CHAPTER 1

Introduction

What is MSC.visualNastran Desktop?

MSC.visualNastran Desktop is MSC.Software's three-dimensional viewing, authoring, and simulation product line for CAD engineering and marketing environments (Microsoft Windows® operating systems). Each of the Desktop products ---MSC.visualNastran 4D, MSC.visualNastran Desktop FEA, and MSC.visualNastran Motion --- is designed to suit your engineering design needs, from annotating CAD files and authoring professional presentations to building prototypes and running real world simulations with functional modeling capabilities.

- **MSC.visualNastran 4D** is the ultimate mechanical simulation platform for the integration of motion and stress simulation into a single functional modeling system: You can perform integrated dynamic motion and stress simulations on your assemblies in one program, without intermediate files or links to third-party programs. Calculated loads are automatically transferred from assembly mates and joints to the model parts for a more accurate stress simulation. MSC.visualNastran 4D has integrated and associative links to the latest versions of CAD software. It also provides for data transfer in standard formats, including STEP, Parasolid, ACIS, IGES and STL. MSC.visualNastran 4D includes all the functionality of MSC.visualNastran Desktop FEA and MSC.visualNastran Motion.

- **MSC.visualNastran Desktop FEA** includes analysis capabilities for stress, buckling, vibration, or thermal simulations on solid parts and assemblies. You can link to parts and assemblies from your favorite CAD systems through CAD integration, or import geometry in a wide variety of standard formats such as ACIS, Parasolid, STEP and IGES.

- **MSC.visualNastran Motion** provides the motion simulation features for building native models with advanced components such as conveyors, bushing constraints, and much more. You can also link to geometry created in your favorite CAD environment. A rigorous, automatic constraint mapping engine assures tight, reliable translations from the widest variety of CAD packages. Then test your design — MSC.visualNastran Motion's dynamic simulation engine

applies real world Newtonian mechanics to desktop computer simulations. An extensive analytical tool set includes meters, tables, and tabular data support.

All of the MSC.visualNastran Desktop products include the following functionality:

- **Visualization:** Quickly access almost any CAD assembly file. Manipulate product views, measure and markup part dimensions, and redline prototype assemblies. An integrated viewer opens these 3D CAD file types: MSC.Nastran™ output (XDB), STL, SAT (ACIS), IGES, SLDASM, SLDPRT, Parasolid, and STEP formats. MSC.Nastran output files of many types can be opened and viewed, as can AVI animation.

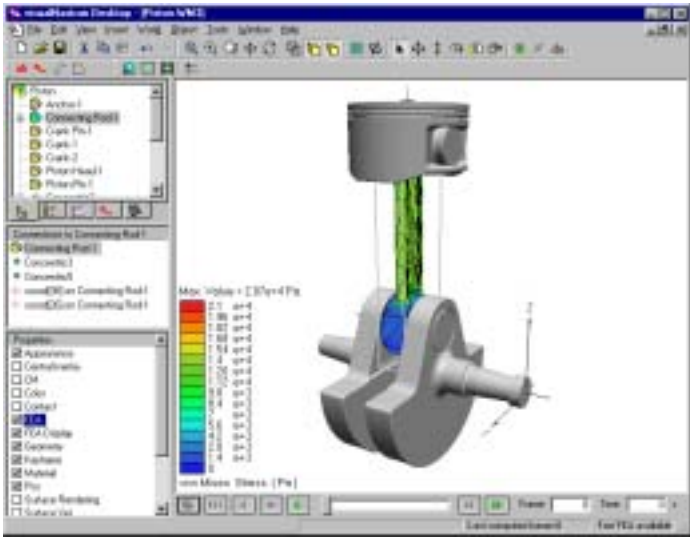
- **Physics-Based Animation:** Use photorealistic rendering and keyframed animation, including support for multiple cameras, lighting techniques, and an exploding parts feature. These professional post-production capabilities make outstanding presentations for product roll-outs and trade show demos.

Powerful, Easy-to-Use Features

MSC.visualNastran Desktop has full simulation analysis capabilities and the following advanced features:

MSC.visualNastran 4D

Figure 1-1
MSC.visualNastran 4D's Integrated Motion & Stress Simulation Environment



Integrated Motion and Stress Simulation

To perform an integrated motion and stress simulation, select any body in your assembly to be an FEA part using the Properties window. Then you can perform a stress simulation at all Frames (time-steps) in the Motion simulation, or pick specific Frames and perform a stress, vibration, or buckling simulation.

The accelerations of the bodies are included in the stress simulation, and the loads will be calculated and distributed dynamically.

