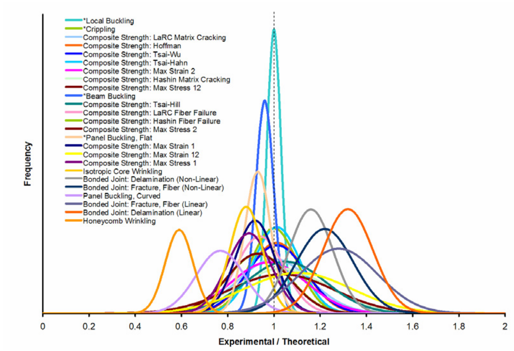
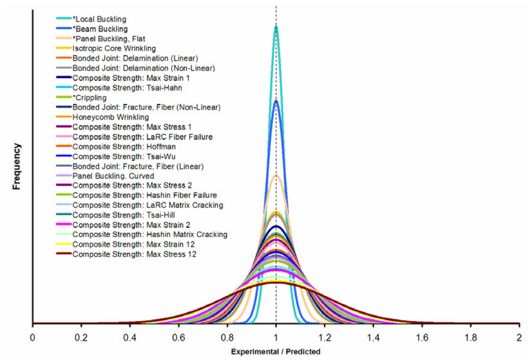
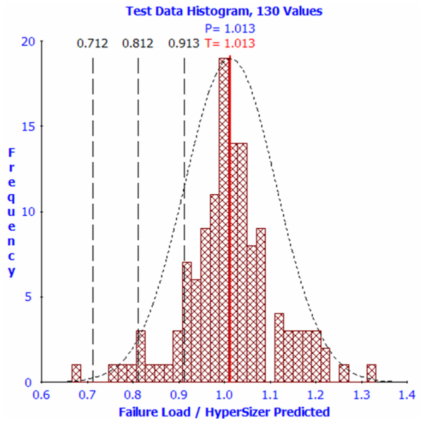
From composite planes to composite sports

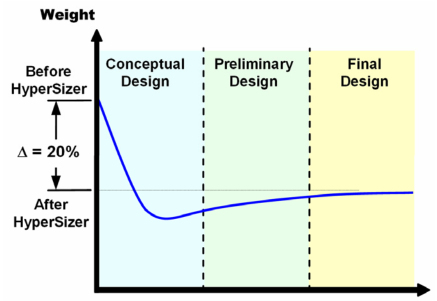






HyperSizer generated probability density functions and histogram.

Real world customer projects experience a 20% weight savings on their baseline structural design after using HyperSizer. Give HyperSizer a try today – at any design phase.



Analysis Summary

HyperSizer® is stress analysis & sizing optimization software for structures. HyperSizer couples automatically to FEA such as NASTRAN for system level trade studies and structural component margin-of-safety reporting, while reducing engineering time and effort. The software solves detailed mechanical and thermal stresses/strains for metallic and composite materials, and performs detailed failure analysis of panels, beams, and joints. Composite failure analyses are available for traditional quadratic and new physically based ply theories, a fiber/matrix micromechanics approach, and laminate AML and polynomial damage tolerance design curve allowables. Flat and curved panel buckling, local buckling, post buckling, crippling, and beam-column stiffened panel specific analyses are provided, as well as honeycomb sandwich specific analyses such as facesheet wrinkling. BJSFM bolted hole and recently advanced fully anisotropic multiaxially loaded bonded joint analyses are provided. 19 failure criteria are identified specifically for peel and interlaminar stresses that cause delamination and adhesive debonding damage initiation. For bonded joint damage tolerance, HyperSizer includes a Strain Energy Release Rate (SERR) calculation with a non-FEA Virtual Crack Closure Technique (VCCT) for rapid, damage tolerant preliminary design.

Test Database

Failure analyses have been validated to 130 tests for composite materials, including the World Wide Failure Exercises (WWFE) composite test data. This test data, as provided in the delivered database, is used for establishing correlation factors for test scatter and analysis inaccuracy. These correlation factors are then used by an included probabilistic method. The top left image is the scatter between experiment and theory, the middle image after the correlation factors are applied, and the bottom image is a resulting histogram for a composite strength failure prediction. The user can enter and store their own test data and generate these histograms automatically for driving optimum designs based on literally hundreds of different deterministic and reliability failure predictions.

