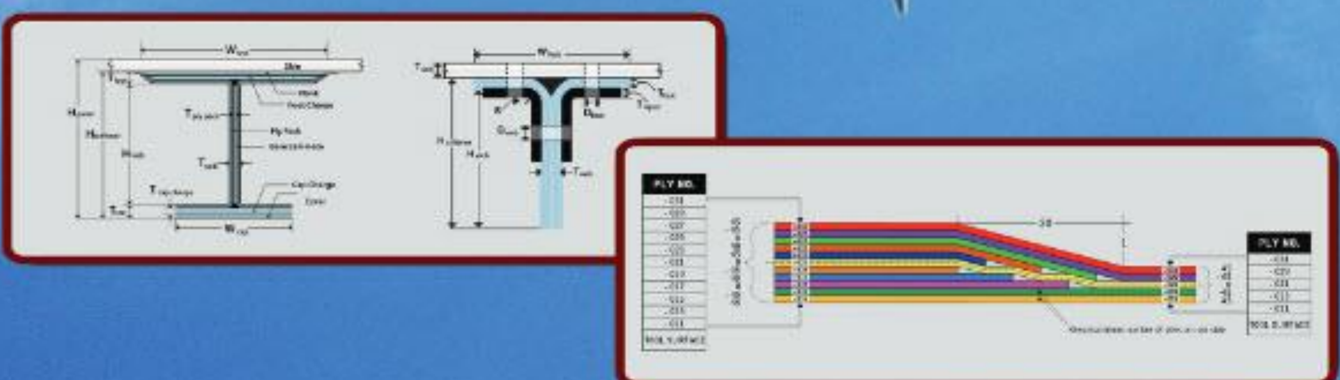
HyperSizer® Software

Structural Analysis and Optimization Software for composite and metallic airframes that provides a complete analysis solution from preliminary design to final analysis and certification.

DESIGN ANALYSIS OPTIMIZATION



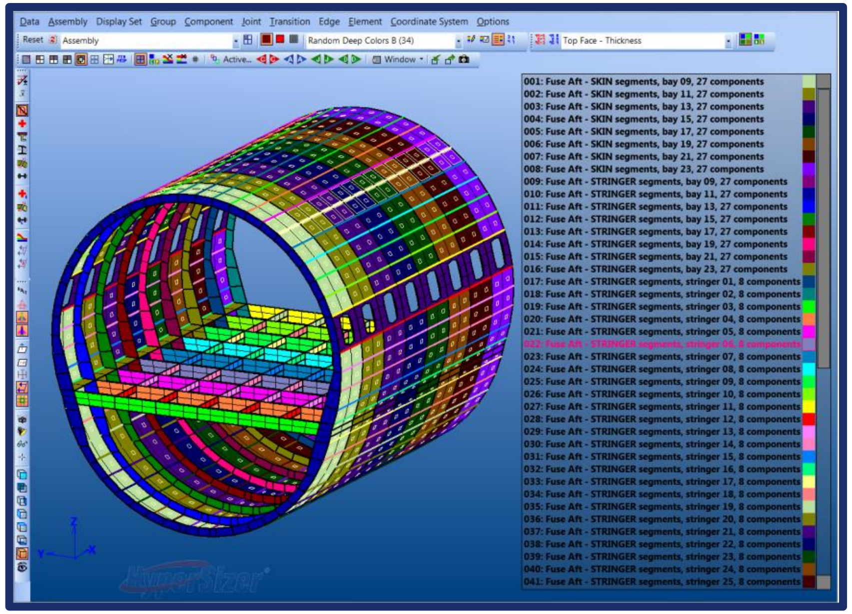
Prov:
H.Azargoshasb

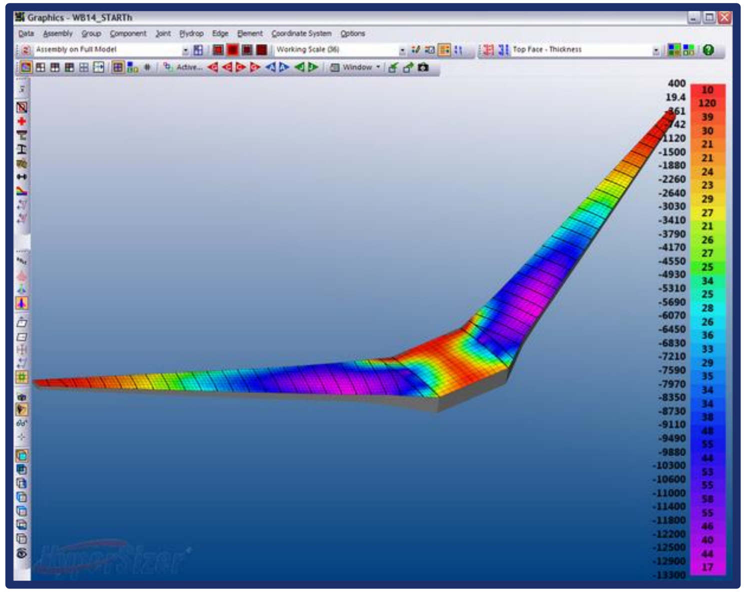
What Is HyperSizer?

HyperSizer is **Design**, **Analysis**, and **Optimization**

Software for **Composite** and **Metallic Structures**

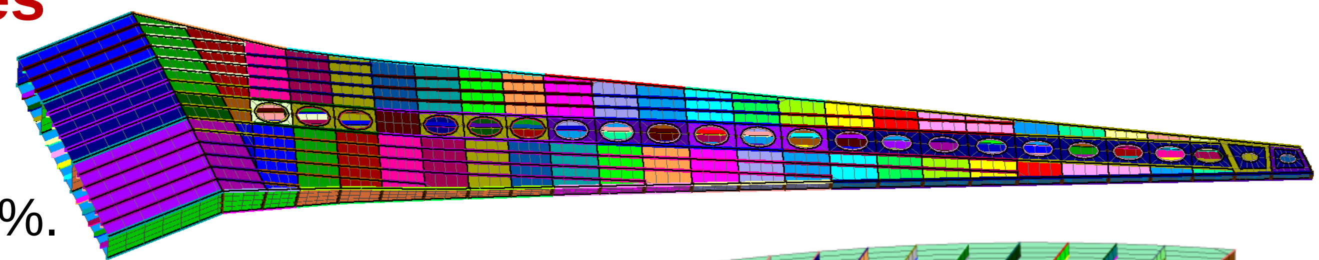
- **Preliminary Design Optimization**
- **Final Analysis Margins of Safety Calculations**
- **Stress Report Documentation**
- **Test Data Validation**
- **Graphically** represented by unique color regions on the FEM
- **Determine the lightest weight**
- **Combination** of **material systems** (including layup ply angles and stacking sequences) and cross sectional **geometric dimensions** (panel height, stiffener spacing, etc.)
- **Laminate optimization**



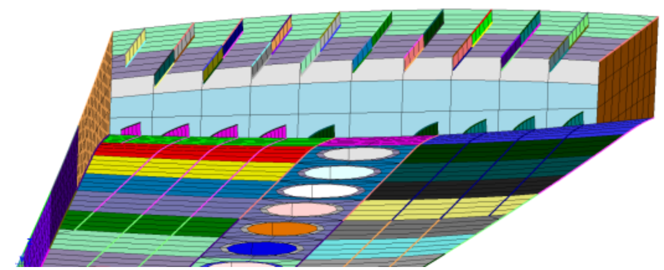


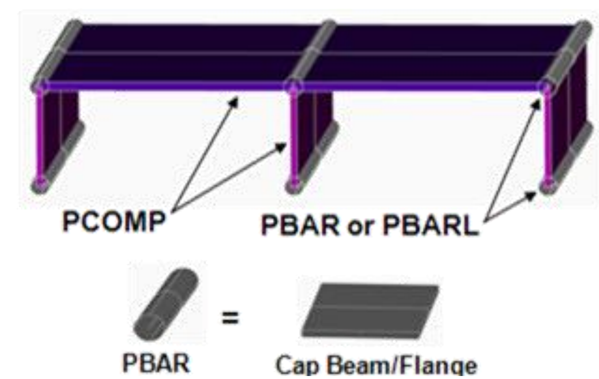
What HyperSizer Does?

HyperSizer Extends the Capabilities of Your Existing Software



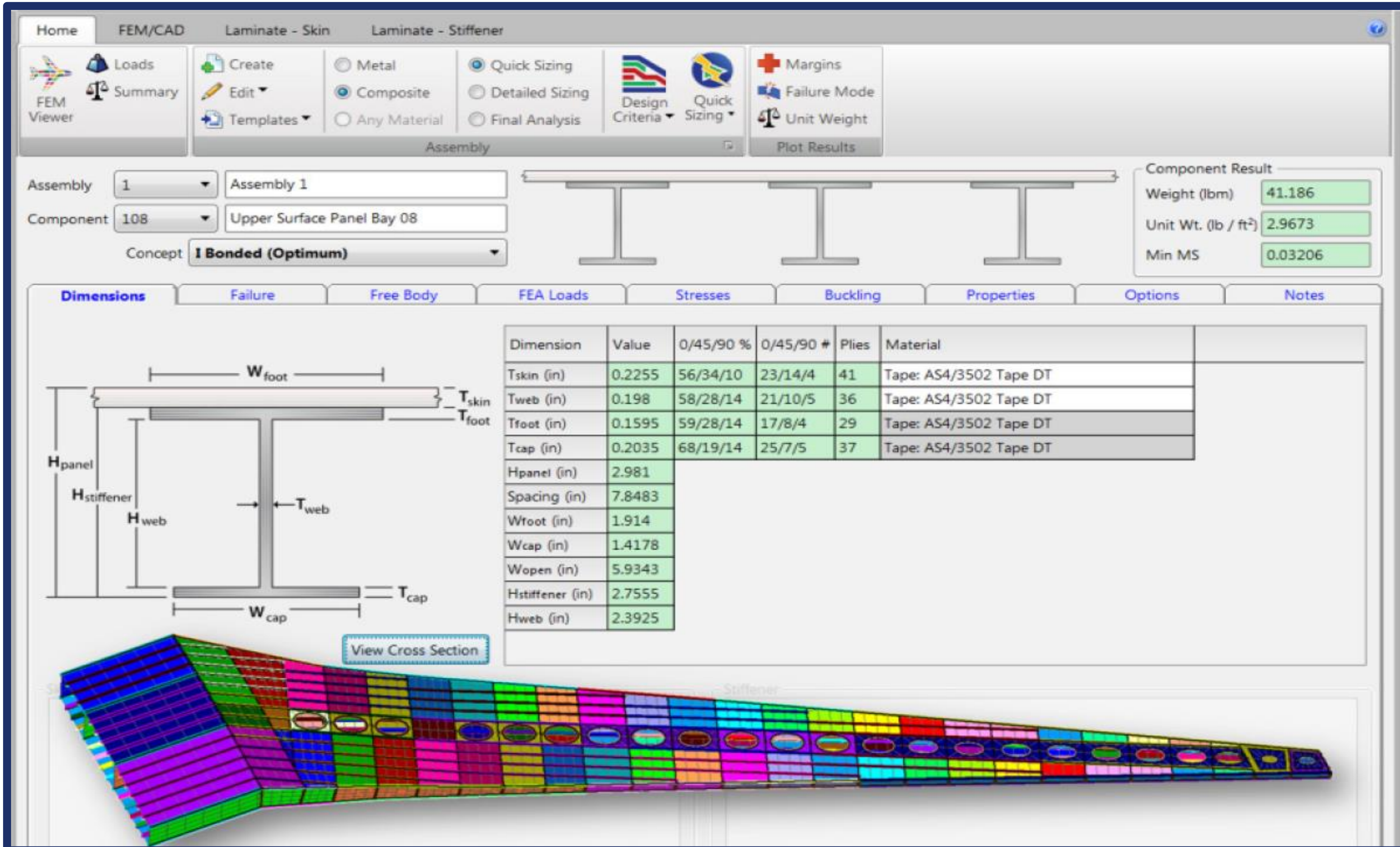
- **Reduce** structural **weight** by more than 20%.
- **Increase productivity** by automating the types of airframe structural analyses that are performed.
- **Reduce design cycle time and engineering effort** while also evaluating millions of panel and beam cross sections. No remeshing is required.
- **Certify structures faster** by analyzing hundreds of industry standard failure methods, generating complete documentation for FAA certification, and providing a test database for test data validation.





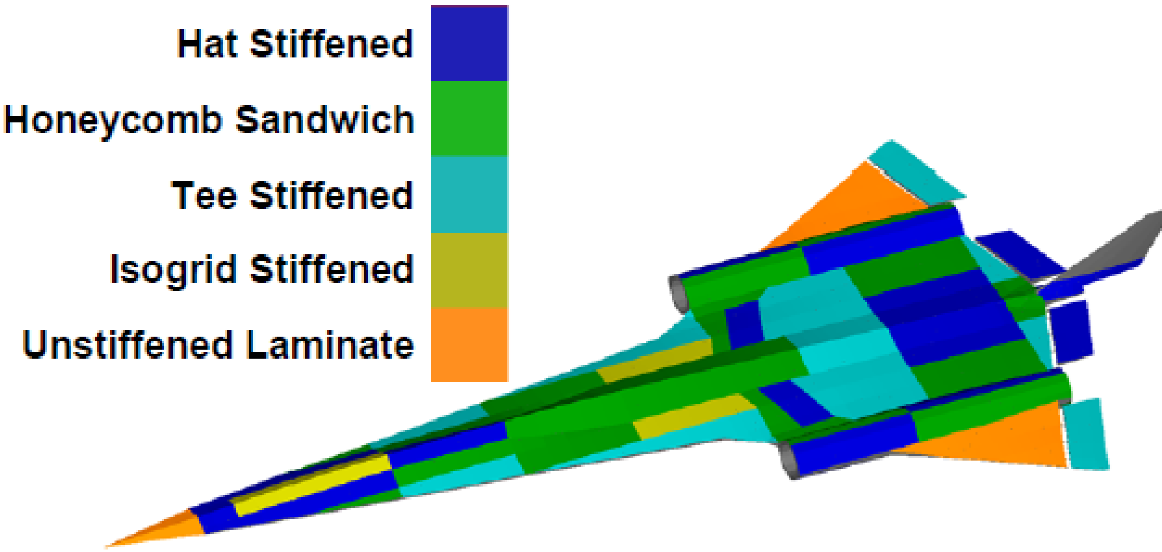
The HyperSizer Process?

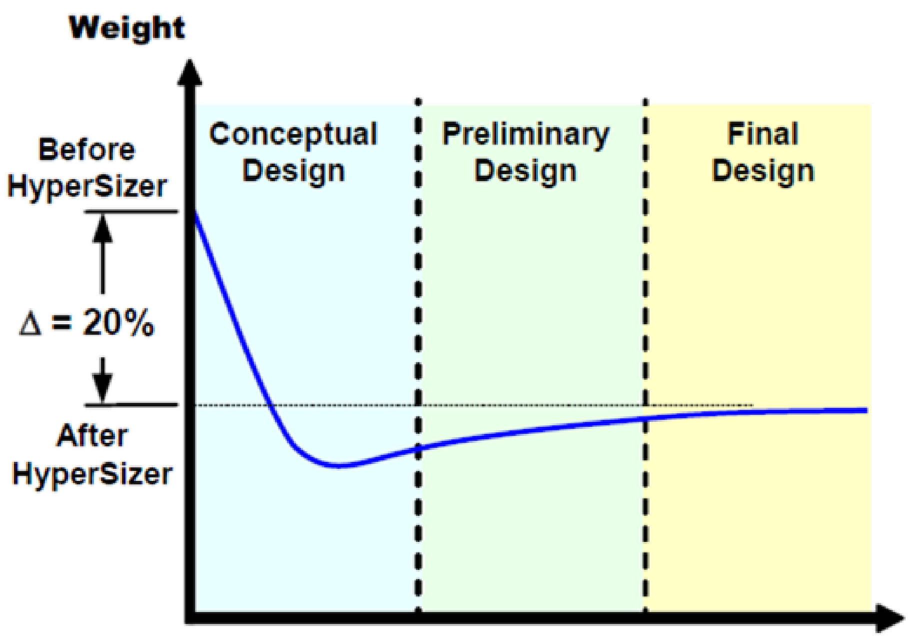
- **Import a Finite Element Model** from your existing FEA tool.
- **Optimize the panels and beams** to resolve all negative margins of safety for your selected analysis methods.
- **Design composite structures for strength, stability and manufacturability** by following HyperSizer's composite optimization process.
- **terate with FEA automatically with HyperFEA** which executes the solver and controls iterative convergence.
- **Integrate with your company's established analysis methods** using plug-ins to integrate legacy codes into HyperSizer. Use COM to execute HyperSizer externally from applications such as **Excel**, **Matlab**, and integrated environments such as **ModelCenter** and **Isight**.
- **Generate stress reports** hat include the calculations for all HyperSizer-computed margins of safety, material properties, design-to loads, optimum design dimensions, etc. These comprehensive engineering reports are used for FAA certification and to support the hardware throughout its life cycle.

