Advanced composite simulation
Simcenter 3D Launch
TREND

Increasing product development complexity driven by smart products, new materials and manufacturing methods and increased customization.

IMPLICATION

Current practices inadequate to meet new demands. More unknowns imply longer lead times and greater risk products will not perform as intended leading to lost opportunities and dissatisfied customers.
Issues facing 3D CAE today

Verification only
Out of synch with design
Disconnected tools & dataflow
Lack of flexibility

Be more efficient
Enable new insights
SIMCENTER 3D: The response to CAE challenges

Broad range of physics simulation solutions in a single environment

- Fast and accurate solvers
- Fully coupled multi-physics solutions
- Scalable performance on high performance computing (HPC)
- Licensing flexibility: cloud, tokens
- Backed by Siemens industry expertise
Simcenter 3D Engineering Desktop

*Single modelling environment open for external solvers and CAD*

- **Synchronous Technology for Multi-CAD Geometry Editing**
- **Advanced Meshing, Mid-Surfacing**
- **FE Assembly Management**
- **Multi-discipline Modeling**
Technical capabilities

Highly efficient for model preparation AND what-if studies

Simcenter embeds various efficient tools for model preparation with associative meshing. Bringing engineers: very efficient design change, what-if, up to optimization capabilities.

- **Efficient mid-surfacing** replaces solid geometry with surface geometry faster
- **Automated face-pairing and trimming** with multiple bodies
- **Automatic free edge stitching** reduces manual editing
- **One-click updates** eliminate manual intervention as base geometry changes
Technical capabilities
Simcenter Laminate Composite

Fully integrated to the composite development process.
Efficient (drive the complete process), openness (support multiple FE solvers), customizable

Core Capabilities...

- **Laminate Modeling** (Zone based, Ply based)
- **Composite Materials** (Ply material…)
- **Laminate Failure** (Several criteria + User defined)
- **Laminate Validation** (ADB matrix)
- **SC FE Solver Interfaces** (Samcef, NX Nastran…)
- **Laminates Post Reporting** (3D view, tabulated data)
Technical capabilities
Unique Combination of Range and Depth

Simcenter is the only product (Pre, Post, Solver) which combines **RANGE** and **DEPTH**
Bringing engineers: a highly efficient process complemented with high fidelity simulations
Simcenter 3D Engineering Desktop

Direct access to own and 3rd party solvers

- NX Nastran
- LMS Samcef
- Abaqus
- ANSYS
- LS-Dyna
- MSC Nastran

- Create models
- Postprocess and share results
- Open to structural, thermal, fluids
- Integrate in house codes

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Simcenter 3D for Composite

**Finite Element solver**

### Strength / Stiffness Analysis / Linear Response
- Displacement
- Stress
- Strain
- Frequencies
- ...

### Buckling and Post-Buckling Analysis
- Nonlinear with large displacements/rotations, large strains & various types of contact and gluing conditions
- Dedicated algorithm for buckling, post-buckling

### Progressive Damage Simulation
- Classic Failure criteria computed directly by FE solver (performance): critical ply, value, load case
- Progressive damage simulation for inter- or intra-laminar damage modeling

### Manufacturing Simulation
- Curing analysis (spring-back)
- Effects on the mechanical behavior and the tolerance for assembly.
Curing simulation
Physical mechanism

Thermal modeling: evolution of temperatures, degree of cure, $T_g$ over time and space

PURELY VISCOUS
no load
no residual stress

1. LIQUID

VISCO-ELASTIC
stress generation
but relaxation

2. RUBBERY

ELASTIC
linear behavior

3. GLASSY

Mold temperature
Temperature in the part
Glass transition temp.
Degree of cure

$T_g$, $T_c$, $X$, $X_{gel}$, $T_g(X)$, $T$
Challenge
• Predict the effects of the manufacturing process
• Predict the performances of the part, taking into account the effects of the manufacturing process

Solution
• Coherent virtual process (draping approach, a sequential coupled thermochemical, thermo mechanical analysis)
• Parameterized solution

Benefits
• Better knowledge of the composite structural performance: “As-Planned” vs “As-Built”
• Accurate values and the correct estimation of the residual stress of the component

NAFEMS Seminar: Simulation von Composites, 2014
“Virtual process chain combined with online process monitoring for first time right manufacturing of composite structures” Brauner C., Miene A., Hermann: FASER Institute, Bremen University
Bruyneel M., Pascon F: SAMTECH (Siemens Company), Liège

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Simcenter 3D for Composite
Progressive damage simulation

Target: reaching 50 percent weight reduction by 2020 or 2030

- Predictive damage models at the coupon level and at composite subsystem design concept level
- Development of the parameter identification procedure, based on a limited amount of physical tests on coupons

“Not only at Honda, but many engineers in this field think that we can still make vehicles that have a 50 percent lighter body structure using composites while maintaining the mechanical properties of the replaced metallic parts.”

Yuta Urushiyama, Composite body innovation programs Honda R&D Co., Ltd.

- LMS Samtech Samcef Mecano non-linear finite element solver
- LMS Engineering Services for composite damage model identification
Simcenter 3D for Composite
*Progressive damage simulation*

- Facilitated the engineering and analysis of complex composite structures
- Used improved understanding of composites to increase lead over competitors
- Enhanced ability to perform composite damage analysis

**Leveraging the value of composites with Simcenter 3D**

Damage on a composite helicopter blade

- Identify delamination and damage in composite structures
- Use nonlinear analysis to determine adequate safety margins

“Thanks to the implementation into LMS Samcef of advanced composite material laws […] Airbus Group gained much deeper physical insights, thus extending the gap with its competitors by positioning itself as the first and leading research department able to offer such advanced expertise.”

Didier Guedra-Desgeorges, VP "Materials, Structures & Manufacturing Technologies” Airbus Group Innovations
Simcenter 3D for Composite
Buckling and Post Buckling analysis

Leveraging the value of composites with Simcenter 3D

- Virtual prototype of the stiffened panels
- Better knowledge of the non linear structural behavior to predict the buckling, post buckling and collapse of the structure
- Accurate results and fast solution procedure

Damage on a composite stiffened panel
Correlation between simulation and test results

- Non linear analysis of thin-walled damaged stiffened composite panels: buckling, post-buckling and collapse

“In the aeronautical industry it is very important to verify that there is no risk of failure in a structural component that is allowed to buckle in flight. For that, […], it is absolutely needed to capture by analysis the most critical scenario. […] In the collapse phase, the best behavior was given by the code SAMCEF that has found the right buckling mode”

“Garteur(SM) AG-25 Post-buckling and collapse analysis”, M.H. Van Houten and A. Zdunek
Simcenter 3D for Composite
A step forward in the simulation process

- Fibersim™ for draping process
- Manufacturing data set
- Manufacturing optimization
- Structural Analysis
- Simulate as manufactured
- Spring back, curing
- Thermal Analysis
- Production
- Laminates, plies, materials definitions
- Damage tolerant design
- Real light weight design

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