXPORT
- Geometry (nominal shape and idealized shape)
- FEM/FEA (linear static and modes/eigenvectors)
- Configuration Control Data.
- Optional conversion to Parasolid form for application of advanced editing capabilities

- Export of Parasolid geometry
- Export of IGES files:
  - Geometry entity types accessed include; points, curves, surfaces, and solids
  - Finite element entity types that can be accessed include nodes, elements and coordinate frames

### Geometry Creation and Editing

#### DESCRIPTION

MSC.Patran contains an advanced set of geometry creation tools in addition to the direct CAD access capabilities for generating finite element model geometry.

#### GEOMETRY CREATION FEATURES

- Comprehensive library of commands to generate and manipulate geometric entities:
  - Basic entity types include points, curves, surfaces and solids
  - Advanced entity types include trimmed surfaces, triparametric solids, volumes and B-rep solid
  - Consistent menu structure used to build all entity types
  - Various creation options include: translate, rotate, scale, mirror, glide, normal, extract, fillet, XYZ, extrude, revolve, decompose, intersect, manifold, project, and many more
  - Option to combine many surfaces (including overlays, gaps and holes) into a single trimmed surface for meshing purposes
  - Ability to chain many curves into a single curve
- The optional CAE Solid Modeling provides advanced solid creation and editing tools including primitive solids, Boolean operations, extrude, revolve, edge blend, shelling, face imprint and mid-plane surface extraction
- Options for geometry creation via group transformations
- Local coordinate systems in any location and orientation
- Cartesian, cylindrical and spherical coordinate systems options
- Ability to calculate mass properties for the geometry model

#### AUTOMATIC/INTERACTIVE FEATURE RECOGNITION

- The robustness and flexibility of the CAE Solid Modeling module is further enhanced by the automatic/interactive feature recognition capabilities
  - Parasolid based

- Edit/Delete/Show features
- Recognizable features
  - Hole
  - Blend
  - Chamfer

### INTEGRATION WITH LEADING ANALYSIS

#### DESCRIPTION

MSC.Patran's Analysis Preferences Feature enables the user to customize the analysis environment for use with leading analysis codes. Code-specific menus and forms enable the input of data required for the analysis code of choice, minimizing the need to learn multiple sets of code-specific terminology.

#### ANALYSIS PREFERENCES FEATURES

- Preferences can be selected for:
 

– MSC.Nastran	– ANSYS
– MSC.Marc	– ABAQUS
– MSC.Dytran	– LS-DYNA3D
– SAMCEF	– PAMCRASH
- ★ **MSC.ADAMS**
- Custom forms available for code-specific data input:
  - Loads
  - Boundary conditions
  - Element properties
  - Material properties
  - Multi-point Constraints (MPC's)
  - Solution type and parameters
- Optimized analysis integration with MSC.Software simulation solutions
  - A direct API-based interaction with MSC.Nastran™ for performing efficient, interactive modal frequency response analysis
  - Direct results access without time consuming results data import available for MSC.Nastran™ and MSC.Marc®
  - Simulation components provide a customizable, enterprise-wide solution suite
- The MSC.Patran Neutral File Preference
  - Fully integrated, ready-to-use interface for third-party codes that support MSC.Patran Neutral Files
- Additional preferences and interfaces to MSC.Patran's own analysis solutions include
  - Thermal analysis
  - Fatigue analysis
  - Composite laminate analysis
  - Advanced analysis management

#### Access Results

This capability access results data from the analysis code of choice.

- Read from the analysis code results file
 

MSC.Nastran	ANSYS
MSC.Marc	ABAQUS
MSC.Dytran	LS-DYNA 3D
SAMCEF	PAMCRASH
MSC.Patran neutral file	
- A new "Attach" method has been added to enable the direct access of results file
 

MSC.Nastran	ANSYS
MSC.Marc	ABAQUS
MSC.Dytran	√★LS-DYNA 3D
- Translates model data (nodes and elements), results data, or both
- Support linear, nonlinear, real, complex, time-dependent, and frequency-dependent results
- Optional results filtering during import

### Graphical User Interface

#### DESCRIPTION

MSC.Patran's graphical user interface is a forms-based, mouse-driven menu system for the operation of all tasks. It is designed to be easy to learn and use.

