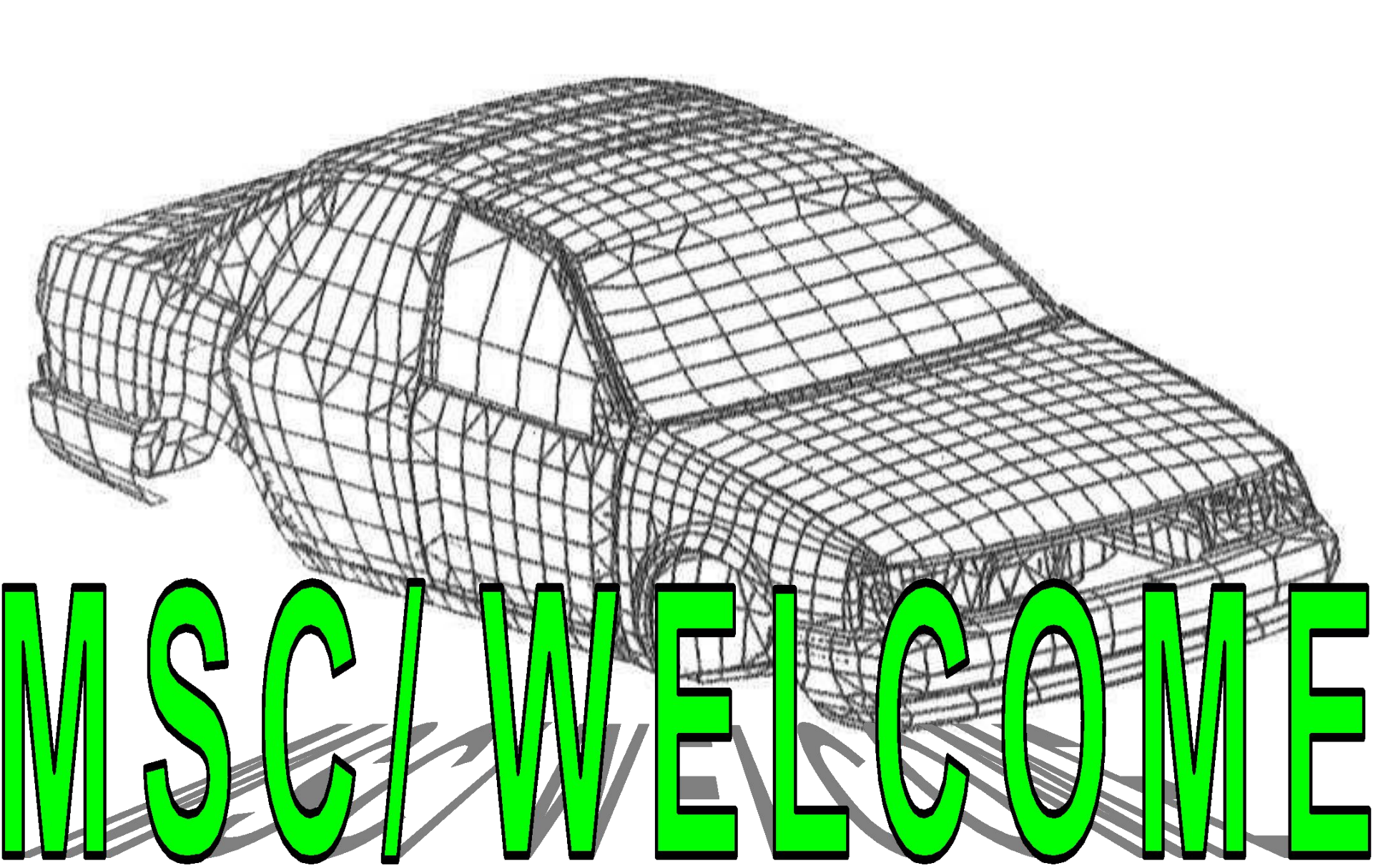

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Bob Gilliver

MSC/ARIES European Product Marketing and Support Manager

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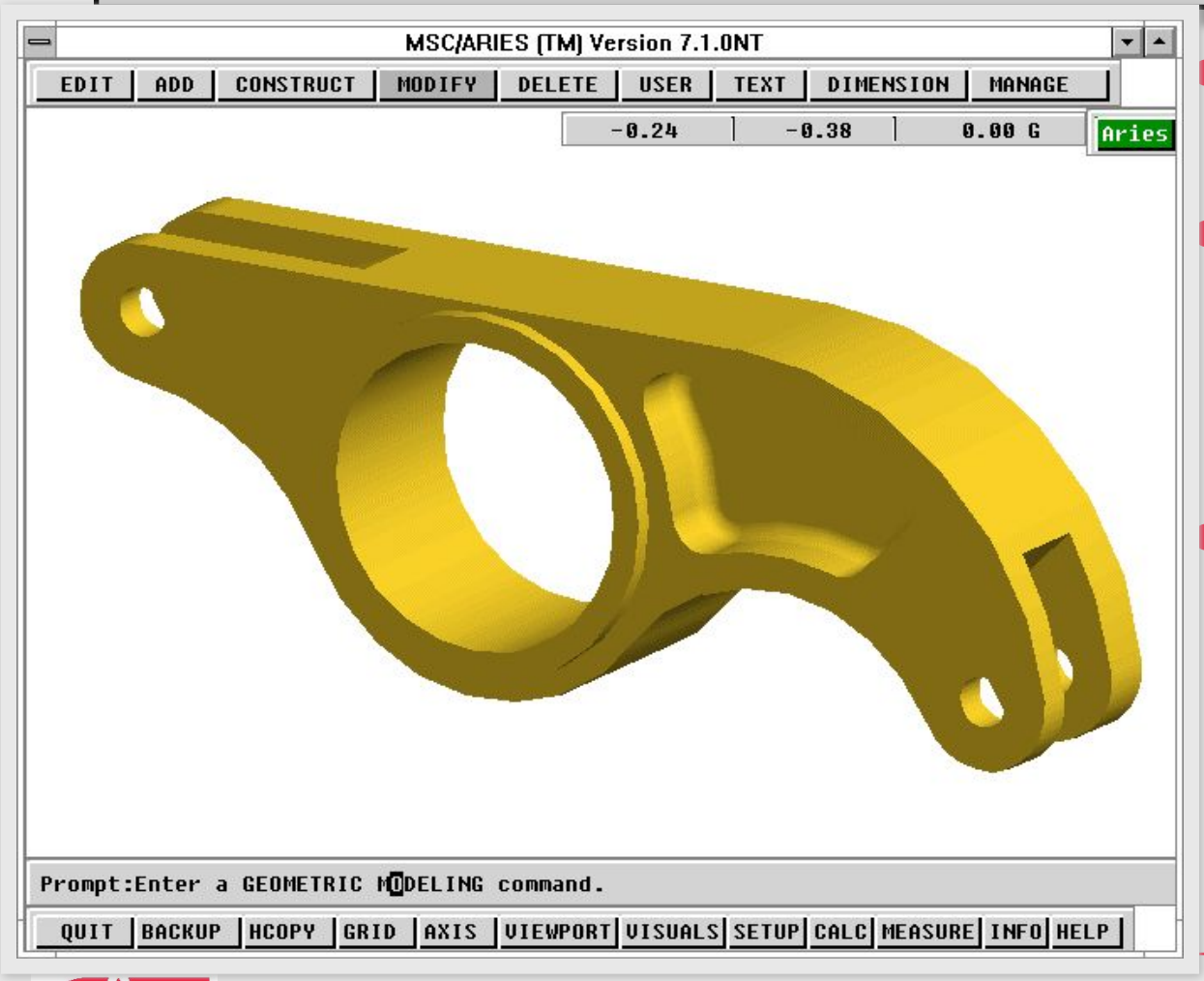
AGENDA

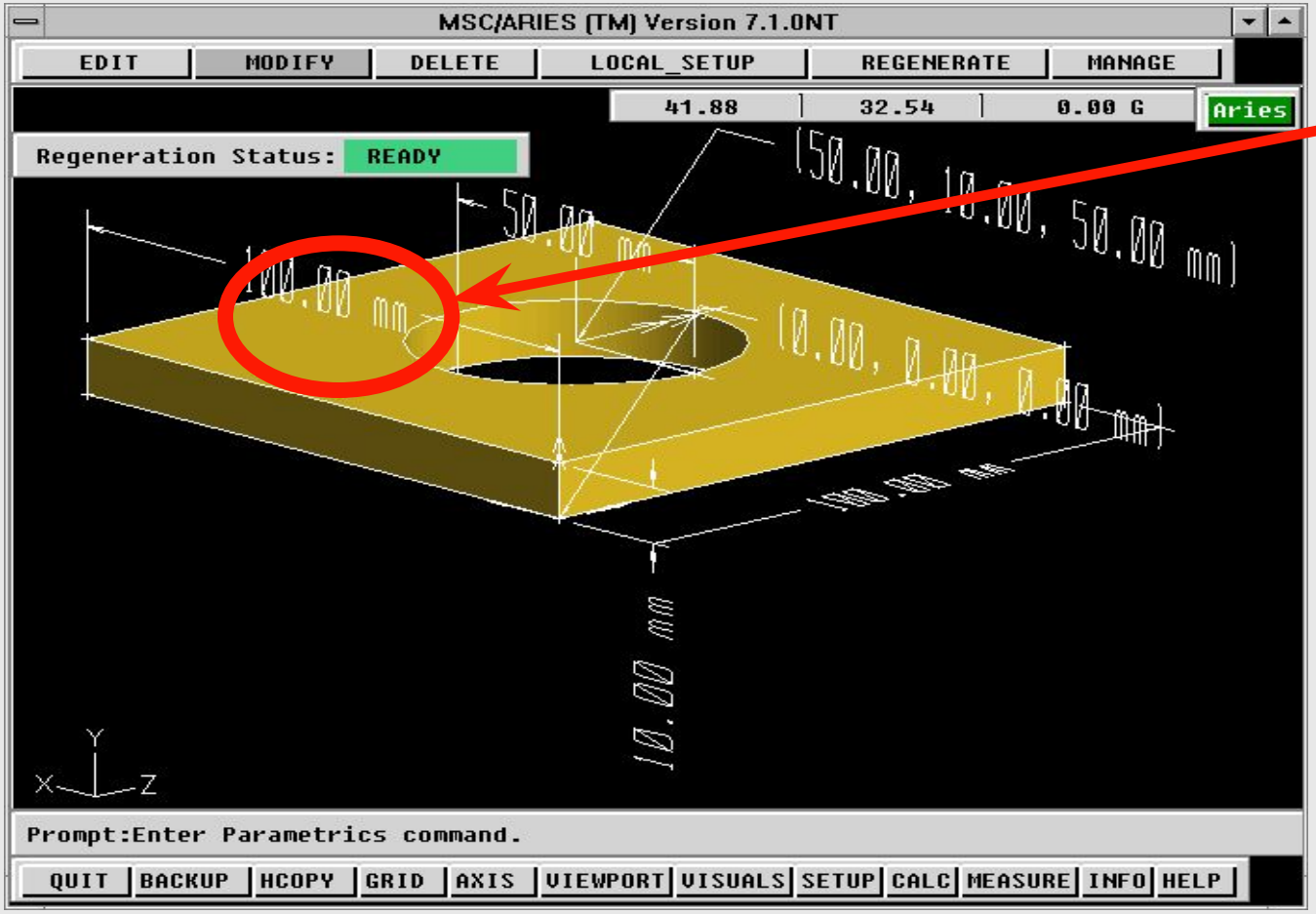
- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

Geometry



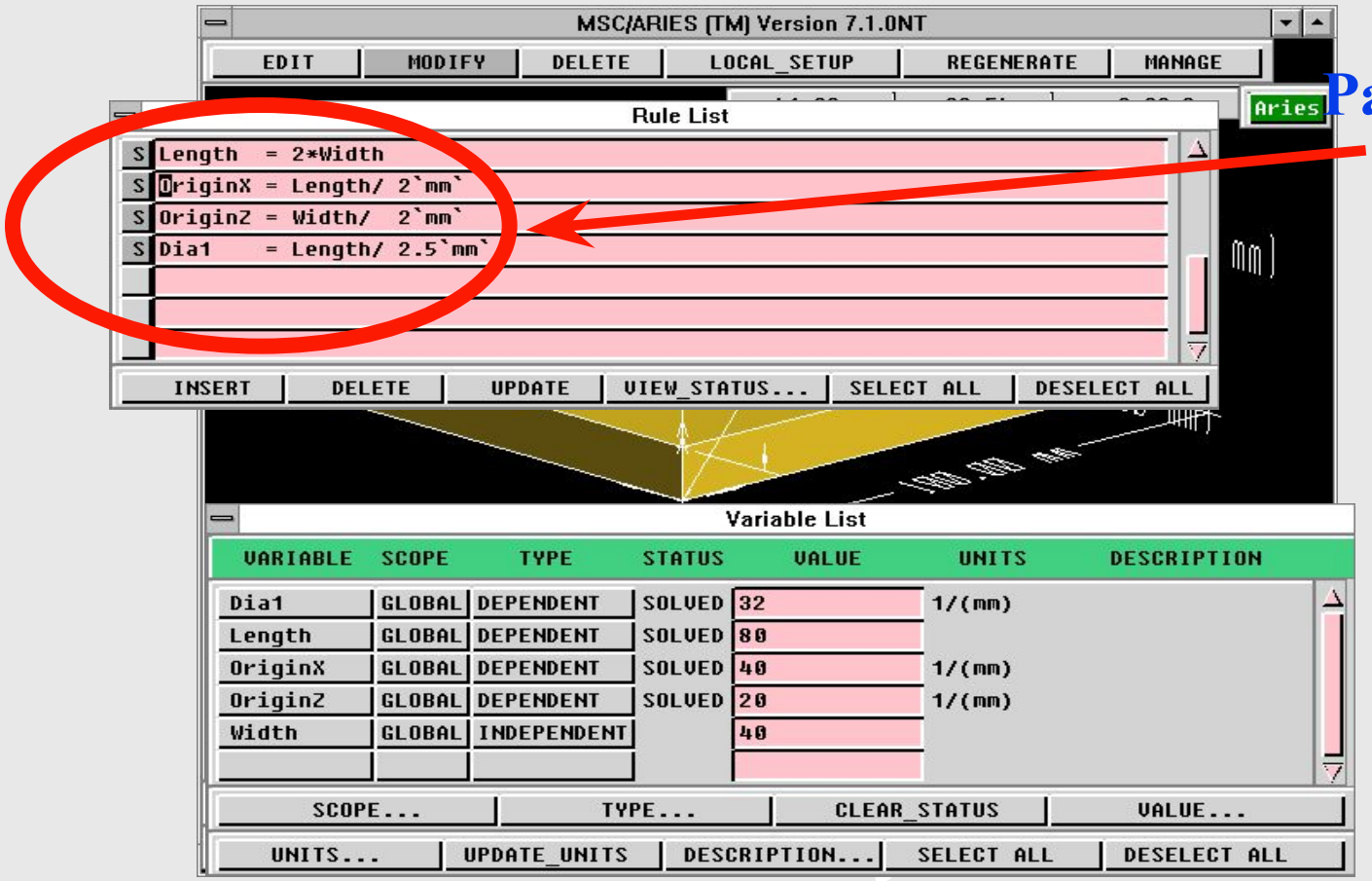
- **Full function ACIS based modeler**
- **Constraints**
  - **full**
  - **partial**
  - **none**
- **ACIS data exchange**
  - **AutoCAD**
  - **Bentley**
  - **Integraph**
  - **HP**

Geometry



Modify dimensions

Geometry



Parametric relationships

Geometry

- **Complex solids**
  - Skin operator
  - Sweep operator
  - Extensive blending and chamfering
- **Region operator to sub-divide geometry**
  - Map meshing
  - Load footprint areas
  - Symmetry

MSC/ARIES Base - Assemblies

- Visualization
- Packaging
  - Clearance
  - Interference
- Mass properties

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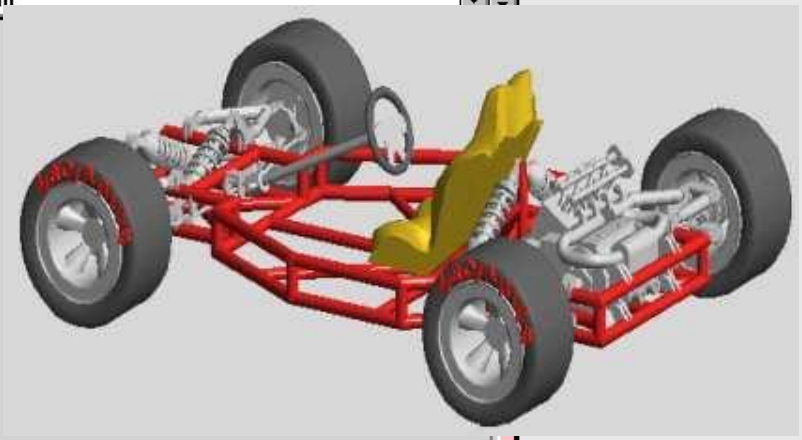
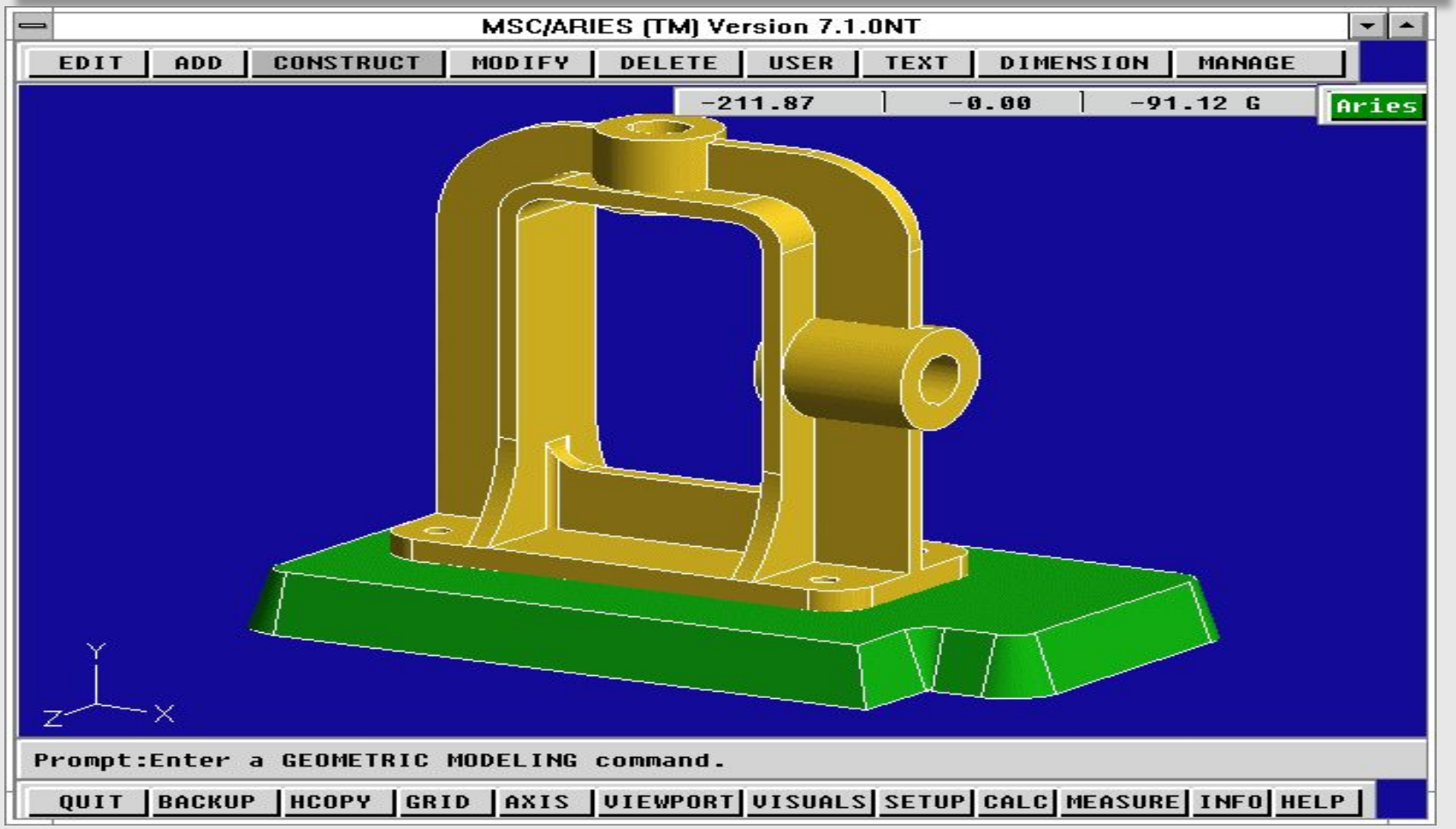
MSC/ARIES Base - Mass Properties

Entity information

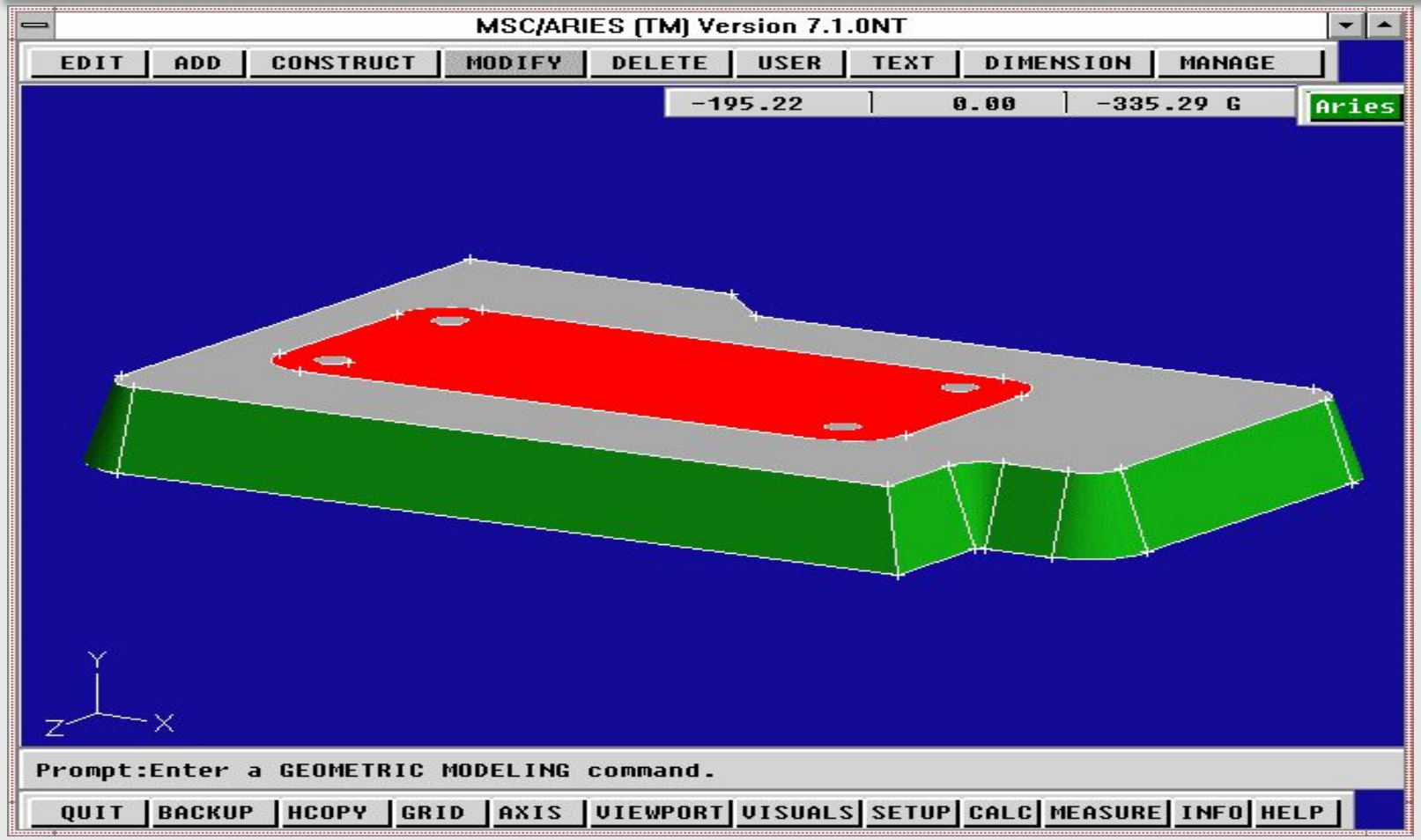
```
Mass Properties of Selected Entities
VOLUME                    = 1.16677e+007 mm^3
DENSITY                   = 7.7504e-006 kg/(mm^3)
MASS                      = 90.4297 kg
WEIGHT                    = 886.812 N
SURFACE AREA              = 503505 mm^2
MASS MOMENTS OF INERTIA :
IX                        = 935469 kg*mm^2
IY                        = 2.43862e+006 kg*mm^2
IZ                        = 3.31991e+006 kg*mm^2
MASS PRODUCTS OF INERTIA :
IXY                       = 0 kg*mm^2
IYZ                       = 0 kg*mm^2
IZX                       = 0 kg*mm^2
RADII OF GYRATION :
K                         =  101.709  164.216  191.605 mm
CENTER OF GRAVITY         =        0        0        0 mm
PRINCIPAL AXES ORIENTATION (DIRECTION COSINES) :
X-AXIS                    =        1        0        0 mm/mm
Y-AXIS                    =        0        1        0 mm/mm
Z-AXIS                    =        0        0        1 mm/mm
PRINCIPAL MASS MOMENTS OF INERTIA :
IXP                       = 935469 kg*mm^2
IYP                       = 2.43862e+006 kg*mm^2
IZP                       = 3.31991e+006 kg*mm^2
PRINCIPAL RADII OF GYRATION :
KP                        =  101.709  164.216  191.605 mm
```



