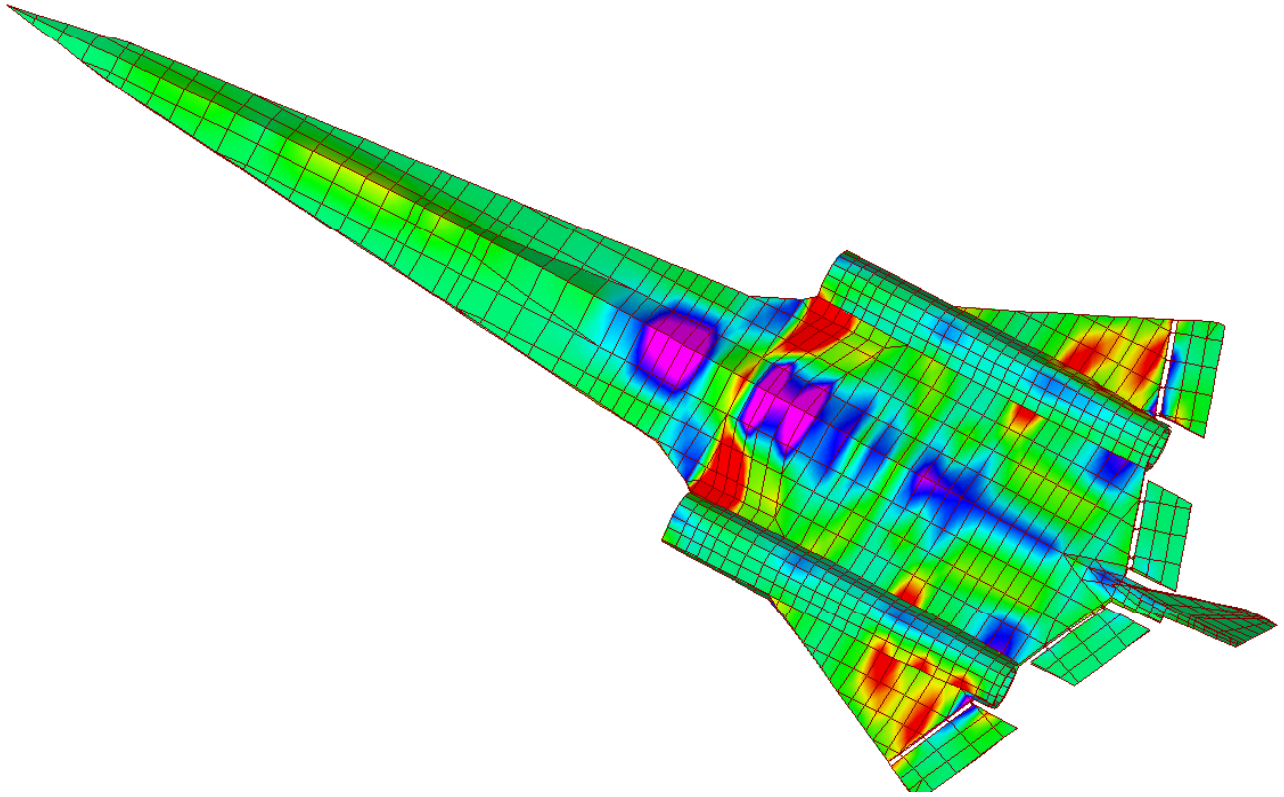
HyperSizer®

Main Points Summary

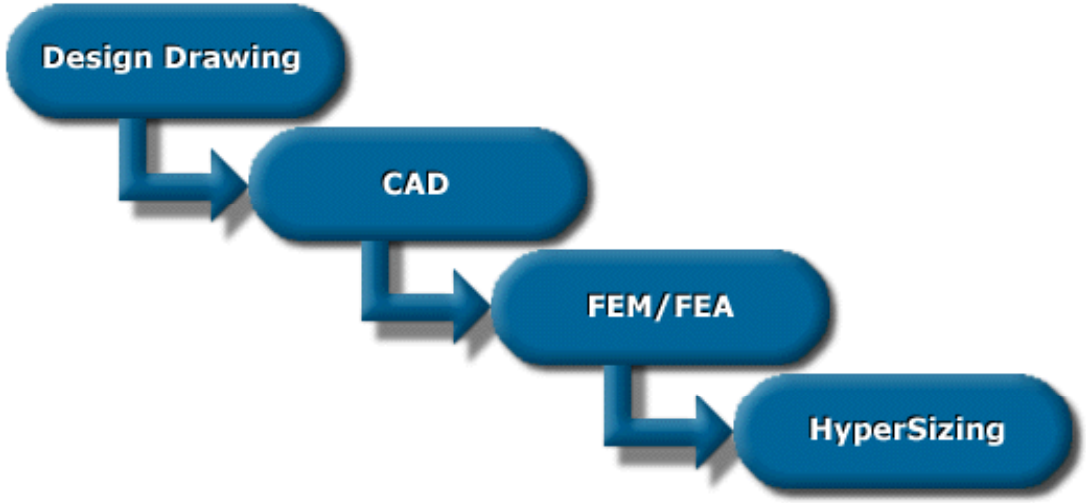


Collier Research Corporation

Introduction: What is HyperSizer?

- HyperSizer is not FEA
- HyperSizer is not a CAD
- HyperSizer provides automated structural analysis, material selection, and design optimization
- HyperSizer is the emerging next step in structural design automation, referred to as "Sizing"

