MSC Software

CASE STUDY

MSC Software: Case Study - TLG Aerospace, LLC

Making Better Aircraft Everyday

TLG Aerospace, LLC (TLG) is an aerospace engineering services company founded in 2008 in Seattle, Washington. TLG, 'The Loads Group' specializes in full vehicle analysis and optimization including static and dynamic loads, flutter, stability and control, aerodynamic design, Computational Fluid Dynamics (CFD) analysis, FAA certification and aircraft performance and handling qualities. TLG provides design, analysis and certification for new and modified aircraft and related aerospace products.

TLG's primary customers are OEMs, third-party modifiers, and other companies who design, analyze, build and sell aircraft, aircraft modifications, and related products. TLG's focus is on helping these customers get those products to the marketplace and in service as efficiently as possible. TLG routinely works with hardware-related groups such as manufacturing and test organizations. TLG engineers specify flight test instrumentation requirements and test conditions, act as engineering test crew for test flights, and prepare flight test reports within their disciplines.TLG also provides overflow capability for OEMs needing extra capacity, and helps new aircraft companies develop and validate their own loads and dynamics capabilities. TLG engineers have analytical and hands-on experience with over 100 aircraft models from more than 40 different manufacturers.

Sample static aeroelastic load condition. Certification loads surveys require accurate representation of the cases to be analyzed.

Key Highlights:

Industry

Aerospace

Challenge

Determine design loads by involving a full aircraft analysis of the air pressure and inertia forces during prescribed maneuvers, either in the air or on the ground.

MSC Software Solutions

MSC Nastran & Patran

Benefits

- Faster design iterations
- efficient use of capabilities for aeroelastic analysis is used in all parts of the design process
- More efficient aircraft design & analysis

"TLG is proud to use MSC Nastran to drive their industry-leading capability in aircraft design, analysis and certification for loads, dynamics, and flutter."

Robert Lind, TLG Aerospace

State of the Art Technology

TLG uses state of the art technology to provide its customers with advanced engineering solutions. TLG's core business is in airframe certification loads, dynamics, and flutter analyses. Working to rigorous FAA and foreign airworthiness specifications, TLG engineers participate in all levels of design, analysis, test, and certification of flight vehicles. TLG uses MSC Software's products including MSC Nastran and Patran as the core model development and analysis engines for aircraft certification. MSC Nastran provides industry-leading coupled aeroelastic calculations which are advanced and flexible enough to handle modern transonic aerodynamic vehicles, but also fast and efficient enough to be usable for loads and flutter, which can require tens of thousands of individual solutions.

Aircraft Loads Analysis

Aircraft loads are the forces and moments applied to the airplane structural components to establish the required strength level of the complete airplane. These loadings may be caused by air pressure, inertia forces or ground reactions during take offs and landings. Determining design loads involves a full aircraft analysis of the air pressure and inertia forces during prescribed maneuvers, either in the air or on the ground. Aircraft loads are needed at all design phases, from day one through certification and product lifecycle support. Early in preliminary design, structural designers need initial loads to size the preliminary structure. As the design iterations progress, the detail and fidelity of the loads increases. The final step for an aircraft is a full set of certification loads for submission to governmental agencies such as the FAA and European Aviation Safety Agency (EASA).

The loads analysis needs to cover all possible combinations of speed, altitude, flap angle, airplane gross weight, airplane center of gravity, passenger and payload distribution, fuel quantities, engine thrust and airbrake positions for each of the required maneuver and load cases for each part of the airplane. Static loads are calculated for conditions in which the aircraft is assumed to be at steady state and range from high speed dives to low speed stalls. The dynamic loads are how the airplane responds to gusts and bumps, including landing.

The input data to the loads analyses are accurate airplane geometry, aerodynamic data, weight (inertia) data, design speeds, stiffness data, miscellaneous systems data, operational data and regulations and requirements. This makes loads a multidisciplinary process. Early in a design program, these parameters can be estimated from various methods. As the design becomes more detailed and defined, the inputs will be more refined, and for the final certification level, verified by test.

TLG has developed an extensive set of tools to facilitate quickly setting up and running a large number of static and dynamic loads cases and then rapidly post-processing to obtain the most critical load cases, and then providing "loads envelopes" to the stress and structural engineers. TLG utilizes MSC Nastran as the core aeroelastic solver for both static and dynamic loads for these surveys.