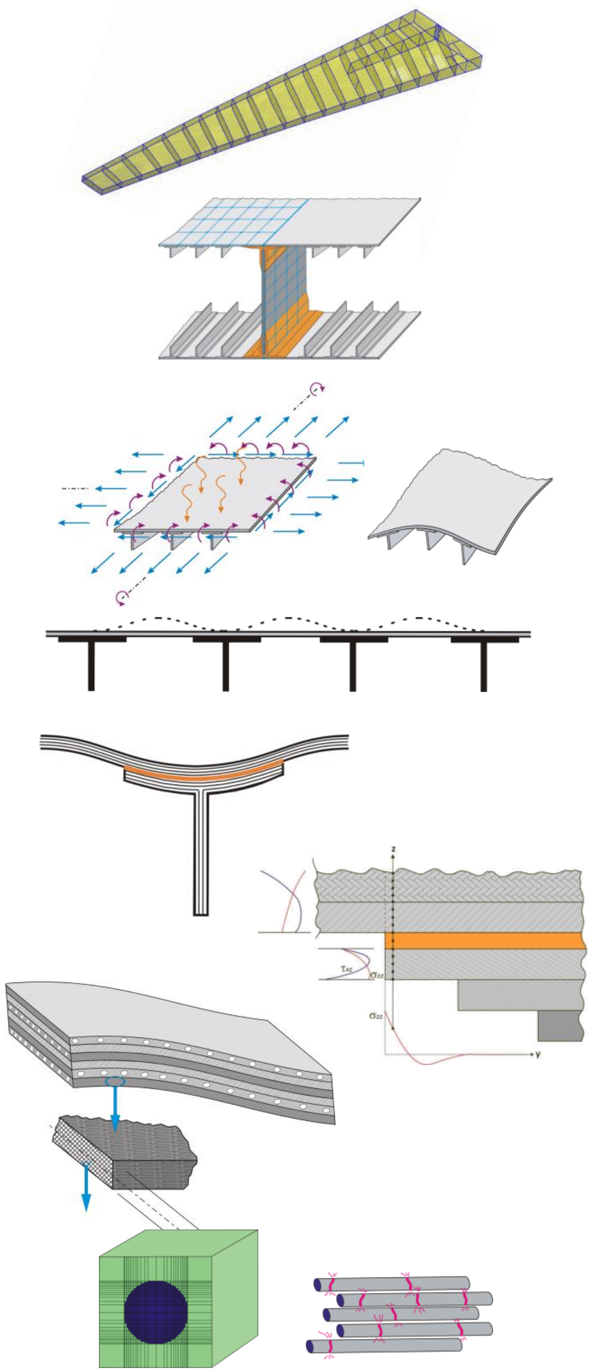

Home
FEM/CAD
Laminate - Skin
Laminate - Stiffener
FEM Viewer
Loads
Summary
Create
Edit
Templates
Metal
Composite
Any Material
Quick Sizing
Detailed Sizing
Final Analysis
Design Criteria
Quick Sizing
Assembly
Margins
Failure Mode
Unit Weight
Plot Results
Assembly
1
Assembly 1
Component
108
Upper Surface Panel Bay 08
Concept
I Bonded (Optimum)
Component Result
Weight (lbm)
41.186
Unit Wt. (lb / ft²)
2.9673
Min MS
0.03206
Dimensions
Failure
Free Body
FEA Loads
Stresses
Buckling
Properties
Options
Notes
Dimension | Value | 0/45/90 % | 0/45/90 # | Plies | Material
Tskin (in) | 0.2255 | 56/34/10 | 23/14/4 | 41 | Tape: AS4/3502 Tape DT
Tweb (in) | 0.198 | 58/28/14 | 21/10/5 | 36 | Tape: AS4/3502 Tape DT
Tfoot (in) | 0.1595 | 59/28/14 | 17/8/4 | 29 | Tape: AS4/3502 Tape DT
Tcap (in) | 0.2035 | 68/19/14 | 25/7/5 | 37 | Tape: AS4/3502 Tape DT
Hpanel (in) | 2.981
Spacing (in) | 7.8483
Wfoot (in) | 1.914
Wcap (in) | 1.4178
Wopen (in) | 5.9343
Hstiffener (in) | 2.7555
Hweb (in) | 2.3925
W foot
T skin
T foot
H panel
H stiffener
H web
T web
T cap
W cap
View Cross Section

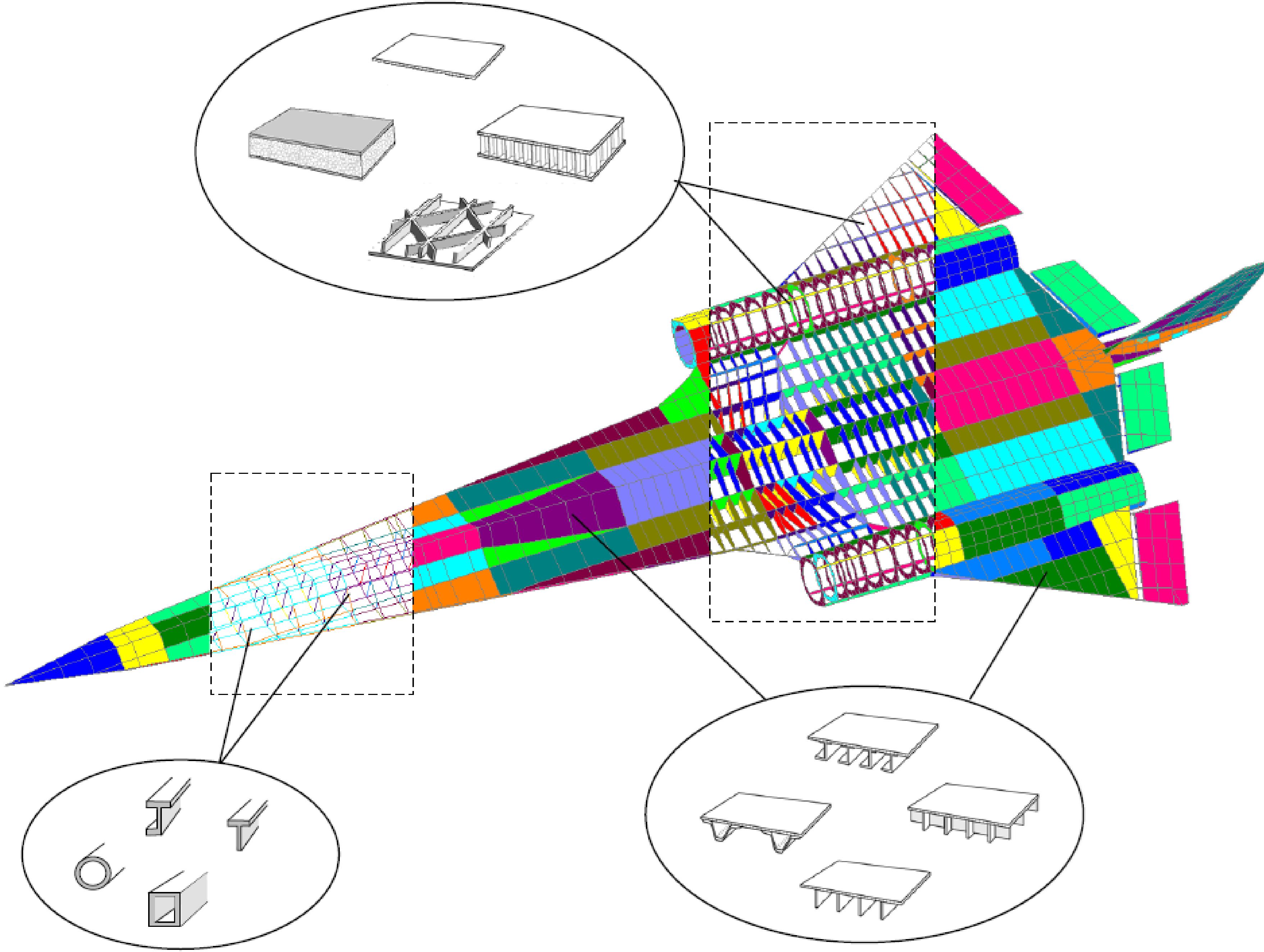
Optimize Aircraft Components

- **Wing box**: skins, spars, ribs
- **Fuselage**: panels and ring frames
- **Empennage**, flooring, bulkheads
- Engine nacelles, cases, IFS
- **Composite or metallic material**
- **Stiffened panels, honeycomb** sandwich and solid laminates
- **All design variables optimized**
- Less ply drops
- Complete part laminate sequencing
- **Reduce structural weight 20%**





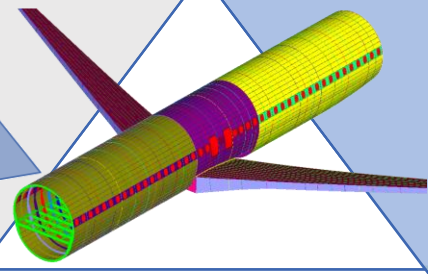




HyperPyramid

Input

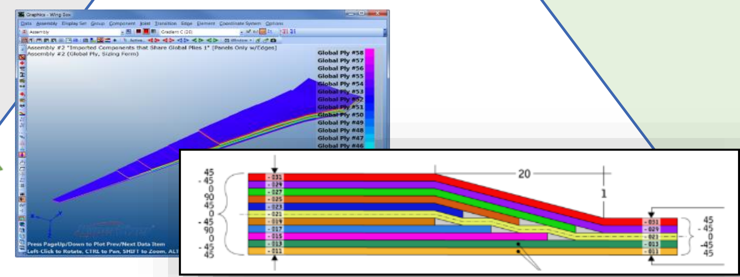
FEM/FEA data



Structure

- GFEM import/update
- Iteration with FEA
- Limit global responses, buckling, etc.
- FEA loads processing

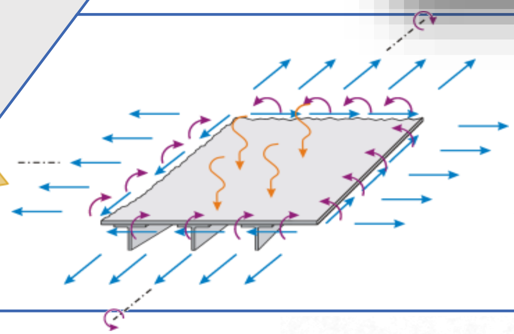
Design and producibility criteria

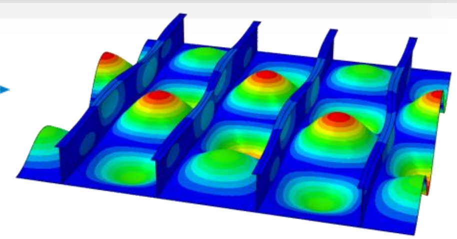


Assemblies

- Margin reporting
- Sizing optimization
- Layup sequencing

Analysis criteria



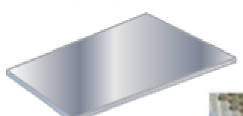


Components

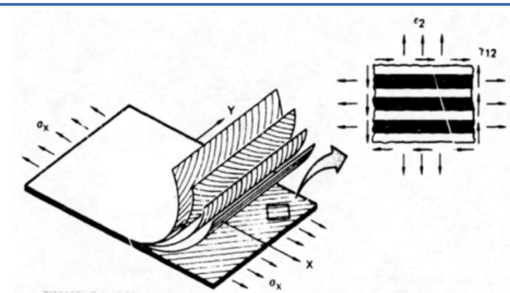
- Free-body analysis
- Panel stiffness formulation
- Panel and object level loads
- Failure analysis

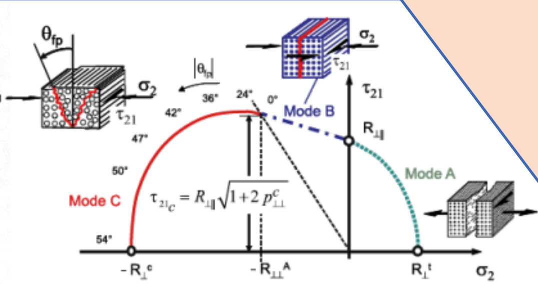
Material data

Isotropic (Metallic)



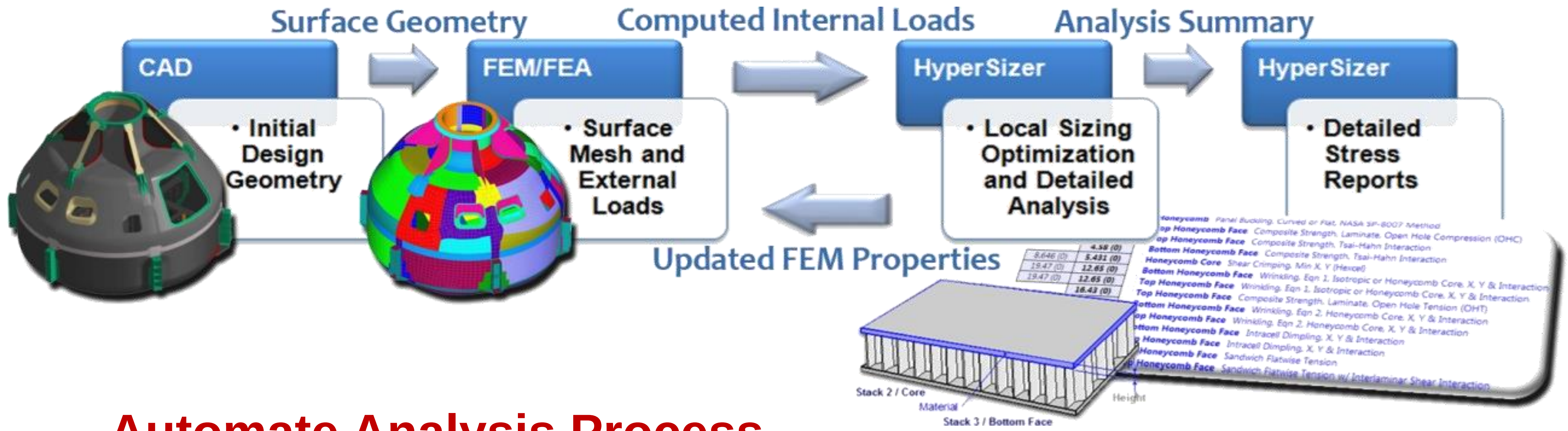
Honeycomb





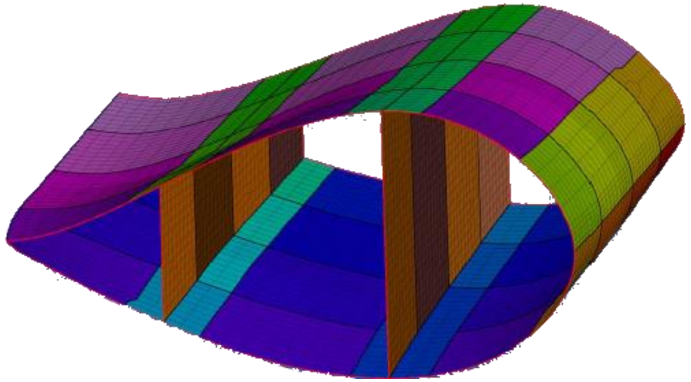
Materials

- Material properties
- Lamina analysis
- Laminate analysis



Automate Analysis Process

- **Integrated materials database**
- **Integrated test data database**
- **Vehicle layout** and **concept trades**
- **HyperFEA** automatic iteration with FEA for load path convergence
- **Supports** (MSC,Autodesk,NX) **Nastran, Abaqus, ANSYS, OptiStruct**
- **HyperFEMgen** for FEA verification