HyperSizer®

www.hypersizer.com

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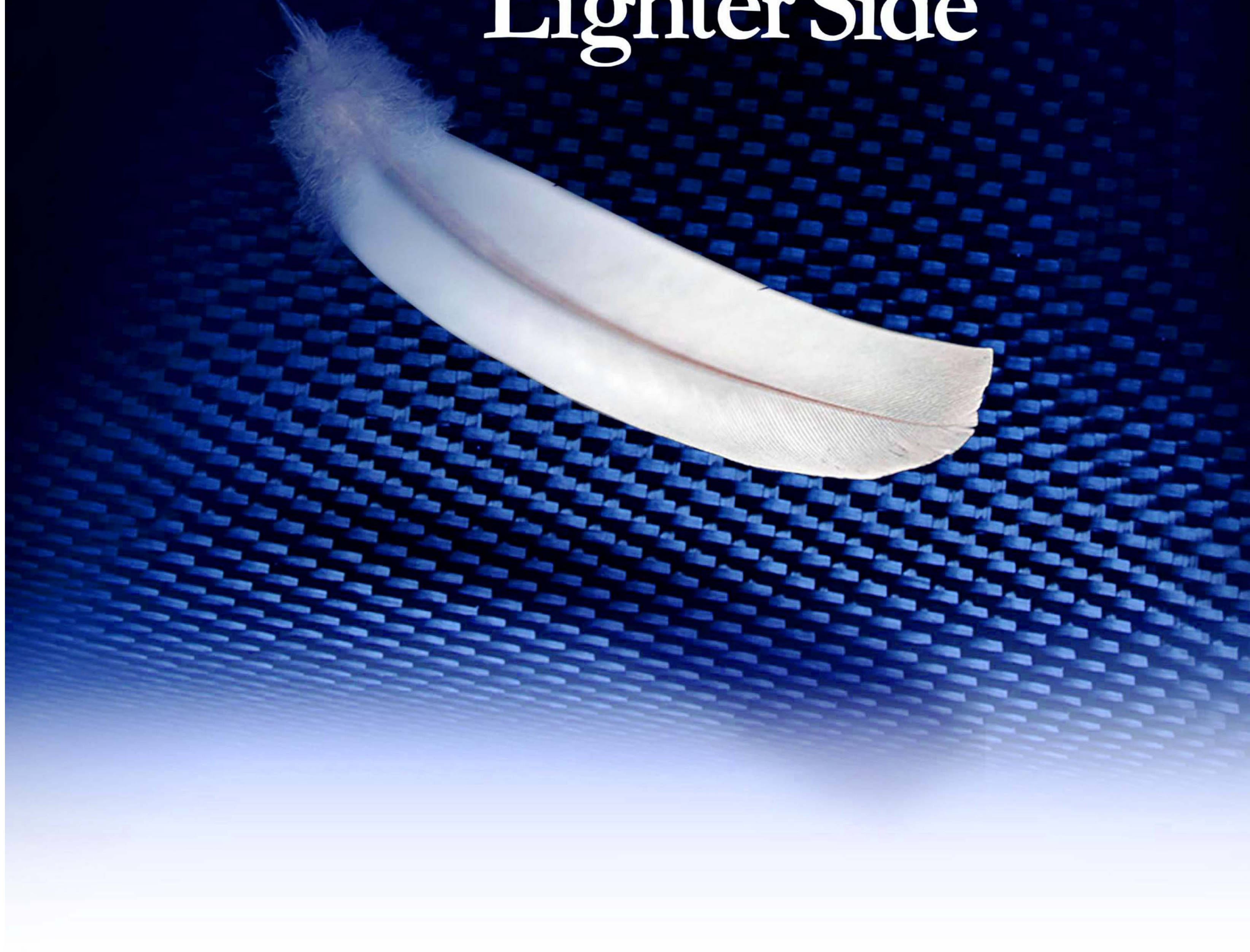
Design on the Lighter Side



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HyperSizer...Design Right, Fly Light.

