Simulation Trends

Earlier and faster iterations

More complex phenomena

Larger models, systems

Increasing amounts of data
Simulation Challenges Today
Complex Workflows

3D Master Model

- Roof Crush Analysis
- Heat Transfer Analysis
- Radiator Analysis
- Underhood Cooling Analysis
- Suspension Analysis
- HVAC Analysis
- Life Analysis
- Acoustics Analysis

Geometry
Analysis Data
Simulation Today
Lack of a Cohesive Environment

People
- Expert analysts

Simulation Software
- Various pre/post tools
- Many solvers

Simulation Processes
- Capture
- Re-use

Simulation Data
- Work in progress
- Variants
Evolution of the Role of CAE

Modern Simulation Environments

“CAE is evolving from being a set of ‘black box tools’ for highly specialized individuals toward a group productivity environment that delivers strategic competitive advantages to the business by supporting simulation-driven design.”
Modern CAE Environment
Delivering Competitive Advantages

People
- Expert analysts
- Designers / Design Engineers

Modern Simulation Environment

Simulation Processes
- Capture
- Re-use

Simulation Data
- Work in progress
- Variants
Modern CAE Environment
Delivering Competitive Advantages

People
- Expert analysts
- Designers / Design Engineers

Simulation Processes
- Capture
- Re-use

Simulation Data
- Work in progress
- Variants

Modern Simulation Environment

Smarter Decisions
Elements of a Modern Simulation Environment

Integrated Modeling and Solutions

Multi-Discipline Simulation and Optimization

System Level Modeling and Simulation

Simulation Data and Process Management
## Simulation Trends

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NX CAE
A Modern Simulation Environment

Simulation Modeling

Structural

Thermal

Flow

Motion

Multiphysics

Optimization

Data Management & Automation

Simulation Driven Design
Global NX CAE Customers

“In the space of three hours, four different designs were created and evaluated, and by that afternoon we were designing the part that was going into production,”

Andre Van der Watt
Chief Technology Officer
VW Group South Africa – Motor Division

“We worked with Siemens PLM Software on a simulation project that would have been impossible with our previous simulation tools. We completed the analysis in record time. It took just two days compared to five previously.”

Jack Webb
Senior analyst

“With NX, CAE is an integral part of the design process. Meshing, solving, visualization: it’s all integrated and that’s what makes the whole approach viable.”

Paul Crooks
Head of Design
Wirth Research
Elements of a Modern Simulation Environment

- Integrated Modeling and Solutions
- Multi-Discipline Simulation and Optimization
- System Level Modeling and Simulation
- Simulation Data and Process Management
Integrated Modeling and Solutions

Leverage geometry for faster CAE analysis modeling

- Fast, easy-to-use geometry tools
- Automatic clean up of CAD models
- Rapid, robust midsurfacing
- Quick creation of fluid domain
- Associative to design for rapid updates
- Open, multi-CAE solver support (Nastran, SAMCEF, ANSYS, Abaqus, LS-Dyna)
The Traditional CAE Process

Part Design

Find & Import Data

Repair & Edit Geometry

Mesh

Loads & BCs

Analysis Modeling

Solve

Evaluate
NX CAE vs. Traditional CAE

Faster initial iteration

Rapid update for later iterations
Integrated Geometry Access

Integrated into both NX and Teamcenter

- Instant access to the correct model definition
- Eliminates risk of translating geometry
- Locate and re-use existing models
- Reduces time to start process of CAE modelling
Integrated Geometry Tools

- CAE performed on a geometry variant
- Intuitive and fast direct geometry editing with Synchronous Technology
- Create the geometry required for CAE quickly
- NX ease-of-use combined with user roles to tailor UI
Rapid creation of fluid geometry

Surface wrap fluid domain
- Quickly creates meshable fluid domain geometry
- “Wraps” interior of complex assemblies

Benefits:
- Greatly simplifies fluid domain creation in complex parts or assemblies
- From hours to seconds
- Associativity to design is unique to NX
Large Model Meshing

Meshes the most challenging geometry

- Best-in-class tet mesher
- NX knowledge based approach to meshing and geometry simplification
- Robust automatic and manual mesh options for 1D, 2D and 3D meshes
- Efficient connection modeling
Rapid Iteration of CAE Models

Adapt quickly to changes in geometry

- Geometry edits and mesh associativity to design geometry
- Reduce build time for subsequent model iterations
- Analysts able to perform geometry changes for what-if analysis
Simulation Modeling
Examples

Defeaturing imported geometry using Synchronous Technology

Quickly analyze design variants using Synchronous Technology and associativity

Rapidly create fluid domain geometry

Fast, accurate mid-surfacing
Services Précicad Inc
Case Study

Business challenges:
- Smelter requested a fleet of aluminum electric utility vehicles
- Vehicles needed a load-carrying capacity of 1,000 lbs.
- 6 months to 1 year for development

Keys to success:
- Import Solid Works geometry into NX CAE
- Rapid FEA pre-processing
- Fast design-analysis iterations

Results:
- First prototype ready in 6 months
- Lower weight contributing to longer operation time per battery charge
- 60% fewer welds; lower production costs
- 1,500-pound carrying capacity exceeded original requirements

“NX CAE is really fast and, in the same day, we could do many iterations.”