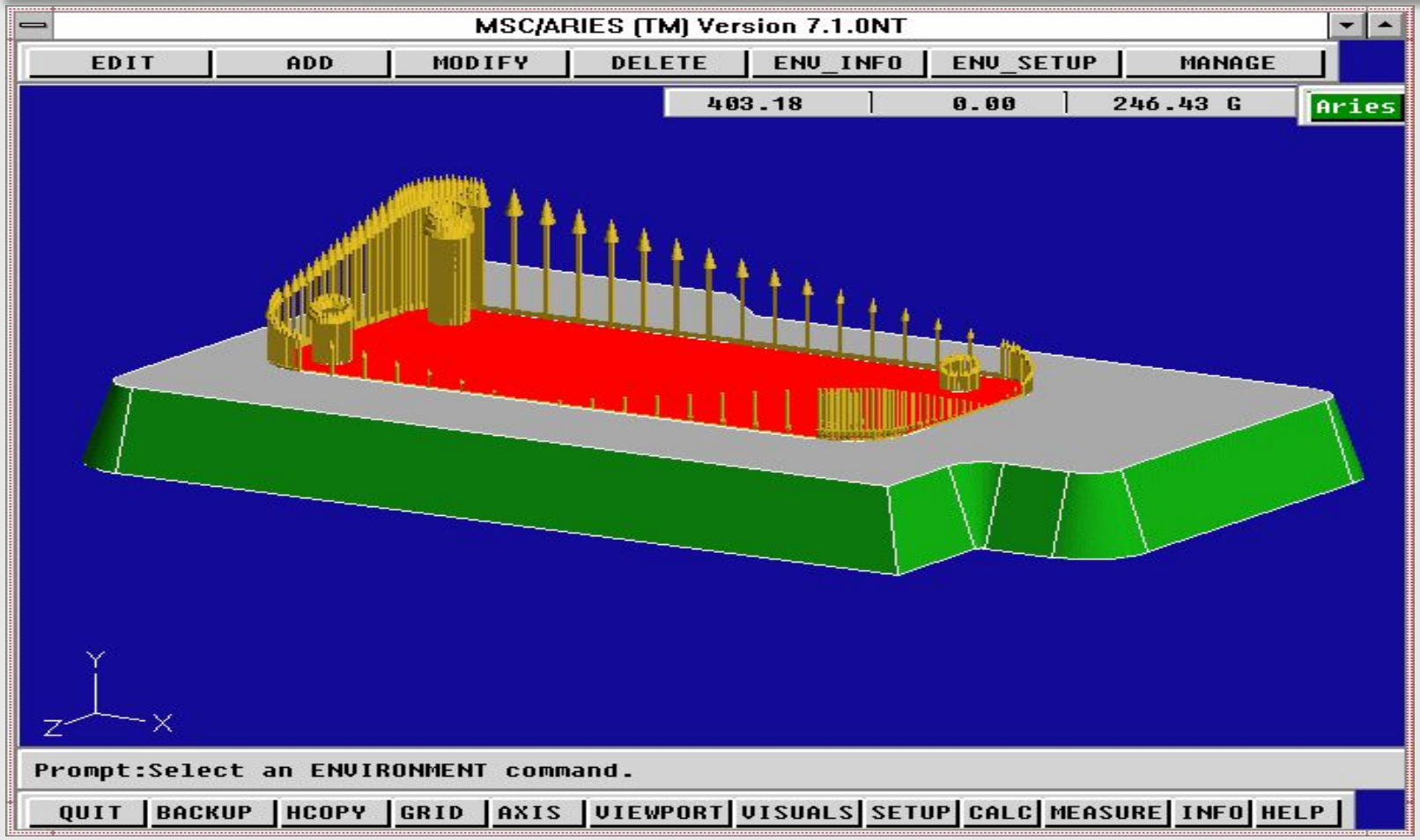
Geometry - Regioning



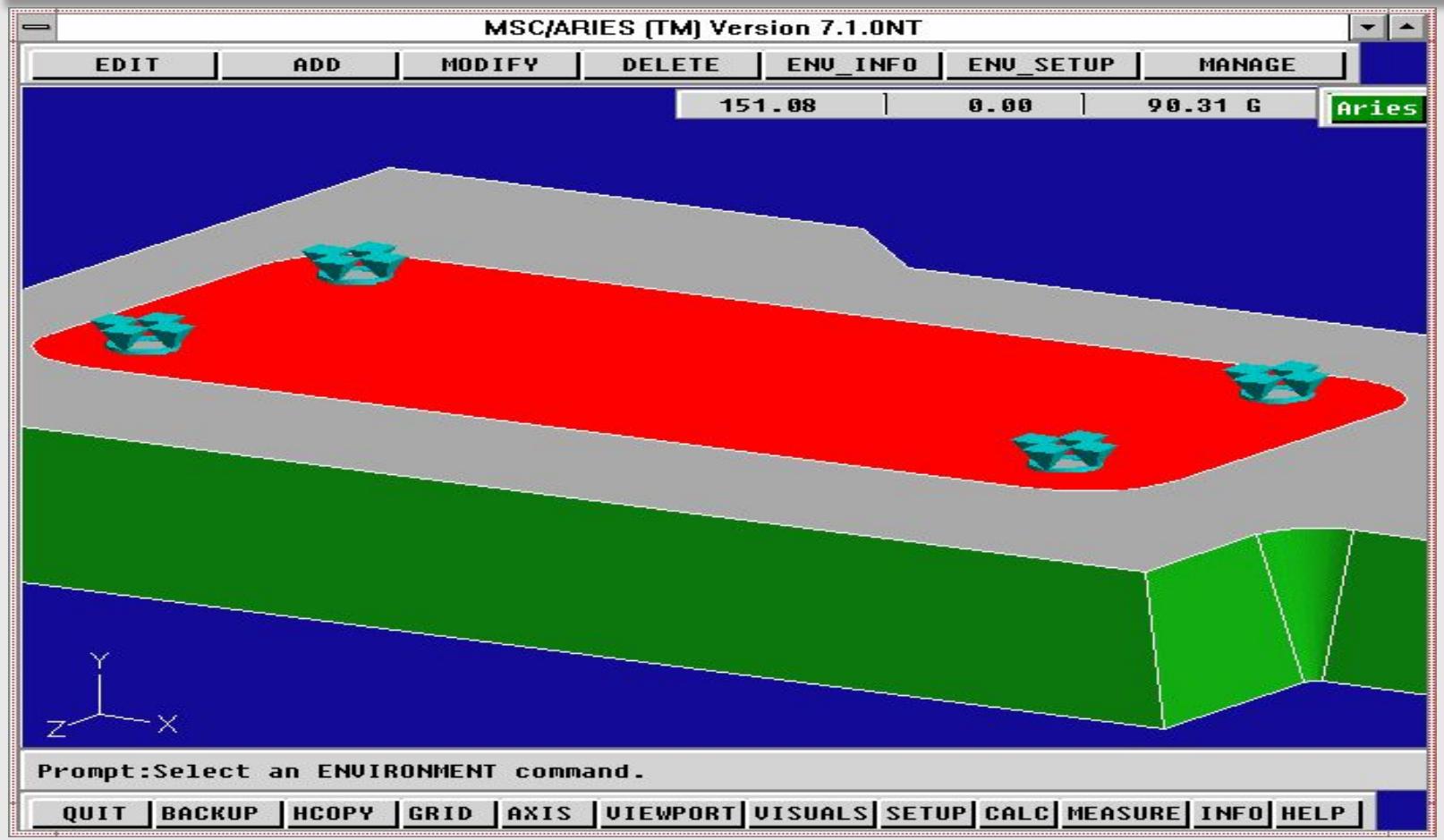
Geometry - Regioning



Geometry - Regioning



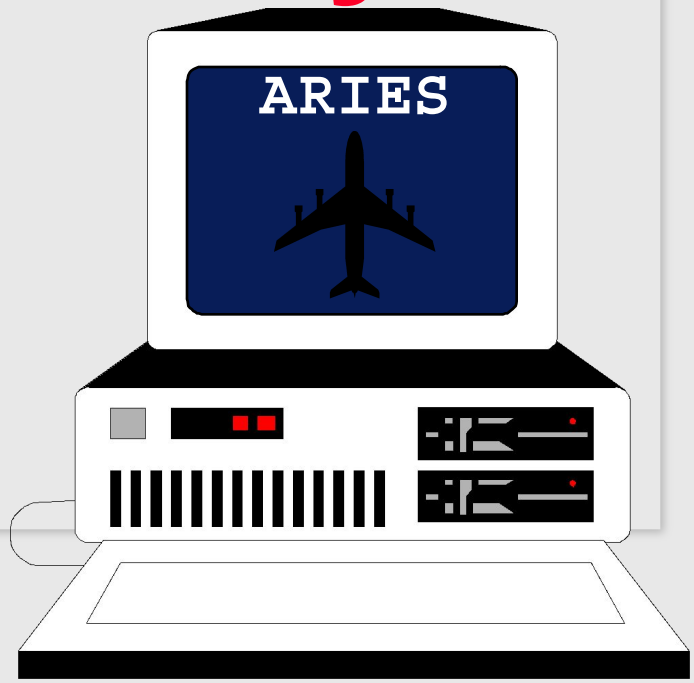
Geometry - Regioning



Pre Release Solids Shelling

- Shelling of solids to thin walled solids
- Per face (uniform) thickness control
- Face exclusion to create “open” solids
- Full Parametrics support
- Not supported
  - Spline faces (fillet, sweep, skin, spline segments in curve based primitives, extrude with draft <arc segment>)

Analysis Of ACIS
&
Imported Geometry



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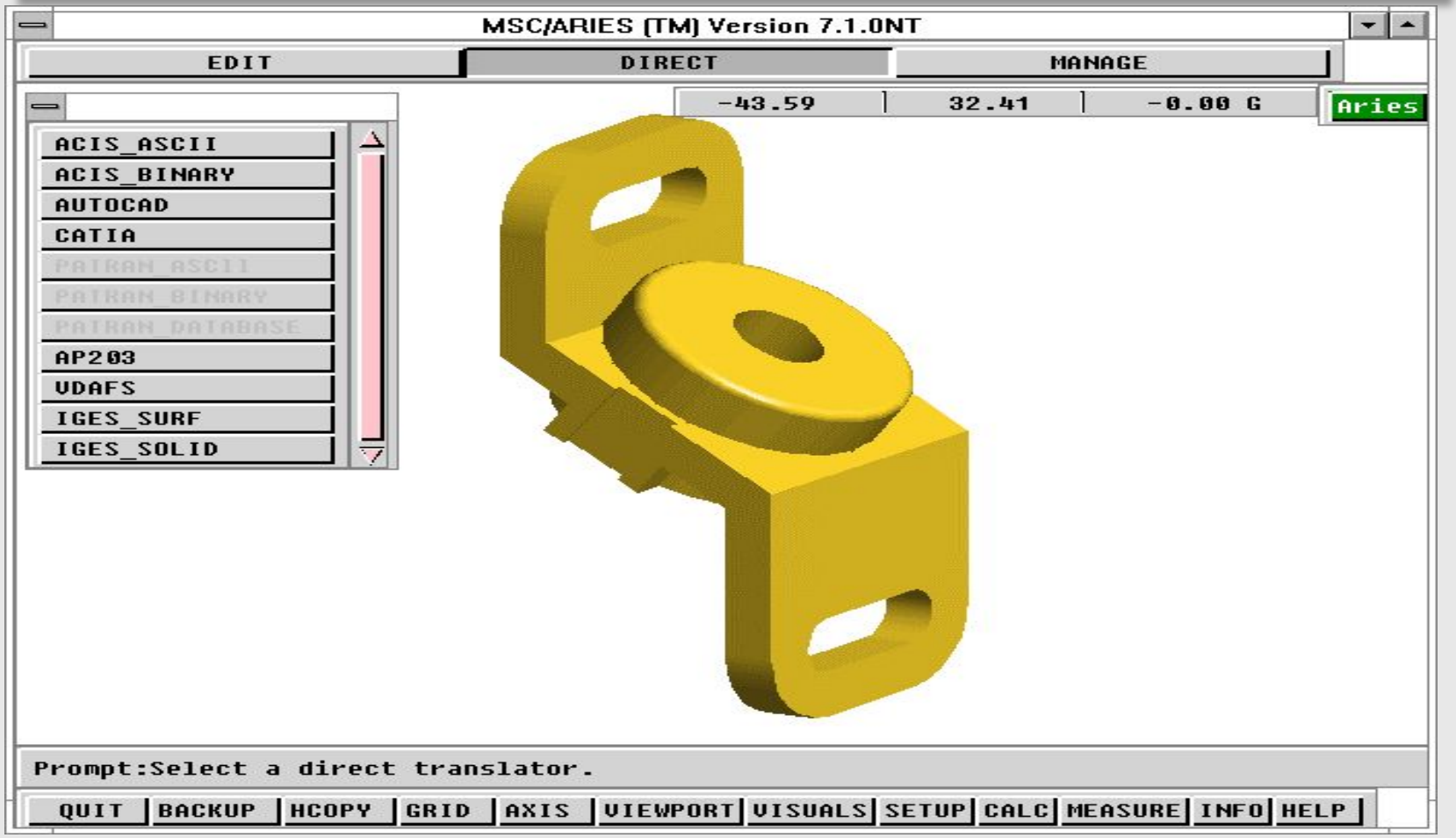
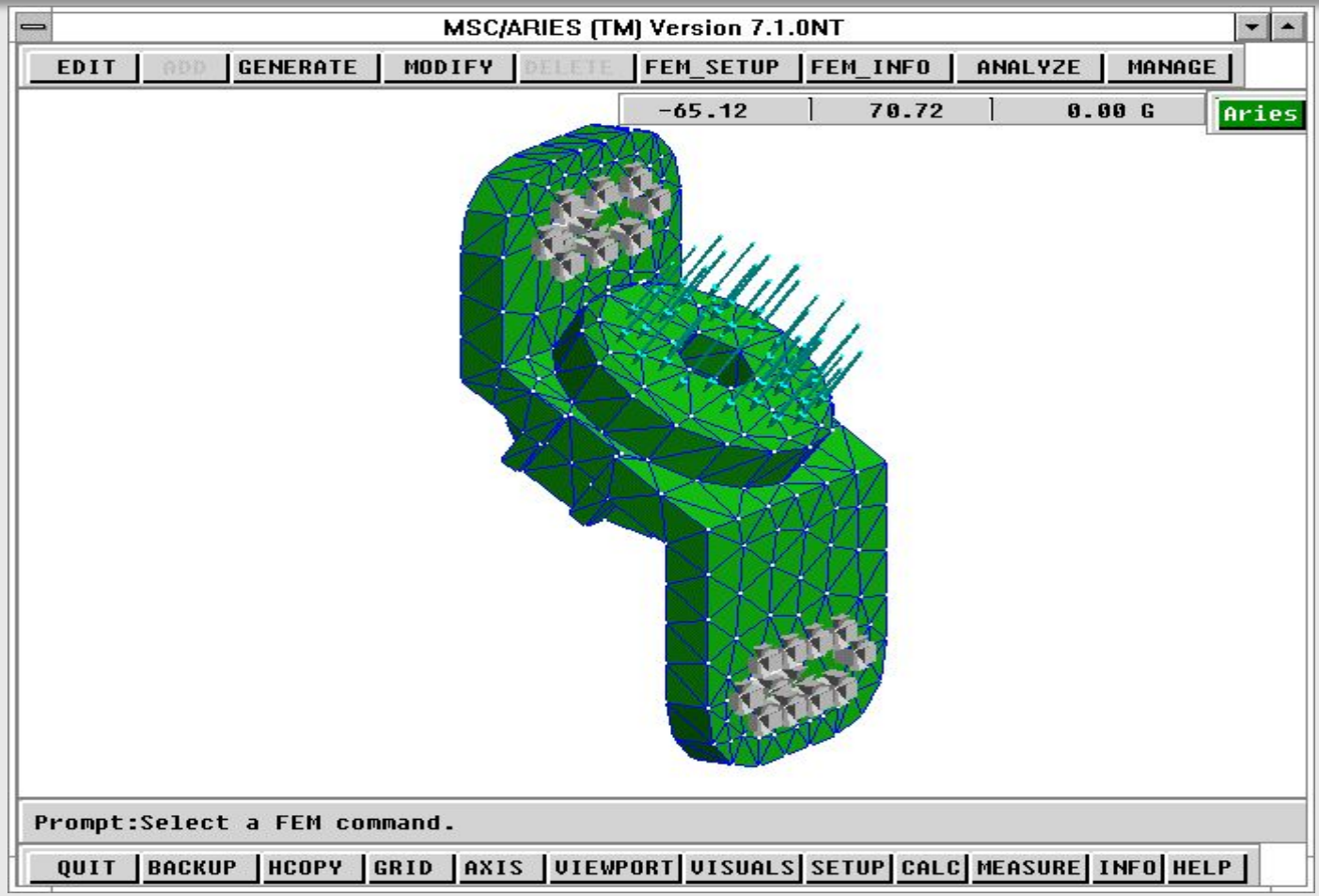
Geometry Interface - ACIS

- Support for ACIS sat (ASCII) and sab (binary) file formats
- Allows bi-directional exchange of solids, surface and wireframe
- Currently the most reliable solids data exchange format
- Transfers geometry only
  - No feature or history information