Automation Through the Years – Now HyperSizer

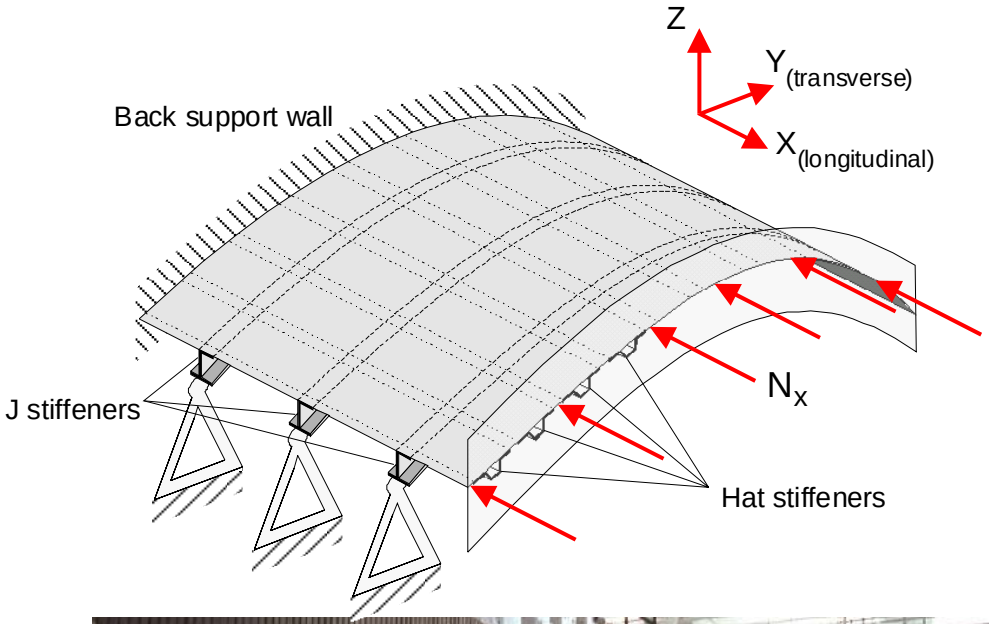


HyperSizer's Two Major Uses

- 1st, without FEA
  - Design-to loads are known
- 2nd, with FEA
  - Design-to loads are not known, the internal loads are indeterminate and FEA is required to determine load paths
  - In this case, HyperSizer couples to FEA such as MSC/NASTRAN, I-DEAS,…