Stephane Arsenault
Head of FEA Department
Elements of a Modern Simulation Environment

Integrated Modeling and Solutions

Multi-Discipline Simulation and Optimization

System Level Modeling and Simulation

Simulation Data and Process Management
Multi-Discipline Simulation and Optimization

Broad range of physics simulation solutions in a single environment

- Structural, thermal, flow and motion
- Geometry, topology & shape optimization
- Streamlined multiphysics solutions
- Scalable performance on HPC
Structural Analysis

Solutions for body, chassis, powertrain and component applications

- Linear & nonlinear
- Dynamics
- Durability
- Test correlation
- Composites
- Component strength
- Roof crush
- NVH
- Part fatigue
Daimler Case Study

Usage
- Body/Chassis NVH analyses
  - Rough road transient
  - Engine vibration
  - Wheel unbalance
  - Interior noise acoustics – with interface to SFE Akusmod
  - Large eigensolutions – with interface to CDH AMLS
  - Brake squeal frequency analysis
  - …

- Powertrain
  - Thermal stress of exhaust systems
  - Drivetrain vibrations from gear mesh
  - Powertrain frequency analysis
  - Powertrain radiation with interface to Sysnoise

Trends
- Larger full vehicle models
- More integrations with other solutions such as acoustics, durability, MBD
Structural Analysis
Examples

- Roof crush analysis
- Roof bow analysis within design environment
- Nonlinear analysis of rubber boot
Thermal Analysis

Solutions for body, chassis, powertrain and component applications

**Capabilities**
- Conduction
- Convection
- Conjugate Heat Transfer
- Radiation

**Applications**
- Brake squeal
- Exhaust piping
- Engine water jacket
- Exhaust manifold
- Engine block
- Cylinder head
- Passenger compartment solar heating
- Lamps
Thermal analysis of a brake rotor
Flow Analysis

Solutions for body, chassis, powertrain and component applications

<table>
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<tr>
<th>Capabilities</th>
<th>Applications</th>
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<tr>
<td>Compressible</td>
<td>Engine intake and exhaust flow</td>
</tr>
<tr>
<td>Incompressible</td>
<td>Cabin A/C flow</td>
</tr>
<tr>
<td></td>
<td>Brake system hydraulics</td>
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<tr>
<td></td>
<td>Engine coolant system</td>
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<tr>
<td></td>
<td>Transmission and engine lubrication systems</td>
</tr>
<tr>
<td></td>
<td>Fuel system</td>
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Flow Analysis
Examples

Automotive HVAC system flow analysis

Flow analysis with geometry optimization of intake duct
Motion Analysis

Solutions for body, chassis, and powertrain applications

Capabilities
- Rigid body
- Flexible body
- 2D & 3D contact
- Co-simulation with control systems
- Clearance & interference checking

Applications
- Suspension
- Sunroof mechanisms
- Convertible top mechanisms
- Piston and crankshaft
- Automatic doors
Motion Analysis
Examples

- Truck steering mechanism
- F1 car suspension analysis
- Simulation of a flexible brake line
- Co-simulation of motion with control systems
Optimization

Solutions for body, chassis, powertrain and component applications

**Capabilities**
- Geometry optimization
- FE parameter optimization
- Weight reduction
- Correlation to test
- Optimal fluid flow

**Applications**
Geometry optimization of an automotive intake duct for flow pressure loss
### Multiphysics

#### Streamline workflows for combined physics solutions

<table>
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<td>Thermal-fluid</td>
<td>Underhood cooling</td>
</tr>
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<td>Thermal-stress</td>
<td>HVAC</td>
</tr>
<tr>
<td>Fluid-structural</td>
<td>Fuel tank sloshing</td>
</tr>
<tr>
<td>Motion-structural</td>
<td>Suspension components</td>
</tr>
<tr>
<td>Radiators</td>
<td></td>
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</tbody>
</table>
Multiphysics Examples

Motion, structural, and durability on a motorcycle suspension link

Fluid-structure interaction in a fuel tank

Thermal-fluid analysis of automotive radiator
Volkswagen Group South Africa
Case Study

Challenge:
- Tight timeframe for making changes to race cars

Solution:
- Tight integration of NX and Teamcenter
- NX with synchronous technology
- Kinematics analysis and finite element analysis

Results:
- Fast changes to existing geometry
- Even complex parts can be redesigned in half a day
- Entire team, suppliers and sponsors kept in the loop

“When you’re changing certain designs in such a short period of time, obviously there must be a level of confidence, and that comes from the Siemens software.”