Optimized Solver

The FEA solver is used very efficiently while performing an integrated motion and stress simulation. As long as the restraints and assembly joints for a body do not change, MSC.visualNastran Desktop does not perform a complete stress simulation at every frame (time-step). Only the first frame will require the full time for stress simulation. After this, you will see dramatically faster simulation time (approaching real time for many models).

MSC.visualNastran 4D includes the functionality of MSC.visualNastran Desktop FEA and MSC.visualNastran Motion.

MSC.visualNastran Desktop FEA

Structural Analysis

Perform **stress**, **vibration** or **buckling** simulations on parts or subassemblies. **Meshing** is automated and adaptive. Rigid parts and a variety of joint/constraint types can be included in the models, so you can perform assembly-based stress analysis. View **Factor of Safety** plots for your model.

Steady-State Thermal Analysis

The heat transfer tool in MSC.visualNastran Desktop FEA offers the fundamental FEA capability for steady state thermal analysis. Include thermal load and boundary conditions such as volumetric heat generation, surface convection, surface radiation, surface heat flux, and prescribed temperature. Provide temperature-dependent film coefficients for convection boundary conditions. Control heat transfer boundary conditions with formulas and tables.

Loads

Define total loads, distributed loads, pressures, torques, and concentrated loads with respect to the world, body, or coords in either Cartesian, cylindrical, or face normal coordinates.

Stress Simulation Control

MSC.visualNastran Desktop's stress simulation capabilities streamline processing and save time by giving you complete control over simulation. Through Properties windows, you can control whether stress is calculated for the body during simulation and modify the display of stress simulation results.

MSC.visualNastran Motion

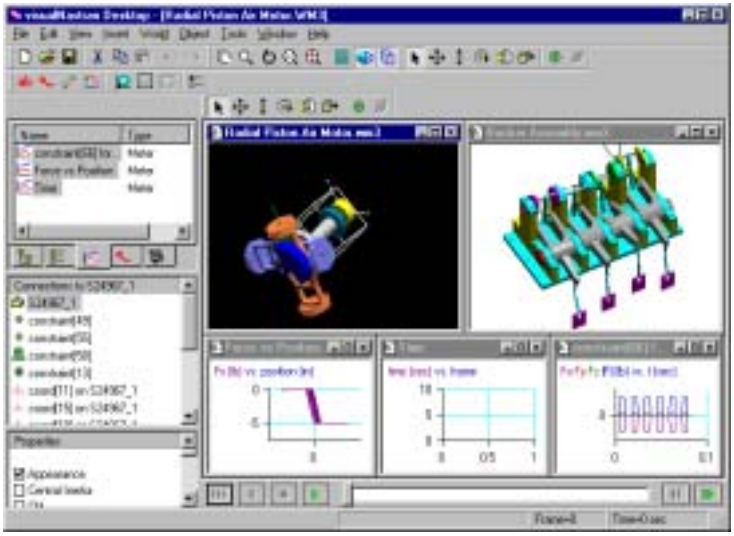


Figure 1-2
MSC.visualNastran Motion's Analysis Environment

Bushing Joints

The bushing joint accurately models "slop" in rigid, revolute, and spherical joints. A bushing joint can deviate from its initial configuration during the simulation according to the applied loads and the bushing parameters.

Conveyors & Surface Velocity

Model conveyors by choosing a **conveyor belt body** from the predefined MSC.visualNastran Desktop geometries. Specify **surface velocity** for all geometry (except spheres and non-faceted ACIS parts). Surface velocity has a magnitude (speed) and body frame direction (rotation direction) that allows you to model conveyor belts and similar objects.

ACIS-based Collision Detection

Use the **ACIS-based collision detection** feature to simulate smooth collision of ACIS imported objects. This is especially helpful when modeling collisions of objects with curved surfaces such as cams.

Custom Collision Models

Customize the response forces used when two bodies collide. You do this by selecting object properties and specifying a "contact model."

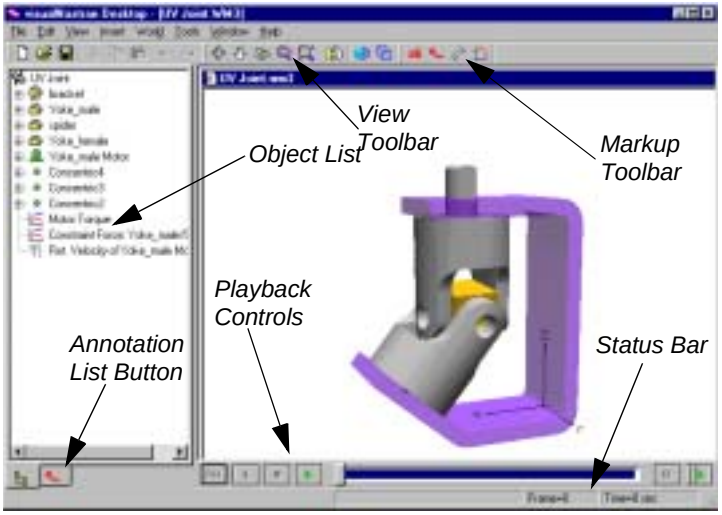
Load Transfer FEA Reports

User reports to generate load information suitable for use with FEA software. The text file contains the load information of the current (simulation) frame in MSC.visualNastran Desktop. The information can also be output in an MSC.Nastran input file format.