MSC Nastran SOL144 and SOL145 are very suitable for these calculations, which require both structural and aerodynamic capabilities. Specific features, recent enhancements and upgrades have increased its utility:

Aerodynamic data can be input directly on aerodynamic or structural meshes

Aerodynamic pressures may be calculated from the built-in doublet lattice solver or alternatively input directly as pressures or forces on structural grid points. All of these aerodynamic variables may be linked to control variables and used in the airplane force balance for flight maneuver conditions. This capability allows TLG to input real-world data directly into the model, even if the results are difficult to calculate with the industry standard doublet lattice model. Examples include engine thrust, aerodynamic effects of deployed spoilers, and high trailing edge flap deflections.

User-defined input variables

MSC Nastran allows arbitrary combinations of user-defined inputs to be used as part of the balanced airplane calculations. These inputs can control arbitrary pressure inputs as mentioned above, or existing MSC Nastran trim variables, or combinations of existing variables. This functionality allows TLG to perform such tasks as balancing the airplane in any way needed for particular calculations, defining control surface relationships such as control wheel to aileron gearing, or linking any set of balance variables together.

Separate rigid and flexible mesh

A single aeroelastic trim calculation can be performed using one aerodynamic mesh for the rigid aerodynamics and second aerodynamic mesh for the flexible increment.

TLG customer aircraft modification. TLG performed the complete static & dynamic loads, and flutter certification analyses using MSC Nastran.

TLG uses this capability to maintain total control over the aerodynamic data.

Monitor points

Loads calculations require complete user control over how the aerodynamic and inertial loads are tracked and accounted for in the downstream output. Structural FEM and aerodynamic mesh elements do not inherently provide this level of control. The aerodynamic and structural monitor point capability in MSC Nastran allows TLG to define engineering-level loads summations to sort for critical conditions and to provide loads to stress engineers.

Flutter

Flutter is an aeroservoelastic phenomenon in which unsteady aerodynamic forces combine with structural vibrations to produce a self-feeding oscillation which, if unstable, usually leads to airplane damage! Flutter analysis is done to ensure that the aircraft is safe and free from flutter at all points in the flight envelope. The interaction between structural vibrations and unsteady aerodynamics are modeled to show whether an airplane will respond in a stable or unstable fashion to atmospheric or other disturbances.

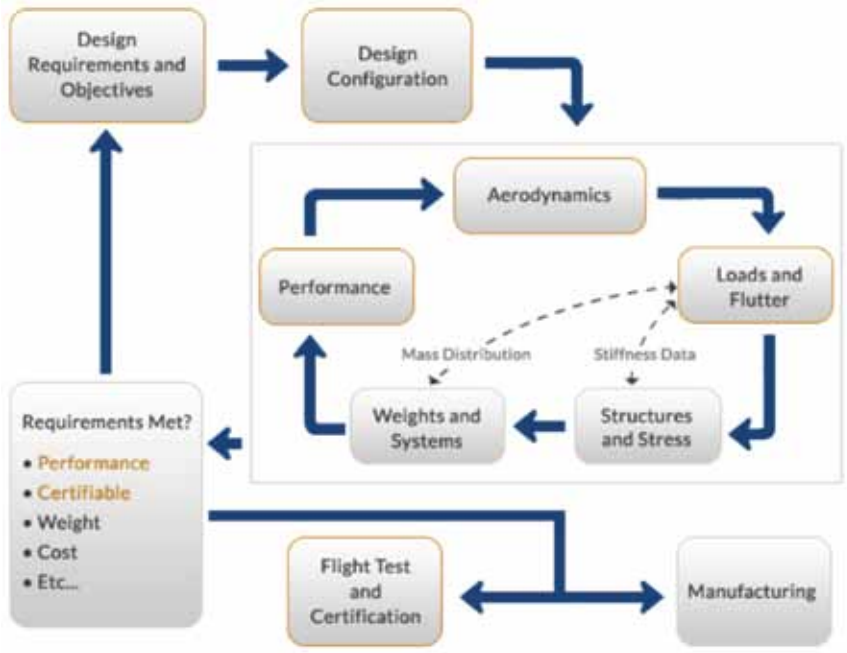
The FAA, EASA and other agencies require that the aircraft is shown to be free from flutter for all nominal flight conditions and for critical combinations of failed systems and structures. All possible combinations of fuel, payload and operating conditions must be considered. Flight flutter tests must be performed for some of the conditions to demonstrate the accuracy of the analysis and to prove the airplane is safe to operate.

