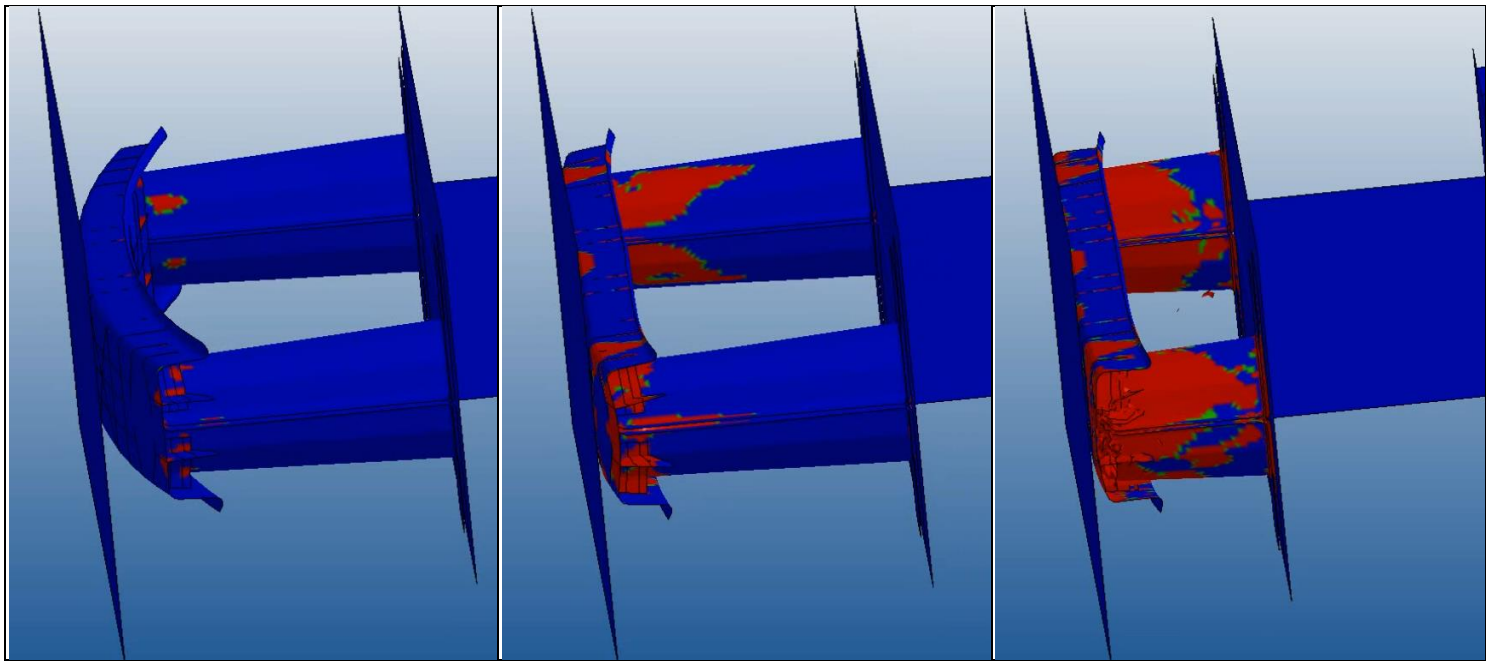
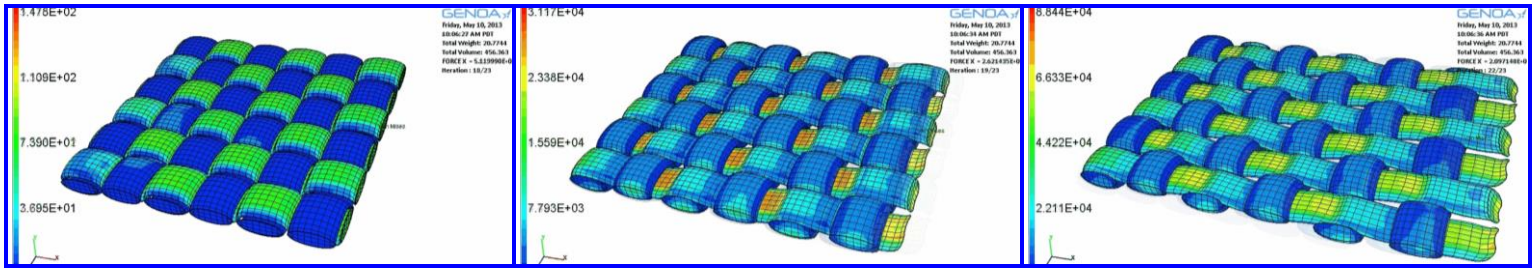
GENOA
M S - P F A



GENOA is a durability & damage tolerance, progressive failure, and reliability software that provides engineers with predictive computational technology to characterize and qualify advanced composite materials and structures. Through GENOA's true De-Homogenized Multi-Scale Progressive Failure Analysis, engineers are able to assess failure at the macro, micro and nano levels for advanced materials and composite structures subject to static, fatigue, impact and environmental loadings. Using a closed-form, de-homogenized, analytical methodology, the software is integrated with building block strategies which result in the accurate assessment of failure and test reduction. GENOA's ability to assess damage, fracture initiation and evolution, integrate the damage & fracture mechanics, and determine percent damage contribution make it a unique tool for advanced structural design.