1st Use Without FEA; Pretest Prediction to Uniform Compression Load -Hat Panel

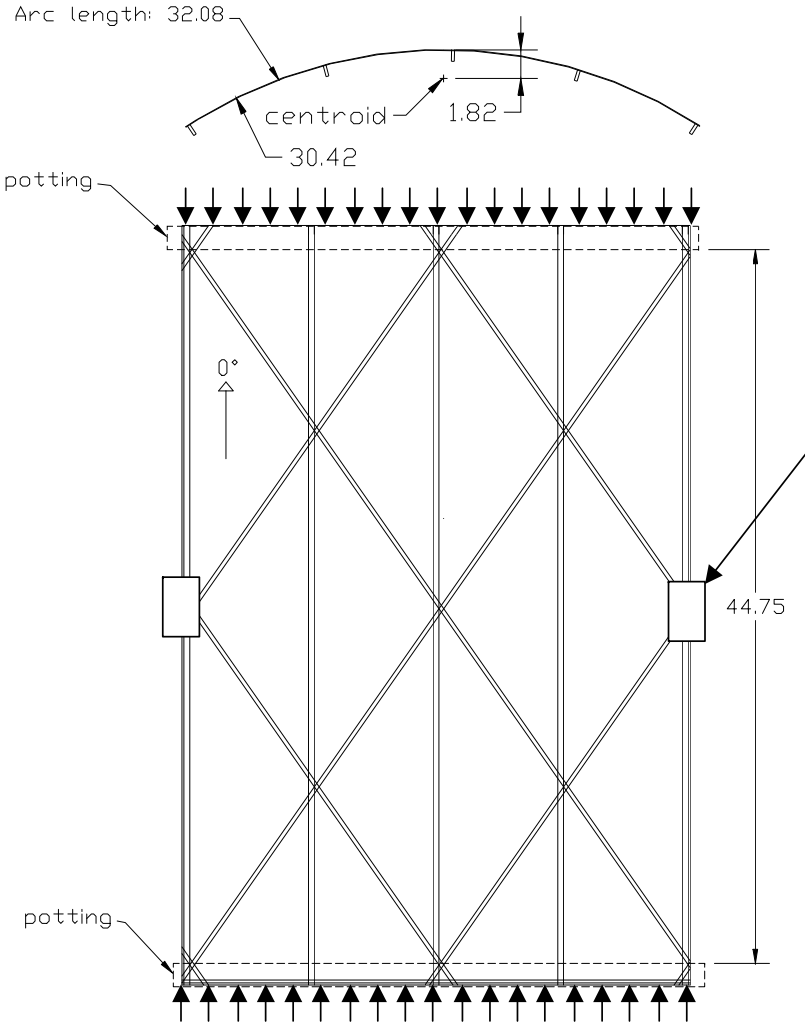
Reusable Launch Vehicle (RLV) Intertank - Failure Load Prediction for a Test Article



Analyze and optimize structural area in detail

RLV HyperSizer Customers

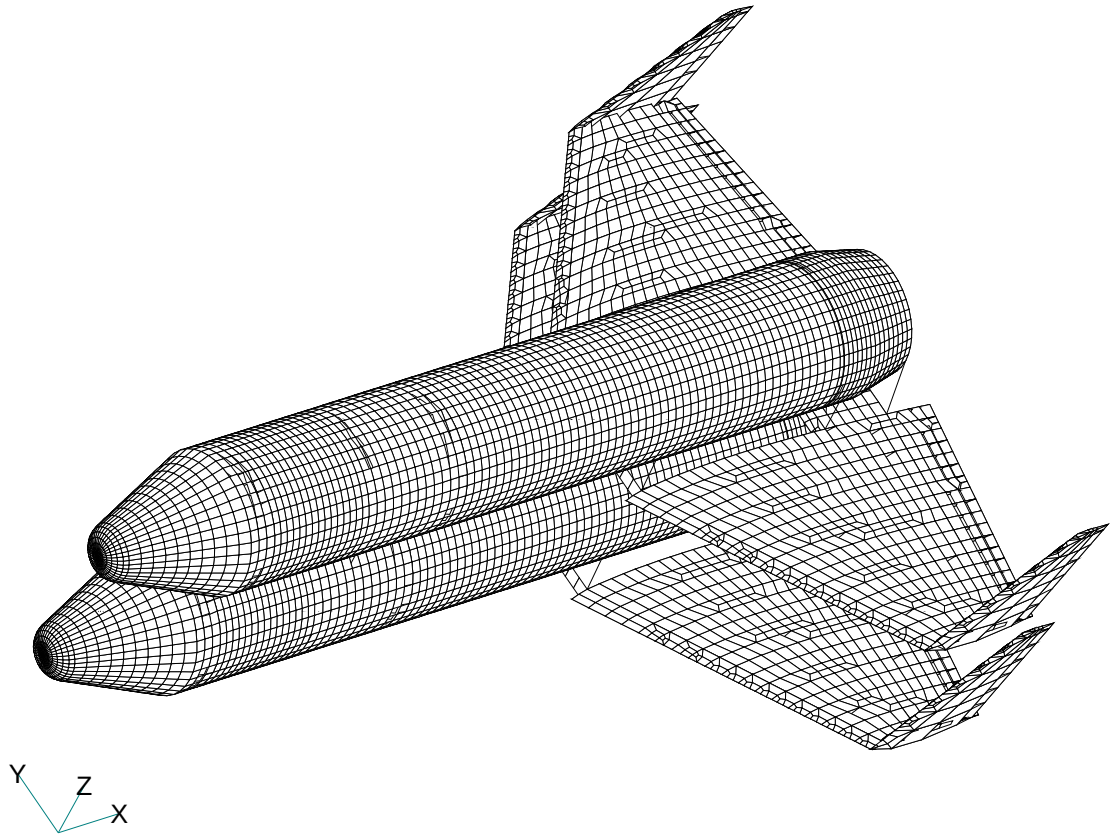
1st Use Without FEA; Pretest Prediction to Uniform Compression Load – Grid Stiffened Panel