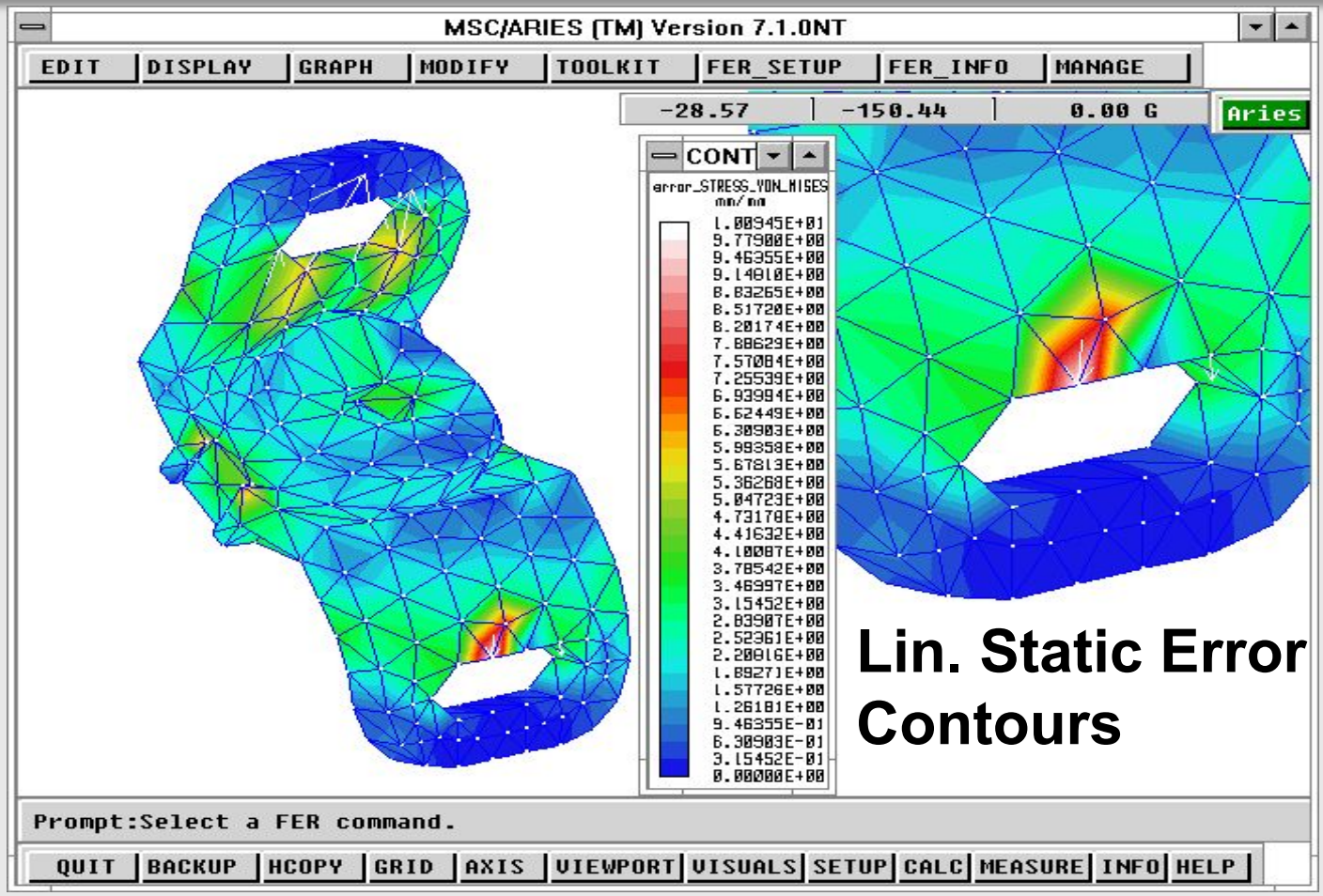
Geometry Interface - Autocad Import



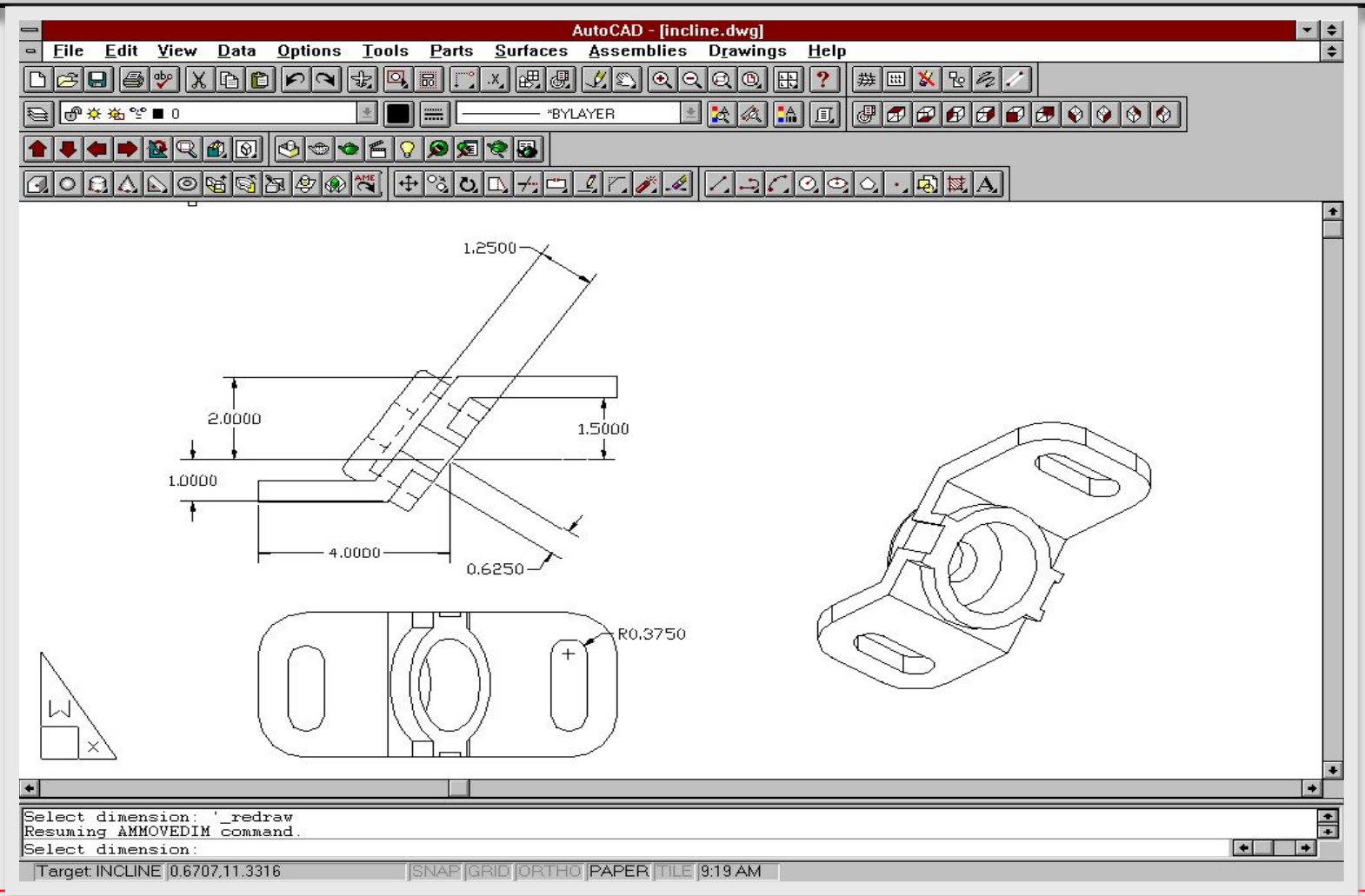
Geometry Interface - Autocad Import



Geometry Interface - Autocad Import



Geometry Interface - Autocad Export



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Geometry Interface - IGES Import

- **Supports**
  - **Wireframe**
    - **Point, line, arc, composite curve, spline (112,126), conics (104), copious data (106)**
  - **Surface**
    - **Untrimmed (118, 120, 122, 128)**
    - **Trimmed (144)**
  - **Solid**
    - **Solid BREP (186, 514, 510, 508, 504, 502,)**

Geometry Interface - IGES Export

- **Supports**
  - **Wireframe**
    - **Point, line, arc, composite curve, spline (112,126), conics (104)**
  - **Solid/surface**
    - **Decomposed to precise wireframe BREP**
    - **Decomposed to surface collection (trimmed or untrimmed - 128, 142, 144)**
  - **Text**
  - **Hidden line removal**
  - **Silhouette edge generation**

Geometry Interface - DXF Import

- **Wireframe**
  - Point, line, arc, polyline
- **Text**

Geometry Interface - DXF Export

- **Supports**
  - **Wireframe**
    - **Point, line, arc, composite curve, spline**
  - **Solid/surface**
    - **Decomposed to precise wireframe BREP**
  - **Text**
  - **Hidden line removal**
  - **Silhouette edge generation**

Geometry Interfaces - STEP, VDAFS

- **PDES/STEP AP203**
  - Import and export of solid/surface/wireframe data
- **VDAFS**
  - Import and export of surface/wireframe data
  - Data format that emphasizes surface transfer
  - Used predominantly by European automotive industry

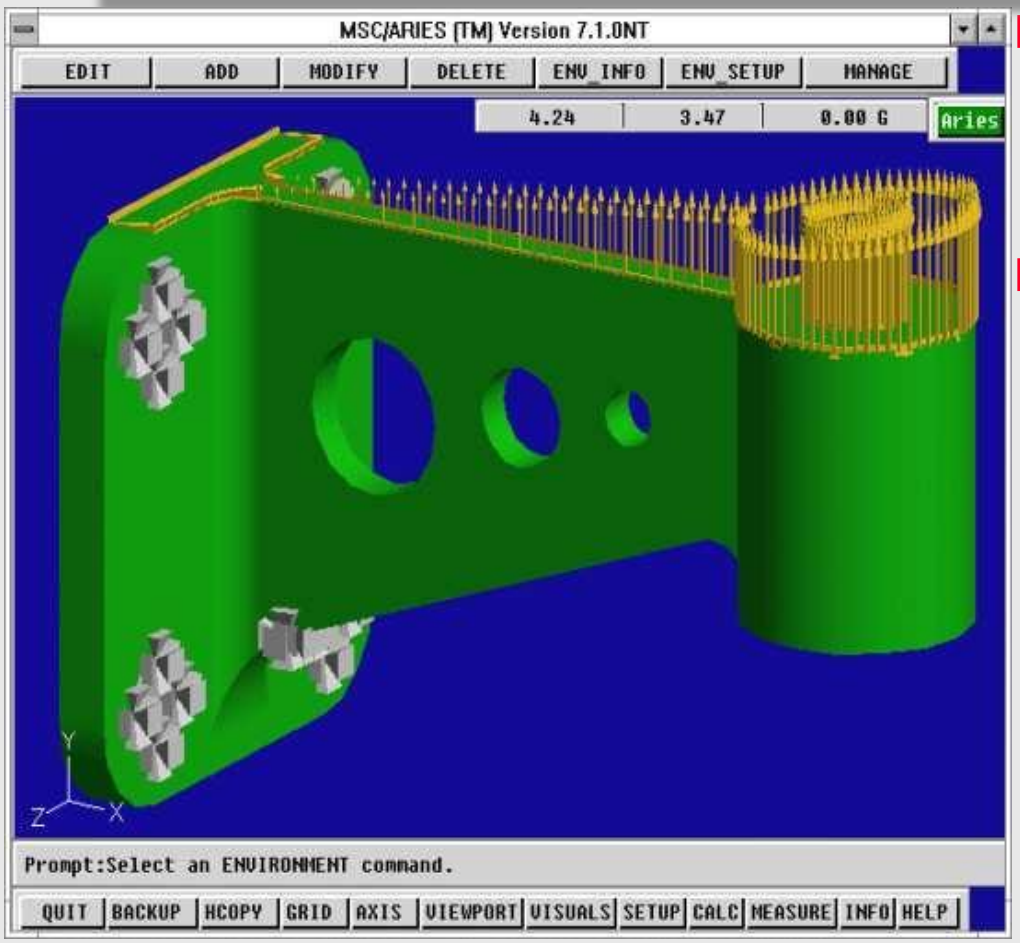
Geometry Interfaces -Stereolithography

- Translates solids into standard “stl” format
- Rapid manufacture for physical part prototyping

AGENDA

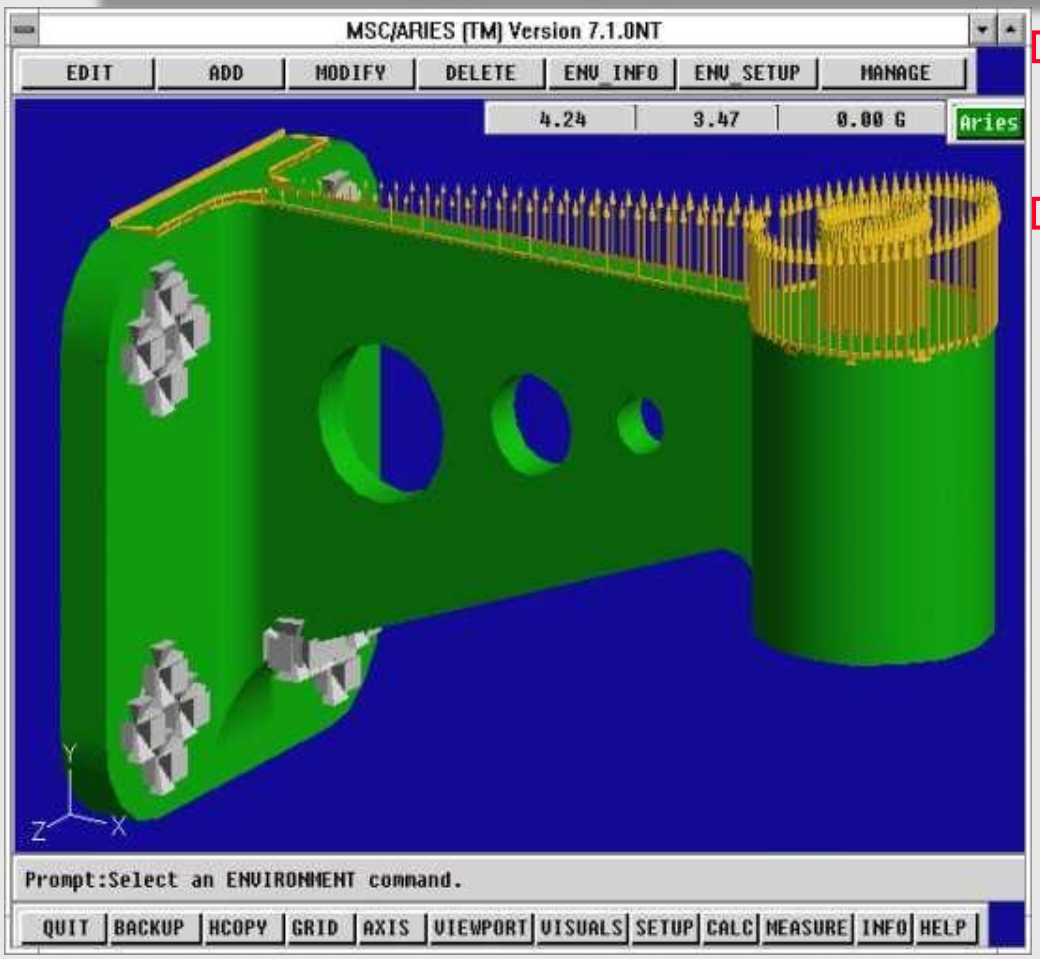
- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

Load and Boundary Conditions



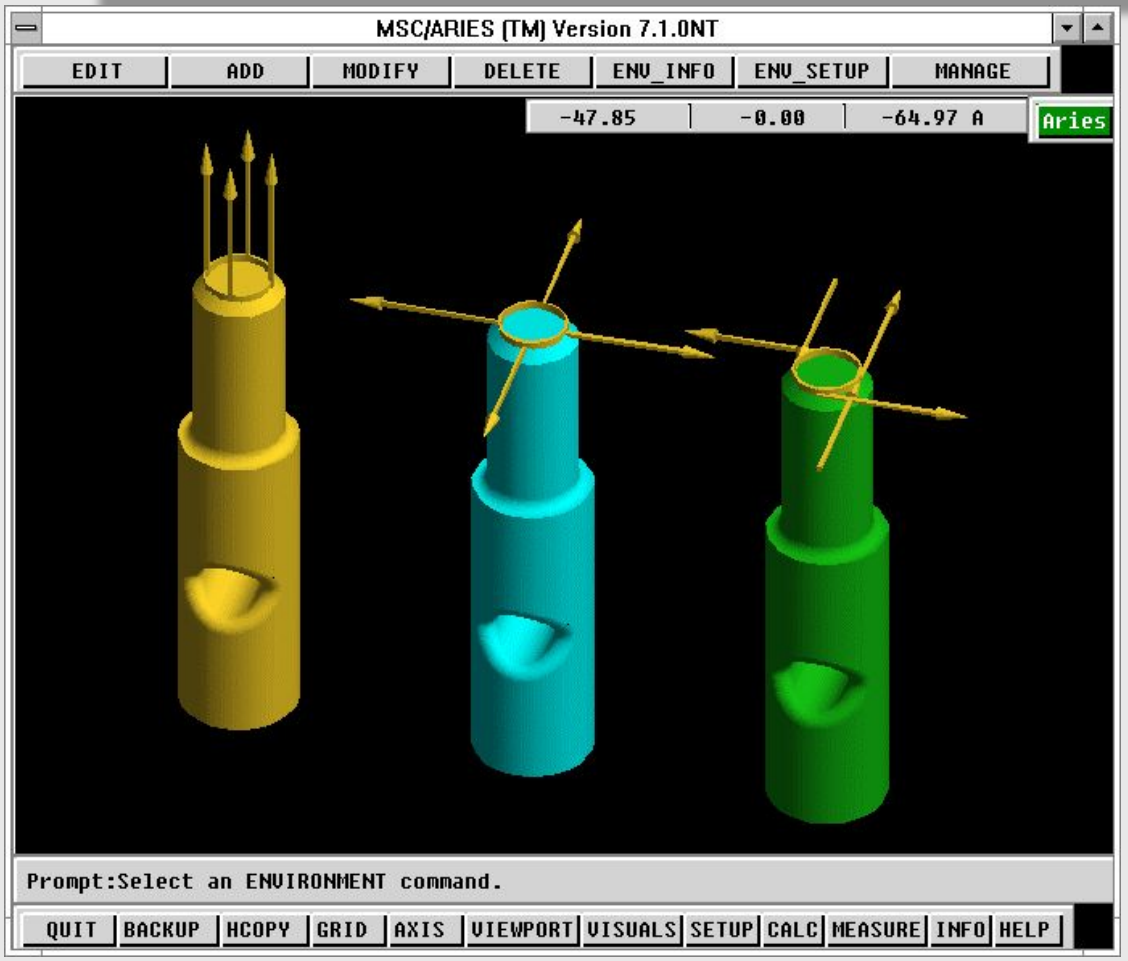
- LBC's applied to geometry or to nodes & elements
- Supported loads
  - Force, moment, pressure
  - Gravity
  - Velocity
    - Translational
    - Rotational
  - Acceleration
    - Translational

Load and Boundary Conditions



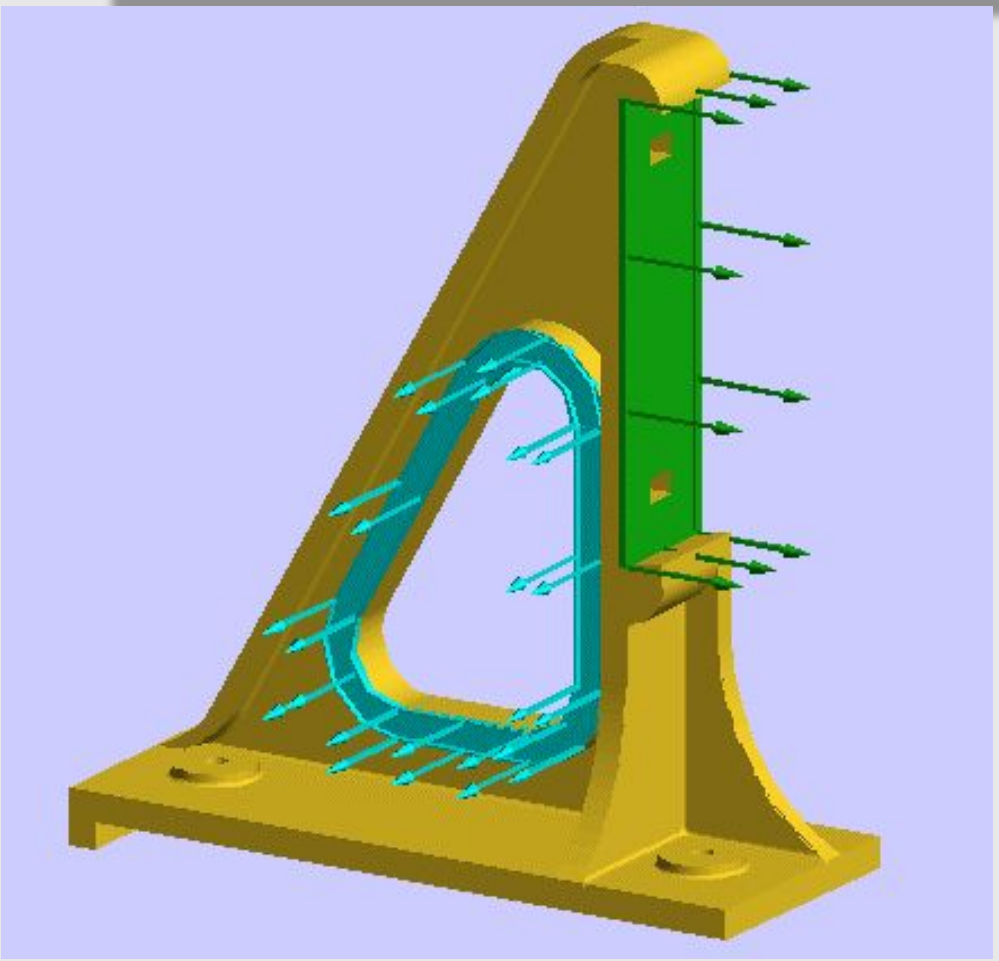
- Constant or functional varying magnitude
- Geometry based load and boundary conditions survive geometry change

Load and Boundary Conditions



- **Direction control for load/boundary conditions**
  - XYZ
  - Radial
  - Tangential

Load and Boundary Conditions



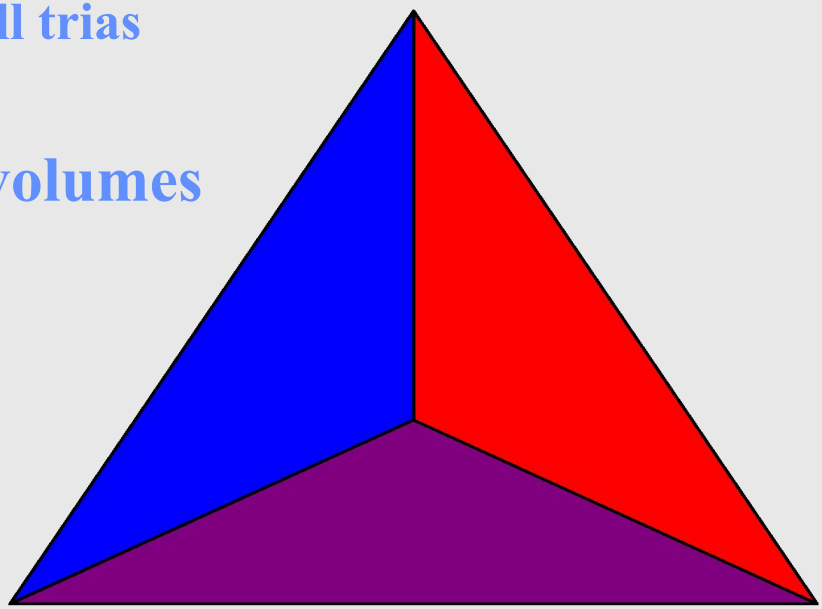
Load case combination

(5 * load_1) +

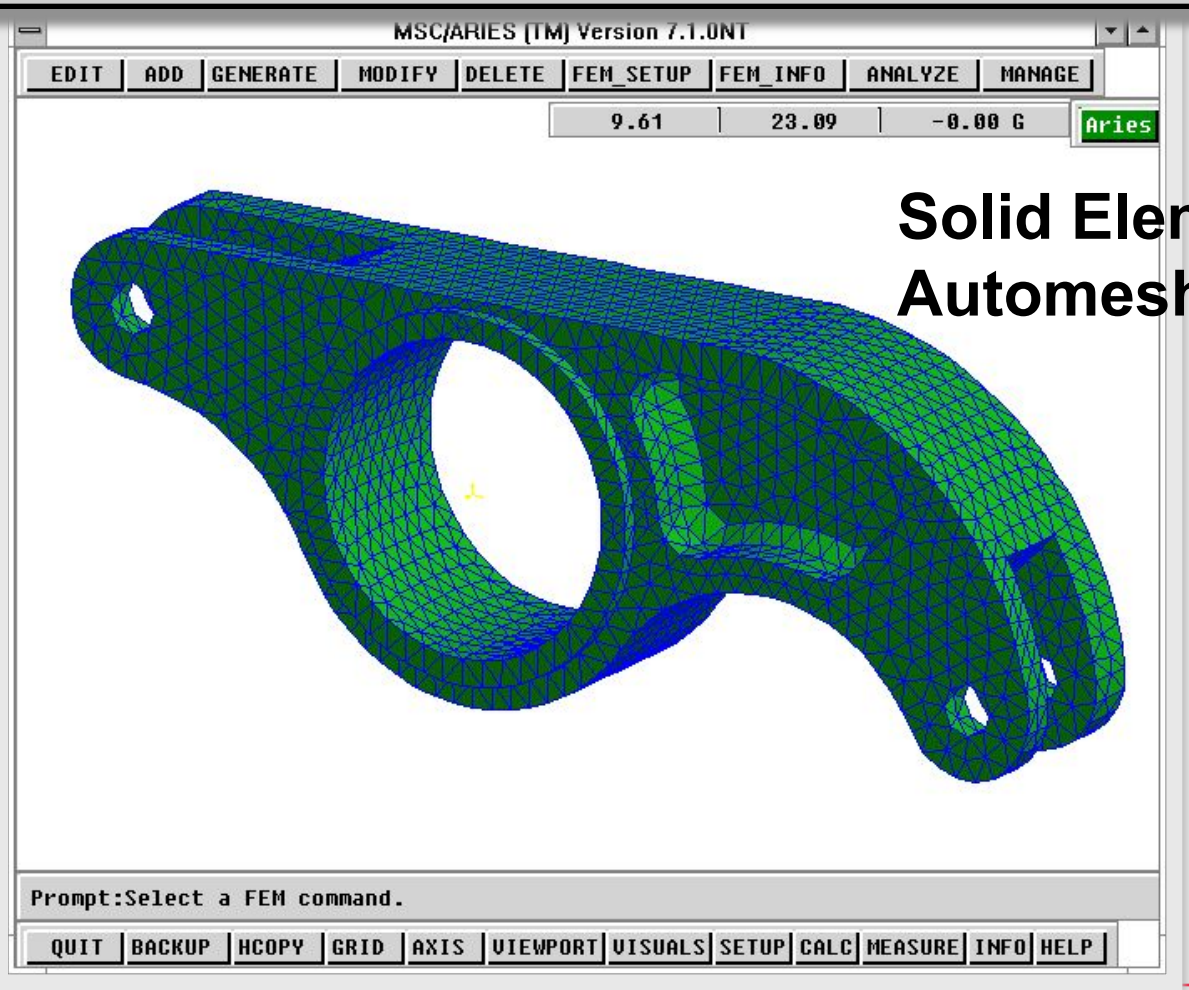
(3 * load_2)