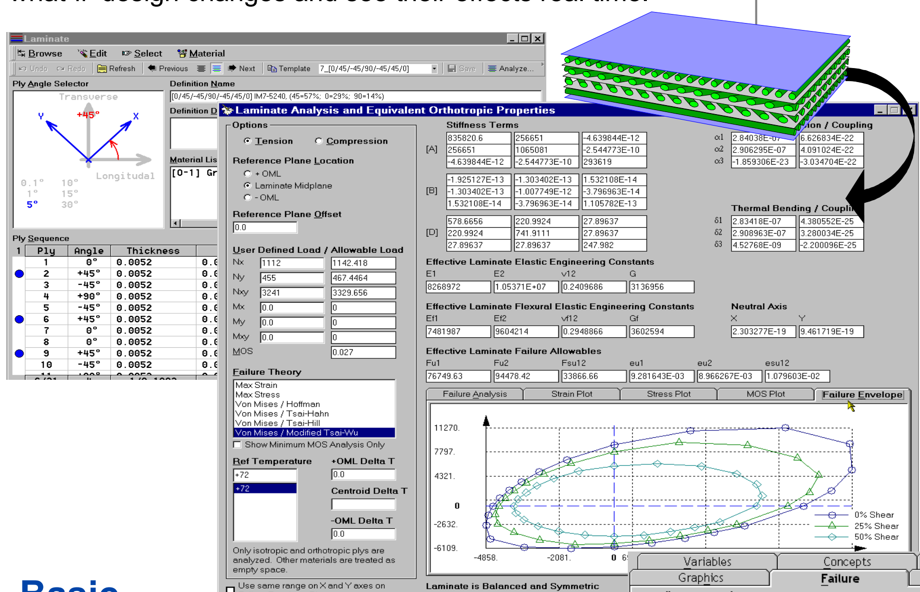
Recent HyperSizer design and analysis projects.

For over a decade, HyperSizer has significantly reduced weight on major aerospace programs with rapid analysis and composite optimization. Originally developed at NASA, it's now greatly enhanced and supported as a commercial product worldwide. HyperSizer is not CAD and is not finite element analysis (FEA).

HyperSizer is something different and is described next as three separate products that all share and build upon the same integrated and internal database. Starting with a user friendly software interface, it's both easy to use and powerful.

Material Manager

With Material Manager, you can build composite laminates with any arbitrary stacking of material forms or material types. Use native Windows cut, paste, and copy functions for quick ply insertions and layup arrangements. Define and save stack templates and use other advanced layup tools. Graph failure envelopes and stress/strain profiles automatically. Perform highly interactive 'what-if' design changes and see their effects real time.



Basic

HyperSizer Basic™ includes all the functionality of HyperSizer Material Manager, such as composite laminate analysis, plus stress analysis and detailed design optimization for over 50 different stiffened and sandwich panel and beam concepts. Any material or cross sectional dimension can be optimized to all load cases. Apply general edge loadings and/or boundary conditions through the Free Body Diagram software tab and solve for the resulting stresses and structural integrity using over 100 different failure analyses. Analyses include traditional industry methods and modern analytical and numerical solutions.

Pro

HyperSizer Pro™ includes all the functionality of Basic, plus coupling with FEA for system level analysis and automatic finite element model resizing and results display.