#### USER INTERFACE FEATURES

- Compliant with OSF Motif standard on Unix platforms
- Windows native UI on Windows / Intel platforms
- Full-screen menu system
- Command interrupt capability
- User input from the mouse, spaceball or keyboard
- Both "drag-box" and "polygon" screen picking
- Command Undo capability
- Identification of entities by labels or by cursor picking with pre-selection highlighting
- Entity re-numbering features
- Ability to access any MSC.Patran system application at any time
- Customizable, icon toolbar feature for easy access to frequently used commands
- User-definable forms creation and menu capabilities
- ★ Screen picking of properties
- ★ Screen picking of materials
- ★ Enhanced data entry through automated calculator and measurements tool

### Interactive Help On-Line

#### DESCRIPTION

MSC.Patran's "Help" system provides a "context-sensitive" hypertext mechanism enabling the user to quickly navigate through the entire on-line document to find information on topics of interest.

### ON-LINE HELP FEATURES

- Fully-interactive
- Topical help
- Context-sensitive help
- Full search capabilities

### Finite Element Modeling

#### DESCRIPTION

MSC.Patran finite element modeling system permits the user to directly access model geometry and to quickly develop finite element meshes.

### Finite Element Modeling Features

#### AUTOMATIC SURFACE MESHER

- Automatic 2-D surface meshing
- User specification of element size globally and/or in individual regions
- Automatic mesh smoothing assures best quality mesh
- Mesh density controls including curvature checks
- Geometry source independent surface meshing
- Advanced algorithm ensures that elements with the best shape are created at edges and other areas of interest
- p-element mesh option reduces number of elements for optimal p-element analyses
- Advanced sheetbody surface mesh tool for improved quality of mesh generation on topologically congruent surface regions without being constrained to follow the internal surface edges, or small boundary edges
- Create new mesh regions applied to a surface defined by a finite element mesh, without geometric definition. Using the underlying mesh, another mesh of different type or density can be generated which follows the "surface" defined by the original mesh, allowing for mesh refinement or re-shaping
- A Midplane Meshing Component allows for creation of a mid-plane finite element representation for a thin walled solid. This tool is a mesh-based method for direct mid-plane mesh creation, without the need to create any mid-plane geometry entities.

#### Advanced Surface Mesher

★ This new advanced surface mesher will greatly enhance and streamline our users' ability to handle complex/dirty surface models. Traditionally, substantial user interaction time and effort are needed to clean up the non-congruencies, gaps and overlaps prior to the actual meshing operation. With the new Advanced Surface Mesher, the same part can now be meshed in less than a

minute (originally, they would take at least 20 minutes). That's a huge improvement in productivity and efficiency.

- Handle complex surface models
  - Non-congruencies, gaps, overlaps, slivers and small edges
- Provide optional global and local editing tools to accommodate meshing specific requirements
- Automatic and manual tools to
  - Fill holes and gaps, make congruent, stitch gaps, break face, merge faces, imprint hole, delete faces, auto correct
- Added meshing enhancements to
  - Recognize features
  - Support hard points and curves

#### AUTOMATIC SOLID MESHER

- Tetrahedral element meshing
- Arbitrary, geometry source independent 3-D solids meshing
- Extensive user-defined and automatic mesh density controls including curvature checks to rapidly create optimum mesh models
- Advanced algorithm ensures that elements with the best shape are created at boundaries and other areas of interest
- p-element mesh option reduces number of elements for optimal adaptive p-element analyses
- Assembly meshing automates meshing of an assembly for constant or varying mesh density, including the ability to auto-mesh assemblies with small gap separations or some small interference, within proximity tolerances