TLG uses MSC Nastran SOL145 for flutter analysis. The results show which airplane types of vibration result in flutter and at what airspeeds the flutter occurs. Variations in the analysis model can show which design changes can be used to improve flutter behavior.

Aircraft Design Cycle

TLG's areas of expertise form core parts of the aircraft optimization design cycle. Aircraft design is an iterative process; early in the design phase, a loop around the design cycle may take only a few days or weeks. As the design matures and the detail increases, each additional loop may take months. When all the requirements are met, it's time to build an airplane!

The design starts with Design Requirements and Objectives (DRO). Along with size,



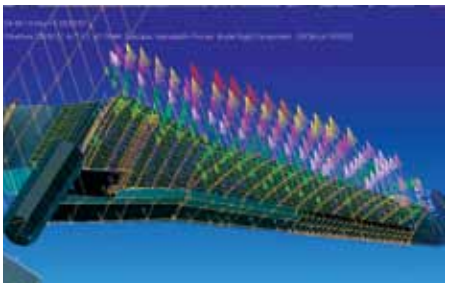
Aircraft Design Cycle

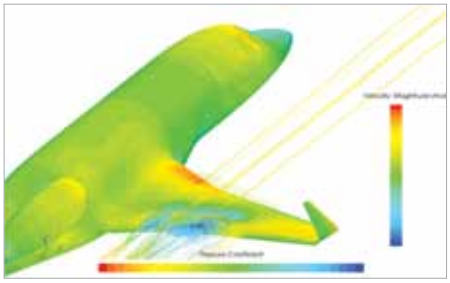
performance and weights, the DRO includes cost objectives and certification requirements. Engineers work from the DRO to create the initial airplane configuration.

Once an initial configuration is defined, the first design cycle begins. Estimates and approximations for input data are required - the aerodynamic analysis needs structure and weights design data, structural design requires loads data, and the loads analysis uses aerodynamic, structural, and weight data. After the initial design process, the results are compared against the objectives, assumptions and data are revisited, and an updated design is created. This process continues throughout the design, development, and certification process. Initial design phases involve numerous, relatively short design cycles as the configuration evolves to meet requirements. Later design phases are longer and involve higher fidelity data and more complicated analyses. The cycle continues through the project certification, as the certification loads depend on ground and flight test validation of the final dataset.

TLG is proud to use MSC Nastran to drive their industry-leading capability in aircraft design, analysis and certification for loads, dynamics, and flutter. TLG's capabilities in vehicle analysis and optimization make efficient use of MSC Nastran capabilities for aeroelastic analysis. These analyses are used in all parts of the design process, from conceptual design through to final certification and fleet support. TLG customers - including OEMs, modifiers, and new aircraft companies - benefit from more efficient designs and faster design cycles.

Please visit www.tlgaerospace.com or email us at info@tlgaerospace.com for more information on how we can support your aircraft design, analysis and certification projects.





MSC Nastran allows the user to define & import complex aerodynamic data such as the effects of deflected spoilers. The spoiler effect is calculated with a CFD code & used in the MSC Nastran calculations.

About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit www.mscsoftware.com.

Please visit www.mscsoftware.com for more case studies

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.

About Patran

CAE Modeling and Pre/Post Processing

Patran is the world's most widely used pre/post-processing software for Finite Element Analysis (FEA), providing solid modeling, meshing, and analysis setup for MSC Nastran, Marc, Abaqus, LS-DYNA, ANSYS, and Pam-Crash.

Designers, engineers, and CAE analysts tasked with creating and analyzing virtual prototypes are faced with a number of tedious, time-wasting tasks. These include CAD geometry translation, geometry cleanup, manual meshing processes, assembly connection definition, and editing of input decks to setup jobs for analysis by various solvers. Pre-processing is still widely considered the most time consuming aspect of CAE, consuming up to 60% of users' time. Assembling results into reports that can be shared with colleagues and managers is also still a very labor intensive, tedious activity.

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