FE Meshing

- Automeshing technology
  - Edges -- 1D elements (beam, gap, rigid, spring)
  - Surfaces -- quad dominant or all trias
  - Volumes -- tets only
- Map meshing for surfaces and volumes
  - 3/4 side surfaces, 5/6 face volumes
  - Composite edge support



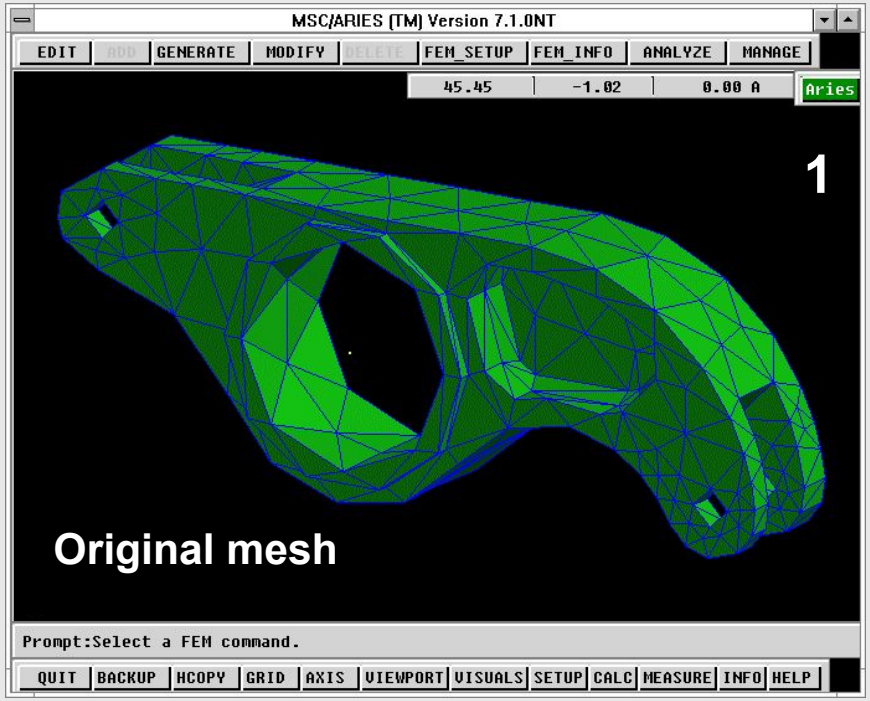
Auto Meshing

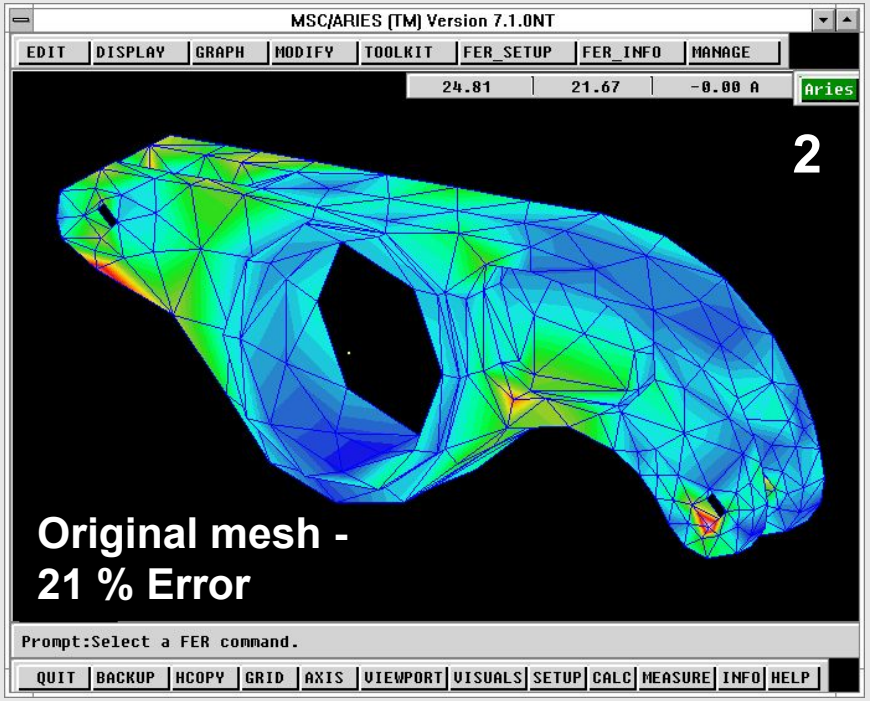


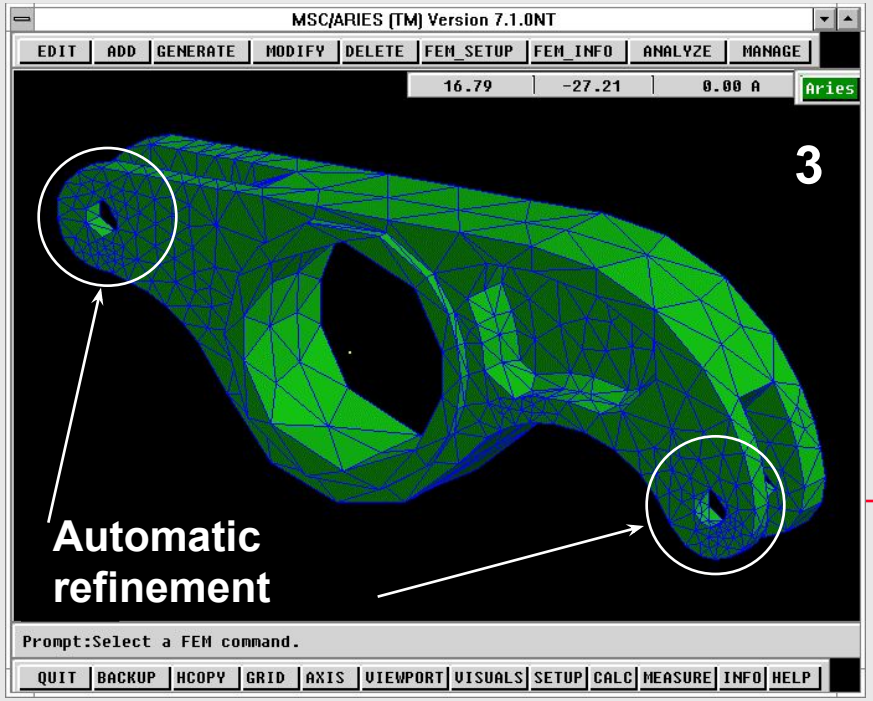
Solid Element Automesh

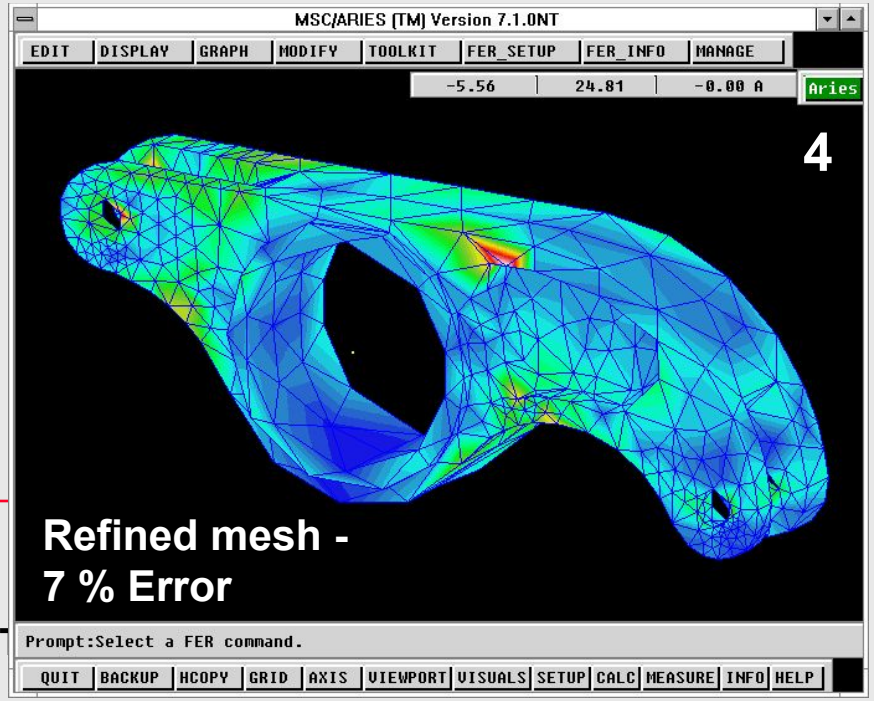
FE Meshing

- **Adaptive mesh refinement**
  - Automatic mesh refinement to optimize mesh density
  - Use with automatically generated h or p meshes
  - Global or local refinement
  - New mesh density based on current error versus target error
- **Reduces mesh density related errors**


MSC/ARIES (TM) Version 7.1.0NT
EDIT ADD GENERATE MODIFY DELETE FEM_SETUP FEM_INFO ANALYZE MANAGE
45.45 -1.02 0.00 A
Aries
1
Original mesh
Prompt:Select a FEM command.
QUIT BACKUP HCOPY GRID AXIS VIEWPORT VISUALS SETUP CALC MEASURE INFO HELP


MSC/ARIES (TM) Version 7.1.0NT
EDIT DISPLAY GRAPH MODIFY TOOLKIT FER_SETUP FER_INFO MANAGE
24.81 21.67 -0.00 A
Aries
2
Original mesh -
21 % Error
Prompt:Select a FER command.
QUIT BACKUP HCOPY GRID AXIS VIEWPORT VISUALS SETUP CALC MEASURE INFO HELP


MSC/ARIES (TM) Version 7.1.0NT
EDIT ADD GENERATE MODIFY DELETE FEM_SETUP FEM_INFO ANALYZE MANAGE
16.79 -27.21 0.00 A
Aries
3
Automatic
refinement
Prompt:Select a FEM command.
QUIT BACKUP HCOPY GRID AXIS VIEWPORT VISUALS SETUP CALC MEASURE INFO HELP


MSC/ARIES (TM) Version 7.1.0NT
EDIT DISPLAY GRAPH MODIFY TOOLKIT FER_SETUP FER_INFO MANAGE
-5.56 24.81 -0.00 A
Aries
4
Refined mesh -
7 % Error
Prompt:Select a FER command.
QUIT BACKUP HCOPY GRID AXIS VIEWPORT VISUALS SETUP CALC MEASURE INFO HELP

FE Meshing

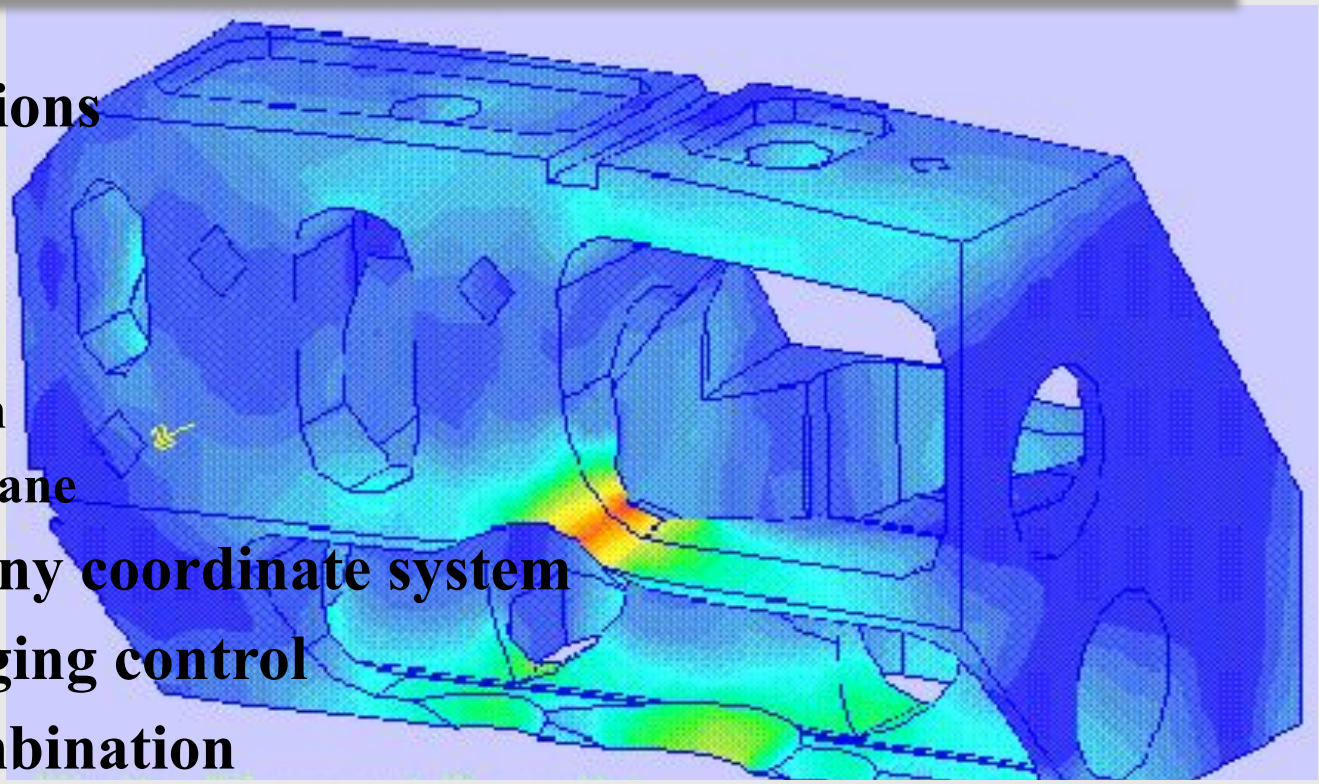
- Direct creation of nodes/elements
- Extrude/revolve 1D to 2D, 2D to 3D

- Mirror
- Mesh editing

- Element quality checks
- Merge node

- Auto MPC connection of meshes between linear or quad tets to linear hex

Results Review



- Display options
  - Vector
  - Contour
  - Graph
  - Animation
  - Cutting plane
- Results in any coordinate system
- Data averaging control
- Results combination
- Error calculation

Linear Statics

- Loads constant with time
- Material assumed linear and perfectly elastic
- Results calculated
  - Stress
  - Displacement
  - Strain
  - Strain energy
  - Reaction force

Normal Modes

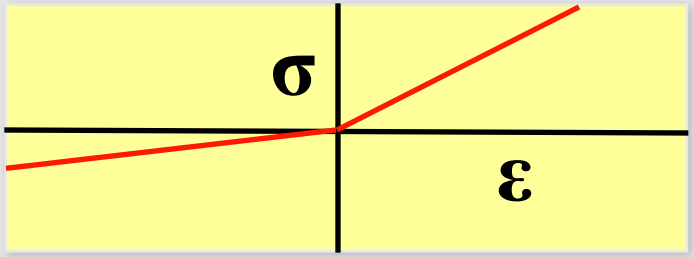
- Calculates undamped natural modes of vibration
- Material assumed linear and perfectly elastic
- Results calculated (normalized)
  - Stress
  - Displacement
  - Strain
  - Strain energy
  - Reaction force

Linear Buckling

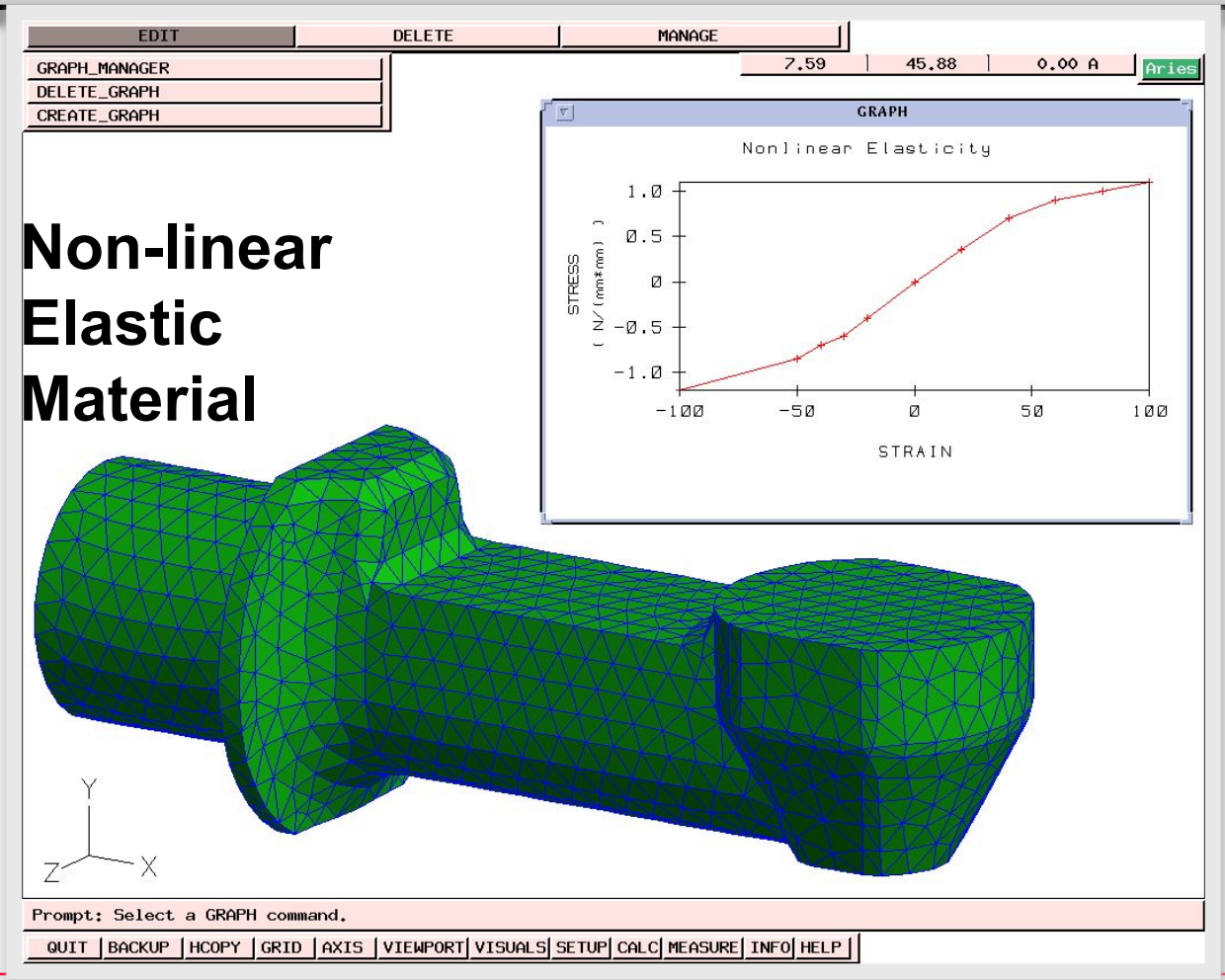
- Calculates load factor for critical buckling
- Material assumed linear and perfectly elastic
- Results calculated
  - Stress
  - Displacement
  - Strain
  - Strain energy
  - Reaction force

Non-Linear Statics

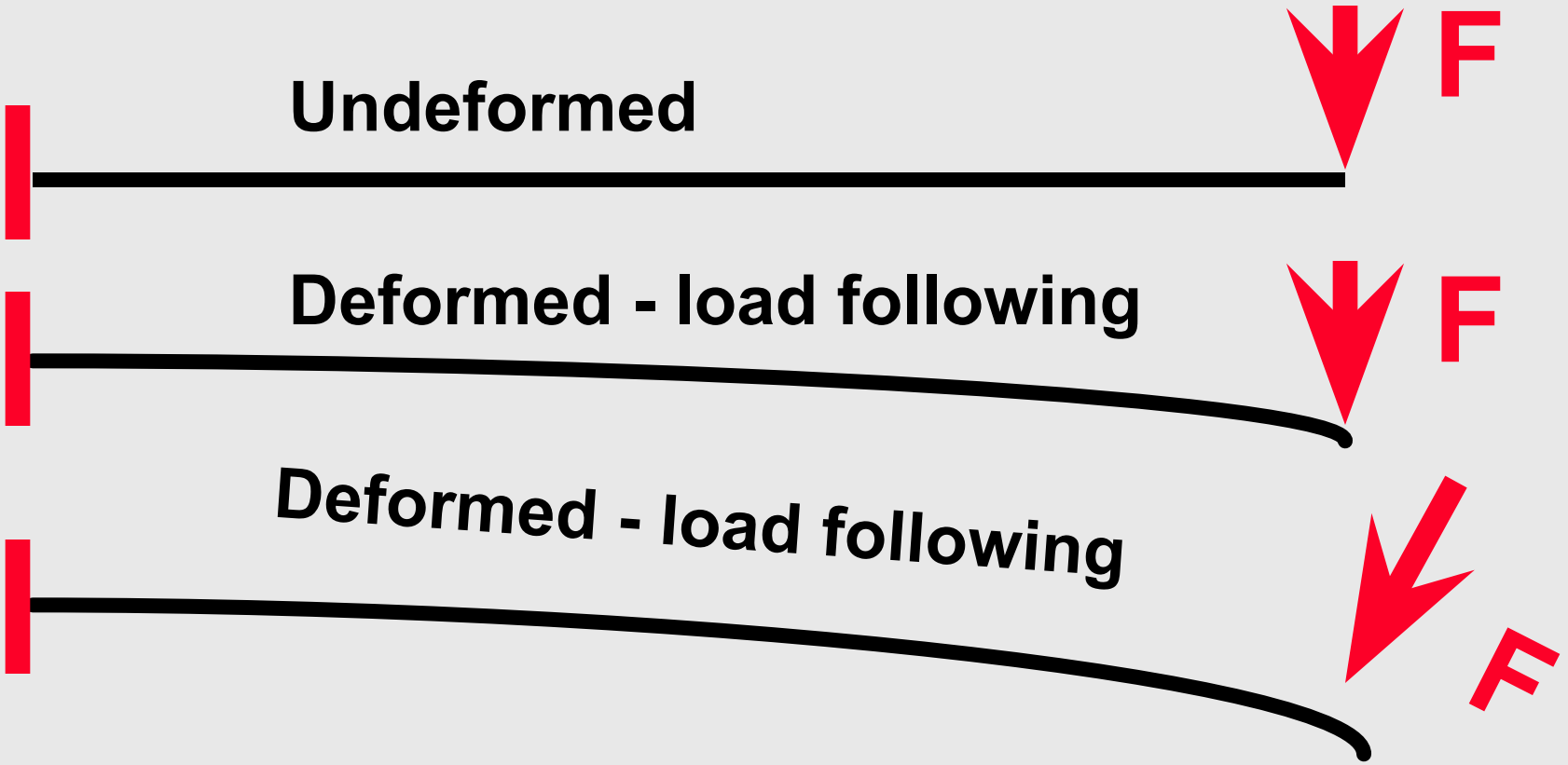
- **Geometric non-linearity**
  - Change in stiffness associated with large deformations
  - Load follows deformed shape
- **Material non-linearity**
  - Bi-linear elastic/plastic with plastic strain, or
  - Non-linear elastic, no plastic strain
    - Compressive/tensile stress-strain curves can be different