MSC.visualNastran Desktop Features

All of the MSC.visualNastran Desktop products include the visualization and animation features described below.

Figure 1-3
MSC.visualNastran Desktop's Visualization Environment



Model Viewing

Open **MSC.Nastran (.XDB)** files, **ACIS-based (.SAT)** CAD models and assemblies, **stereo lithography (.STL)** files, **IGES** files, **Parasolid (x_t, x_b)**, **.WM3** files, **STEP (AP203)**, **AVI** files, and graphics files such as **TIF**, **GIF**, **BMP**. All of these formats except the STL file are imported as ACIS bodies, which allow for stress simulation and NURBS-based collisions.

View models in **shaded**, **wire-frame**, and **kinematic** views.

View models in **perspective** or **isometric** views.

Pan, **zoom**, **rotate**, and **fly-through** assemblies.

Run pre-authored simulations of .WM3 files.

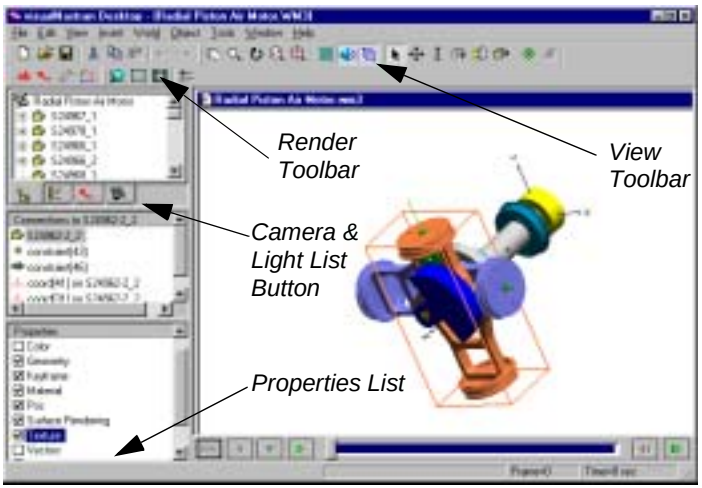
Visualization of MSC.Nastran Output Files

Open and view MSC.Nastran binary output files (**.XDB** files) from any source. This allows you to visualize the **FEA simulation results**, adding other bodies to the model to show the results "in context."

Annotation & Dimensioning

Red-line assemblies with **smart notes**, highlight parts using an **automatic dimension calculator**. Dimensions are updated in real time during simulations.

Figure 1-4
MSC.visualNastran Desktop's Animation Environment



Lights & Cameras

Place **spotlights** anywhere, controlling cone angle, beam distribution, and attenuation. Spotlight and distant light controls include color, intensity, direction and programmatic capabilities.

Use one or more **cameras** to record simulated or animated motion from different angles. Point and click for full zoom and pan control.

Animation

Combine physically-based, simulated movement with **keyframed animation** to create motion sequences of unprecedented realism.

Specify object motion in ways that may not be physically based. For example, you can script a corporate logo to fly through the air, or create a part-exploding automobile engine to show how it is assembled. Even cameras can be keyframed to create "movie-like" scenes that pan, zoom, and highlight product features and technologies.

Photorealistic Rendering

Render your model in production-quality images and videos. Select **surface properties** from predefined materials such as steel and chrome. Add realistic **surface finishes** such as casting. You can also use image files to apply **texture** or **logo decals** to objects. Light settings and camera motion are directly translated from MSC.visualNastran Desktop, and shadows, reflections, and refraction resulting from the physical model are automatically calculated. Save the rendered images in industry-standard formats as well as **AVI** files for animated simulations.

Simulation Engine

The simulation engine is designed for both speed and accuracy. It calculates the motion and/or reaction forces of interacting bodies using advanced numerical analysis techniques. The engine allows the construction of complex systems, and computes their motion under a variety of constraints and forces. In addition to user-imposed constraints such as **spring dampers** or **joints**, the engine has the capability to simulate **multi-body interactions** such as **collisions**, **gravity**, and **external load conditions**. The engine is fully configurable, and every aspect of a simulation from the time step (fixed or variable) to the integration technique can be specified by the user.