Scope of HyperSizer-FEA Integration

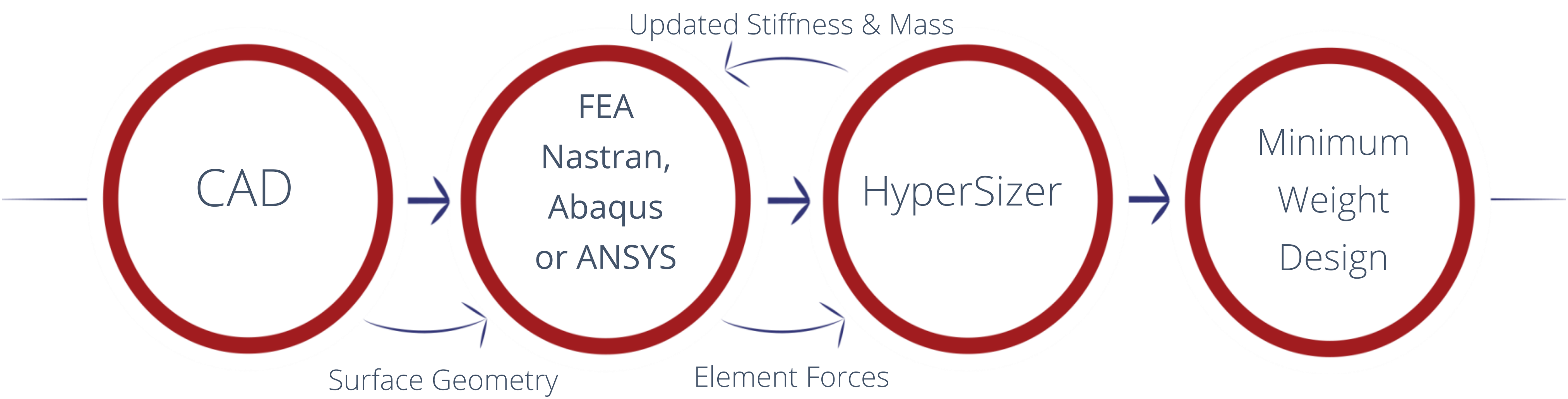
HyperSizer is NOT:

CAD

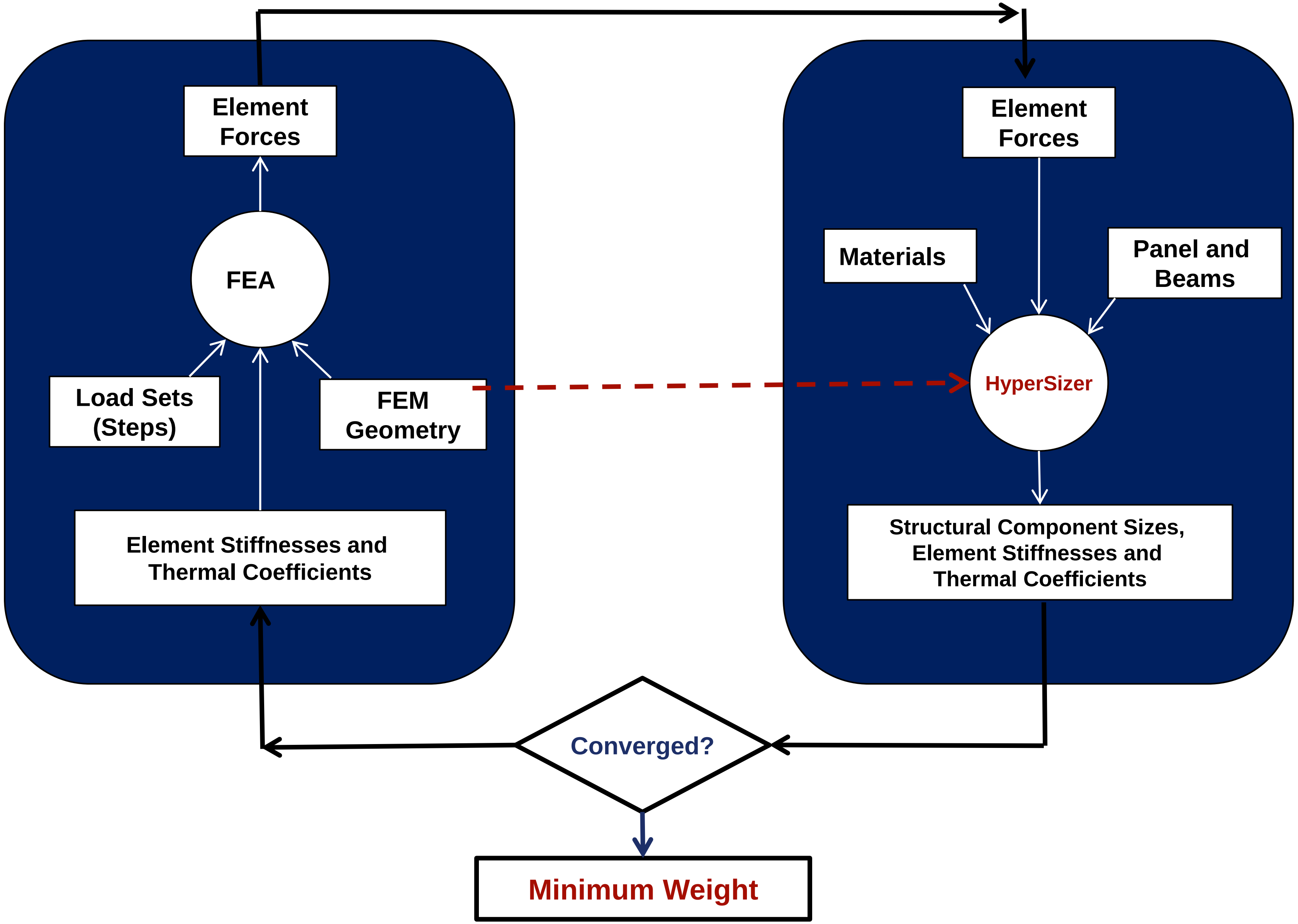
FEA

HyperSizer couples to FEA to capture load distribution

HyperSizer performs non-FEA failure analyses to determine optimum panel/beam design and detailed stress reports

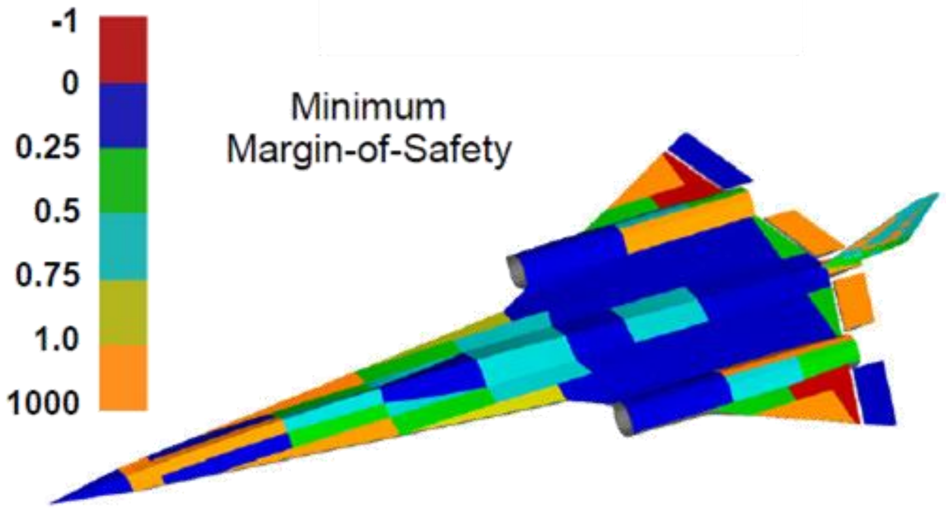


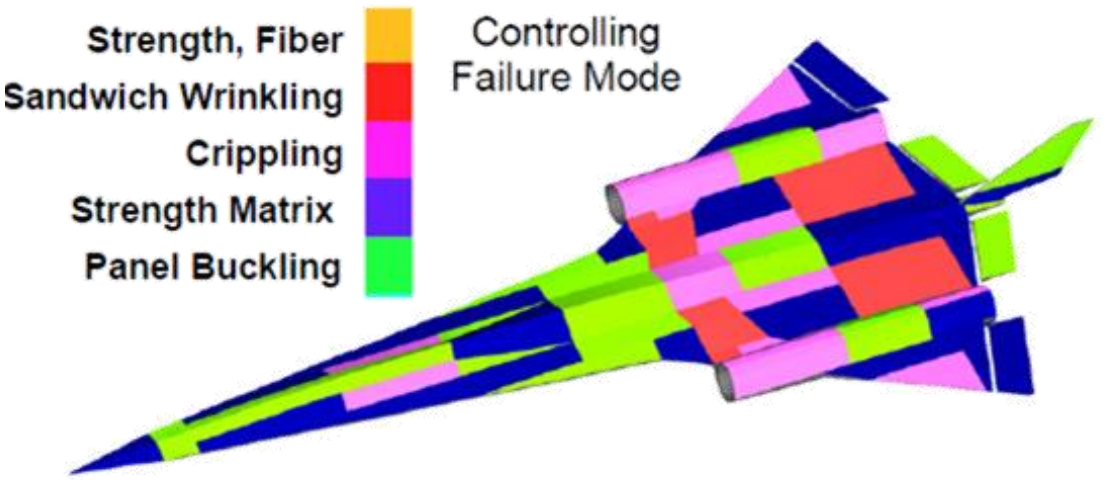
Scope of HyperSizer-FEA Integration



Certify with Analysis & Test Data

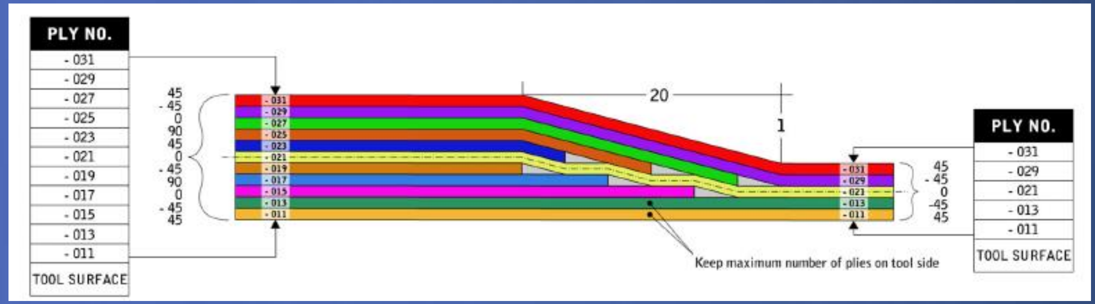
- Detailed analysis stress **reports**
- Summary tables of controlling **margin of safety, load cases, and failure modes**
- Correlation of **failure predictions to tests**
- **Damage tolerant** composite strength BVID/CAI/OHC etc.
- Discrete Source **Damage Analysis**
- Extensive **material** allowable **correction factors**
- **Stiffener buckling** and **crippling**
- Compression and shear IDT **postbuckling**
- **Interlaminar stresses/bonded joints**
- **Bolted joints** including BJSFM





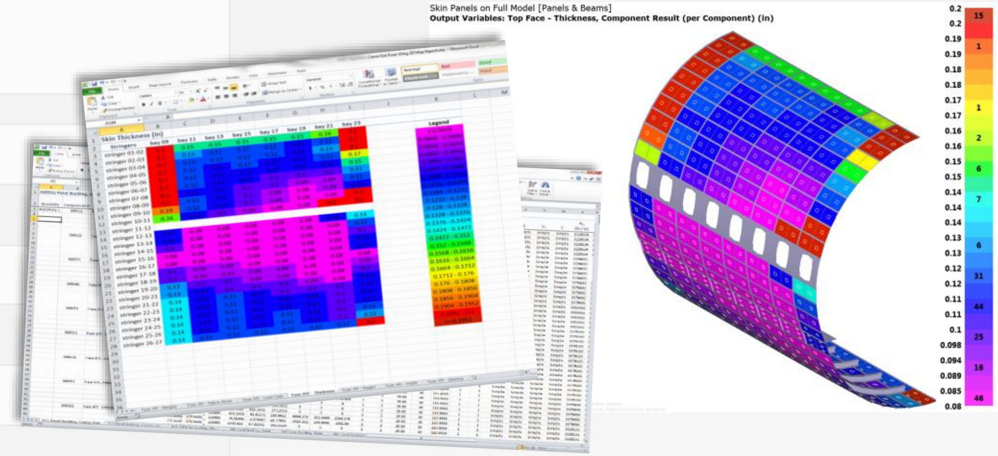
Lower Fabrication & Engineering Cost

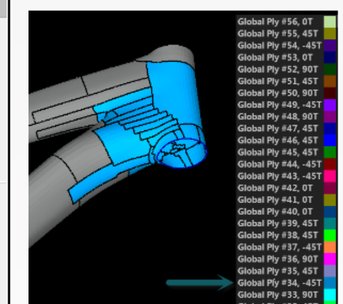
- Eliminate **costly** hours of manual calculations
- Eliminate spreadsheets and model remeshing
- **Standardize analyses**
- **Optimize for manufacturability**
- Generate detailed **stress reports** for **certification**
- Tracking of global plies to CAD part numbers
- Export/import laminate specs to CATIA/Fibersim

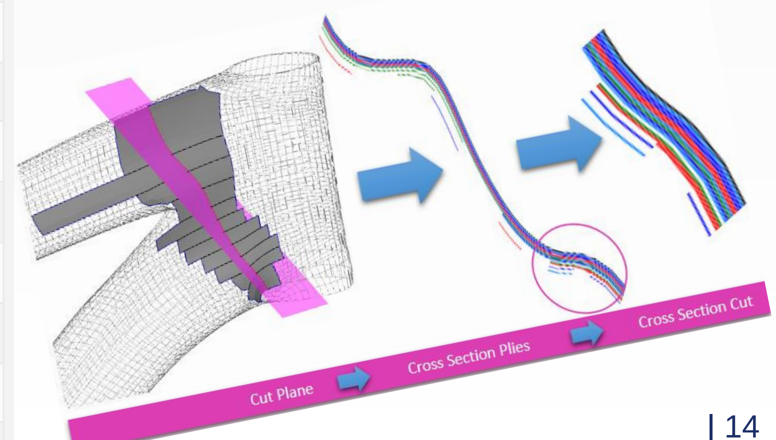


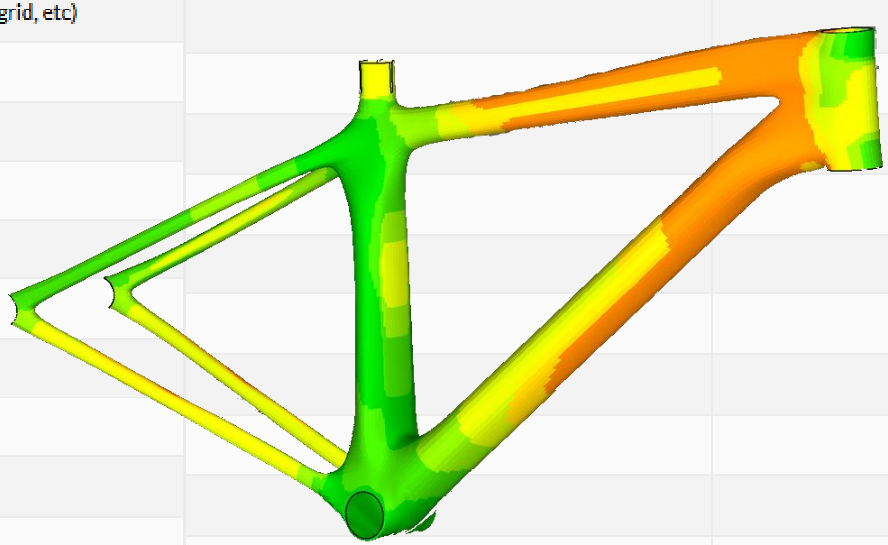
- Minimizing drops cuts costs by improve **manufacturability** and **fatigue life**.