Highlights:

- ✓ Multi-scale, Micro-mechanics Toolset
- ✓ Closed Form Analytically Based
- ✓ de-Homogenized: Examines Fiber, Matrix, Interface, Interphase
- ✓ Augments Commercial Finite Element Solvers (ABAQUS, LS-DYNA, NASTRAN, etc.)
- ✓ Damage/Fracture Evolution
- ✓ Assess Durability and Damage Tolerance
- ✓ Identifies Where, When, Why and How Failure Occurs
- ✓ Includes Failure Mechanism Percentage Contribution

Key Benefits:

- ✓ Predict structural performance considering defects (void, fiber waviness, curing and residual stress)
- ✓ Modeling and simulation of complex parts and materials
- ✓ Address design envelope parameters
- ✓ Compatible with HPC for parallel processing of large complex models
- ✓ Guides test by analysis to reduce testing up to 50%
- ✓ Optimize design of lightweight structures and vehicles
- ✓ Delivers Greater Accuracy with Minimal Computational

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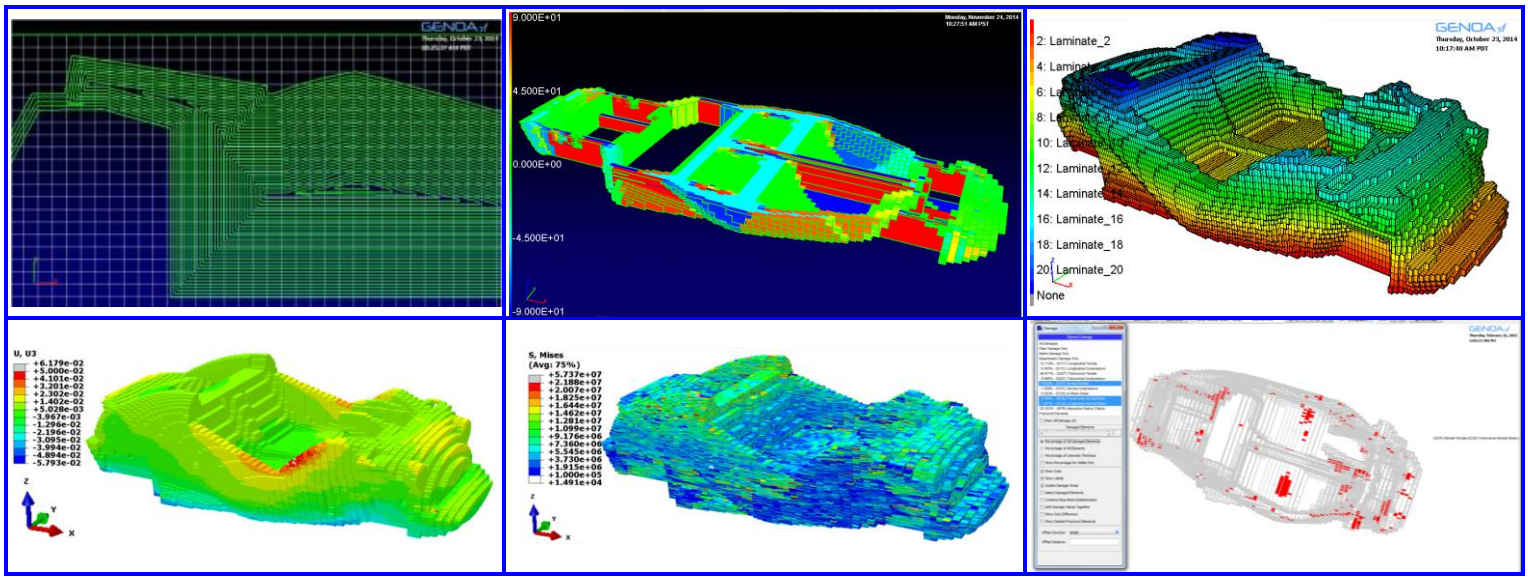
GENOA
3DP SIMULATION

Overhead



GENOA 3DP Simulation is an additive manufacturing design tool and software suite that simulates the 3D printing process, for both polymers and metals, to accurately predict the deflection, residual stress, damage initiation, and crack growth formation associated with as-built AM parts. Advanced Multi-Scale Progressive Failure Analysis methods are used to replicate the entire 3D printing process from the level of Material Characterization to Advanced Structural Analysis in order to determine voids, delamination, manufacturing anomalies, and other irregularities and inefficiencies from micro to macro scales. More significantly, GENOA 3DP Simulation provides the end user with an ability to import an STL file/G-Code; generate a structural mesh, run analysis and optimize the build in order to reduce weight, reduce scrap rate, improve performance and meet specification.

Highlights

- ✓ Generate structural Mesh from STL file or printer G-CODE to mesh and simulate the manufacturing process
- ✓ Supports validated database of powder metals, chopped fiber (thermoplastics), and graphene platelet (thermosets)
- ✓ Predicts presence of residual stress, deformation, and delamination (initiation/propagation)
- ✓ Predicts fracture, failure type and percentage of contribution of failure type (when, where, why)
- ✓ Identifies location and extent of damage and fracture; i.e. diffusion creep, void and surface roughness
- ✓ Generates stress-strain curve for static analysis/prediction
- ✓ Generates Fatigue + Defects: a-N,S-N Curve for fatigue analysis/prediction
- ✓ Supports thermal profile validation performed for wall model
- ✓ Provides coupled structural-thermal solution (fully/sequentially coupled)
- ✓ Identifies scatter, uncertainty, sensitivity for process and material optimization
- ✓ Identifies parameters to be changed to improve manufacturing process; i.e. printing speed, intrusion distance, material temperature, ambient temperature, material type, inclusion orientation, aspect ratio (i.e. fiber length); etc.

Key Benefits

- ✓ Characterize AM materials in coordination with an ICME framework
- ✓ Integrates AM process simulation with structural design and design analysis
- ✓ Provides process improvement for robust design optimization in order to minimize defects
- ✓ Design, model, and fabricate AS-BUILT Parts
- ✓ Manufacture optimized part topology
- ✓ Addresses performance and manufacturing constraints
- ✓ Validate developed/enhanced model for AS-IS Performance

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