#### MAPPED MESHER

- Generalized 1-D, 2-D, and 3-D finite element meshing
- Multiple mesh generation options available using a single command:
  - Uniform mesh spacing
  - Non-uniform mesh spacing includes one-way, two-way and curvature-based biases
  - Mesh transition regions
  - Mesh seeding
- Arbitrary mesh transitions for 1-D, 2-D, and 3-D elements
- Complete mesh generation by specifying 1-D, 2-D, or 3-D element edge length
- User-controlled mesh smoothing Surface mesh between two curves

#### MESH SWEEPER

- 1-D, 2-D, and 3-D elements created from lower-order elements
- Numerous sweep methods available:
- Loft solid elements between existing topologically similar Quad meshes

## GENERAL MESHING FEATURES

- Extensive element library that includes linear, quadratic and cubic order elements:

Element Shape	Number of Nodes
Bar	2 3 4
Triangle	3 4 6 7 9 13
Quadrilateral	4 5 8 9 12 16
Tetrahedral	4 5 10 11 14 15 16 40
Wedge	6 7 15 16 20 21 24 52
Hexahedral	8 9 20 21 26 27 32 64

- Specialty elements that include:
  - Mass
  - Spring
  - Damper
  - Spring-to-Ground
  - Degree-of-Freedom Lists
  - Multipoint Constraint (MPC) relationships
- Automatic creation of higher-order elements with mid-edge, mid-surface or centroidal nodes
- Element replication and manipulation through the translate, rotate, mirror and scale operators
- Node and element modification:
  - Local spatial manipulation, replacement, addition, deletion, splitting and re-definition of an individual or group
  - Local and global modifications without changing the solid geometry
- Generate several analysis-dependent meshes from one geometry
- Option to create congruent nodes for zero-length elements such as gaps and slide lines
- Automatic equivalencing of duplicate nodes:
  - Topological or geometric methods
  - Select nodes individually, by group, by region or entire model
  - Checks for element collapse and specialty elements
  - Option to preview nodes to be equivalenced
  - Node exclusion option
- Full user control over node and element numbering, as well as specific XYZ locations
- Verification features ensure the completeness of every analysis model:
  - Aspect ratio, warp, skew, taper and reversed normal checking for shell elements
  - Normal and tangent offset checking for higher-order shell elements

- Aspect ratio, edge angle, twist, face skew, face taper, face warp, tet collapse, connectivity and duplicate element checking for solid elements
- Jacobian tests (Variation and Zero) for most elements
- Graphical display of properties, materials, and boundary conditions
- Graphical identification of all element free edges and free faces
- Options to optimize solution sequence for bandwidth and wavefront analysis solvers:
  - Compacts and/or re-sequences nodes and elements
  - Utilizes Cuthill-McKee and Gibbs-Poole-Stockmeyer solution techniques
- Ability to associate meshes with geometric points, curves, surfaces or solids if not performed during creation or if imported from another source
- Mesh creation options via group transformations
- Options for creating elements from faces or edges of other elements
- Ability to project nodes to a plane, surface, curve or specific XYZ locations
- Zip or unzip element meshes

## MESH ON MESH

A new FEM based surface mesher will allow users to create a new QUAD/TRIA mesh over an existing shell mesh. Relevant features (points and lines) on the original model can be preserved

## FUNCTIONAL ASSIGNMENTS

In MSC.Patran, the term “functional assignments” refers to the application of loads and boundary conditions, as well as the selection of element and material properties.