Features	Express	Pro
Metal Analysis & Optimization	✔	✔
Laminate Analysis & Optimization	✔	✔
FEM Updates and FEA Iteration	✔	✔
CAD (CATIA) Laminate Updates	✔	✔
Stress Reports	✔	✔
FEM Zone Pattern Optimization	✔	
Organic Ply Shape Optimization	✔	
Strength Optimization	✔	✔
Stiffness Displacement Optimization	✔	✔
Eigenvalue Buckling Optimization	✔	✔
Eigenvalue Frequency Optimization	✔	
Stiffened panels (I, Tee, Hat, Isogrid, etc)		✔
Beams (I, Tee, caps, tubes, etc)		✔
Bolted Joints		✔
Bonded Joints		✔
FEM Line Joints		✔
Multiple Assemblies		✔
Test Like You Fly (TLYF)		✔
Test Optimizer		✔
Analysis Plugins		✔
Object Code Scripting		✔

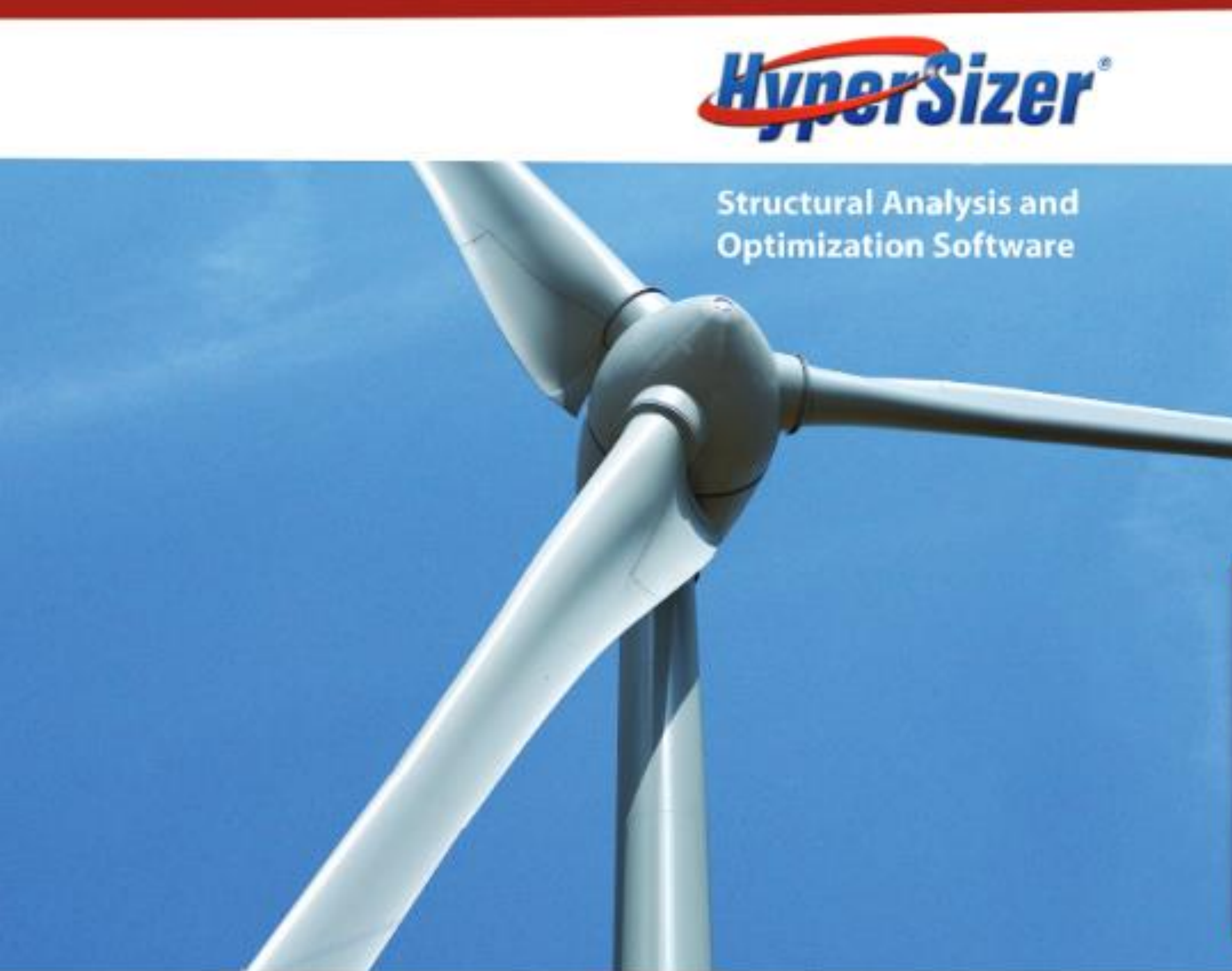


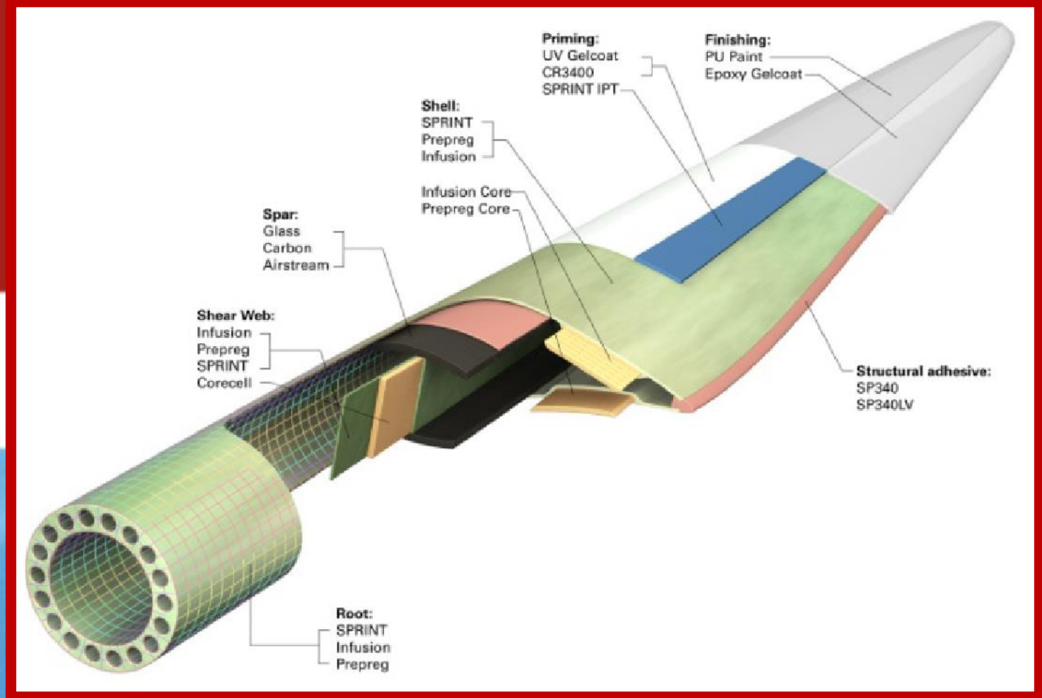


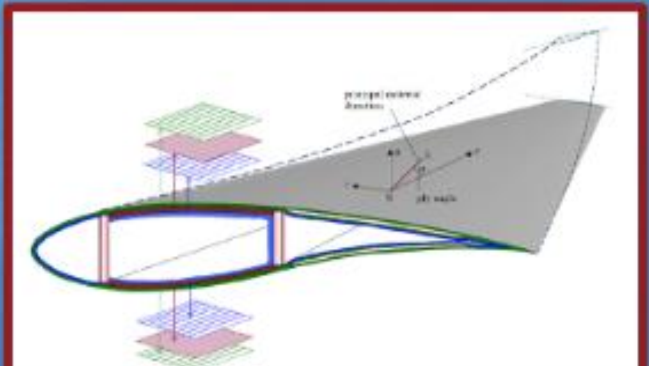




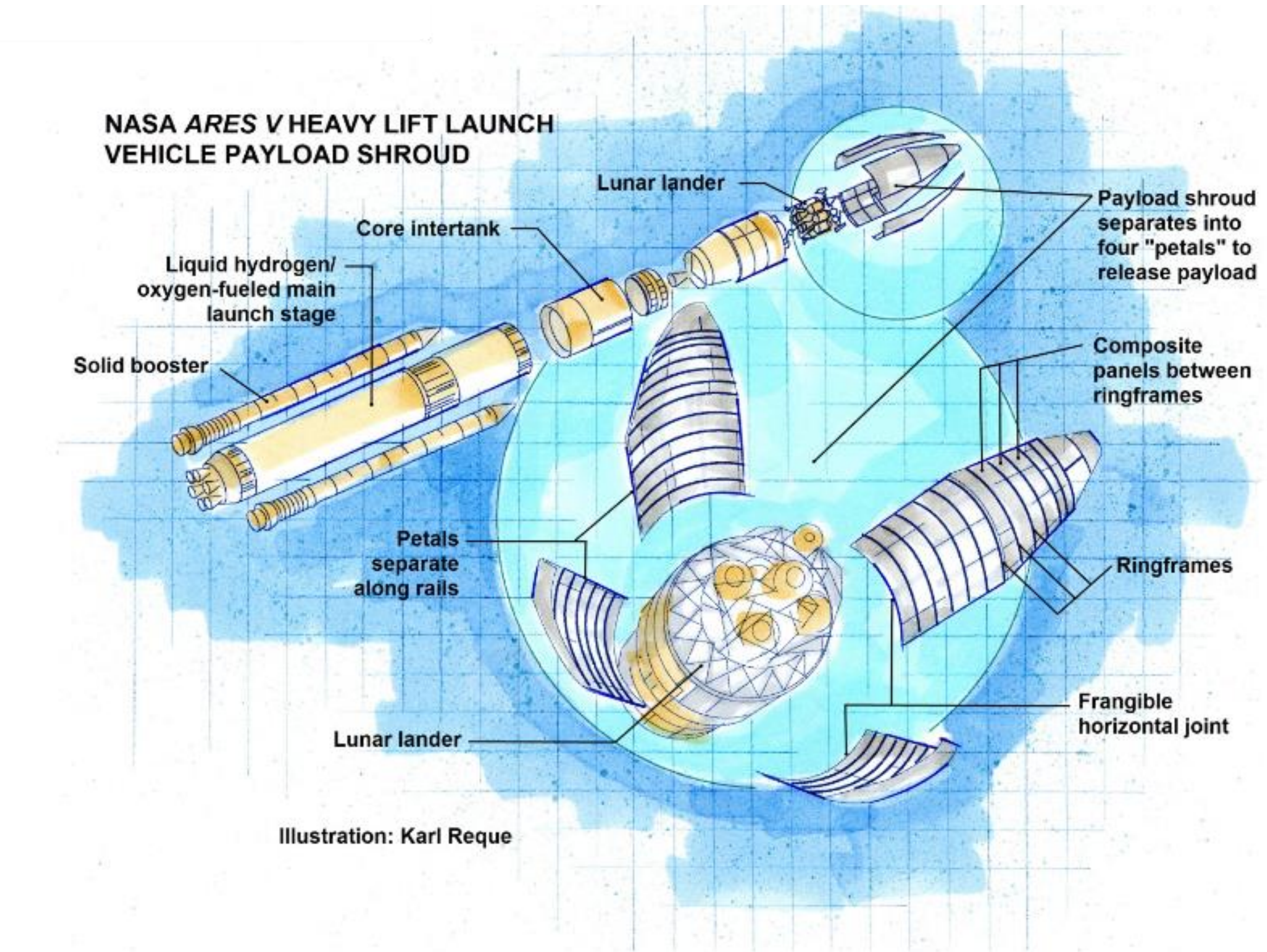
Wind Turbine Blade Design, Analysis, and Optimization