HyperSizer Grid Stiffened Panel Test

2nd Use With FEA; Full Vehicle Analysis, Optimization, and Weight Prediction

Reusable Launch Vehicle (RLV) Bimese Architecture, NASA



Analyze and optimize an entire vehicle in detail

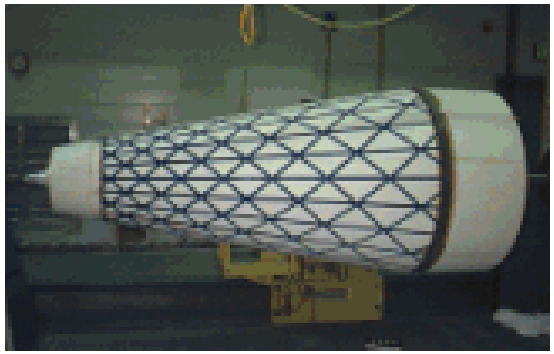
2nd Use With FEA; Full Vehicle Analysis, Optimization, and Weight Prediction

- An on-going example: HyperSizer used by NASA Glenn and P&W for the entire vehicle
  - Airframe: Fuselage, Tanks, Wings,…
  - RBCC Engine: Inlet, Nozzle, Combustor, Cowl,…
- All panel concepts: hat stiffened, orthogrid, foam sandwich, …
- All material types: C/C, C/Sic, Gr/Pi, Gamma TiAl,…
- Airframe/Engine Integration
- Synergistic structure-TPS sizing with blankets, tile,…

HyperSizer

Satellite Launcher Fairing Analysis, Optimization, and Weight Prediction

Composite Grid Stiffened Fairing for Orbital Corporation / USAF



HyperSizer Customer Application

Main Points - HyperSizer is:

- An Analysis tool
- A Design tool
- A Productivity tool
- A Standardization tool
- A Documentation tool

To be used throughout the product life cycle - from conceptual design phase all the way to in-service support

HyperSizer is an Analysis Tool

- Provides a knowledge base of classical methods
  - Answers “What analysis methods should be used?”
- Performs the analyses - from panel buckling to detailed stress
- Ensures structural integrity by including:
  - All analyses
  - All load cases
  - All locations
- Couples to FEA

HyperSizer is a Design Tool

- Performs detailed structural “sizing” design
  - Flange width, facesheet thickness, stiffener spacing, etc.
- Concurrently optimizes:
  - Panel/beam concept
  - Material selection
  - Cross sectional dimensions
  - Layups
- Presents alternate lightweight designs for manufacturing and producibility review

HyperSizer is a Productivity Tool

- Saves the analyst time
  - Automates the analyses - avoids tedious and time consuming hand number crunching
  - Reduces time lost going back and forth from the FEM to classical hand strength checks
- Reduces total designer and analyst labor hours
  - The designer/analyst is able to do quicker designs
  - Requires less iteration between the designer and analyst
  - Speeds up the design and analysis process cycle

Gets the job done quicker and saves engineering time

HyperSizer is a Standardization Tool

- Standardizes your company's methods
  - Ensures consistent use of company approved methods
  - Permits co-workers to quickly "jump-in" on other's on-going projects
  - Eliminates the need for engineers to make short cut solutions or forego analyses altogether to get the work done in time , i.e. less design changes and field problems
- Easily integrates user defined analysis software
  - Your company proprietary codes in Fortran, C, and C++
  - Full database integrity and GUI support

HyperSizer is a Documentation Tool

- Generates Reports
  - Design reports: dimensions, materials used, ...
  - MS Word Stress reports: ‘design-to’ loads, margins-of-safety...
  - PDF methods documentation
- Documents all project data in a relational database
  - Any change to material or project data is automatically cascaded throughout the database and reflected in the next report
  - Data is always the current latest-and-greatest, data integrity is maintained

Three Products

- HyperSizer consists of three separate tools:
  - HyperSizer Material Manager
  - HyperSizer Basic
  - HyperSizer Pro
- These tools seamlessly function together and share the same database.