## FUNCTIONAL ASSIGNMENT FEATURES

### LOADS AND BOUNDARY CONDITIONS

- Options to directly apply functional assignments to geometry and/or finite element mesh in several ways:
  - Continuously
  - Concentrated at a point
  - Along an edge
  - Within a plane, cylinder or sphere
  - Across a surface
  - Through a solid
- Custom forms for analysis-specific input
- Wide range of loading and constraint options that include:
  - Force and moment
  - Pressure and surface traction
- Application of Total Load and Distributed Loads
  - Displacement (imposed or constrained)
  - Temperature

- Heat source (point, area or volumetric)
- Convection
- Heat flux
- Multiple application regions to relate nodal or elemental data to other nodes and elements
- Fields which can be created from mathematical functions for application of variable loads
- FEM Fields can be created from a finite element mesh and associated results
  - automatically interpolate result values for any points within its defined space
  - map one set of analysis results onto another finite element model
- Load case creation for multiple applications of loads and boundary conditions

## MATERIALS AND ELEMENTS PROPERTIES

- Supported material models include:
  - Isotropic, orthotropic, anisotropic, composite, thermal isotropic, thermal orthotropic and thermal anisotropic
  - Spatially varying densities and fiber directions
  - Hyperelastic material definitions
- ✓ ★ Fluid material definition
- ✓ ★ Fluid property definition
- Assigned directly to geometry and/or finite element models
- Ability to synthesize composite material properties:
  - Symmetrical and asymmetrical laminates
  - Halpin-Tsai
  - Short-fiber composites
- Defined as: stress-, strain-, strain rate-, temperature-, or frequency- dependent properties
- MSC.Mvision™ material information can be directly imported into MSC.Patran using the optional MATERIALS product
- Up to 96 assignable properties per property definition
- All data values can be color-coded and displayed for visualization and verification
- Each property value is automatically given an analysis code-specific name

## Results Evaluation

### DESCRIPTION

MSC.Patran can quickly and clearly display analysis results in structural, thermal, fatigue, fluid, magnetic terms, or in relation to any other application where the resultant values are associated with their respective finite elements or nodes.

### POSTPROCESSING FEATURES

- Multiple resultant color-coding and display types:
  - ✓ ★ Contours
  - Color fringes

- Continuous-color fringe bands
- Blended fringe bands
- Element fill plots
- Vector arrows
- Element tensor plots
- Value plots
- Deformed shape plots
- Isosurfaces
- Streamlines
- Stream surfaces
- Marker plots
- Engineering X-Y plots
- Thresholds
- An unlimited number of adjustable color look-up tables
- Resultant color range can be assigned:
  - Semi-automatically
  - Manually
  - To identify minimum, maximum or both
- Resultant value display options include:
  - Display at element centroid or node
  - Display of nodal values for nodes on visible surfaces only
  - Display based on user's selected nodes and elements
- On-screen printed title options include:
  - Automatic or manual placement anywhere
  - Adjustable size and color spectrum with associated values
  - Optionally displayed
- Device-dependent feature for solid shaded and continuous-fringe transient animation
- Results can be displayed as deformed geometry superimposed upon undeformed geometry:
  - Wireframe or hidden-line
  - Deformed animation
  - Adjustable exaggeration factor
- Results can be displayed as contour lines or fringe bands superimposed onto deformed or undeformed hidden-line geometry
- Animation of wireframe, hidden line and solid-shaded images may be performed on any load or time dependent resultant data:
  - Mode shapes
  - Deformed shapes
  - Contour plots
  - Fringe plots
  - Continuous fringe plots
  - Element color fill plots
- Tensor and vector data can be displayed using a variety of options:
  - Showing magnitude, orientation and direction of nodal and/or element results
  - Superimposed onto deformed or undeformed geometry
  - With optional labels applied
  - With color-coded or single color tensors
  - With scaled tensors
  - With global, element, external element file, and alternate coordinate frames

- Distribution of results along beam elements are shown using X-Y plots:
  - Up to three simultaneously displayable plots
  - Measures distance between first and last beam versus resultant value (shear, moment)
  - Results can be generated and displayed at any point along a beam element
  - Results can be plotted versus another result, global variable or along an arbitrary path
- Imaging features help decipher results:
  - Display at any selected node or element
  - Identification of minimum and/or maximum values
  - Display of all values
  - Evaluation of results across screen-clipping planes
  - Alternate color look-up tables
  - Unlimited multiple windows
  - Extensive label control
- Hardcopy images and animations can be generated for all plots and displays in a wide variety of industry standard formats, including web-based reports.
- Results Templates

The Results Templates functionality provides a convenient means of storing in the database collections of settings for the Result Display Attributes and Plot Options menu settings, and will undoubtedly streamline the process of result handling for your customers. Not to mention the added benefit of eliminating all sorts of ambiguities/errors commonly associated with post-processing.

