ANSYS Environment for Multidisciplinary Simulation

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Duxford Air Museum
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Range of Technologies

ANSYS Software provides a comprehensive range of simulation technologies:

• **Computational Fluid Dynamics (CFD)**

• **Finite Element Analysis (FEA)**
  - Implicit (low speed)
  - Explicit (high speed impact/blast)

• **Electromagnetics**
  - Low frequency (Motors / Transformers)
  - High frequency (Microwave / Signal Integrity)
CFD and FEA models offer reliable, validated techniques for simulating how fluids and structures behave.

The underlying technology is very similar:
- A ‘CAD’ model of the part is made,
- This is decomposed into a large number of component grid ‘cells’, or ‘elements’
- The governing equations of fluid or structural mechanics are then solved at each of these grid locations (usually in an iterative manner).
- Combined, this provides a detailed 3D picture of how the part responds to the loads / flow conditions involved.
Simulation Driven Product Development
Our Vision & Strategy

- Structural Mechanics
- Fluid Dynamics
- Thermal Analysis
- Electromagnetics
- Meshing
- High Performance Computing
- Comprehensive Multiphysics
- Complete System Modeling
- Bi-Directional CAD Associativity
- Workflow Management
- Automated Tools
- Dynamic CAE Collaboration
- Access Management
- Data Management
- Process Management
- Design Exploration
- Virtual Prototyping
- Advanced Technologies
- Process Compression

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Structural

- Advanced Capabilities
  - Nonlinear materials
  - Large deformation
  - 3D frictional contact
  - Structural dynamics
  - Explicit dynamics
  - Large overall motion

- High Performance Computing
  - Parallel processing
  - Highly scalable

- Customizable
  - User elements & materials
  - Scripting
Fluids

- Advanced Capabilities
  - Multiphase
  - Multispecies flows
  - Reacting flows
  - Multiple reference frames
  - Latest turbulence models
- High Performance Computing
  - Large models: >1 billion
  - Large clusters: >1024 cores
- Integrated
  - Unified meshing
  - CFX & Fluent solvers
  - Unified post-processing
Thermal

- Advanced Capabilities
  - Radiation
  - Phase change
  - Mass transport
  - Steady-state
  - Transient
  - Conduction
  - Convection
  - Far field decay
  - Time dependent boundary conditions

- Advanced Materials
  - Temperature dependent
Electromagnetics

- High Frequency
  - Full wave solution
  - S-parameters
  - Radiated field outputs
- Low Frequency
  - Magnetostatic
  - Transient
  - Eddy current
- Advanced Materials
  - Nonlinear
  - Isotropic & anisotropic
  - Frequency dependent
- Automated Pre & Post-Processing
  - Adaptive meshing
Meshing

- CAD Associativity
  - Bi-directional
  - Persistent
  - Parametric
- Flexible
  - Geometry clean up
  - Multiple mesh methods
  - Advanced mesh controls
- Highly Automated
  - Automatic contact
  - Apply loads to features
  - Physics aware

Courtesy of Ford Motor Company
In-Depth Technology Spanning Multiple Domains

- **Technical Breadth**
  - Meshing
    - Tet/Prism
    - Structured Unstructured
    - Multi-zone Body-fitted Cartesian
    - Patch Independent

- **Structural**
  - Large Displacements
  - Finite Strain
  - Contact
  - Multibody Dynamics
  - Random Vibration
  - Implicit & Explicit
  - More...

- **Fluids**
  - Compressible
  - Incompressible
  - Laminar Flow
  - Turbulence
  - Multiphase Flow
  - Non-Newtonian Fluids
  - More...

- **Thermal**
  - Conduction
  - Convection
  - Radiation
  - Phase Change
  - Mass Transport
  - More...

- **Electromagnetics**
  - Quasi static (Low Freq)
  - Full Wave (High Freq)
  - Eddy current
  - Transient with motion
  - Circuit Coupling
  - More...