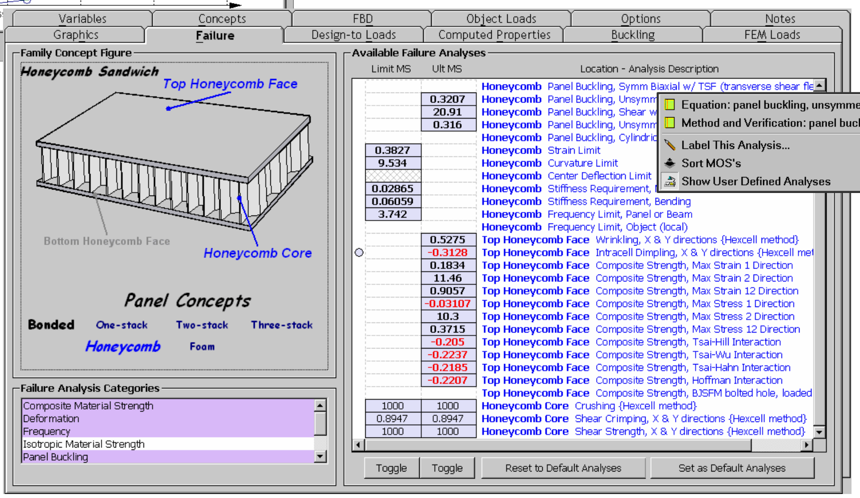
Finite Element Models

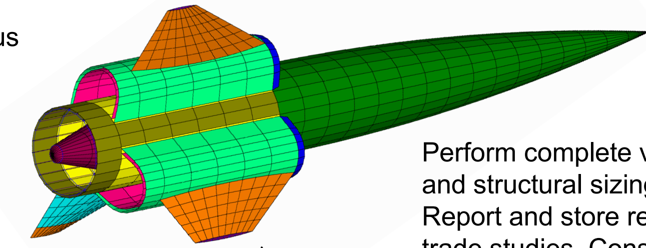
Using panel, beam, and laminate analyses from the Basic and Material Manager products, Pro provides a complete and detailed analysis of entire systems such as airframes, rocket engines, ship hulls, and train bodies. Complete margin-of-safety (MS) summaries of all potential structural failure modes for all load cases are reported.

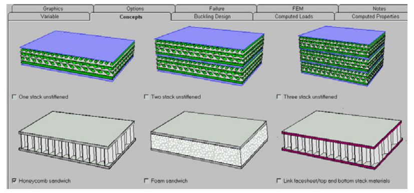
FEA computed internal loads are retrieved and input automatically for sizing the panels and beams. HyperSizer then creates generalized thermoelastic stiffness terms to send back to the FEM for another iteration of computed internal load paths. HyperSizer controls this iterative convergence and controls FEM global responses such as wing-twist deflections and includes external pressure loading updates based on deformation.

This Aerospace Vehicle

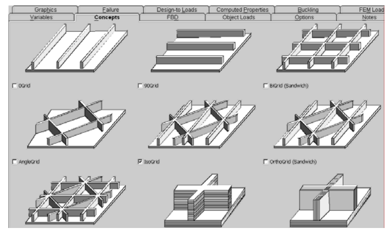
The general FBD loading approach that allows general loadings, deformation, and boundary conditions at each panel/beam edge was used for this aerospace vehicle design. Design-to loads were coded with closed-form equations in an Excel spreadsheet. With HyperSizer's programmable Object Model, the two software packages passed data with each other using the underlying Microsoft operating system COM. Once optimum internal substructure layouts for wing spar, rib, and fuselage ringframes were defined based on panel span length optimization trades, finite element models were built and external loadings applied.