Non-Linear Statics



Structures-2 Non-Linear Statics
Load Following



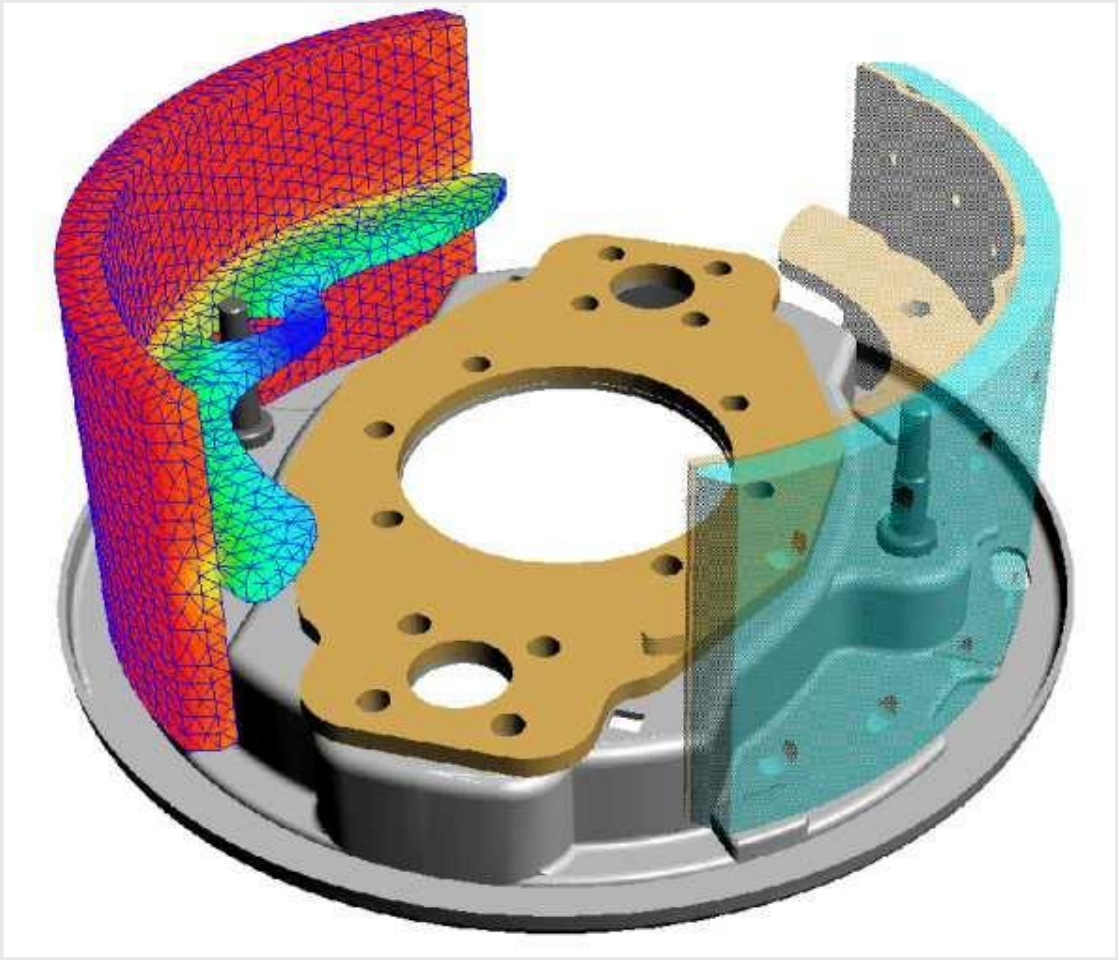
Linear Transient Dynamics

- Time varying geometry and finite element loads
- Structural and modal damping
- Results calculated for each time step
  - Stress
  - Displacement
  - Strain
  - Velocity
  - Acceleration
  - Reaction force

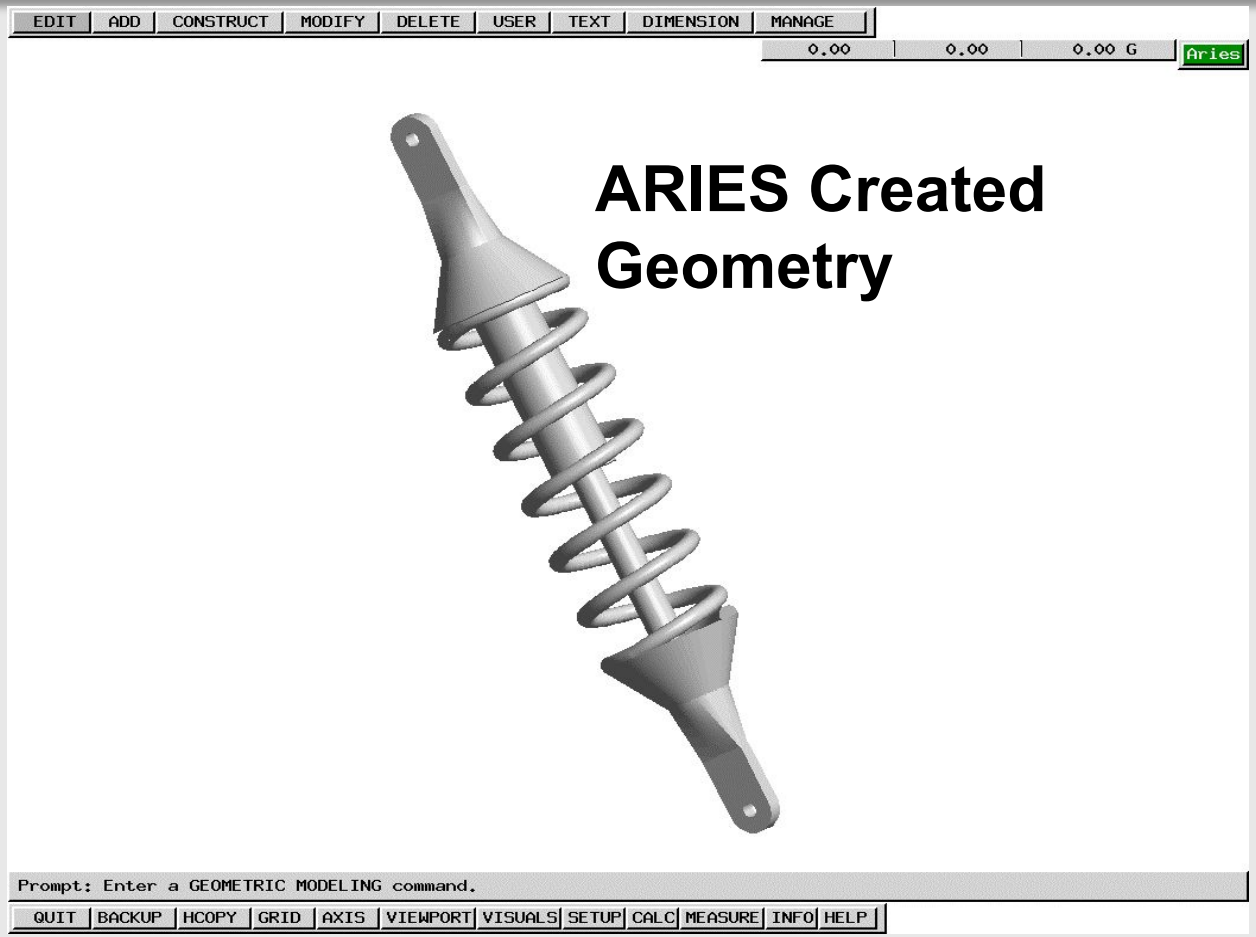
Heat Transfer

- Steady state and transient linear and non-linear heat transfer
- Heat transfer modes
  - Conduction
  - Free convection
  - Forced convection
  - Radiation
- Temperature and time dependent
  - Heat flux
  - Mass flow rate

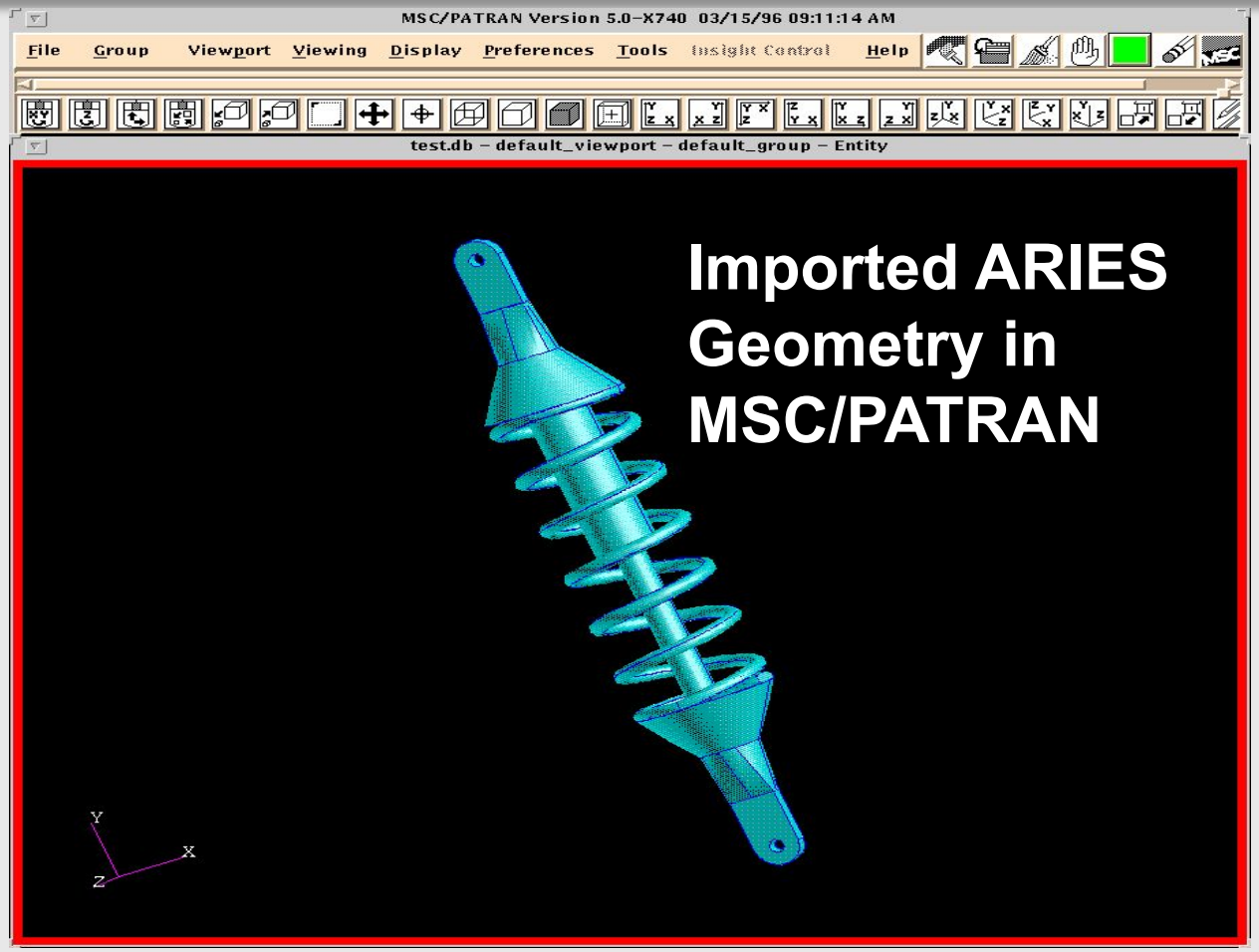
Heat Transfer



MSC/ARIES To MSC/PATRAN



MSC/ARIES To MSC/PATRAN



AGENDA

- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

Optimization

An Automated Process That:

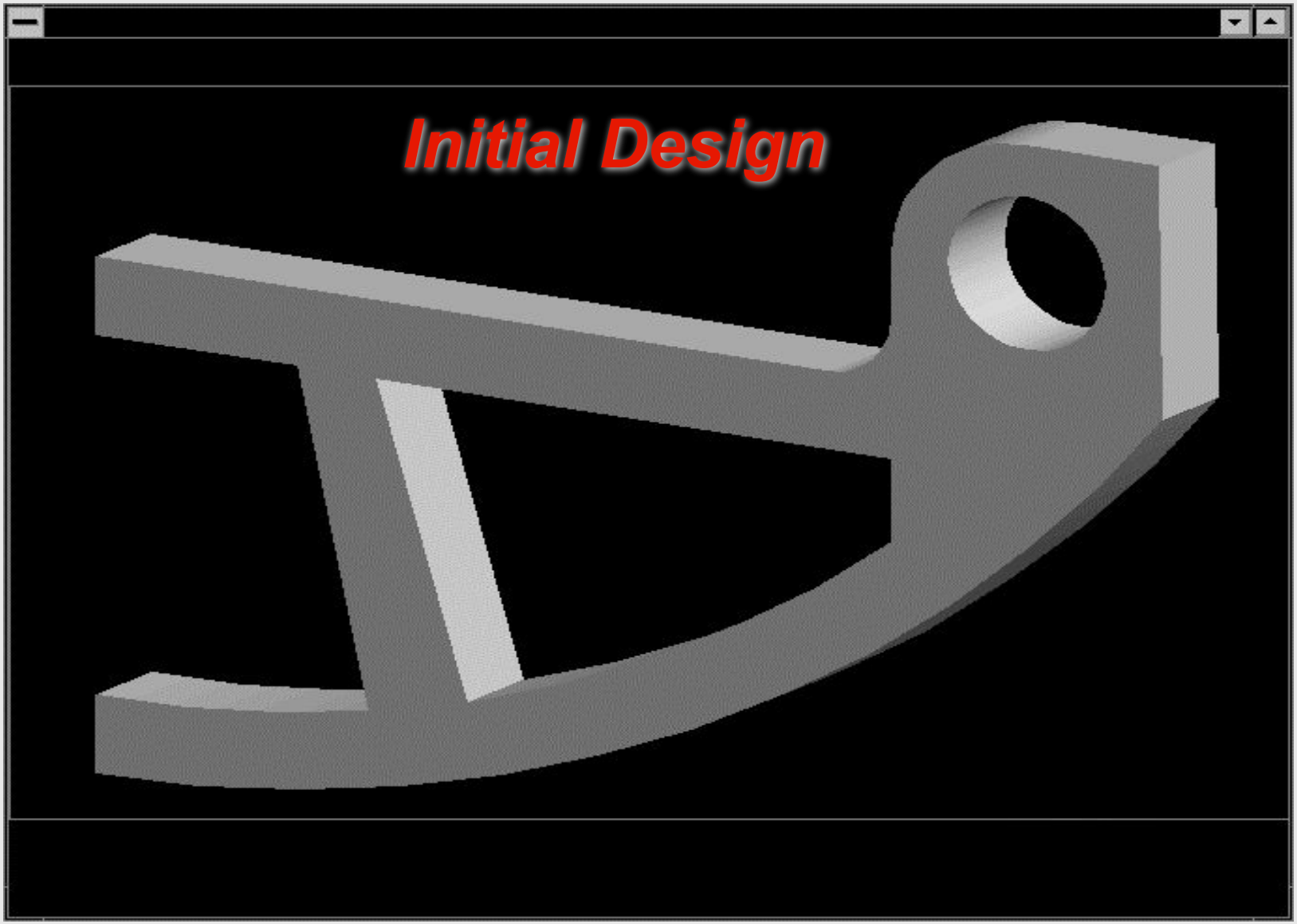
- Satisfies Your Design Objective
- Within Design Constraint(s)
- By Modifying Design Variables

Optimization - Overview

- **1 Design Objective**
  - minimize/maximize weight, frequency, load factor
- **'n' Design Constraints - local and or global**
  - min/max stress, displacement, freq, load factor
- **'n' Design Variables**
  - Dimensional variables
  - Element shell thickness, Non Structural Mass
- **Solve multiple constraints simultaneously**
  - Linear statics (with multiple load cases)
  - Modal (per mode shape max/min control)
  - Buckling analysis

Optimization - Overview

- **Shape**
  - Geometry dimensions as design variables
- **Sizing (element properties)**
  - Shell thickness, non-structural mass
- **Design sensitivity**
  - Effect of a change in a design variable on
    - Design Objective, Design Constraint(s)
- **Shape and sizing can be combined**



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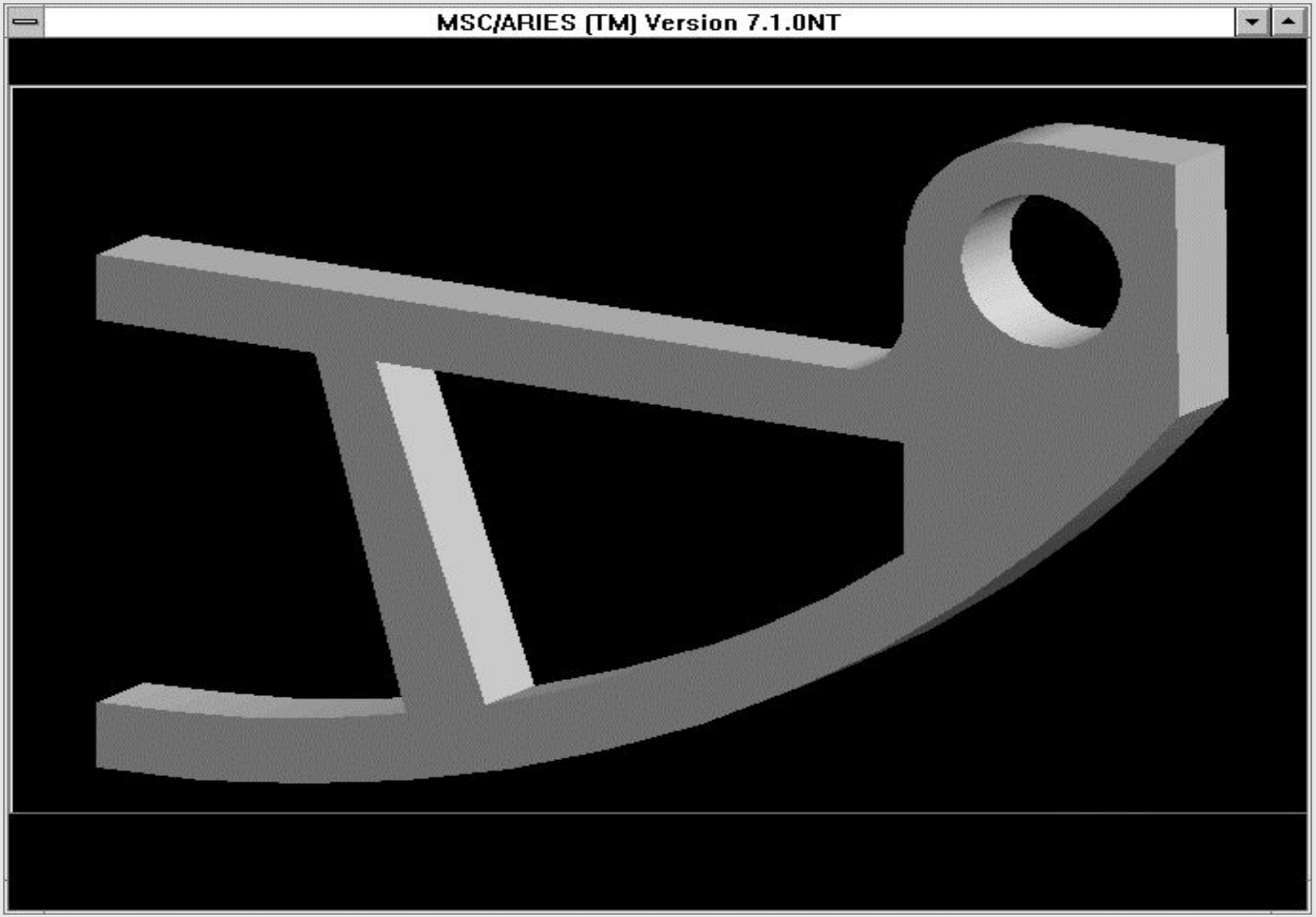

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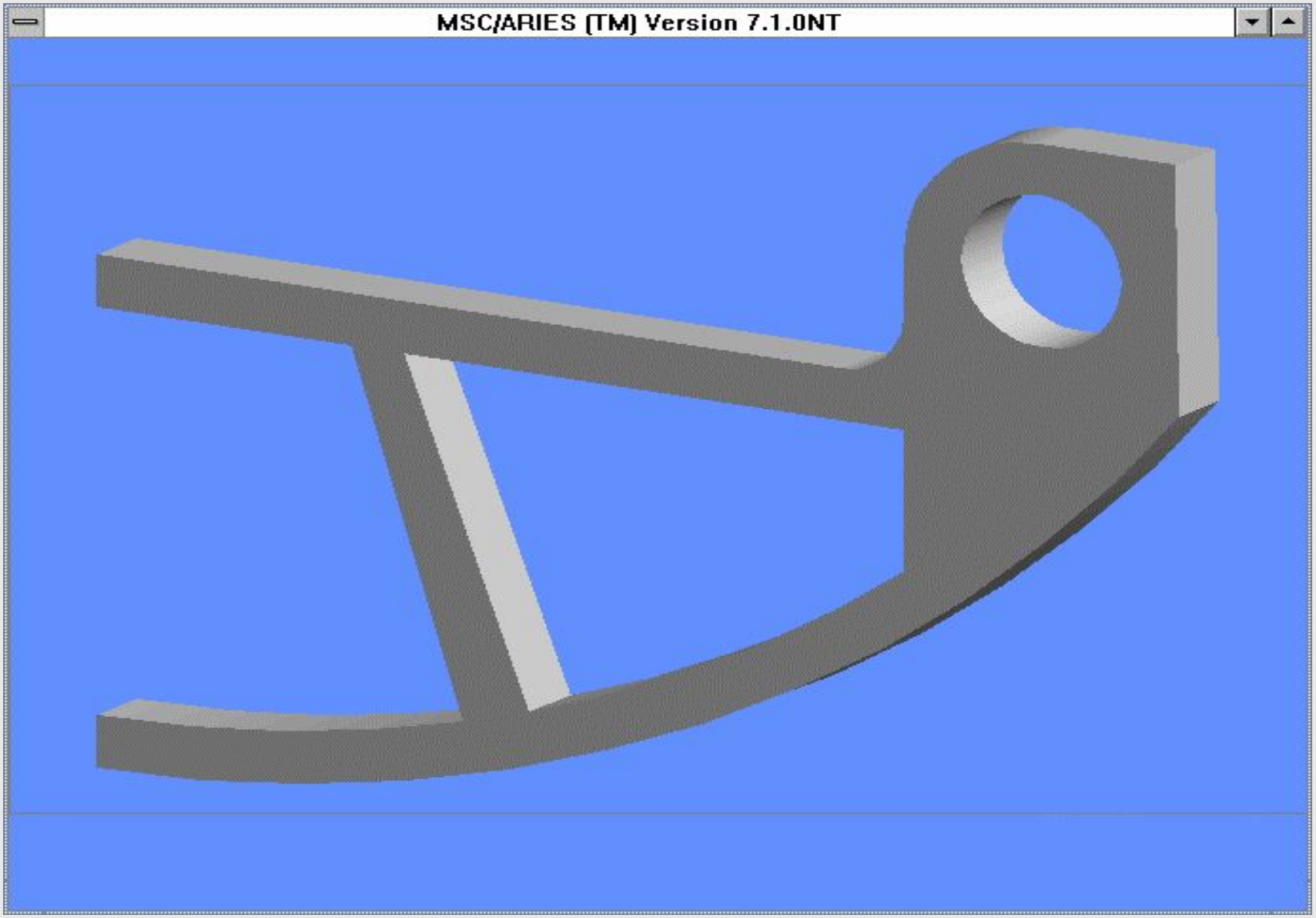