- **Steady-State, Transient, Harmonic & Modal**
  - Linear & Nonlinear
End-To-End Solutions
In a Unified Environment

Arrive at the answer faster & easier without application barriers
Multiphysics
Built on a Strong Foundation

Reduce engineering assumptions by coupling multiple physics

Increase productivity by including all physics in unified environment

Rely more on high fidelity virtual prototypes

Depend less on costly physical testing
Reduce engineering assumptions by including all physics in one unified environment.
Scalable Performance
Desktop to Cluster

- Moderately Complex Geometry
- Moderately Complex Assemblies
- Multiple Physics
- Long Transient Analyses
- Complex Geometry
- Large Assemblies
- DOE

Problem Size/Solution Speed
Scalable Deployment Expands with Maturing Processes

An Interface Which Reduces Technical Barriers

Model & Data Sharing

Automated Workflow

Knowledge Capture Data Mgmt Protect Intellectual Property

Single User

Work Group

Enterprise

Organization/Process Maturity
Scalable Flexibility
Balancing Automation & Control

Rapid Modeling
Transparent Meshing
Automated Simulation

Best Practice
Settings

Application
Engineer

Flexible Controls

CAE
Specialist

Full Solution Control
Advanced Meshing
Customization

Simulation Control
Underlying Technology : CFD

ANSYS has 2 CFD codes in its portfolio, ‘CFX’ and ‘FLUENT’
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These codes enable the simulation of flows that are:
- **Single-Phase**

Steady pump and valve flows
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  • Single-Phase
  • Multiple Species

Smoke dispersion in atrium of large building

Courtesy of RWDI, Inc., Guelph, Canada
Underlying Technology: CFD

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Ice Build-Up on Leading Edge

Inducer flow with thermal cavitation
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- **Turbulent Flows**
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- Turbulent Flows
- Particle-laden flows

Droplet Flow in a Scrubber
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Heat transfer can be included from:

- Thermal Conduction in a solid
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- Thermal Radiation

Thermal Radiation in an Automotive Headlight
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Heat transfer can be included from:
- Thermal Conduction in a solid
- Thermal Radiation
- Internal Heat Generation

Temperatures in a Fuel Transport Cask
ANSYS has 4 codes that include FEA technology in its portfolio:

- ‘ANSYS Mechanical’
- ‘ANSYS Explicit STR’
- ‘ANSYS AUTODYN’
- ‘ANSYS LS-DYNA’
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- Full 3D Stress Analysis

Stress distribution in a valve, during a transient analysis of a shutdown event

Courtesy Structural Integrity Associates
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Image courtesy of CADFEM GmbH / Elektromotorenwerk Grunhain GmbH & Co KG
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- Full 3D Stress Analysis
- Multibody Dynamics
- Multiphysics
- Modal Analysis
  (inc new ‘Supernode Solver’)

Impeller four-nodal diameter mode associated with its first natural frequency; this value, 141 Hz, is close to other vibrational frequencies of the global system.

Courtesy Riello SPA
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- Full 3D Stress Analysis
- Multibody Dynamics
- Multiphysics
- Seismic Analysis
- Composites

A liquid-hauling tank and associated structures of the truck were analysed. The truck's tank was made of filament-wound composites and sandwich structures.

Courtesy Componeering Inc.
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- Full 3D Stress Analysis
- Multibody Dynamics
- Multiphysics
- Seismic Analysis
- Composites
- High Speed Impact

F4 Phantom Impacting Reinforced Concrete
Inter-Connectivity of these Codes

The ANSYS products are integrated into ANSYS Workbench, and are readily able to pass data (geometry / mesh / results) between the different products.
Summary

• ANSYS tools offer both an unequalled breadth of application areas (Fluid Dynamics, FEA, etc) ...

• And an unparalleled depth, enabling the most complex of underlying physics to be incorporated

• These tools are all integrated in the Workbench environment