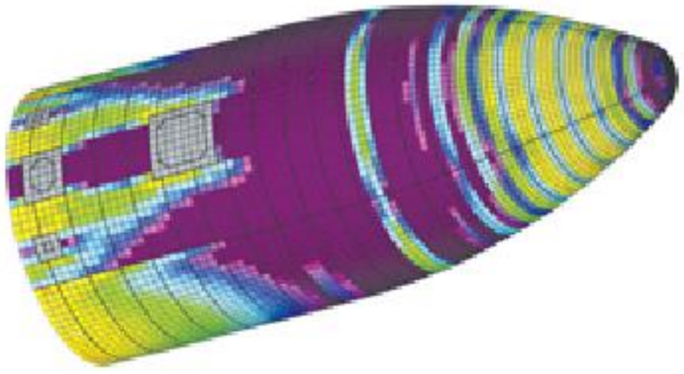




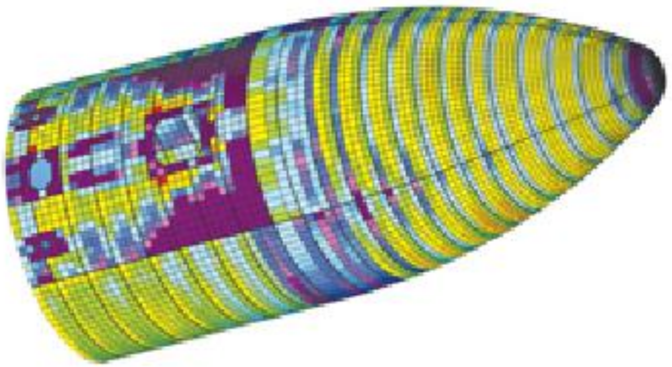


Optimizing the Ares V Payload Shroud



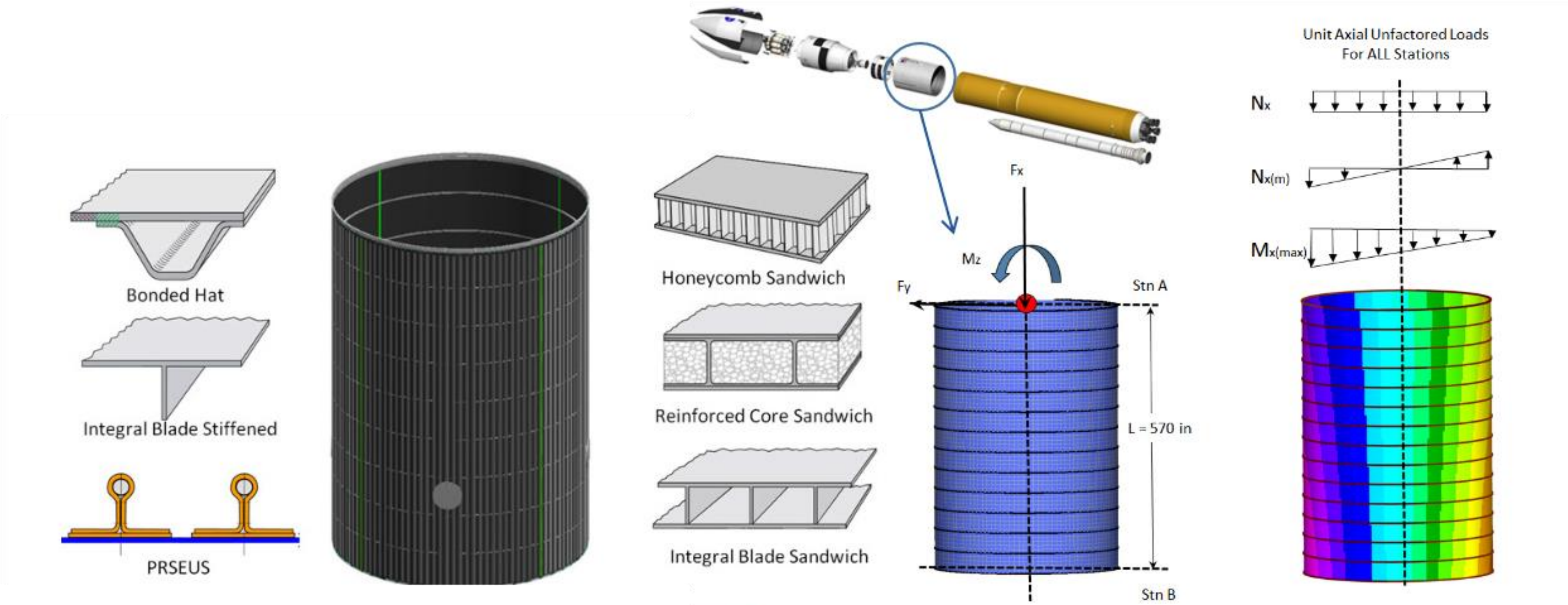


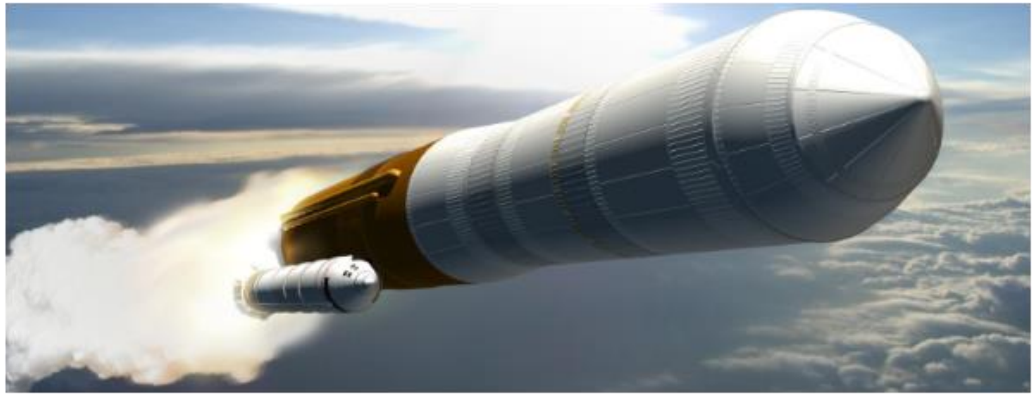
Overdesigned



Optimized

Optimizing the Ares V Payload Shroud

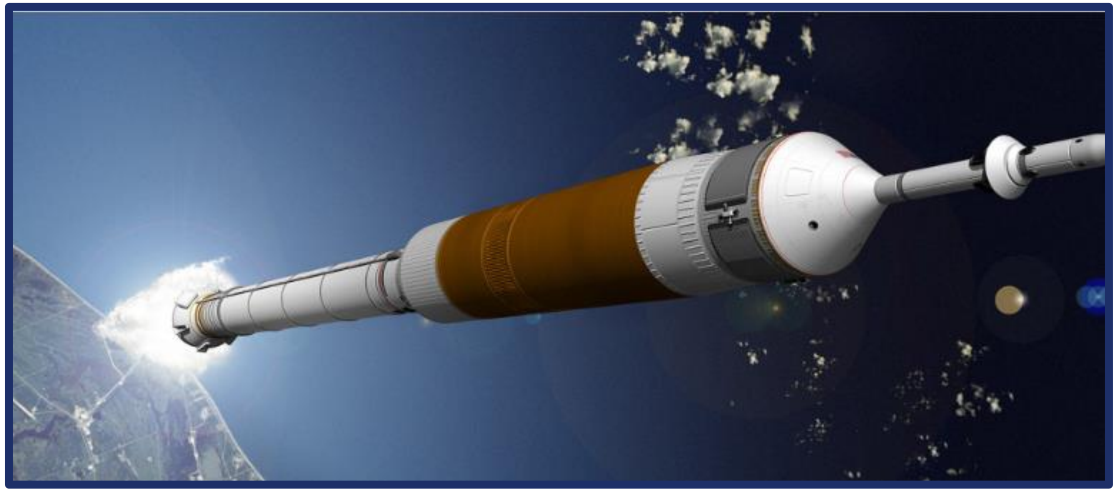


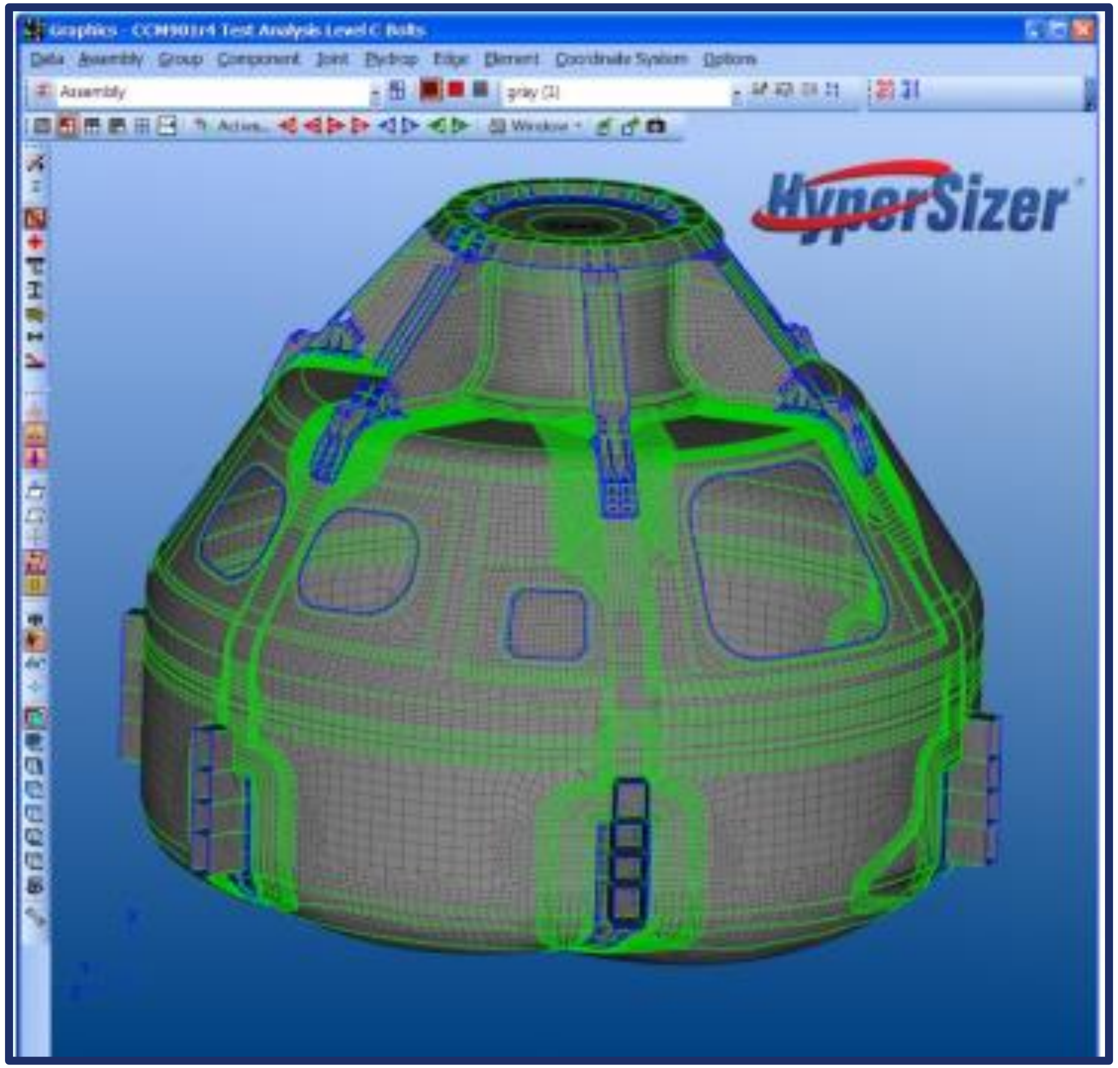


Available Failure Analyses

Limit MS	Ultimate MS	Y	LS	Location - Analysis Description
0.001154 (0)			1	**C** Stiffness Requirement, Bending
	0.04588 (0)		4	**Web** Local Buckling, Longitudinal Direction
	1.458 (0)		4	**Flange Top, one sided** Local Buckling, Longitudinal Direction
	2.155 (0)		3	**Flange Top, one sided** Composite Strength, Max Strain 1 Direction
	2.155 (0)		3	**Flange Bottom, one sided** Composite Strength, Max Strain 1 Direction
	2.155 (0)		3	**Web** Composite Strength, Max Strain 1 Direction
	3.029 (0)		4	**Flange Bottom, one sided** Local Buckling, Longitudinal Direction
	3.691 (0)		4	**C** Crippling, Composite, method Mil-Hdbk-17-3E including Dij
	6.314 (0)		3	**Flange Top, one sided** Composite Strength, Max Strain 2 Direction
	6.314 (0)		3	**Flange Bottom, one sided** Composite Strength, Max Strain 2 Direction
	6.314 (0)		3	**Web** Composite Strength, Max Strain 2 Direction

NASA Orion Alternative - Composite Crew Module





It's all about speed to certification

HyperSizer software performs **design, stress analysis, and detail sizing optimization** for composite or traditional metallic materials in systems such as:

- Unmanned Vehicles
- Fixed and Rotary Aircraft
- Space Launch Vehicles
- Infrastructure

✓ HyperSizer enables structural weight reduction **by 30-40%**

✓ HyperSizer replaces the need for spreadsheets and "hand calculations" with automatically generated stress reports for **FAA certification**.

✓ HyperSizer customers are able to produce results **faster and more accurately,** providing an edge over competitors.

Who We Are, What We Do

- Founded in 1995 by NASA aerospace engineers still developing leading edge methods today
- Leaders in Military Structural Design, Analysis, Optimization for meeting the schedule of rapid development projects
- Successfully reduce 30% -40% weight on military aircraft while also in a shortened design cycle
- Provide Critical Role in Certification

Some of our Customers...

NASA, U.S. AIR FORCE, U.S. ARMY, Department of the Navy, Bell Helicopter, General Atomics Aeronautical, Scaled Composites, Boeing, Orbital ATK, BAE SYSTEMS, Aurora Flight Sciences, Bombardier Aerospace, Lockheed Martin, Spirit AeroSystems, SNC Sierra Nevada Corporation, Gulfstream

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Design
Analyze
Optimize
Certify

HyperSizer®

Over 20 years of success deployment:
Designing | Analyzing | Optimizing

- Manned Aircraft
- UAVs
- Space Launch Vehicles

Why HyperSizer®?

- Weight Reduced
- Structurally Optimized
- Ahead of Schedule
- Within Budget

Designing Bell Helicopter's Next Gen Tiltrotor Fuselage

- To meet the aggressive V-280 schedule, HyperSizer was employed in a 'design-by-analysis' approach that successfully sized and analyzed the fuselage structure.
- Bell Helicopter leadership applauded the team for a job well done, ahead of schedule and within budget.

- See full article at https://hypersizer.com/designing-bell-helicopters-next-gen-tiltrotor-fuselage/

"The automated analysis tool in our software allows the stress analyst to define the required structural configuration, informing the designer about the best configuration that optimizes the stiffness of the structure. A small team of stress and design engineers acquired HyperSizer, the right tool set to support their in-house capabilities and efficiently deliver ahead of schedule."

*"The **shortened schedule** and **headcount savings alone are substantial** as well as the **analysis accuracy that is gained** by a standardized tool suite like HyperSizer."*

– JB, Key Customer

Why HyperSizer?

- ✓ The ONLY commercial software that automates the stress analysis and certification reporting process **for military acceptance of structural integrity** of aircraft
- ✓ Certify structures faster, **FAA certification-ready** automated structural reports produced
- ✓ Reduce structural weight – **30%-40% lighter**, an exceptional achievement for aerostructures
- ✓ Safer, lighter — and **Manufacturable.** Designing with manufacturability in mind from the start yields an easier to manufacture structure
- ✓ Reduce the stress engineering process by an order of magnitude faster, seriously. **10 times faster**, proven in previous projects.
- ✓ Save Money on your Program - 4 ways:
  - ✓ **Schedule** duration reduction
  - ✓ **Hours** allocated to budget reduced
  - ✓ End product has **reduced failures, reduced weight, and reduced manufacturing issues**
  - ✓ Performance: A structurally lighter, **higher performance vehicle** yields long term financial benefits
- ✓ Behind HyperSizer is a team of highly experienced stress engineers that can work with you to make your project a success
- ✓ HyperSizer partners with all major CAE software, and employs all industry standard methods and practices, see below

Software Partners

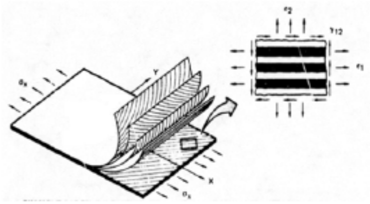
Dassault Systèmes, Altair, Siemens, ANSYS, MSC Software, Autodesk

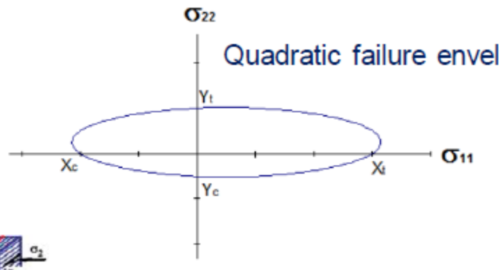
Composite Strength Analysis Methods

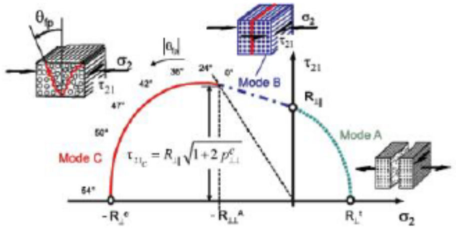
HyperSizer®

Ply Based

- Max Strain
- Max Stress
- Tsai-Hill Interaction
- Tsai-Wu Interaction
- Tsai-Hahn Interaction
- Hoffman Interaction
- Hashin Fiber Failure
- LaRC03 Fiber Failure
- Tsai-Wu Strain
- Puck 2D & 3D
- Interlaminar Shear



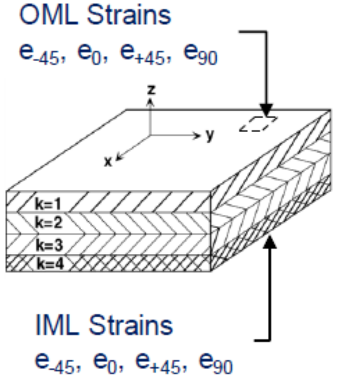


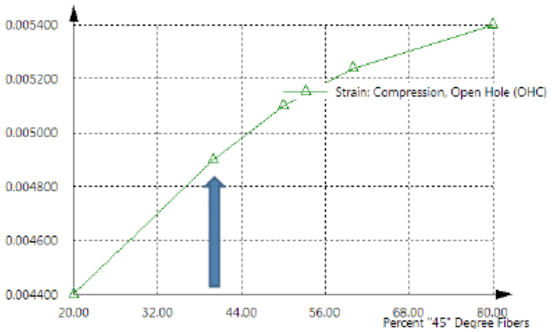


Fracture modes

Laminate Based

- Compression, Pristine
- Compression, After Impact (CAI)
- Compression, Open Hole (OHC)
- Compression, Filled Hole (FHC)
- Compression, BVID
- Tension, Pristine
- Tension, After Impact (TAI)
- Tension, Open Hole (OHT)
- Tension, Filled Hole (FHT)
- Shear, Pristine
- Shear, After Impact (SAI)



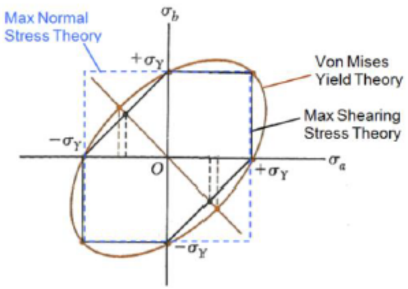


%0, %45s and AML curves

Metallic Strength Analysis Methods

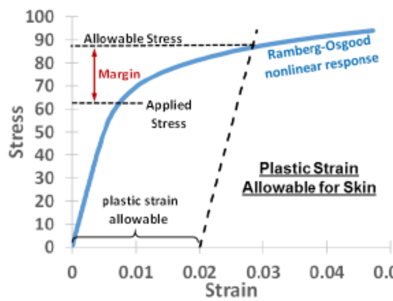
Isotropic Strength

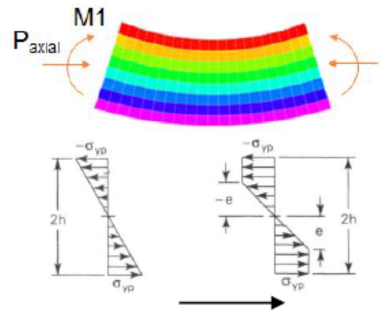
Max Strength (Stress)
Von Mises Interaction Yield
Max Shear Criterion
Max Principal Stress



Plasticity

Plasticity correction – Buckling
Ramberg-Osgood Non-linear parameters
Plastic Bending



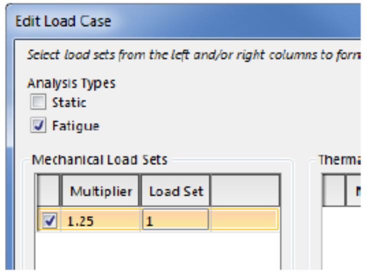


Increasing Bending

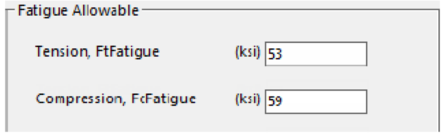
Fatigue

Fatigue Target Stress

Identify load cases as fatigue cases



Write MS using fatigue allowables and concentration factors, Kt



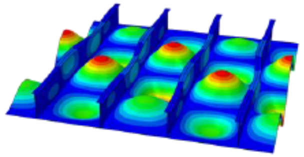
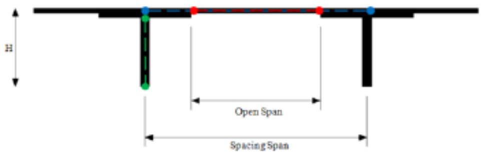
HyperSizer Analysis Methods

Buckling Analysis Methods

HyperSizer®

Local Buckling

Flat, Simple or fixed BC, Biaxial w/Shear &TSF
Curved, Simple or fixed BC, Biaxial w/Shear &TSF
Each panel segment (object)

Local Postbuckling

Compression postbuckling, effective width
Shear postbuckling, diagonal tension IDT

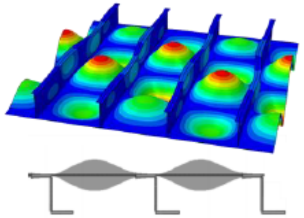
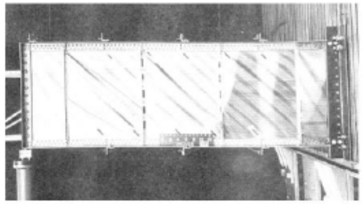
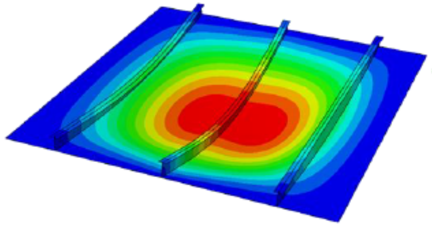
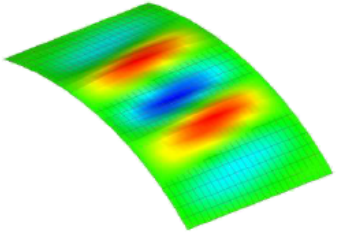



Figure 1, Shear postbuckling – (NACA TN 2662, 1952).