Johan Smit
CAD Design Supervisor
Elements of a Modern Simulation Environment

Integrated Modeling and Solutions

Multi-Discipline Simulation and Optimization

System Level Modeling and Simulation

Simulation Data and Process Management
**NX CAE**
System Level Modeling and Simulation

**Distributed CAE Assembly Model**

- Analogous to CAD assembly
- Individual FE component models
- Assembly model instances FE components
- Supports very large models
Systems Analysis
Mechanical Systems with Controls

Simulate interaction between mechanical systems and controls

- Co-simulate mechanical motion with control systems using NX with MATLAB Simulink
- Integrated solution of motion control with motion flexible body
Solving Larger Models

NX Nastran focus on scalability
- Maximize utilization of cluster
- Reduce run times
- Solve larger models
- Significant increases in scalability between V1 and current V8

Parallel Processing for Flow and Thermal Simulations
Quantitatively and qualitatively compare simulation with physical test

- Correlate analysis with physical test
- Correlate analysis with analysis
- Ensure accuracy of reduced DOF models
- Pre-test planning to optimize sensor locations
- Optimize analysis model to better reflect reality
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Simulation Data and Process Management

Intelligent integration between design & simulation processes
Teamcenter for Simulation
External Reviews Show as Best Solution

- Rated 5 vendors (Altair, Ansys, Dassault/Simulia, MSC, Siemens PLM)
- Siemens PLM scored highest overall
- Siemens PLM scored highest in each of the four categories

Ford Motor Company Scores Quick Win with Teamcenter Simulation Process Management
Keith Meintjes, Research Director, CAE  ▪  December 7, 2010

The CPDA Design/Simulation Council has focused consistently on simulation data management, process management, and the automation of CAE workflows. Part of the Council’s effort is to document case studies on the payoffs and challenges of simulation data management and process automation.

Teamcenter Simulation Process Management was recently installed at Ford Motor Company, which quickly realized substantial gains in their process to develop CAE models. In 2009, Ford began planning to exploit Teamcenter’s simulation process management capabilities, to replace their in-house tools. The system was installed in April 2010, and deployed to production in May. One key objective was to fully leverage an out-of-the-box solution and not a dedicated or proprietary solution. Virtually no customization and a low effort implementation were the key drivers.

- Efficiency gains of 4-8 times for creating and managing CAE configurations
- Virtually no customization on top of an out-of-the-box solution
Late Feedback to Designer

Late Feedback to Designer
Simulation Data and Process Management

Automate simulation processes for analysts and designers

- Automation tools that can drive complex analysis
- Common architecture allowing plug-ins
- Managed environment to distribute process automation to enterprise
- Guide designers through basic simulation tasks
Simulation Knowledge Capture

...Through Automated NX Simulation Processes Created by CAE Analysts

Simulation knowledge transfer via automated NX process

More robust designs passed to simulation for detailed analysis
Challenge:
- Designing the all-new petrol engined Acura ARX-02a sports car to beat the dominant Audi and Peugeot diesels

Solution:
- Use integrated CAE tools of NX to ensure vehicle integrity and reliability

Results:
- First time out, beating Audi and Peugeot to pole position in the Mobil 1 Twelve Hours of Sebring

“With NX, CAE is an integral part of the design process. Meshing, solving, visualization: it’s all integrated and that’s what makes the whole approach viable.”

Paul Crooks
Head of Design
NX CAE – A Modern Simulation Environment

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Why Siemens?
Major Investments in CAE for Product Development

“The integration of product development, simulation and validation is now at the top of our agenda.”
Anton Huber, CEO
Siemens Industry Automation

“We are investing heavily in CAE … for multi-disciplinary analysis throughout the product definition cycle.”
Chuck Grindstaff, CEO
Siemens PLM Software
Siemens acquires LMS International

Providing a closed-loop, systems-driven product development solution

- Based on system simulation and test
- Enabling mission-critical applications and best practices
- Embracing open strategies
- Supported by world-class engineering services
- Providing unprecedented value to customers
System Validation & Optimization
Collaboration between NX CAE and Imagine.Lab

Architecture & Sizing
Imagine.Lab

Detailed Design Validation & Optimization
NX CAD/CAE

System Integration & Validation
Imagine.Lab
A Modern Simulation Environment for Automotive Product Development

Smarter decisions, better products