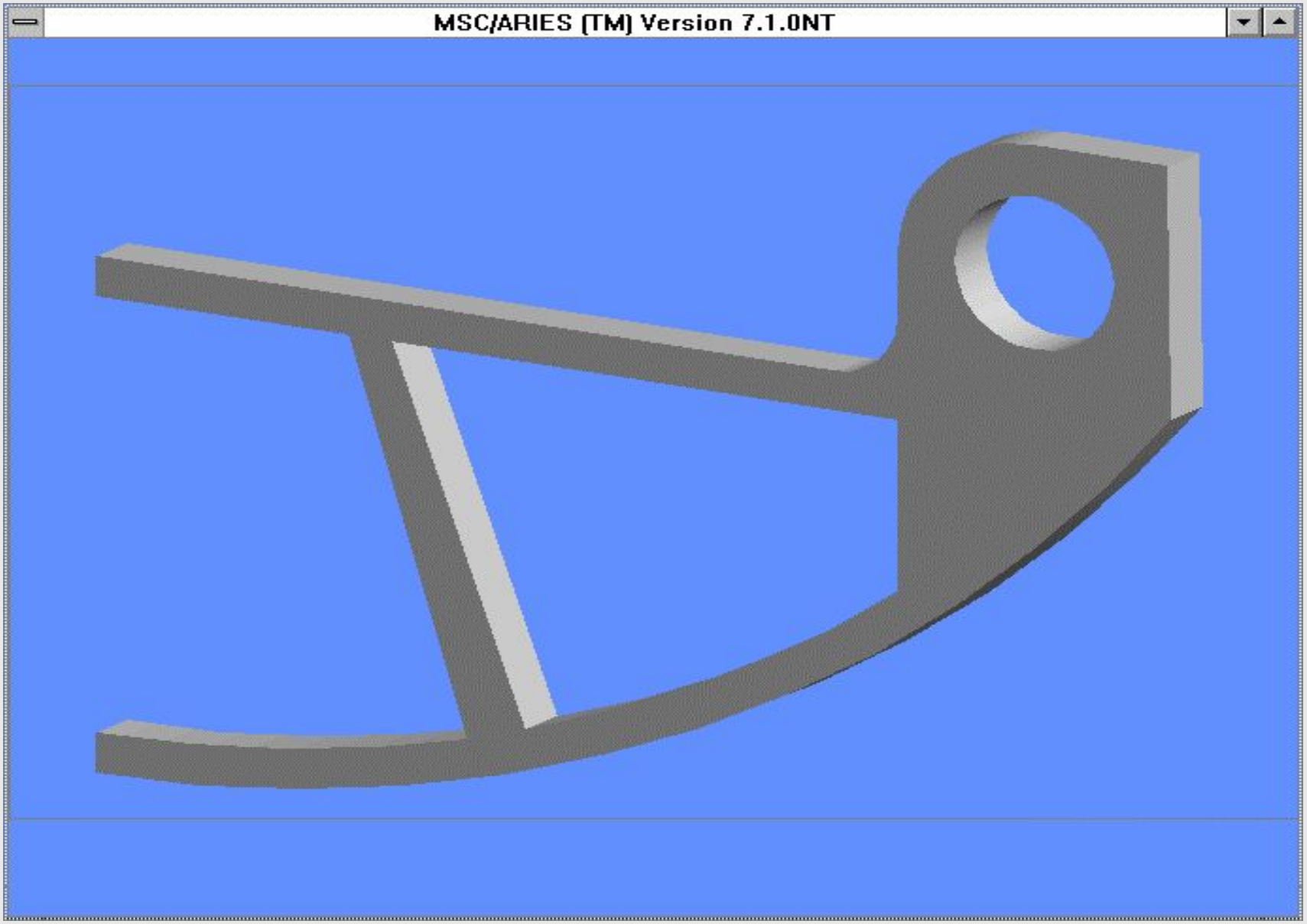

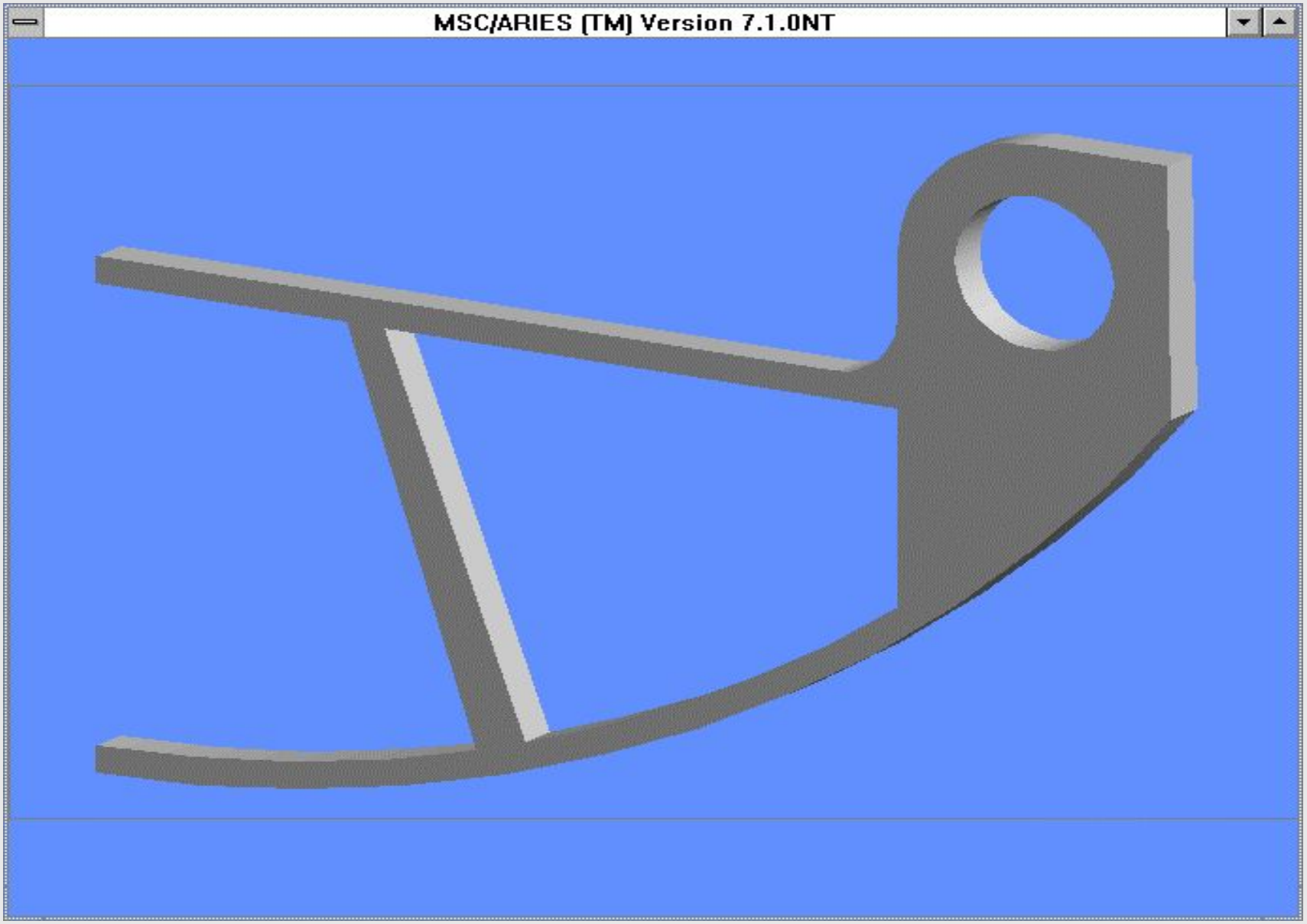

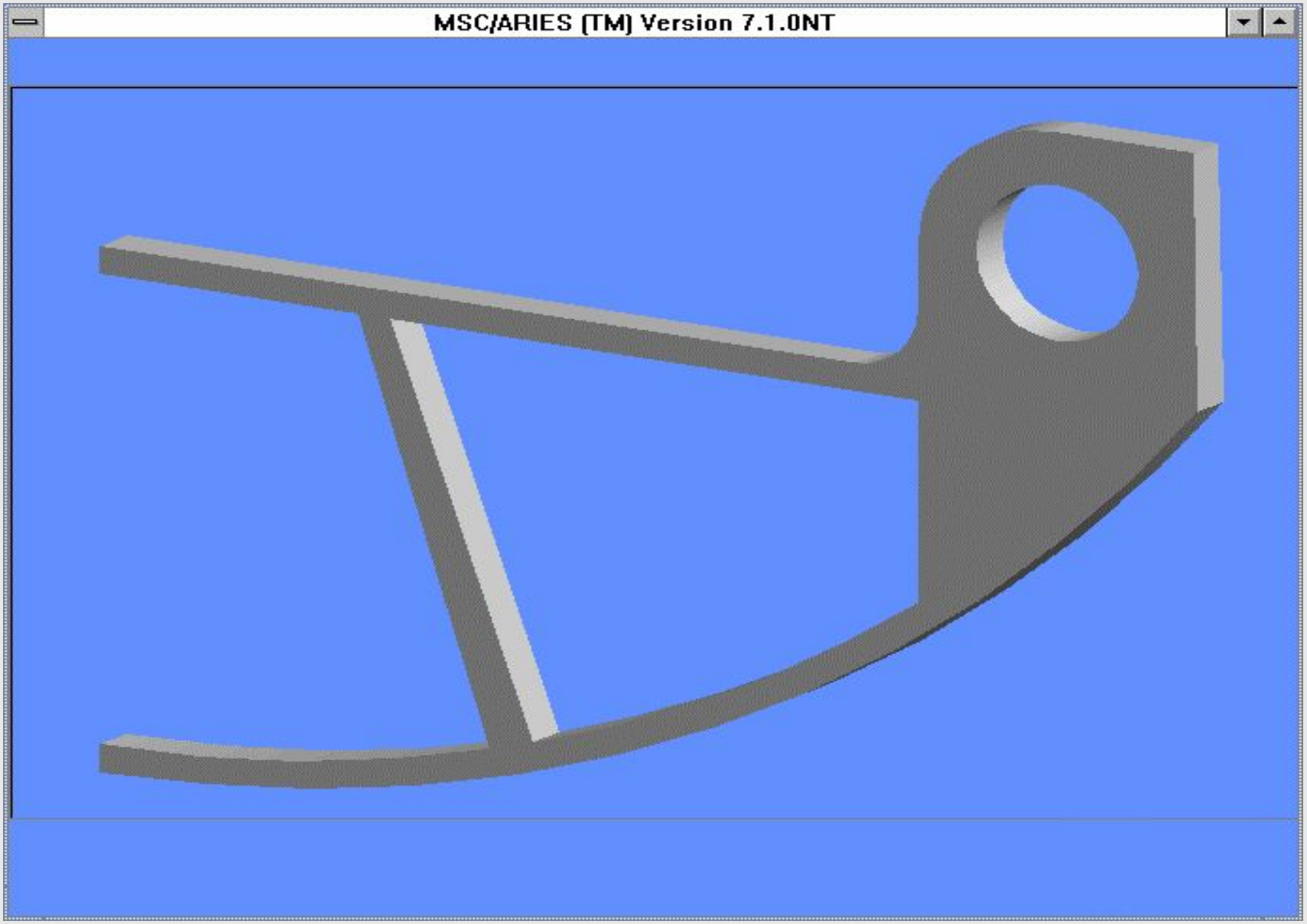

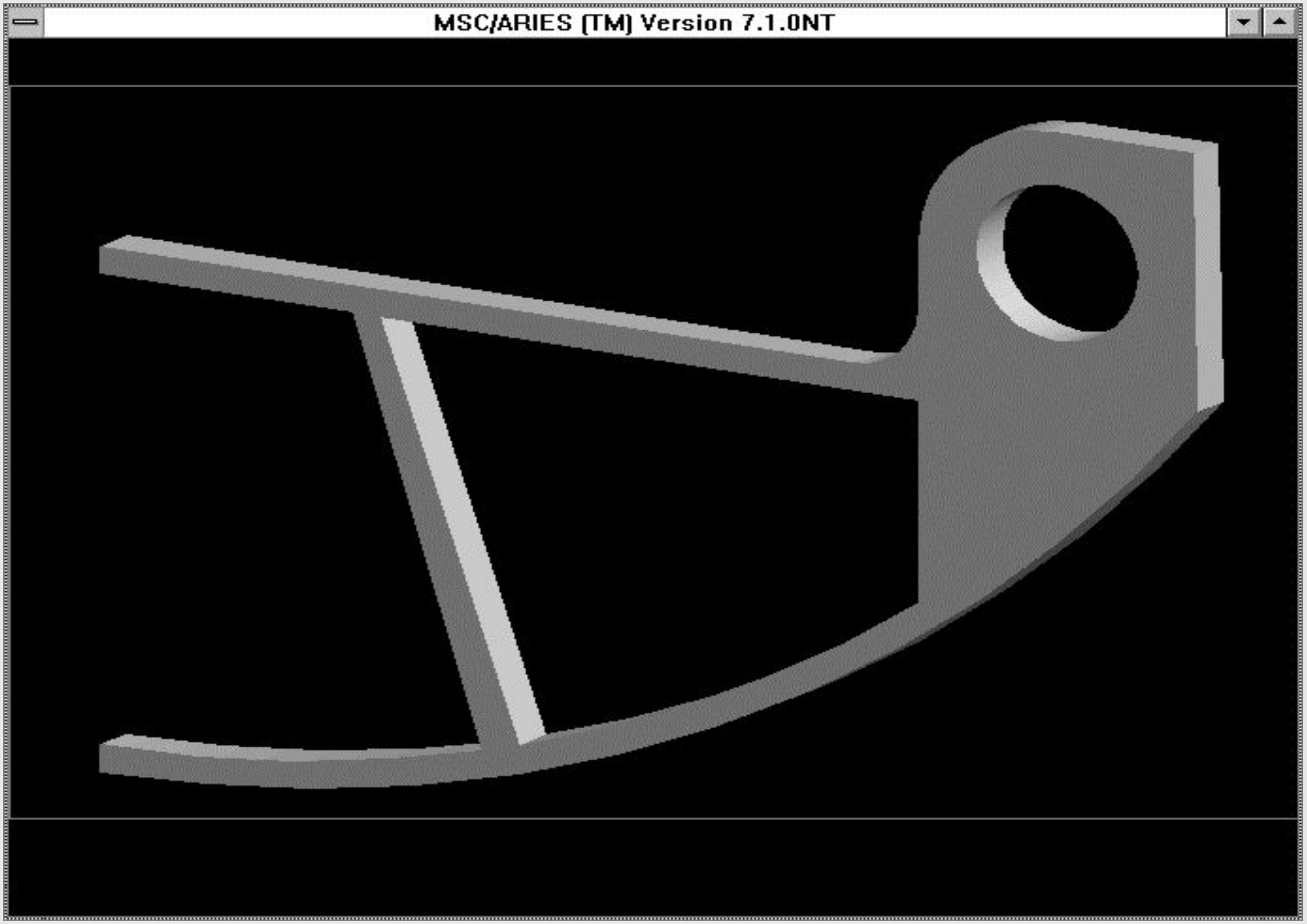

PARTNER

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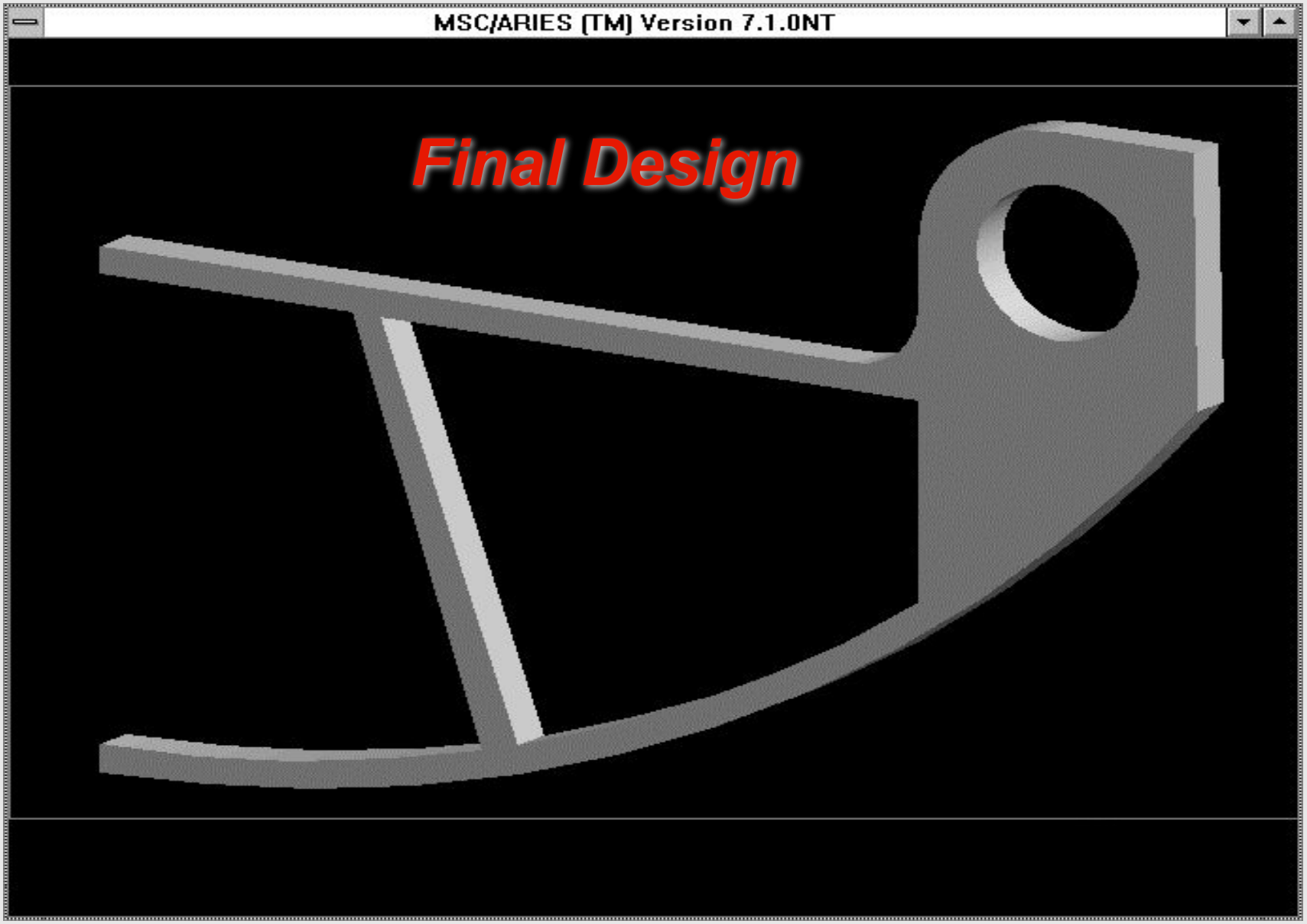
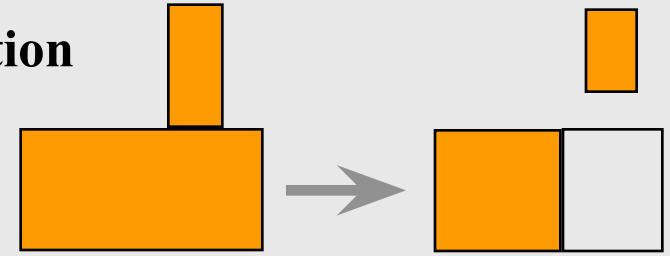
MSC



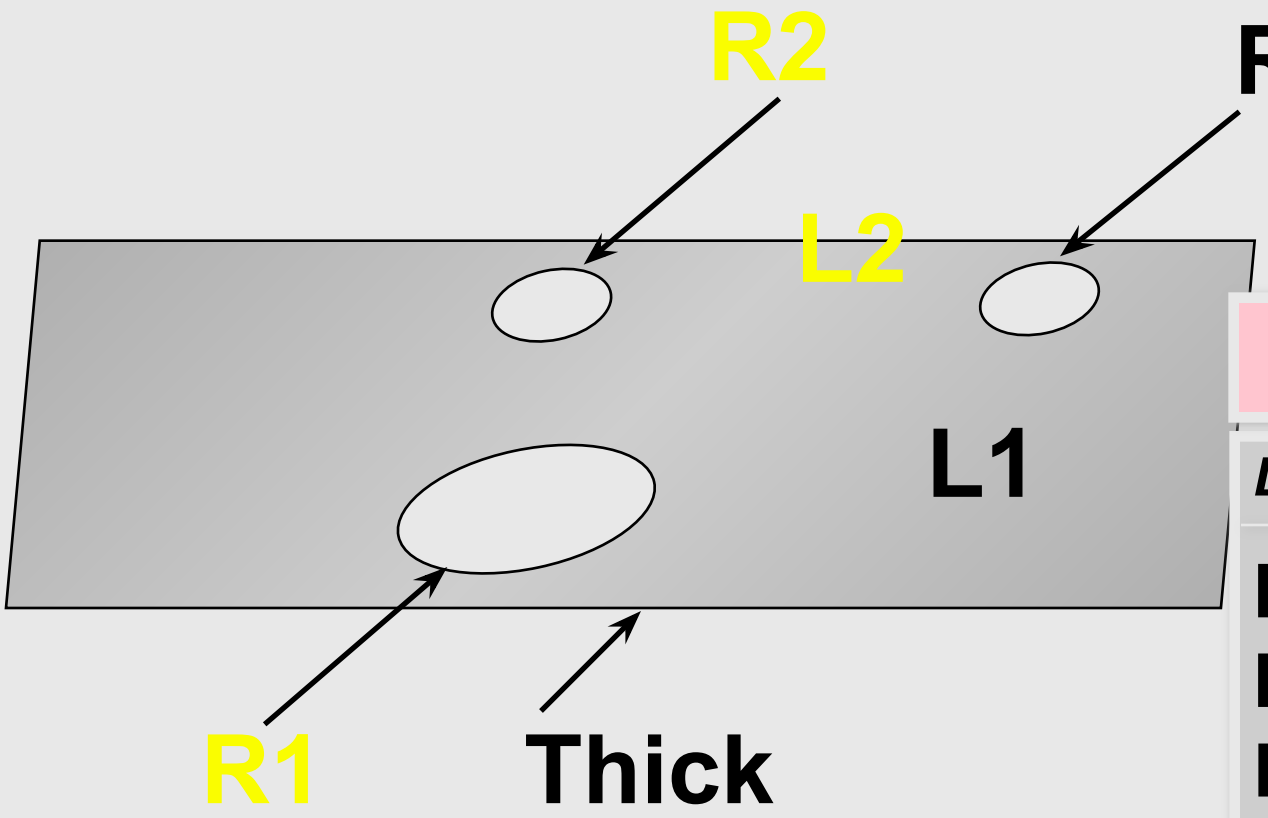
Optimization - Application

- Build solid or surface geometry
- Associate dimension variables in Parametrics:
  - Use as design variables for Optimization
  - Maintain design intent
- (Parameterize using DRP)
  - Maintain design intent
- (Attach DRP model(s) to solids in Parametrics)



Optimization - Application

- Create finite element model
- Select Optimization application
  - 1 Design Objective minimize/maximize:
    - weight, frequency, load_factor
  - ‘n’ Design Constraints - local and/or global min/max stress, disp, freq, load factor
  - ‘n’ Design Variables
    - Dimensional,
    - Shell thickness, Non Structural Mass



DRP Model

DEP		*INDEP*
R1	=	2 x R2
R2	=	R3
L2	=	R1 x 3

Selecting Design Variables

Optimization - Results Review

- **Post process in Optimization application**
  - Graph design objective/ constraint(s)/ variable(s) against design cycle
  - Display geometry at intermediate design cycles
- **Review results of final design in FE_Results**
  - Standard results review process
  - Animate between FEmodels across design cycles