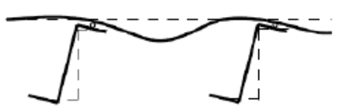
Panel Buckling

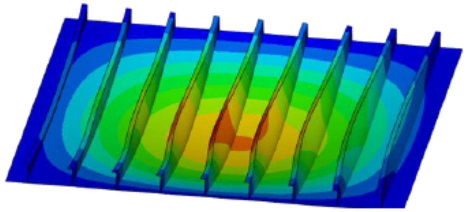
Flat, Simple or fixed BC, Biaxial w/Shear &TSF
Curved, Simple or fixed BC, Biaxial w/Shear &TSF
Flat, L Column w/ Transverse Shear Flexibility
Cylinder, NASA SP-8007 Method

Stiffener Buckling

Flexural-Torsional Stability, Argyris
Flexural-Torsional Stability, Levy


Coupled flexure and torsion

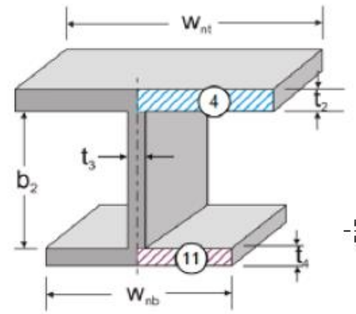


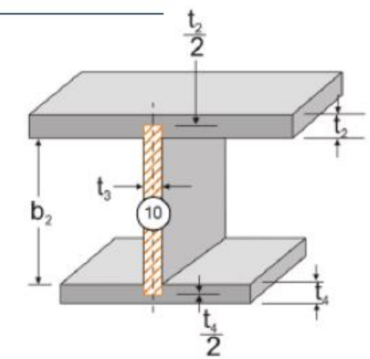
Stiffener Crippling

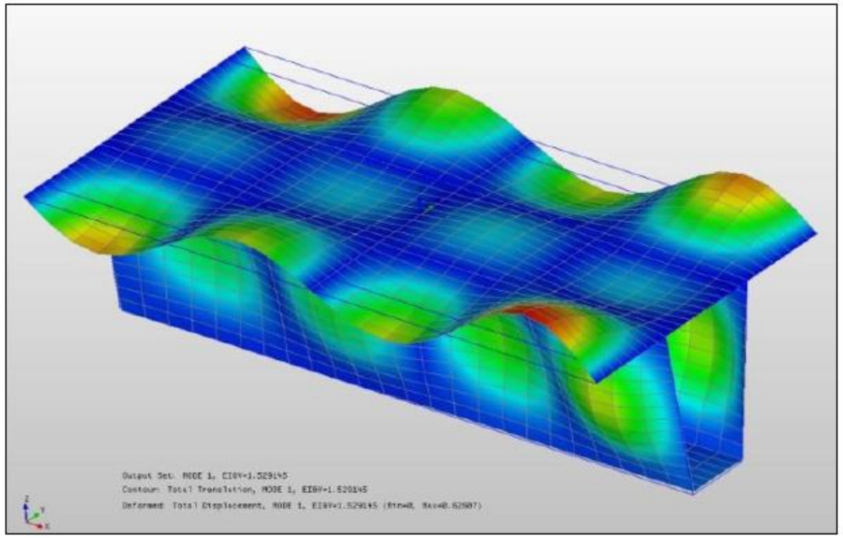
HyperSizer®

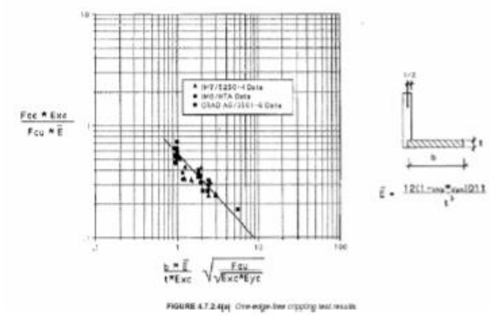
Crippling

Crippling, metallic formed and extruded sections
Crippling, composite, MIL-HDBK-17-3E
Crippling – Buckling Interaction, Johnson-Euler

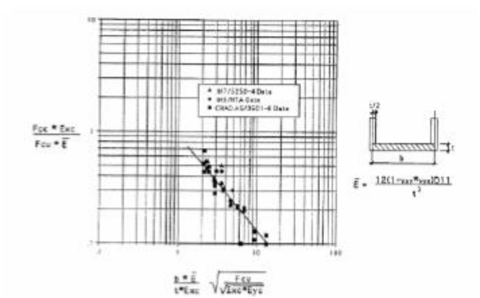








No Edge Free Crippling Curve



One Edge Free Crippling Curve

$$\frac{F_{cc}}{F^{cu}}\frac{E_x}{\overline{E}} \quad \text{and} \quad \frac{b}{t}\frac{\overline{E}}{E_x}\sqrt{\frac{F_{cu}}{\sqrt{E_x E_y}}}$$

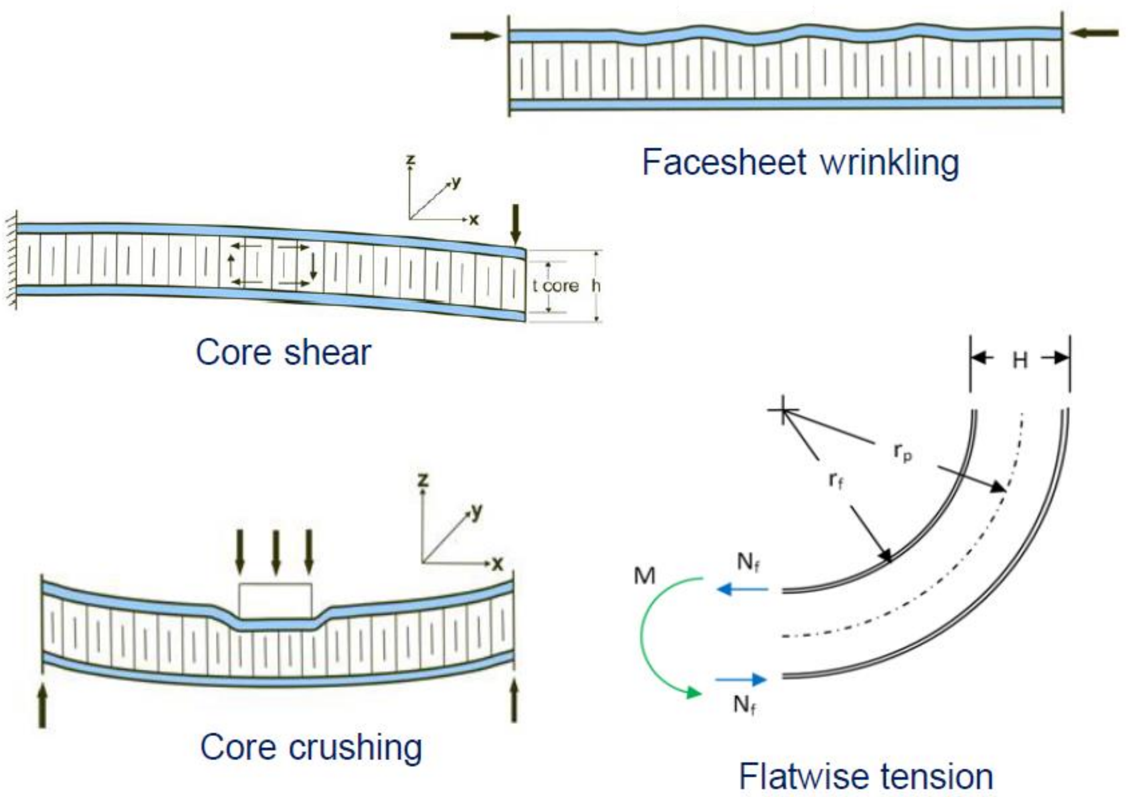
$$F_{cc} = \frac{\sum b_n t_n F_{ccn}}{\sum b_n t_n}$$

Sandwich Panel Analysis Methods

HyperSizer®

Sandwich Methods

- Facesheet Wrinkling, foam cores
- Facesheet Wrinkling, honeycomb cores
- Shear crimping
- Intracell dimpling
- Flatwise Tension
- Flatwise Tension w/Interlaminar shear
- Core shear strength, X direction
- Core shear strength, Y direction
- Core shear strength, interaction, quadratic
- Core crushing, concentrated load
- Core crushing, flexural bending load
- Core crushing, joint support load



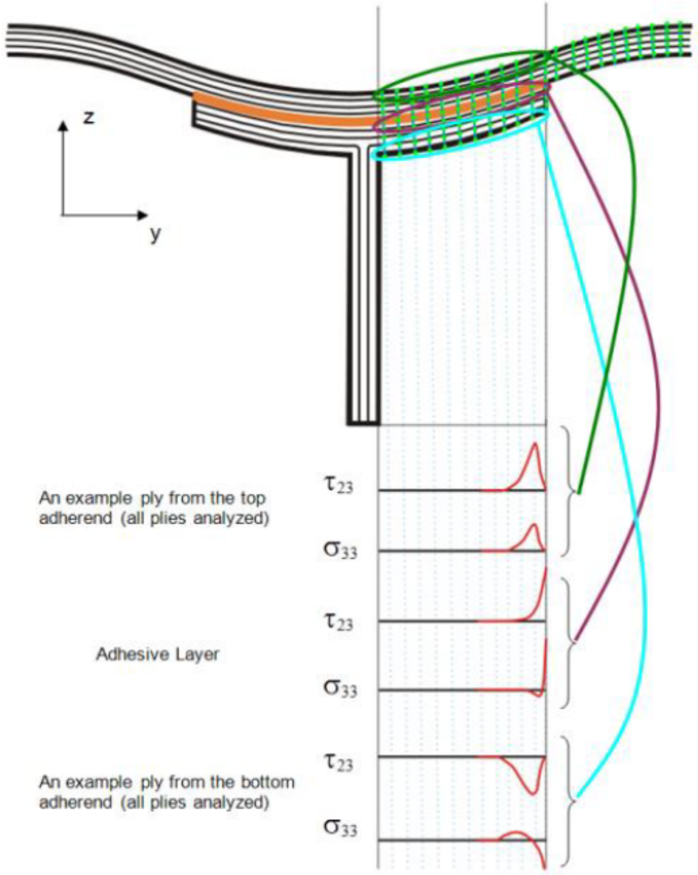
Bonded Joint Analysis

HyperSizer®

Bonded Joint

Edge Delamination Onset
Edge Delamination
Fracture, Principal Transverse
Fracture, Max Stress or Strain
Delamination, Peel Dominated
Delamination, Peel and Transverse Shear
Delamination, Tong, Peel, Transverse Shear
Adhesive, Peel Dominated
Adhesive, Von Mises Strain
Adhesive, Maximum Principal Stress
Adhesive, Peel, Longitudinal & Transverse Shear

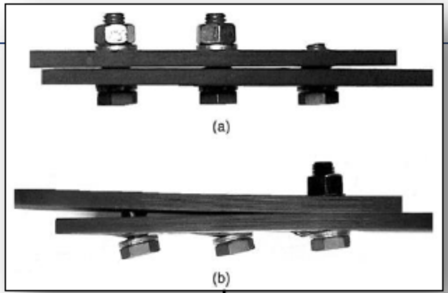
VCCT Virtual Crack Closure Technique

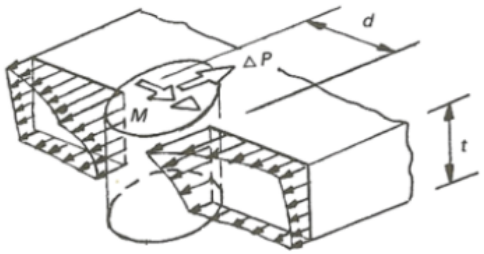


Fastened Joint Analysis

Bolted Joint

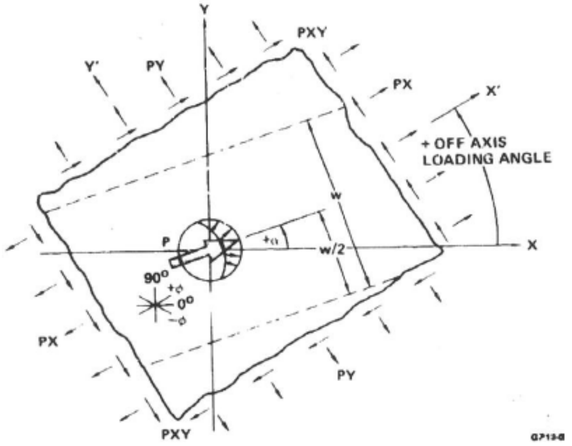
Laminate Bearing, composite
Bearing, metallic
BJSFM, bearing only
BJSFM, bypass only
BJSFM, bearing and bypass



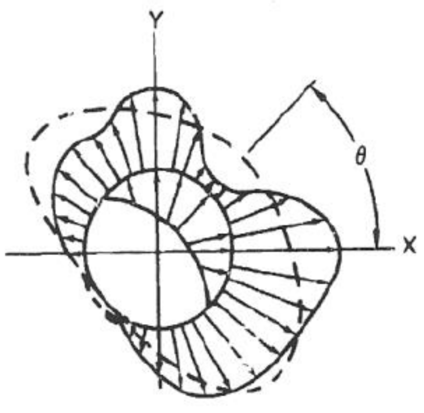


Use BJSFM to capture complex stress state

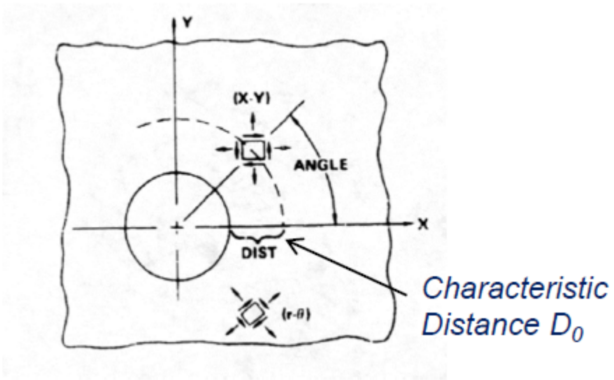
Use bearing analysis with allowables and correction factors