- Available for the following result tools:
  - Deformation plot
  - Fringe plot
  - Marker plot
  - Graph
  - Report
- Results Template operations include:
  - Create, Edit, Copy, Delete
  - Export, Import
  - Apply To Form
- Auto load Results Templates
  - A predefined set of Results Templates will be loaded into the database
- Create a new database and/or open an existing database
  - In the case of loading on opening an existing database
- Replace or keep existing templates with the same name and tool type as those in the predefined set X-Y Plotting Features
- Multiple input methods:
  - Keyboard input
  - External text file input
- Flexible format for X-Y value-pairing:
  - Data entered as X-Y pairs

- Only Y data entered (uses default X value and increment)
- Unlimited simultaneous plots:
  - Plots can be overlaid
  - Plot size is adjustable
- Unlimited curves per plot:
  - Data displayed as points only (scatter), piecewise linear lines, least squares or spline curves
  - Adjustable color, style (solid, dotted or dashed) and thickness
  - Fifteen unique identification symbols
- Axes definition:
  - Adjustable color, style (solid or dashed), thickness and length
- Legends:
  - Color, size, border lines, background color and number of entities are selectable
- Titling:
  - Custom titles for the entire screen, each plot, each axis, each curve, and/or each legend
  - Adjustable font color and size
- Adjustable X and Y scales:
  - Linear or logarithmic
  - Generated automatically, manually or by providing a range

## Imaging

### DESCRIPTION

Imaging encompasses the complete graphics capability found within the MSC.Patran product, including graphic shading and visual verification prior to analysis. Imaging features a number of options that take advantage of specialized hardware capabilities, including local view manipulation, local shading, multiple light sources, and transparency. Imaging Features

- Interactive mouse-driven view manipulation
- Graphical display of all solid model and finite element entities using:
  - Identification labels for all entities
  - Wireframe, hidden-line, color filled or solid-shaded render style
  - Selectable colors for each entity type
  - Options to display only selected entities at any time
  - Group level control for manipulating color, rendering style, and labeling display properties
- Software-driven geometric solid-shading:
  - Adaptive triangulation technique
  - Proprietary shading technique similar to the Phong method
  - Multiple object colors, dynamically changeable
  - Optional parametric interpolation technique

- Additional parameters include spotlight size and intensity, color of the diffuse radiation, light source color, transparency, texture and dithering
- Hidden-line plots:
  - Geometric model
  - Wireframe finite-element model
  - Element fill model
- Combination of shaded, hidden-line, results and wireframe imaging simultaneously
- Software-driven view manipulation:
  - Relative to either the model, screen axis, viewing plane or user's position
  - Manipulation options include: Rotation, magnification and translation
- Multiple graphic viewports and XY-plot windows with automatic and customized window placement features
- Extensive graphic tools:
  - Complete label control
  - Perspective and orthographic views
  - Automatic graphics screen resizing
  - Option to shrink each entity toward its centroid
  - Unlimited number of windows
  - Alternate coordinate frame axes displayed at their respective model locations
  - Front and rear screen-clipping planes
  - Arbitrary clipping planes
- Graphic verification features:
  - Property, material, and free boundary
  - Element property fields
  - Material fiber orientation for composites
  - Uniquely described boundary conditions at their imposed locations
- Device-dependent features:
  - Graphics quality dependent on screen resolution and displayable colors
  - Transparency

Support for dials and spaceball view manipulation

## System Utilities

### DESCRIPTION

The system utilities constitute a collection of programs and features that support the MSC.Patran environment. They represent a framework in which the user can access not only MSC.Patran application modules, but also other tools found within a heterogeneous hardware and software environment.