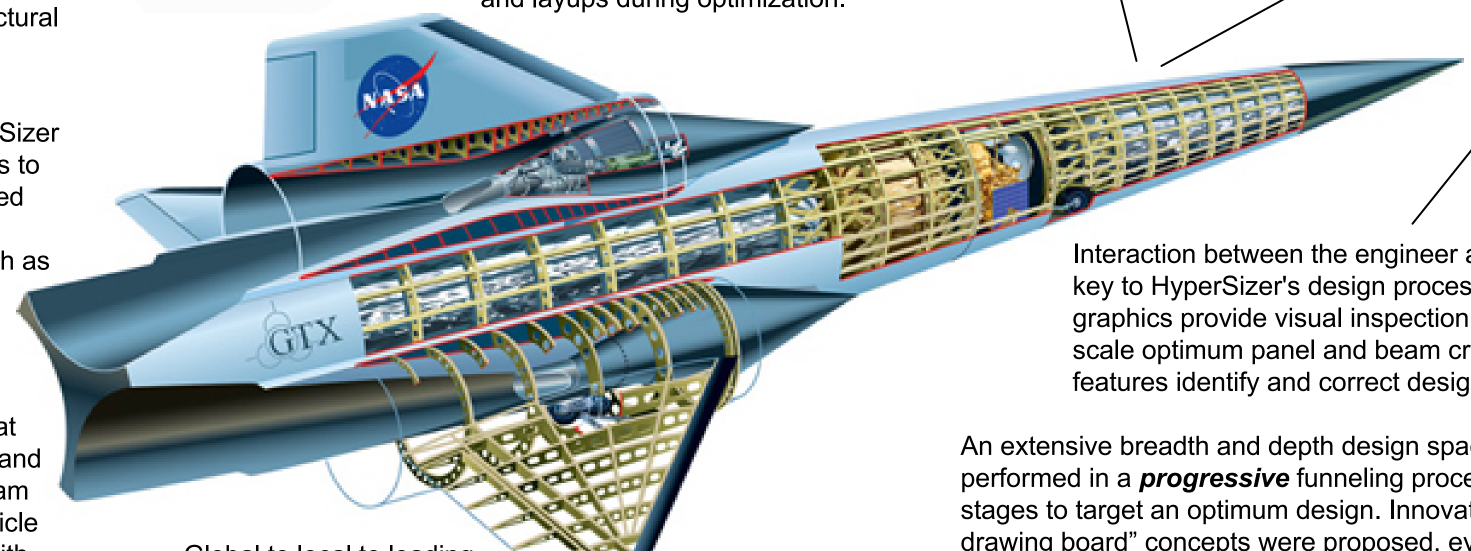






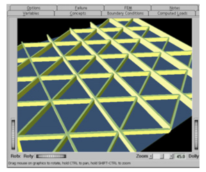
Perform complete vehicle analysis and structural sizing optimization. Report and store results of many trade studies. Consider different panel concepts, material systems, and layups during optimization.

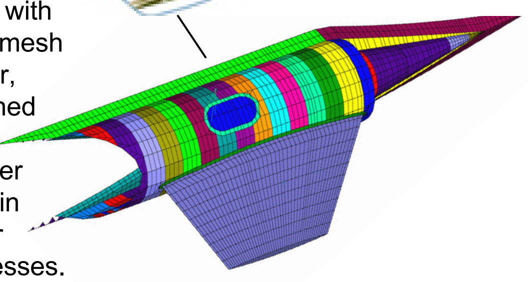




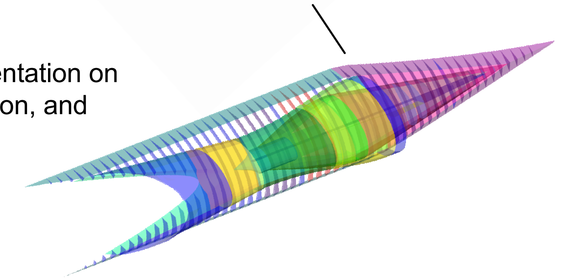
Interaction between the engineer and the software is key to HyperSizer's design process. Interactive graphics provide visual inspection of the drawn-to scale optimum panel and beam cross sections. These features identify and correct design flaws early.

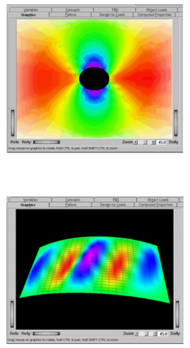
Global to local to loading effects are captured with FEMs of increasing mesh refinement. However, even the finely meshed FEMs do not have to include the stiffener shapes or spacings in order for HyperSizer to capture detail stresses.





Extensive documentation on methods, verification, and validation to tests





Software customization

Plug-in your own analysis software to supplement HyperSizer's methods and have your results integrated with and graphically displayed in the interface, such as these composite bolted joint and energy based buckling solutions.

An extensive breadth and depth design space exploration was performed in a ***progressive*** funneling process performed in stages to target an optimum design. Innovative "back to the drawing board" concepts were proposed, evaluated, and filtered out for the next stage of the design maturation process. The complete airframe including fuselage, tanks, wings and most of the engine including inlet, nozzle, combustor, nacelle and cowl were analyzed and optimized using several different panel and beam concepts and material systems. Panel concepts such as uniaxial Tee, blade, I, Zee, and hat stiffened; orthogrid concepts such as orthogrid, bigrid, isogrid; and sandwich concepts such foam and honeycomb were included. Many materials such polymer composite graphite/epoxy, graphite/polyimide; ceramic composite C/Sic; and advanced metallic alloys such as Gamma Ti/Al were included. A synergistic structure-Thermal Protection System (TPS) sizing was also performed with HyperSizer.

These coarsely meshed FEMs are all that is needed for HyperSizer to quantify details such as computing interlaminar shear and peel stress variation in the last ply in contact with a stepped bonded joint. This ***progressive*** analysis process for including more computationally demanding analysis solutions starting with damage initiation, tracking the progression of laminate failure, and ending with the resulting residual strength at ultimate failure is easily used. Also, easily used is the incremental process of including more design detail, such as ply drop-offs.

Progressive Optimization
→ Progressive Failure Analysis
→ Progressive Detail Design

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