Modeling Objects

Each body has a set of physical properties, including mass, coefficient of restitution, coefficient of friction, moments of inertia, positions, and velocities. **Rotational constraints** include rigid joints, revolute joints, spherical joints, and slot joints (rigid, revolute, spherical). **Linear constraints** include rods, ropes, separators, springs, and dampers. **Forces**, **torques**, **actuators**, and **motors** are also available. The properties of these constraints (e.g., a spring constant) are user definable by numeric or equation input.

Measurement & Analysis

Measure time, position, velocity, acceleration, momentum, orientation, angular velocity, angular acceleration, force, torque, friction, contact, and FEA results in **real time**. Enter equations to create custom measurements. Show any value on any axis. Scale graphs to any value.

Simulate and measure in virtually any unit system, including **SI**, **English**, **CGS**, or **custom combinations**. Change unit systems at any time. Use separately-stored **data tables** to drive simulations.

Attach a **"coord"** to any part of a body and measure properties such as position, velocity, acceleration, orientation, angular velocity, or angular acceleration.

Data Export

Export graph data to **tab-delimited text files** for use in **spreadsheets**.

Smart Constraint Joining

Attach a point coordinate (coord) to an object, position it exactly, and then join it to another "coord" to create joints—the objects self-assemble. Or, "paint constraints" directly onto objects to assemble them. Furthermore, you can graphically position objects on the screen, or use a set of numerical entry tools to specify exact configurations.

Automatic Collision Detection

Collisions are simulated automatically, such as back-lash in gears, parts on conveyors, accident reconstruction, cams/followers, and wedges.

Simulation Control

Choose from **Euler or Kutta-Merson integration techniques** with fixed or variable time-stepping. Users can adjust error/accuracy levels and animation step.

Define **formulas** to control parameters of bodies, constraints, and forces using a mathematical parsing language.

Run simulations in a **gravity field**, specify a gravitational constant, or turn gravity completely off.

Reset, single step, or pause the simulation at any time. Save the **simulation histories** to a file.

Unified Modeling, Simulation, and Analysis—No separate pre-processing, analysis, and post-processing phases. Everything is unified in one design/simulation space—the way you think and work.

CAD Integration & Associativity

Import CAD models directly from Autodesk Inventor™, Mechanical Desktop®, Pro/ENGINEER®, Solid Edge™, and SolidWorks® CAD software, and easily update your simulation when the CAD model changes.

Simulink® Integration

The power of dynamic modeling with MSC.visualNastran Desktop is extended to include control with the integration of **Simulink®** (from The MathWorks, Inc., developers of MATLAB®). MSC.visualNastran Desktop is used to construct the dynamic model, while Simulink is used to design the control system. A MSC.visualNastran Desktop library is inserted as a block (vNPlant) into the Simulink model, allowing feedback between the control system and the dynamic model.

Nurbs-Based Geometry Transfers

Designate **faceted or "polymesh" bodies** or **"NURBS-based" geometry** for assemblies for stress analysis. Nurbs-based ACIS geometry transfers are now possible from all CAD systems that have CAD integration as well as from ACIS, Parasolid, STEP, and IGES. You can also toggle back to polymesh or faceted characterizations if you elect not to perform stress analysis or calculate collisions between parts in, for example, an automatic explode sequence.

Video Export

Export simulations, animations, and rendered sequences to **Video for Windows (AVI)** formats.

Installation

This section includes instructions for installing MSC.visualNastran Desktop products and the sample files on a hard disk.

Installing MSC.visualNastran Desktop Products

MSC.visualNastran Desktop comes with a setup program that installs the application and sample files on your hard disk.

NOTE: Please refer to Appendix A of the **MSC.visualNastran Desktop Tutorial Guide** for network installation information.

1. Insert the MSC.visualNastran Desktop CD-ROM into your CD-ROM drive.
2. Select the product you wish to install. Then follow the instructions that appear on your screen.

   The setup program installs the selected MSC.visualNastran Desktop application, sample files, and any CAD integration files that you select.

Be sure to store the MSC.visualNastran Desktop CD-ROM in a safe place.

Documentation

Complete documentation on how to use the product is provided with the online Help, available in MSC.visualNastran Desktop's Help menu.

If you install the CAD integration files, an online workshop demonstrating how to import a model from your CAD package is also available.

Start with the Tutorials

To learn how to use MSC.visualNastran Desktop most effectively, begin with this **MSC.visualNastran Desktop Tutorial Guide** or the tutorials in the Help menu. These exercises give you step-by-step instructions to guide you through construction and use of sample models, thereby exposing you to the most frequently used features.