### UTILITY FEATURES

- NEUTRAL File:
  - Text-formatted or binary-file generated and read by MSC.Patran
  - Contains selected MSC.Patran information including; geometric model data and finite element definitions

- Well-documented format suited for linking to other software packages
- Result Reader:
  - External-text or binary-formatted

### MSC.Patran results files

- Database access:
  - Collection of FORTRAN and C utilities that permit external applications to access the MSC.Patran database
- Hardcopy:
  - MSC.Patran standard graphics output file [patran.hrd]
  - Support for Adobe PostScript(r) and Encapsulated PostScript
  - Support for HP-GL and HP-GL2 formats
  - Support for Computer Graphics Metafile (CGM) standard
  - Support for web-based graphics image files including BMP, JPEG, MPEG, PNG, TIFF, and VRML
- Environment files:
  - PATRAN Command Language (PCL) command files that automatically customize the MSC.Patran environment
- Network Licensing System:
  - FlexLM standard for network licensing
  - Security utilities and functions that operate in a distributed and heterogeneous computing environment
- MSC.Patran report file:
  - Model summary
  - Node and element attributes
  - Element connectivity
  - Mass properties
  - Results data
- Command procedures:
  - Establish the MSC.Patran system environment
  - Execute MSC.Patran and any ancillary programs

## Patran Command Language

### DESCRIPTION

PCL is the programming language at the heart of MSC.Patran. PCL is a high-level, block-structured language that provides many features found in traditional programming languages. It can be used to write application or site-specific commands and menus, perform variational modeling, and to more completely integrate with commercial or in-house software programs. The MSC.Acumen™ Tool Kit extends the functionality of PCL for process capture and automation.

### PCL FEATURES

- In-line expressions
- Compiled command libraries

- Wide selection of forms and widgets for custom graphical user interfaces
- Subroutines and function calls with recursion
- Functions be grouped into classes
- Conditional branching instructions:
  - IF, THEN, ELSE
  - SWITCH, CASE, DEFAULT
  - BREAK, CONTINUE
- Conditional looping instructions
  - REPEAT, UNTIL
  - WHILE, END WHILE FOR, TO, BY, END FOR
  - LIST, END LIST
- User-definable form creation capabilities, which allow menu options to execute other PCL functions
- Database read and write utilities
- Integer, real, logical, string variables and constants
- Local, global, static and classwide variables
- Arrays of any variable data type
- Virtual memory arrays and management features
- Debug and trace facilities
- Array sorting and searching
- String functions, including upper and lower case conversion and abbreviation checking
- Binary and text file read/write capabilities
- Many mathematical function routines
- Numerous graphics functions:
  - Draw points, lines, empty or filled circles, empty or filled boxes, and empty or filled polygons
  - Display text at any location
  - Change graphics segments
- Model manipulation routines:
  - Scale
  - Rotate
  - Spin
  - Translate
- System utility functions

### ★Parametric Modeling

The parametric modeling toolkit provides an automated parametric analysis mechanism in support of complex design processes. It allows users to parametrically investigate and assess a number of different designs via batch submittal of a number of different design studies. The payoff for this can be tremendous. This powerful feature will enable users to detect serious design flaws early in the conceptual design stage, thus minimize the cost associated with correcting the flaws.

- Permits the use of named variables to replace the usual fixed numerical values of the modeling parameters
- The values of these parameters different than the prescribed default can be provided by an external file
  - Configuration file

- The goal is to make it possible for the user to use names and default values for variables (parameters) in every entry point on every form that can be accessed for modeling purposes

### **Configuration Requirements**

MSC.Patran currently supports many Unix, Windows and Linux based computer platforms, operating systems and graphic devices. System resources required to operate MSC.Patran depend upon a number of factors including the overall size and complexity of each model. Please consult with your local MSC.Software representative for a current list of MSC.Patran supported computer systems for your particular application.

### ★New Features

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