Combined bearing and bypass loading



Complex stress field



Tension/compression D_0

HyperSizer Analysis Methods

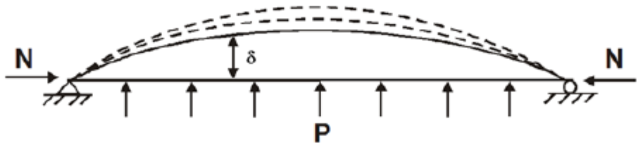
Analysis Methods

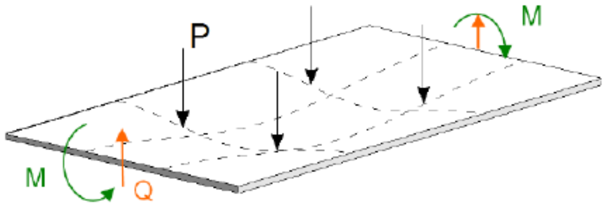
Stress Analysis Methods

Beam-column, imperfection or pressure

Panel pressure

Local pressure





Limits & Requirements

Stiffness requirement, membrane

Stiffness requirement, bending

Strain limits

Stress cut-off, F&DT

Curvature

Center deflection

Frequency limit, panel or beam

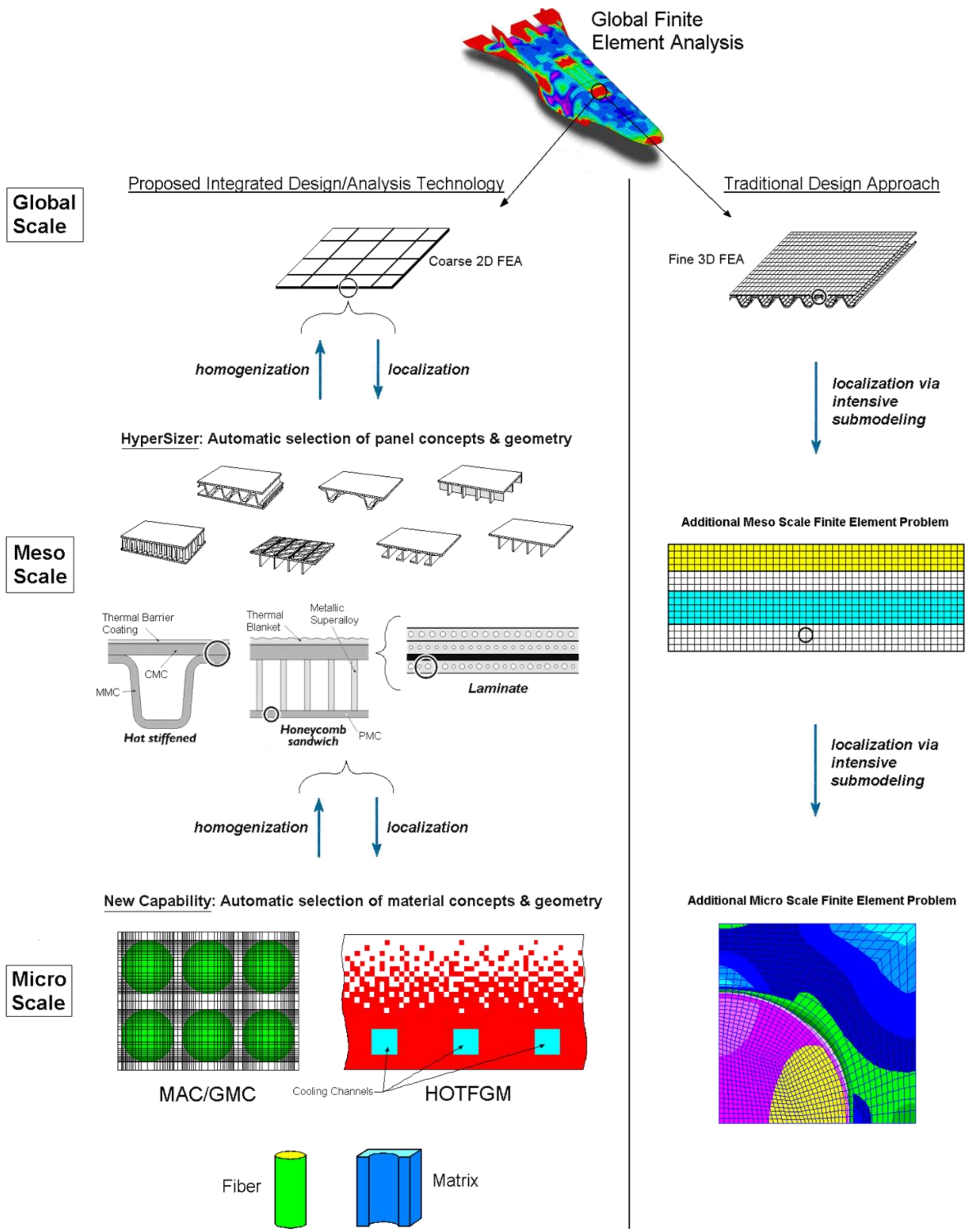
Frequency limit, local object

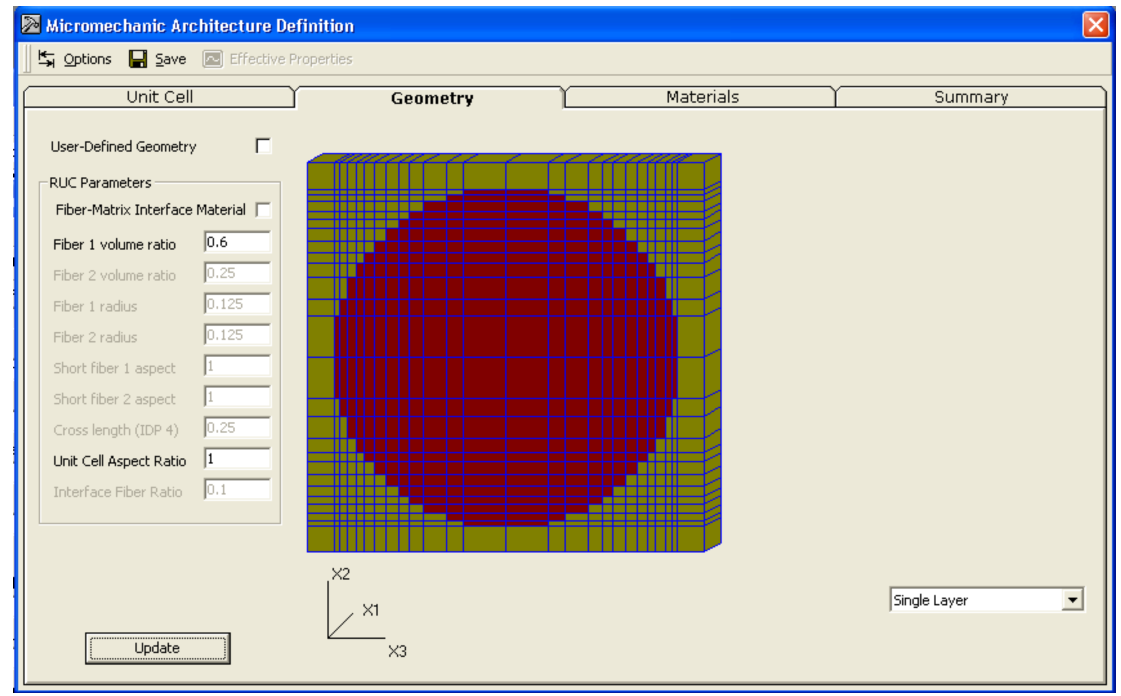
$$MS = \min\left[\frac{\varepsilon_{x,r}}{\varepsilon_x} - 1,\ \frac{\varepsilon_{y,r}}{\varepsilon_y} - 1\right]$$

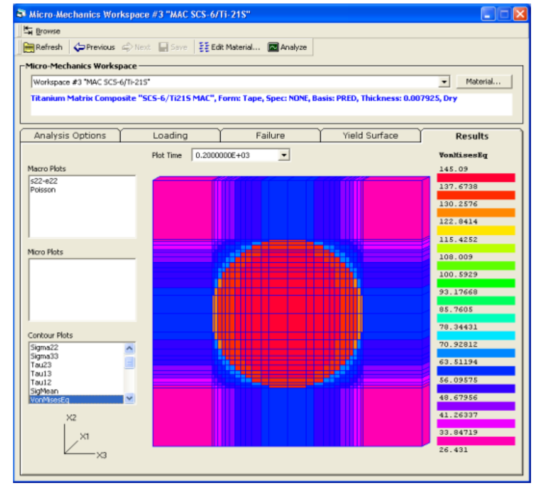
$$MS = \min\left[\frac{D_{11,sym}}{D_{11,sym,r}} - 1,\ \frac{D_{22,sym}}{D_{22,sym,r}} - 1,\ \frac{D_{33,sym}}{D_{33,sym,r}} - 1\right]$$

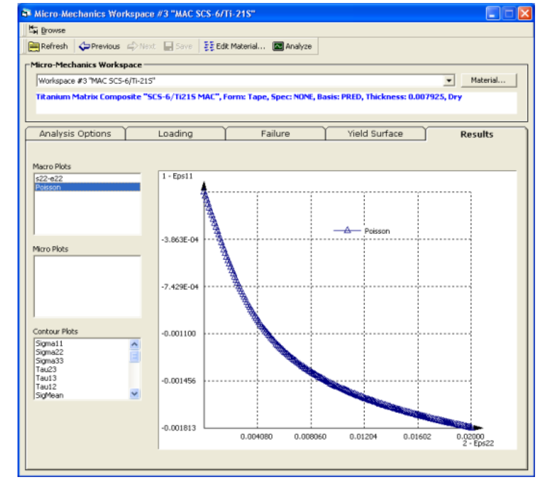
Major new capability EI & GJ

Integration with Micromechanics



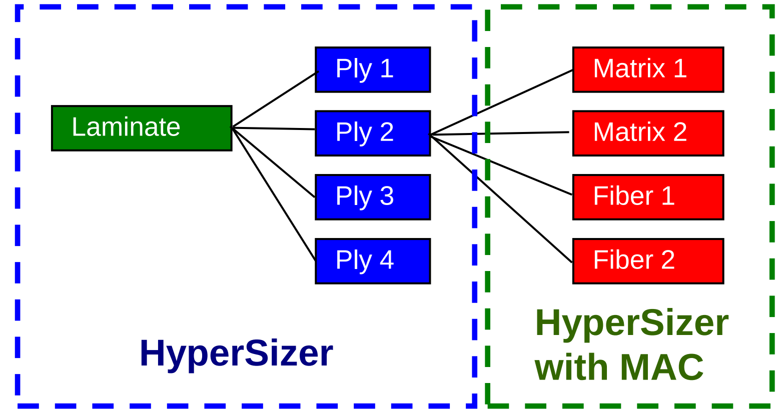




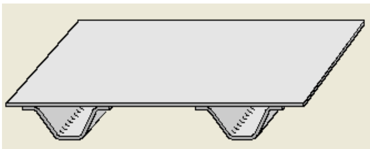


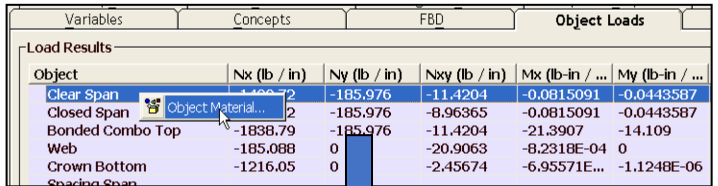
Integration with Micromechanics

HyperSizer Micromechanics allows the user to graphically "peer" into a structural analysis from the macro to the micro level

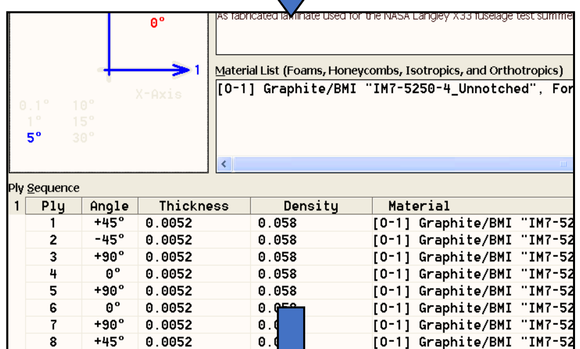


Stiffened Panel

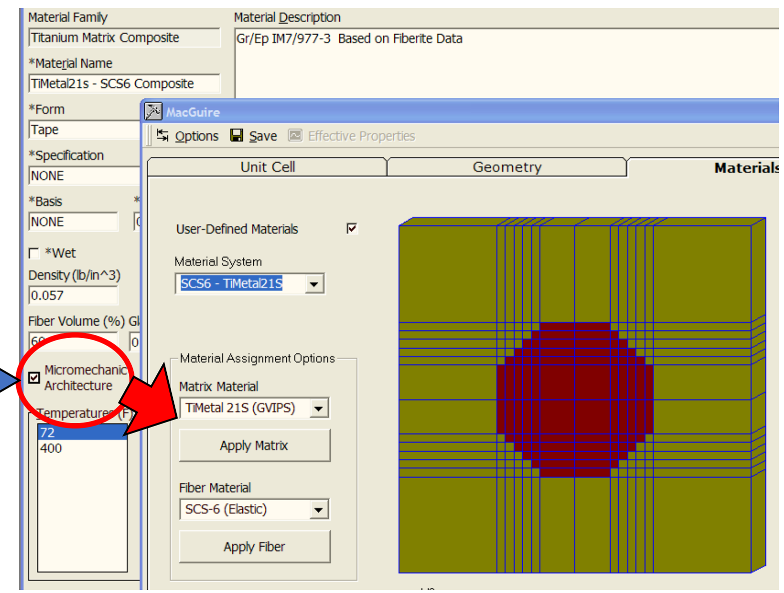




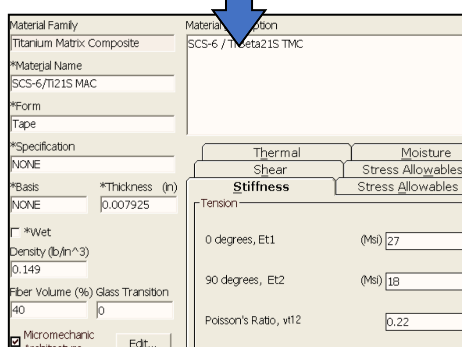
Laminate



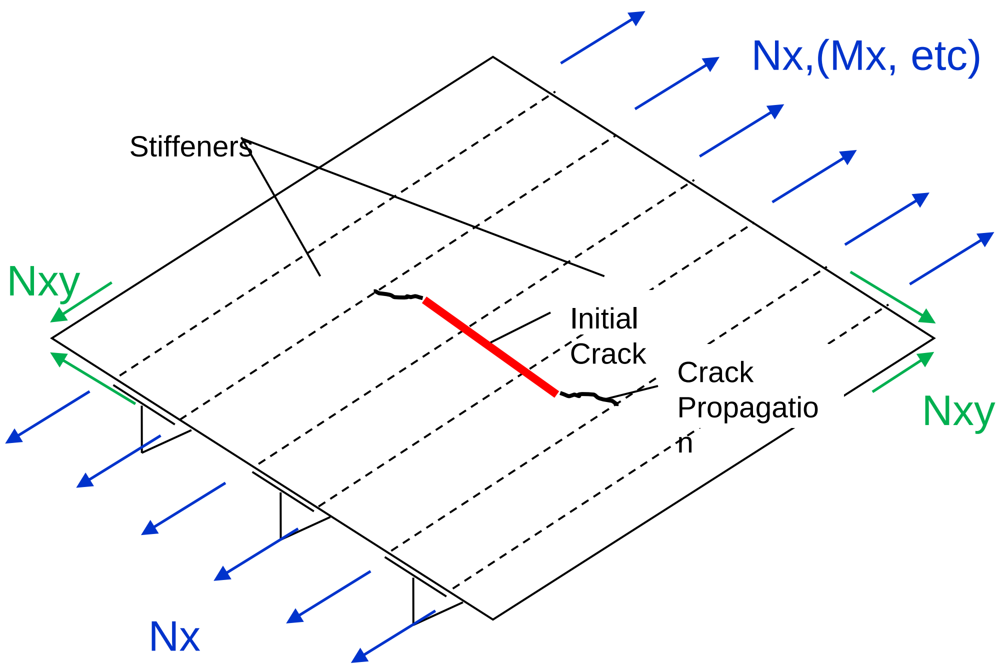
Micro (Fiber-Matrix)