P-ELEMENTS

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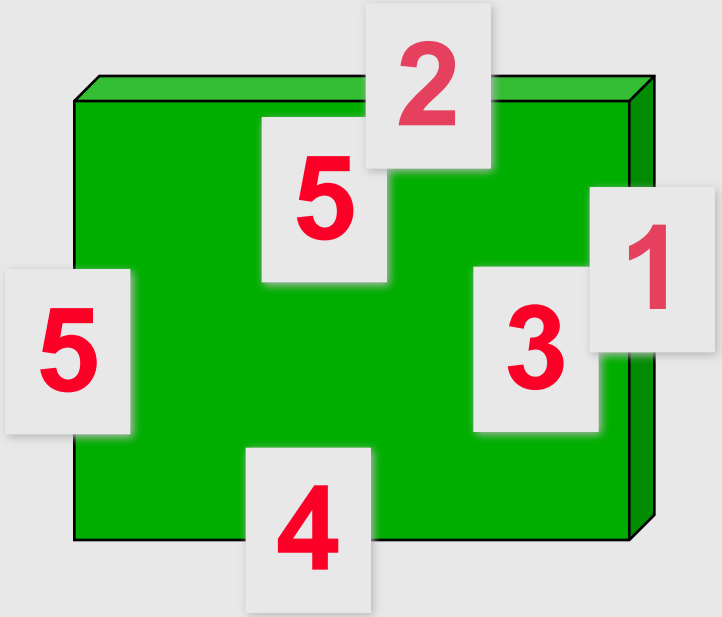
P-Elements - Overview

- Automatically increases element's shape function polynomial order during solution until convergence
- Convergence based on per element strain energy difference between p-order changes
- Mesh remains unchanged

P-Elements - Overview

- Each edge of each element has its p-order independently controlled in MSC/NASTRAN

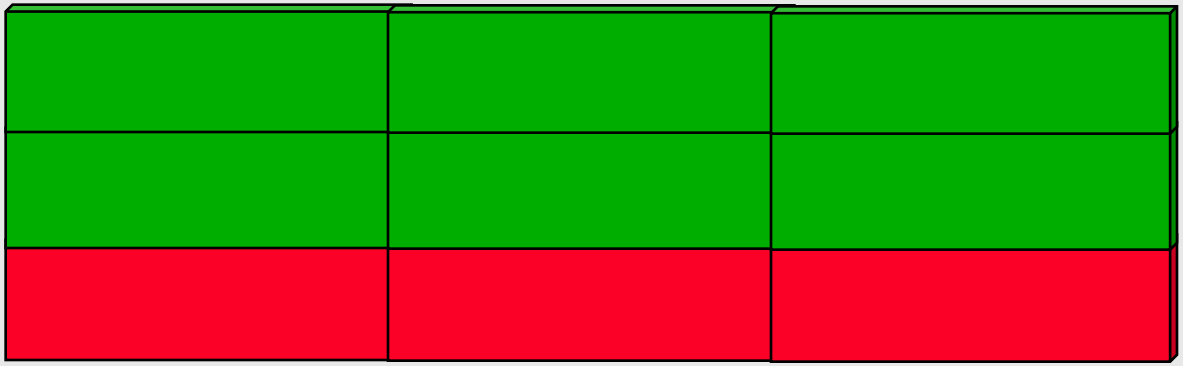


P-Elements - Application

- **Supported element types**
  - Tetrahedron
  - Brick
  - Pentahedron (wedge)
- **p-order min/max control**
  - Recommended p-order range 3-10
- **Adaptivity automatically turns off below specified von Mises stress or strain minimum**
  - Turns off adaptivity for elements where stress and or strain is negligible
  - Reduces CPU time and system resources

P-Elements - Application

- Can mix h and p elements

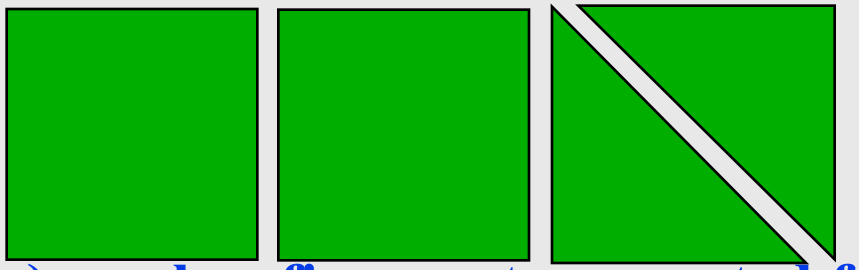


Constrains shared edges to p-order = 1

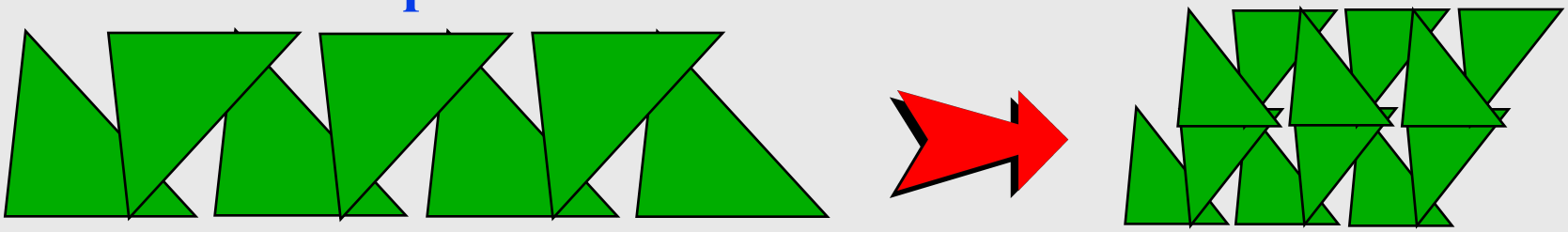
- Use p-elements in areas where high accuracy required, h-elements elsewhere

P-Elements - Application

- Hex to tet mesh connection works identically for p-elements:



- Automatic (h-adaptive) mesh refinement supported for automeshed p-elements



- Uses ERROR DATASET calculated from FER TOOLKIT error estimation

P-Elements - Results Review

- p-element results review identical to h-elements
- Can display final p element order contours

AGENDA

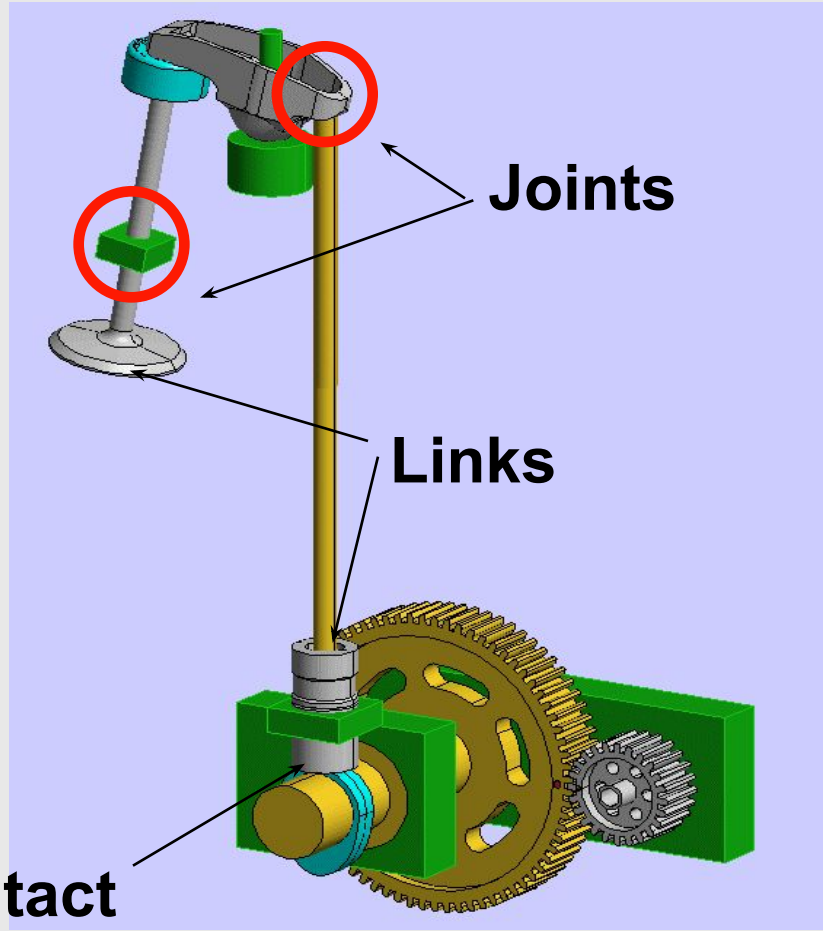
- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

Mechanisms

- Two- and three-dimensional mechanism modeling analysis and results review
- Uses MDI/ADAMS Kinematics solver
- Solves motion of fully constrained (0 DOF) kinematic systems i.e. the motion of the system is completely constrained by applied motion(s) and joint constraints

Mechanisms Pre Processing

- Create link geometry
- Geometry can be solid, surface or wireframe
- Add joints (supports all MDI/ADAMS joints)
- Add constant, harmonic, step, random motion
- Add motion constraints (e.g. cams), applied forces, springs, gravity
- Solve



Mechanisms Results Review

- Animated motion of links
- Motion path of any point
- Joint reaction force/moment
- Rotational/translational link displacement, velocity, acceleration
- Clearance/interference between links
- Results interrogation in local static/dynamic coordinate system

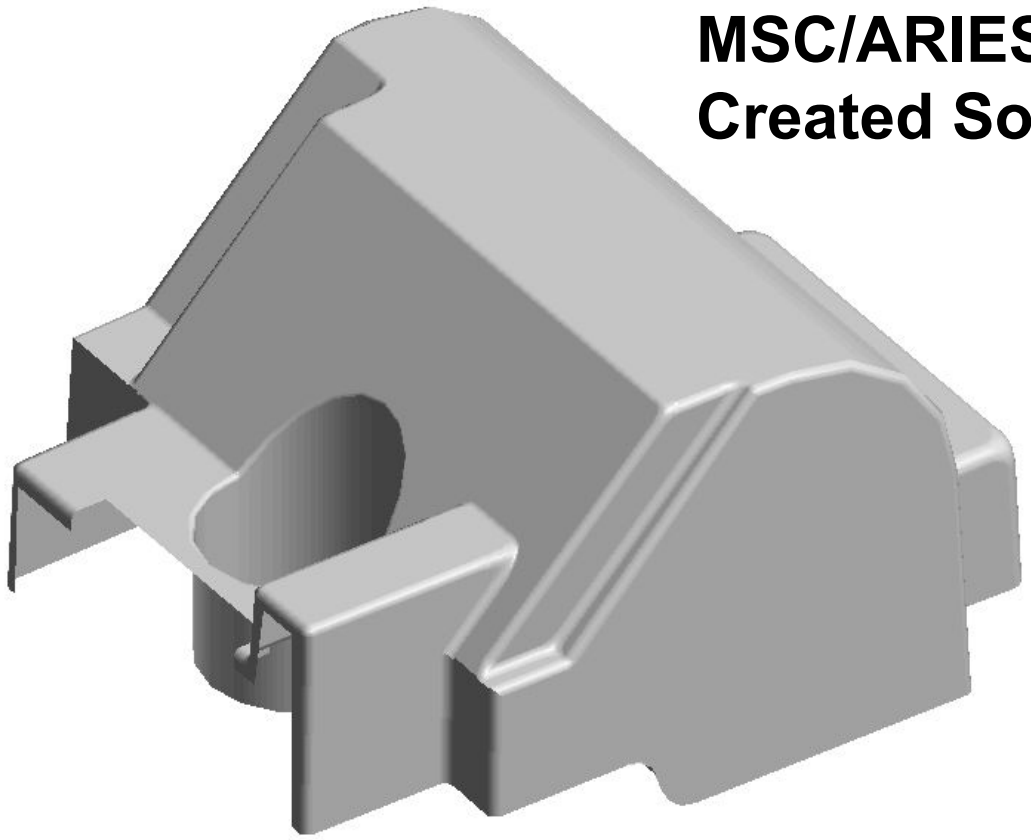
AGENDA

- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

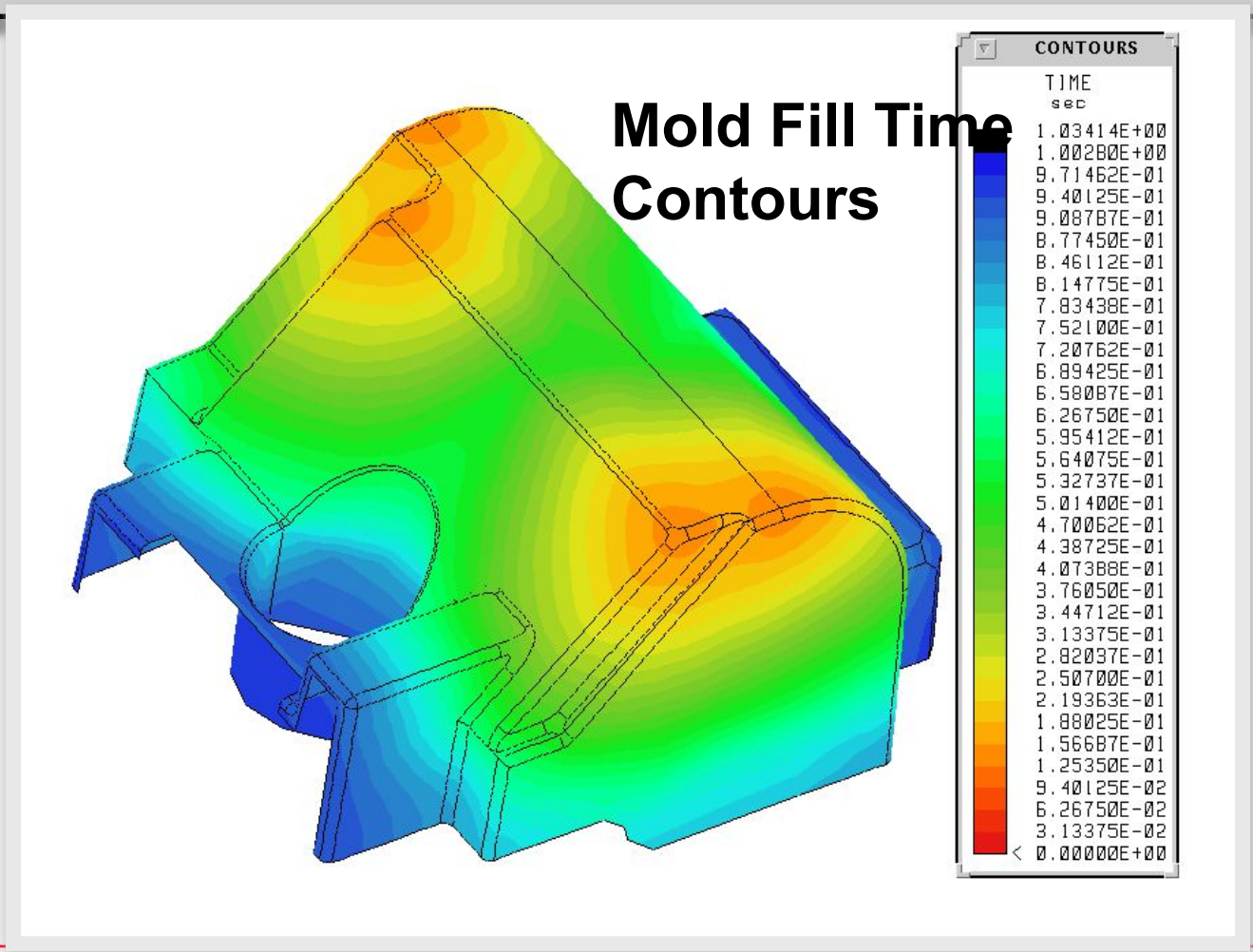
Plastics

- 3D mold fill analysis
- Uses Moldflow/Flowcheck solver
- Solves "Will It Fill"
  - Fast analysis to calculate areas of
    fill / no-fill / possible fill
  - Experiment with number of injection points/ location, material and part thickness
- Solves "Fill_Pattern"
  - Fill time
  - Air trap location
  - Weld line locations

Plastics



Plastics


Mold Fill Time
Contours
CONTOURS
TIME
sec
1.03414E+00
1.00280E+00
9.71462E-01
9.40125E-01
9.08787E-01
8.77450E-01
8.46112E-01
8.14775E-01
7.83438E-01
7.52100E-01
7.20762E-01
6.89425E-01
6.58087E-01
6.26750E-01
5.95412E-01
5.64075E-01
5.32737E-01
5.01400E-01
4.70062E-01
4.38725E-01
4.07388E-01
3.76050E-01
3.44712E-01
3.13375E-01
2.82037E-01
2.50700E-01
2.19363E-01
1.88025E-01
1.56687E-01
1.25350E-01
9.40125E-02
6.26750E-02
3.13375E-02
< 0.00000E+00

CONFIGURATION

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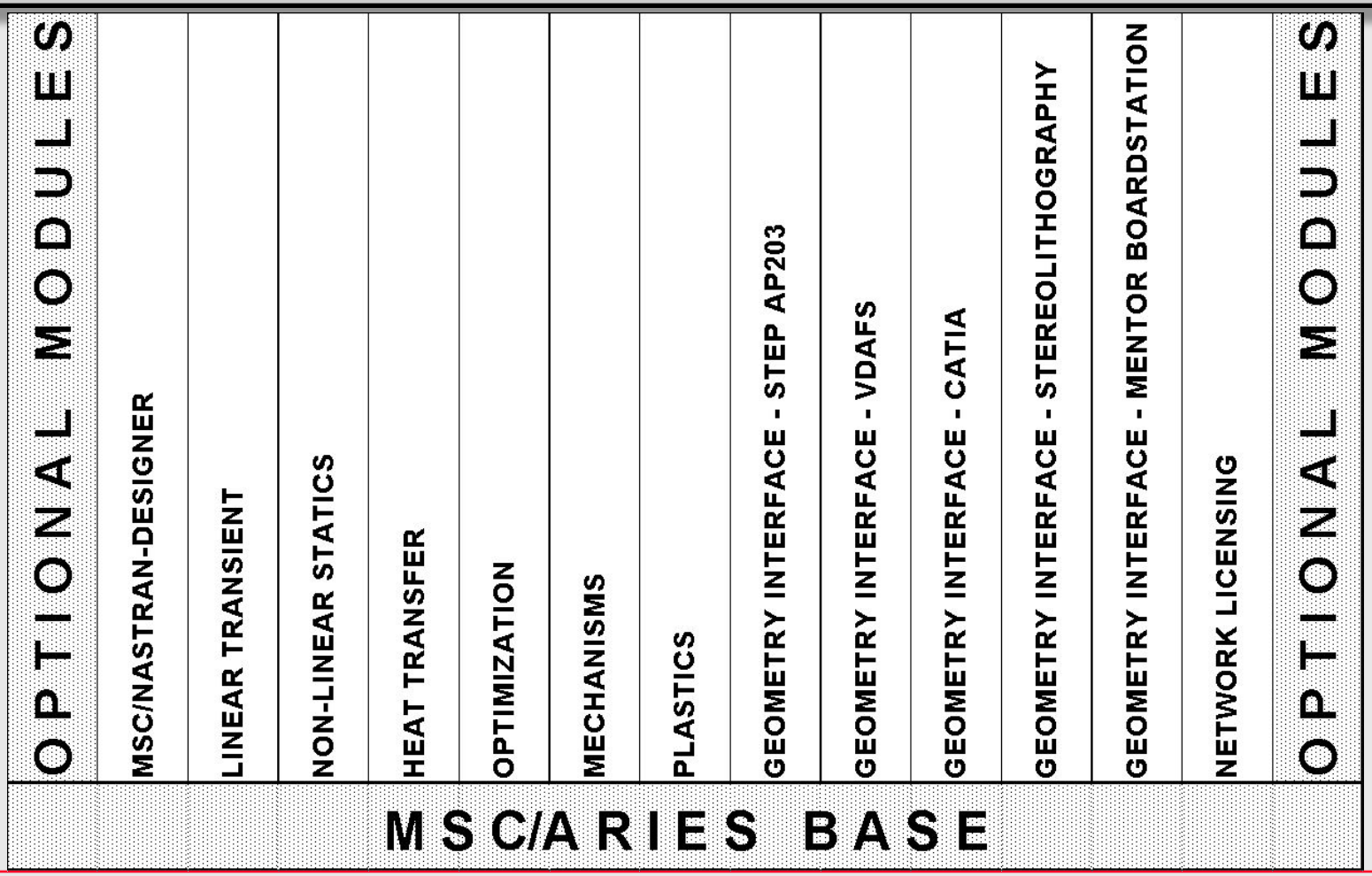
MSC/ARIES BASE

OPTIONAL MODULES
STRUCTURES - 1
STRUCTURES - 2
HEAT TRANSFER
MECHANISMS
PLASTICS
GEOMETRY INTERFACE - IGES
GEOMETRY INTERFACE - STEP AP203
GEOMETRY INTERFACE - VDAFS
GEOMETRY INTERFACE - CATIA
GEOMETRY INTERFACE - STEREOLITHOGRAPHY
GEOMETRY INTERFACE - MENTOR BOARDSTATION
NETWORK LICENSING
OPTIONAL MODULES

Modular Configuration

Modular Configuration



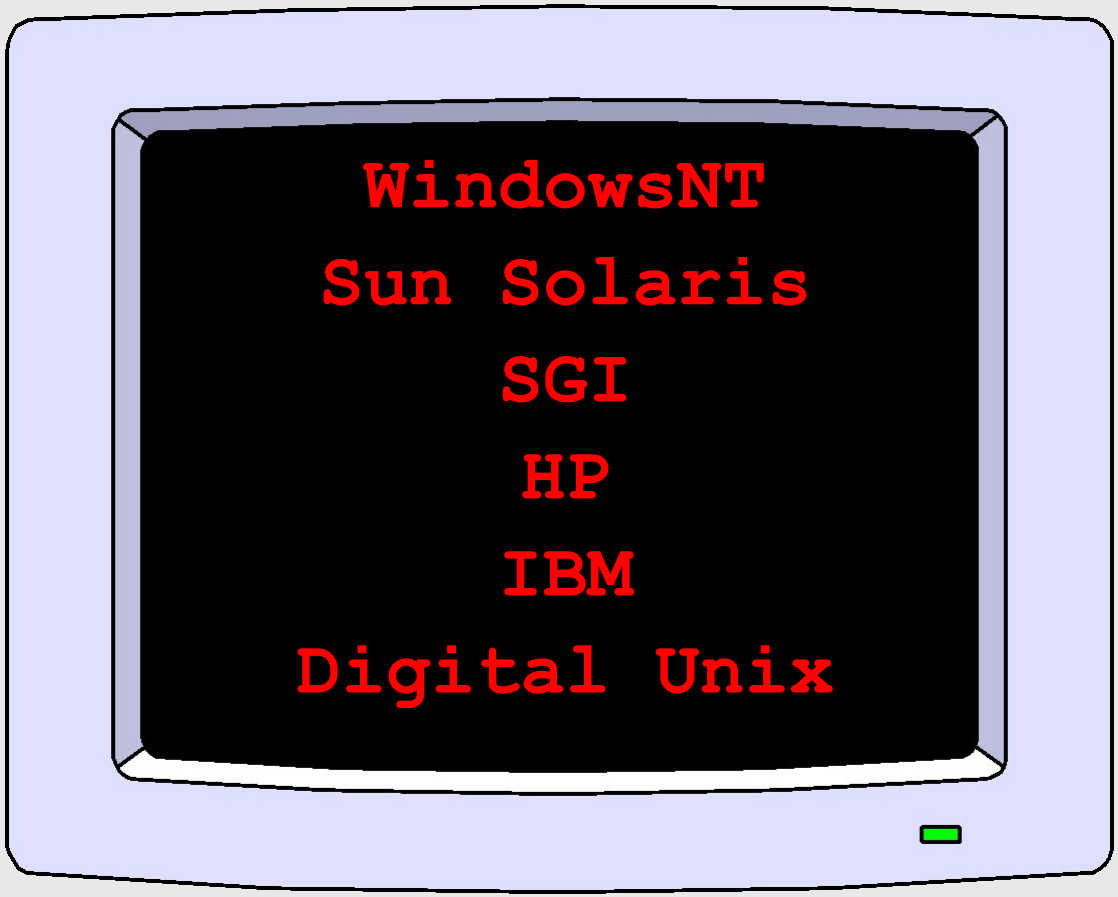
MSC/ARIES Base

MODULE	DESCRIPTION
Geometry	ACIS Based solid, surface, wireframe part and assembly modeling
Parametrics	Parameterization of solids and surfaces
Design Rule Processor	Linear and non-linear equation solver. Solid and surface feature relationships
Mass Properties	Mass properties of parts and assemblies
Materials	Structural and thermal material properties manager
Markup	Part and assembly annotation
Geometry Interface - ACIS	Import and export of solid, surface, wireframe via ACIS sat and sab format
Geometry Interface - MSC/PATRAN	Export of solid, surface, wireframe via PATRAN Express format
Geometry Interface - DXF	Export of solid, surface, wireframe via DXF format
HPGL Plot Driver	HPGL pen plotter driver
Printer Drivers	Printer drivers and tiff, gif, ppm, epsf, raster formats
Graphics Accelerators	Hardware graphics accelerators - Sun Solaris, SGI, HP, IBM
FE Modeler	FE pre and post
FEM Preference - MSC/NASTRAN	MSC/NASTRAN preference for all Structures-1 and Structures-2 analysis types
FEM Preference - MSC/PATRAN	MSC/PATRAN preference for Lin. Statics and Normal Modes. PATRAN neutral format