HyperSizer Material Manager™

- Manage typical Mil Handbook 5 and Composites material data very effectively and very inexpensively
- Distribute and deploy material data locally with organizational control
- Integrate the Material Manager within your own software environment
- Build, edit, and analyze composite laminates with any arbitrary stacking of material forms or material types
  - Use Windows cut, paste, and copy functions for quick ply insertions and layup arrangements
  - Graph failure envelopes and stress/strain profiles interactively
  - Choose from many popular composite failure theories such as Tsai-Wu
  - Perform highly interactive 'what-if' design changes and see their effects real time.

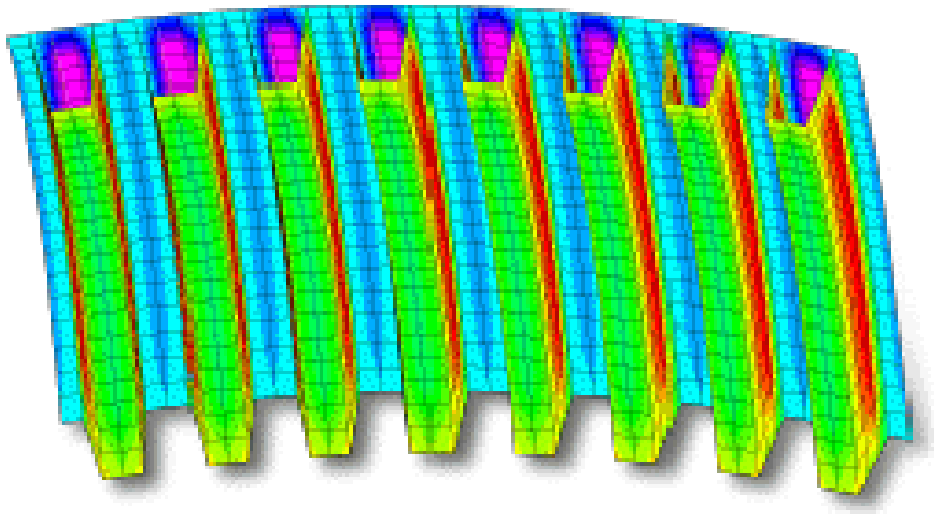
HyperSizer Basic™

- All the functionality of HyperSizer Composites™, plus
- Stiffened panels, sandwich panels, and beams
- Detailed stress analysis
- Hundreds of failure modes such as panel buckling
- Design sizing optimization
  - all panel or beam concepts, material types, layups, and cross sectional dimensions
  - all strength, stability, frequency, stiffness, and deformation requirements
  - VRML display of optimized cross section
- Automatic MS Word stress reports of your work

HyperSizer Pro™

- All the functionality of HyperSizer Basic™, plus
- Coupling with FEA for system level model resizing
- Data maintenance and results reporting of a complete vehicle detail design
- Advanced optimization such as automatic sizing refinement, and finding multiple optimum solutions for manufacturing producibility review
- Plug-in capability of your own analysis software to supplement HyperSizer's methods and have their results integrated with and graphically displayed in the interface

HyperSizer is Commercial Software:



Commercial Software

- Keeps pace with non-aerospace computing technology
  - Such as HTML, relational database management systems, collaborative engineering, web browsers, PDF documentation
- Accelerated tool development at a fraction of the cost
- Only one common interface to learn
  - Supports the ‘design anywhere’ objective
  - Allows plug-in of company/center proprietary legacy codes in either Fortran, C, or C++

Commercial Software

- Underlying powerful relational database management system
  - Data integrity is ensured
  - Automatic cascading of data updates and deletes
  - Automatic archival of project data
- GUI which is intuitive and extensive
  - Easy to learn the first time and to stay proficient
  - Windows XP/Vista compatible
- Extensive documentation:
  - Multiple User Manuals
  - Analysis methods and equations
  - On-the-fly, stress reports with margin-of-safety reporting