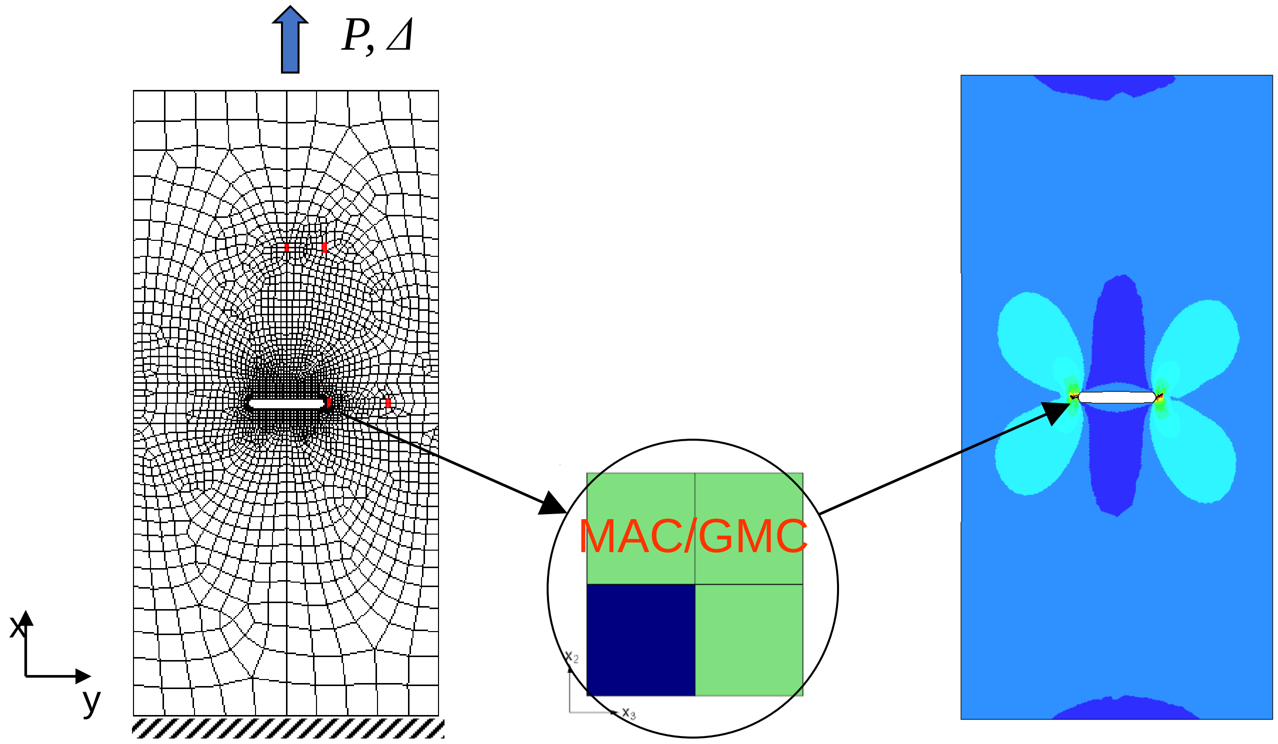


Orthotropic Ply



Methods Coupling of HyperSizer with High-Fidelity Analysis

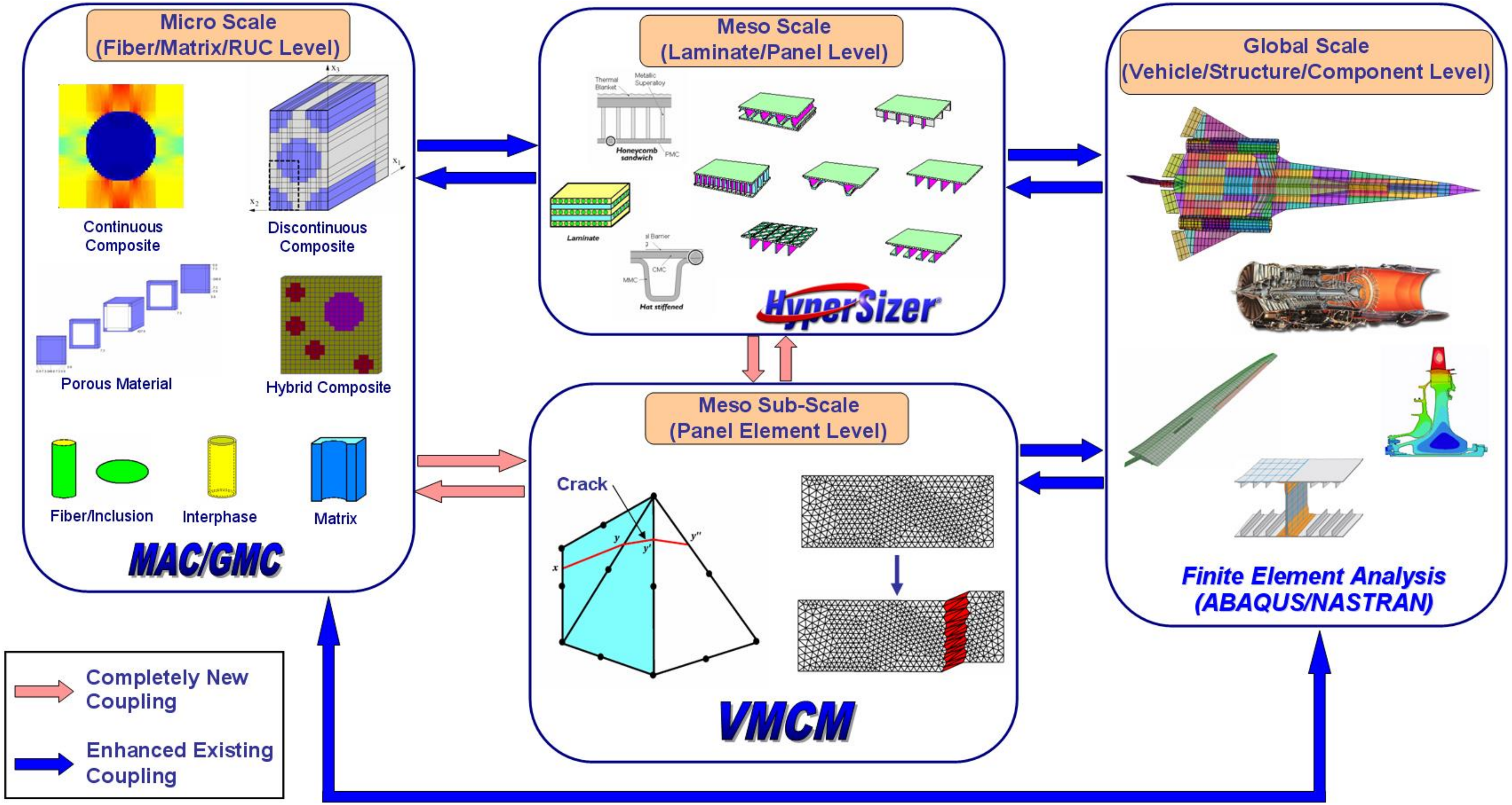




- Coupling between damage and failure at the lamina level and the microscale

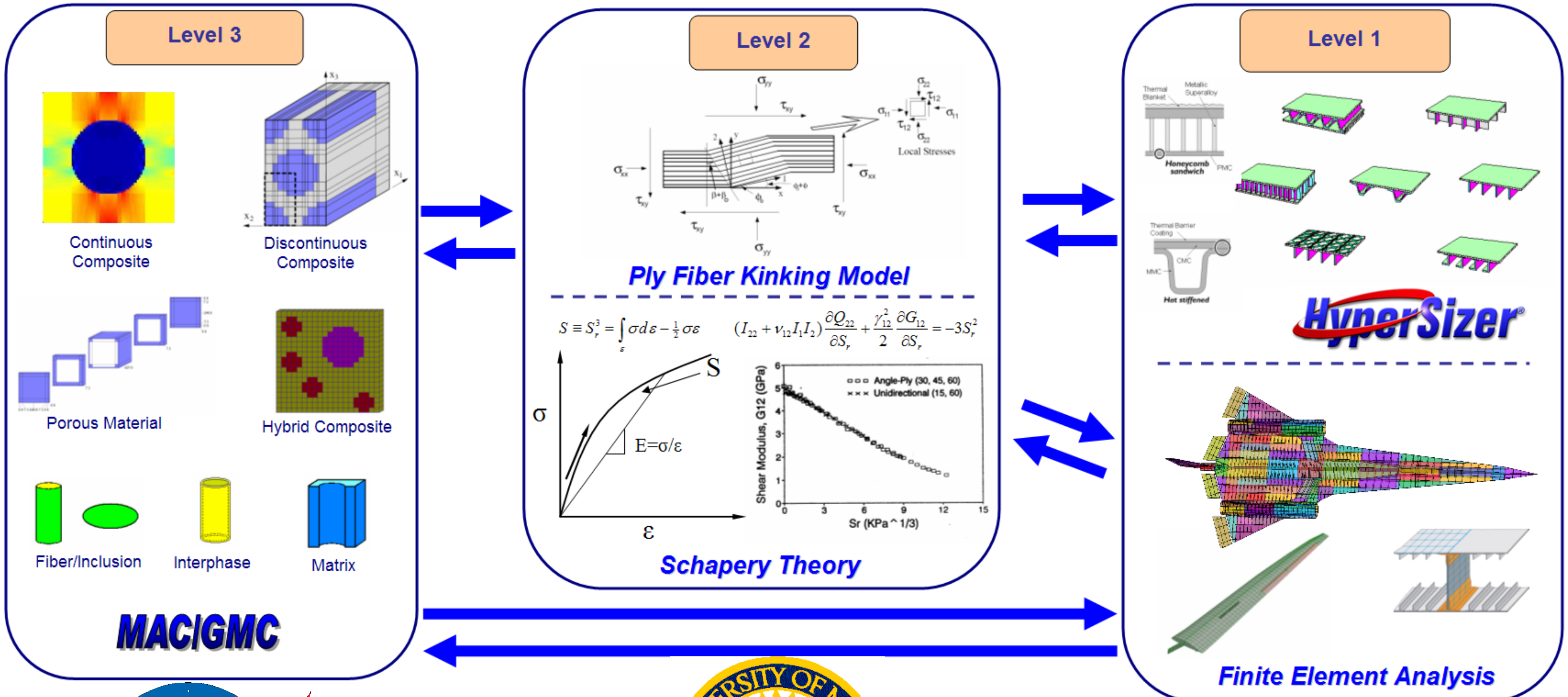
Methods Coupling of HyperSizer with High-Fidelity Analysis

Tight integration of State-of-the-Art analysis/design codes



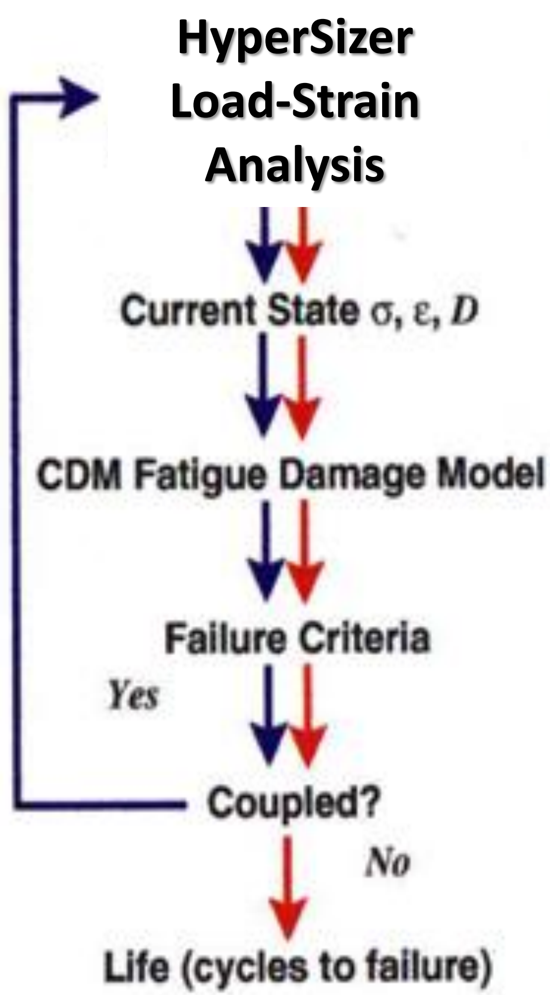
- Development of a unique, multiscale toolset for the rapid prognostics and diagnostics of composite and multifunctional airframe and propulsion structures

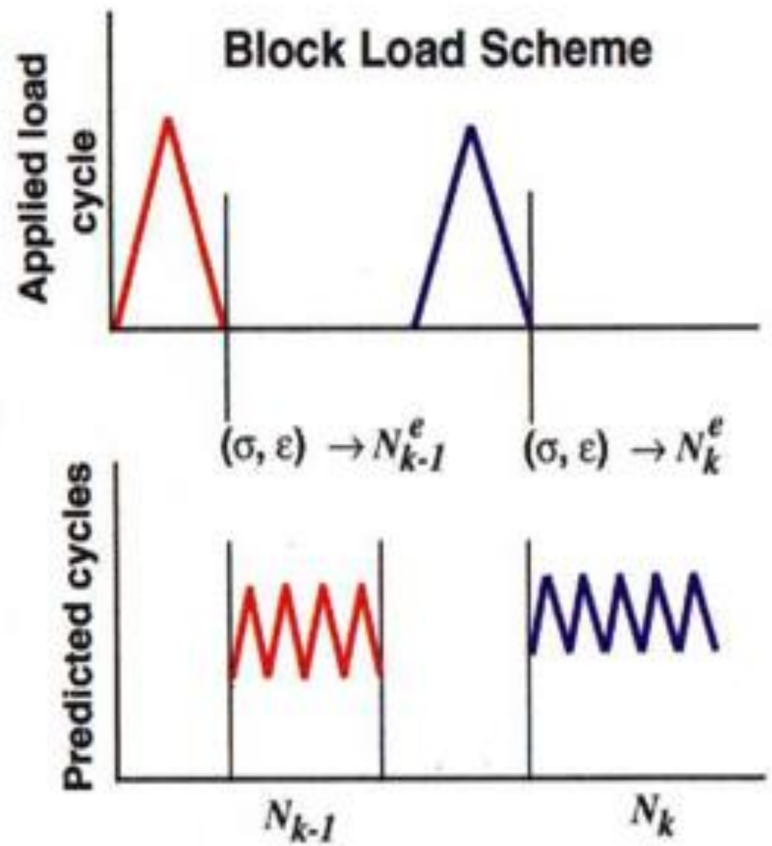
Methods Coupling of HyperSizer with High-Fidelity Analysis

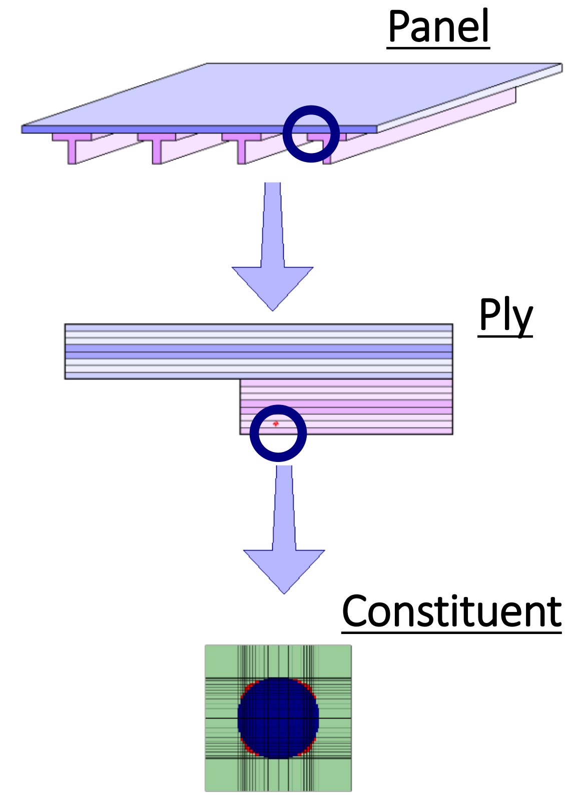


- Develop a multiscale analysis tool that captures complicated failure/damage of advanced composite structures using the physics of mechanisms

Composite Fatigue Damage Analysis in HyperSizer







Predicted Panel S-N Curve