Optional Modules

MODULE	DESCRIPTION
Structures-1	Integrated MSC/NASTRAN solver: Lin. Statics, Normal Modes, Lin. Buckling, Optimization Unlimited Model Size, Interlock Check=ON
Structures-2	Integrated MSC/NASTRAN solver: Nonlinear Statics, Lin. Transient Dynamics, Unlimited Model Size, Interlock Check=ON
Heat Transfer	Integrated MSC/NASTRAN solver: Heat Transfer, Unlimited Model Size, Interlock Check=ON
Mechanisms	Mechanism Modeler (i.e. Pre and Post), Integrated MDI ADAMS Kinematics solver
Plastics	Integrated Moldflow FLOWCHECK solver: Will It Fill, Fill Pattern
Geometry Interface - IGES	Import and export solid, surface, wireframe via IGES standard
Geometry Interface - STEP AP203 (pre-releas	Import and export solid, surface and wireframe via STEP AP203, Part 42 standard
Geometry Interface - VDAFS (pre-release)	Import and export surface, wireframe via VDAFS standard
Geometry Interface - CATIA	Import surface, wireframe via CATIA Export format
Geometry Interface - Stereolithography	Export solid, surface via stl format
Geometry Interface - Mentor BoardStation	Import and export Mentor BoardStation PCB's via IDF format
Network Licensing	Floating network license for MSC/ARIES Base and all optional modules

Platform Support



Platform Requirements - WinNT

- **Intel based (not Digital NT)**
  - **Recommend >= Pentium 75MHz, 32Mb RAM**
  - **125 Mb swap space**
  - **Any Microsoft supported graphics adapter in 256 color mode**
  - **WindowsNT**
  - **Windows 3.1 and Windows95 *not available***
- **Licensing**
  - **Node-lock, standalone only**
  - ***No network license support***
- **Requires Ethernet adapter for licensing**

Platform Requirements - Unix

- **Supported Unix workstation**
  - 32Mb RAM
  - 125 Mb swap space
- **Licensing**
  - Node-lock, and
  - Floating network license

AGENDA

- Geometry
- FE Analysis
- Optimization
- Mechanisms
- Plastics
- MSC/ARIES Positioning

MSC/ARIES Positioning

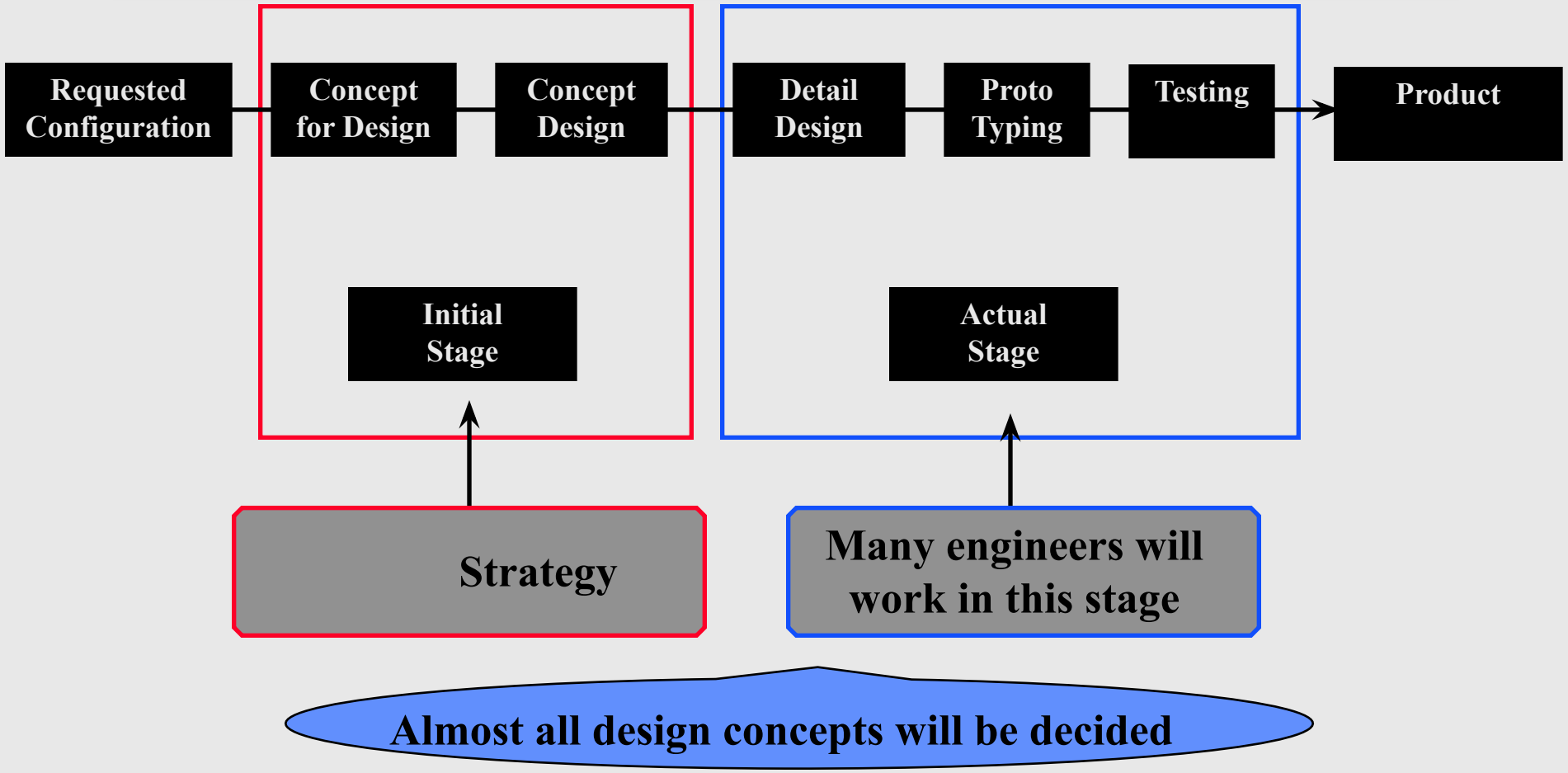
- **Standalone Design and Analysis System**
  - Designed and analyzed in MSC/ARIES
- **Analysis of ACIS Based Geometry**
  - Design built in CAD system
  - Design geometry import into MSC/ARIES
  - Analyzed in MSC/ARIES
- **Focus on Ease-of-Use and Automation For...**

MSC/ARIES Positioning

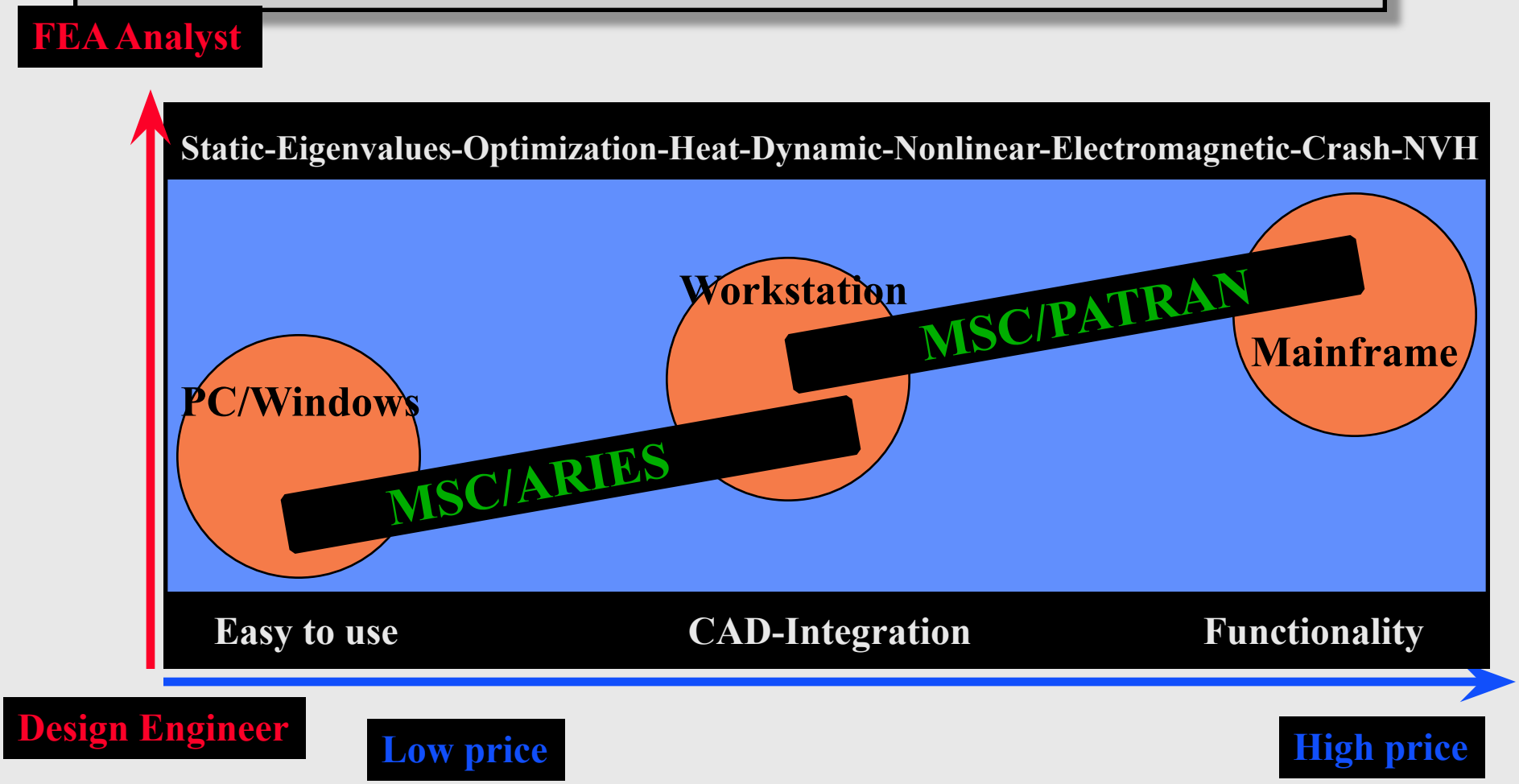
- Structural
- Thermal
- Mechanisms
- Plastic Molding Analysis

MSC/ARIES

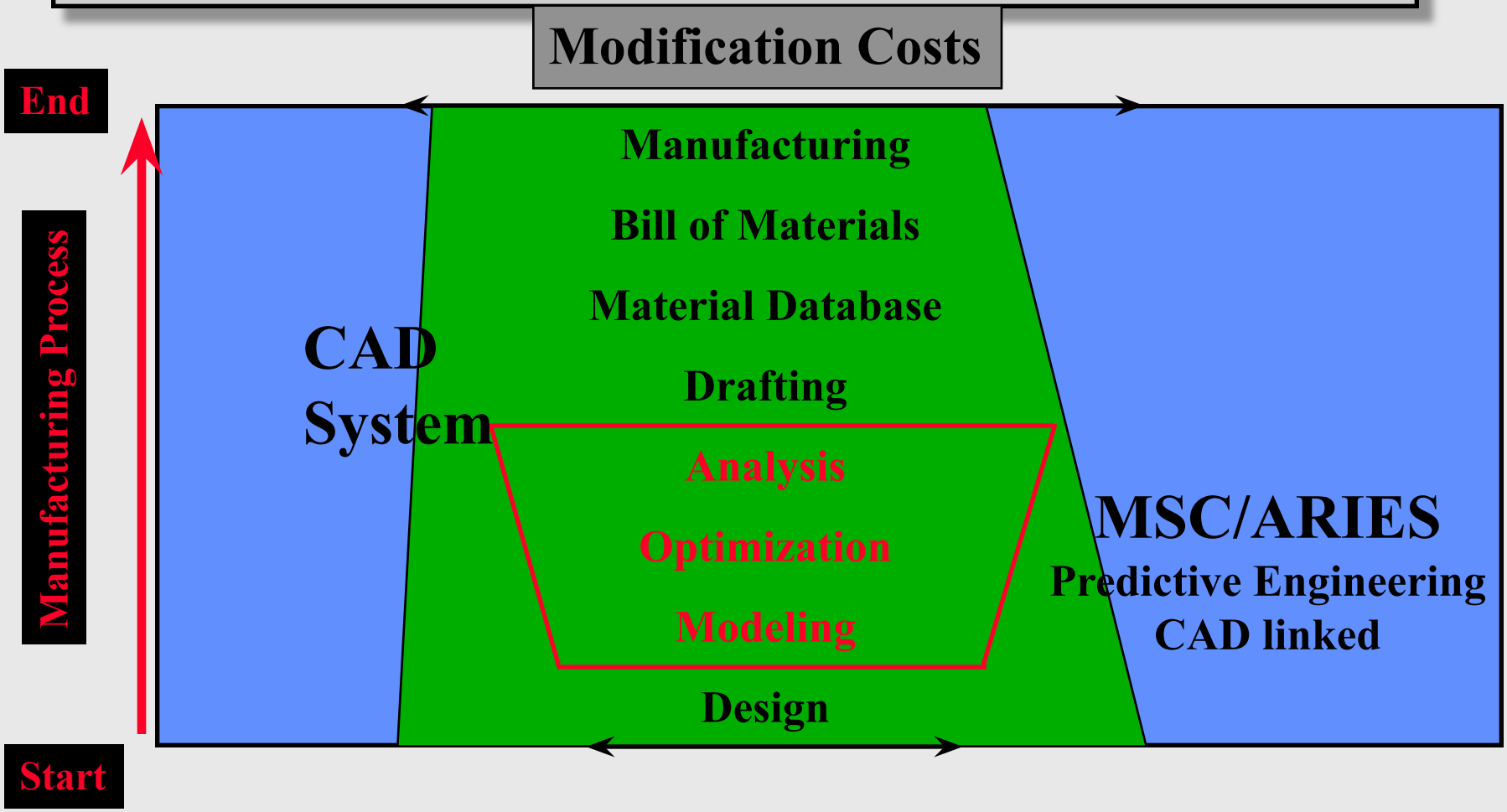
The Flow of Development



Positioning of MSC/ARIES



Positioning of MSC/ARIES

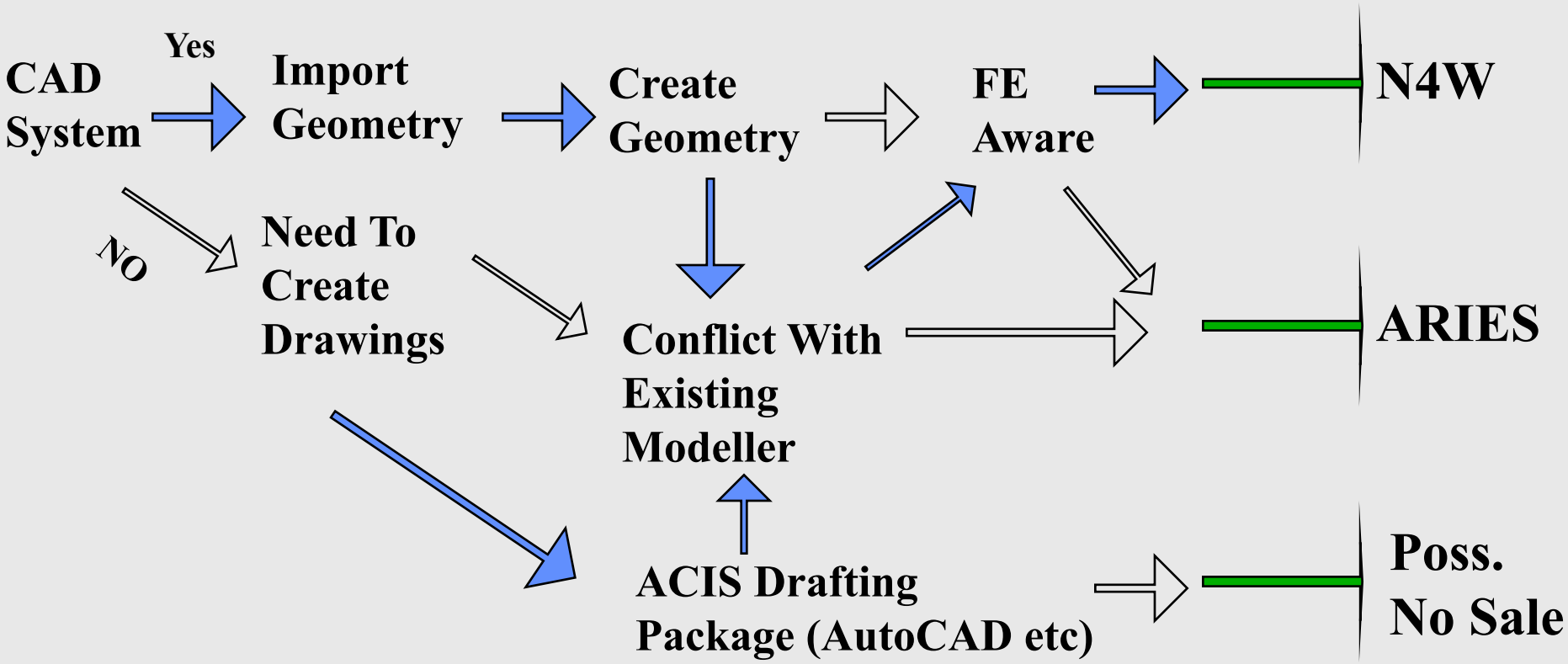


Positioning of MSC/ARIES

MSC/ARIES	MSC/N4W
Targeted User	Targeted User
Non-FE Specialist	FE Knowledgeable
Geometry Based Analysis	GUI Nastran pre &
Conceptual CAE Tool & Modeller	Limited Geometry C
ACIS imported analysis	Relies on Geometry
Designer	Windows Look & F
	Low-High End FE U

Positioning of MSC/ARIES

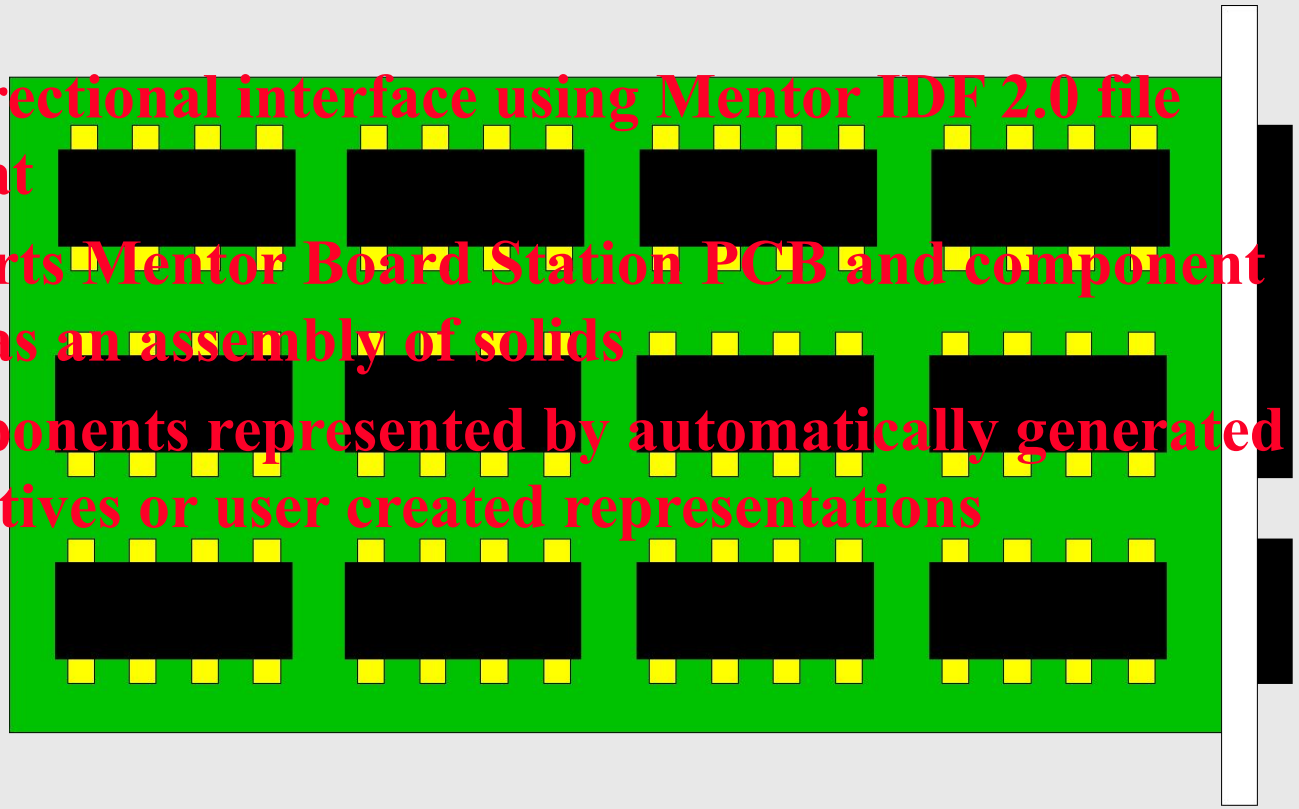
Guide line thought / Question Process



THE END

Mentor BoardStation Interface

- Bi-directional interface using Mentor IDF 2.0 file format
- Imports Mentor Board Station PCB and component data as an assembly of solids
- Components represented by automatically generated primitives or user created representations



Mentor BoardStation Interface

- Supports board holes, vias, keep out and keep within areas
- 2D curves can be added to represent additional keep outs, keep within etc.
- Applications
  - Analysis (e.g. modal, thermal)
  - Checking clearance/interference
  - Housing/rack design