Since HyperSizer’s primary market is aerospace, some of the software’s key features are introduced using a sample wing box for a 160 passenger-sized aircraft similar to a Boeing 737 or Airbus A320. Graphically represented by unique color regions on the Finite Element Model (FEM), finite elements are grouped together to represent panels and beams that share the same cross sectional dimensions and materials systems.

Analysis is performed on the structural parts of skin panels, ribs, spars, and caps - called structural components - not on the finite elements. HyperSizer optimizes to determine the lightest weight combination of material systems and cross sectional geometric dimensions (panel height, stiffener spacing) including layup ply angles and stacking sequences. HyperSizer’s new laminate sequencing provides real-world fabrication constraints that ensure efficient and manufacturable designs by minimizing ply drops across panel boundaries and identifying and reducing ply drawing part numbers and fabrication process steps.

Figure 1: Wingbox FEM. Colors represent structural components of the lower surface.

Figure 2: Sequenced laminates and drop offs for a composite part.

**Key Highlights:**

**Industry**
Aerospace

**Challenge**
Preliminary design optimization of composite and metallic structures

**MSC Software Solutions**
MSC Nastran for solutions and monitor of completion and data exchange during iteration cycles

**Benefits**
- Execute the Solver
- Control Iterative Load Path Convergence
The Unified Software Standardizes and Automates the Design Process

Preliminary Design Optimization of complete structural designs for aerospace, energy, rail, transportation, and shipbuilding projects is optimized in HyperSizer. The lightest weight panel and beam concepts along with design variables and candidate materials are determined and then mapped directly onto the finite element model. Rapid and very accurate trade studies establish the benefits of recently developed composite material systems and newer 3rd generation aluminum-lithium alloys.

Final Analysis Margins of Safety Calculations are performed including hundreds of aerospace industry standard failure analyses to evaluate the strength and stability of entire airframes and engine structures for thousands of load cases. This allows quick identification and resolution of weak spots throughout the design process.

Stress Report Documentation is generated for all failure modes to include the analysis methods and calculations required for FAA airworthiness certification. Summary tables of controlling margins of safety, load sets, and failure modes are included for project reporting and assessment.

Test Data Validation for failure analyses is established by storing the specimen test failure load in the database. By correlating test data failure loads with the analytical predictions, the user is able to quickly establish and permanently maintain within the test database a record of prediction accuracy required for airworthiness certification.

How Does HyperSizer Improve the Wing?

The wing model has applied external loads such as aero pressures (PLOAD4), inertia (GRAVITY), and control surface concentrated forces (FORCE). These are then resolved into internal loads such as shell element membrane and bending unit forces Nx, Ny, Nxy, Mx, My, Mxy, Qx, and Qy. HyperSizer extracts these FEA computed internal loads, per structural component, and uses industry standard failure methods such as stiffener flexural torsional buckling, skin postbuckling, crippling, stiffener bonded joint, and damage tolerant laminate strength to quantify safety factors and eliminate negative margins for thousands of mechanical and thermal load sets. After optimizing to quickly determine the lightest weight combination of material systems, cross sectional dimensions, and ply layups for all panels and beams in the structure, generalized stiffnesses of the improved design are exported back to the FEM and the FEA is submitted for an update of computed internal loads.

Optimize the panels and beams by entering a range of cross sectional dimensions and available materials and laminates to define the pool of candidates in the design space. Based on your defined range of variables, HyperSizer generates permutations of all possible candidates and analyzes them to find the lightest panel and beam dimensions that return positive margins for active failure modes to all load cases.

Figure 5: Define cross sectional variables and generate candidate laminates

Figure 3: MSC Nastran computed internal loads displayed in HyperSizer (half model).

Figure 4: Choose from over 50 panel and beam concepts

Figure 2: Hypersizer
Perform hundreds of industry standard failure analyses to resolve all negative margins of safety for your uniquely selected set of analysis methods. On the HyperSizer Failure tab, toggle a particular failure analysis on or off. If toggled on, HyperSizer will report a margin of safety.

Design composite laminate structures for strength, stability, and manufacturability by defining optimum layup areas and end-of-ply transition zones on the part surface. Solve for ply count compatibility across adjacent zones, and then sequence the actual ply ordering while reducing weight and minimizing ply drops. During this process, factors are provided for controlling which plies to drop, which plies to maintain continuous, and how to interleave across transitions. Lastly HyperSizer provides convenient ways to perform final edits to the laminates and to export and import from Excel spreadsheets, FiberSIM, and CATIA Composite Workbench.

Iterate with MSC Nastran using HyperFEA® to execute the solver and to control the iterative load path convergence. After HyperSizer has optimized the design of the vehicle, generalized thermoelastic stiffness terms are imported back to the FEM for another iteration of computed internal load paths. HyperFEA automatically submits HyperSizer and MSC Nastran solutions and monitors their completion and data exchange during iteration cycles. This automated iteration utility is called HyperFEA and is included in HyperSizer. After the design has been closed and validated, the last step is to make the final report.

Generate stress reports that include the calculations for all HyperSizer-computed margins of safety, material properties, design-to-loads, and optimum design dimensions for all wing structural components. These comprehensive engineering reports are invaluable for FAA certification and assisting the stress engineers with detailed stress calculation data to support the hardware throughout its life cycle.

The Future for HyperSizer CAE and MSC Nastran

HyperSizer CAE software extends the capability of MSC Nastran. The two software packages have worked seamlessly together for 15 years. Now as an MSC Software Community Partner, Collier Research Corporation is developing tighter coupling for faster run times and more efficient and robust data exchange. Recent updates include MSC Nastran-specific efficiencies such as import of OP2 binary output results files for handling thousands of load cases. See a live demo of the two software products working together at the MSC 2011 Users Conference.

Contact:
Craig Collier, HyperSizer
www.hypersizer.com
About MSC Software
MSC Software is the worldwide leader of multidiscipline simulation solutions that help companies improve quality, save time and reduce costs associated with designing and testing manufactured products. MSC Software works with thousands of companies worldwide to develop better products faster with simulation technology, software, and services. MSC Software is a global company with offices in 20 countries. For additional information about MSC Software’s products and services, please visit www.mscsoftware.com.

About MSC Nastran
Accurate, Efficient & Affordable Finite Element Analysis
MSC Nastran is the world’s most widely used Finite Element Analysis (FEA) solver. When it comes to simulating stress, dynamics, or vibration of real-world, complex systems, MSC Nastran is still the best and most trusted software in the world – period. Today, manufacturers of everything from parts to complex assemblies are choosing the FEA solver that is reliable and accurate enough to be certified by the FAA and other regulatory agencies.

Engineers and analysts tasked with virtual prototyping are challenged to produce results fast enough to impact design decisions, and accurate enough to give their companies and management the confidence to replace physical prototypes. In today’s world, nobody has time or budget to spend evaluating the accuracy of their FEA software – you need to know it’s right.

MSC Nastran is built on work done by NASA scientists and researchers, and is trusted to design mission critical systems in every industry. Nearly every spacecraft, aircraft, and vehicle designed in the last 40 years has been analyzed using MSC Nastran. In recent years, we’ve applied some of the best and brightest scientists in CAE to extend MSC Nastran’s power and efficiency, resulting in its continued status as the world’s best, most trusted, and most widely used FEA software – period. New modular packaging that enable you to get only what you need makes it more affordable to own Nastran than ever.

Please visit www.mscsoftware.com for more partner showcases