A Microsoft Windows® Application

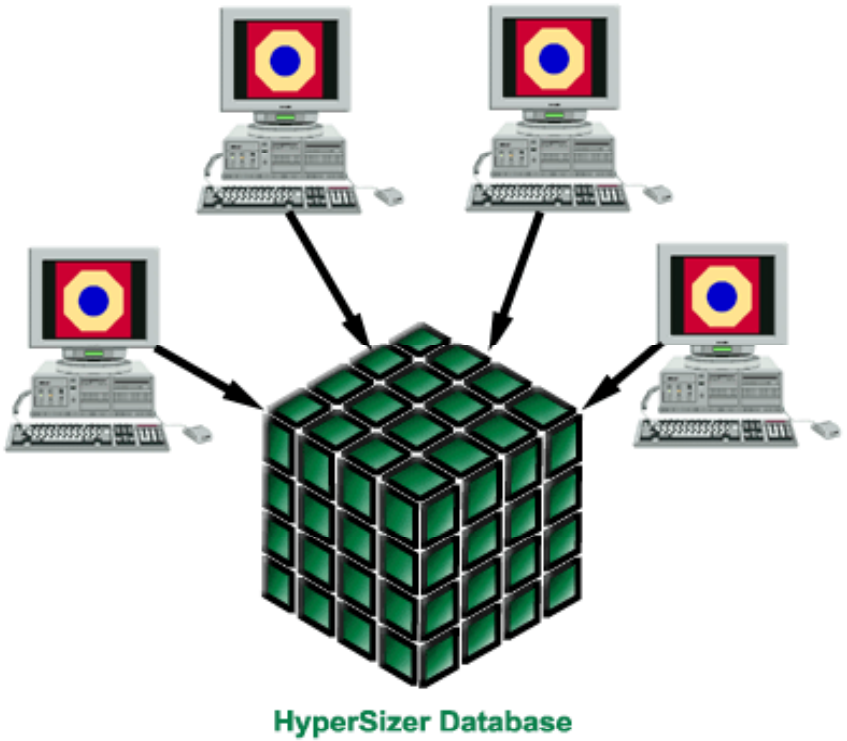
- Designed from the ground up using Microsoft Technology
  - Not Unix emulated for the PC
    - Faster
    - True look and feel of Window applications
- PDF documentation of analysis methods invoked from the Failure Tab
- Microsoft Word ® report generation for the project
- Export of material data from HyperSizer HTML into an Excel spreadsheet

Underlying Relational Database Benefits

- Microsoft's Jet database engine
- Database has over 130 tables with 700 relational data links (about 4000 unique data types)
  - Automatic cascading updates and deletes (triggers)
  - Data integrity ensured
  - Less user data entry errors
- Automatic project archival

HyperSizer User's Can Share the Same Database

Multiple sessions of HyperSizer products, running on different computers, can all access the same database, allowing engineers to analyze and optimize concurrently working as a team.



Database: Concurrent Multi-user and Multi-project

- **Run and automatically save corresponding analysis, design, and weight results for any**
  - **project**
  - **assembly**
  - **group**
  - **component**
- **Automated archival of different vehicle designs and design versions of the same project.**
- **Tested and proven that many very large projects**
  - **(1 million DoF FEMs) can be contained in one database**
  - **No adverse effects on the database - same performance**

HyperSizer Can Consolidate Codes

- Use HyperSizer to pull together other software into one common interface
  - Legacy codes
  - Proprietary codes (at customer facility)
  - Dynamically link your source code, either as Fortran, C, or C++
  - Have your analysis results such as margins-of-safety be displayed in the GUI and stored in the database
  - Have your analysis results be part of the stress report
  - Document your analyses methods in PDF and let them be part of the engineering references as displayed in the GUI

Interaction between the engineer and the software is key to HyperSizer's design process

- **Engineers learn within seconds the strengths and weaknesses of their structural designs from the software's interactive reporting of margins-of-safety**
  - **These features are used to quickly interpret and understand design flaws**
  - **Critical design issues are identified and resolved early in the design process**

- **Interactive 3-D graphics provide visual inspection of the structural component layout, assemblies, and drawn to scale optimum panel and beam cross sections**
  - **Allowing ample time to perform many design trade studies.**
  - **This quick and highly interactive process makes the task of saving weight easy and fun**