HEXAGON

Brochure

Aerospace

MSC Software is the Aerospace Industry's trusted simulation and analysis partner to streamline lighter, stronger and safer aircraft

Rising to the challenge...

Increasing globalization is propelling the aerospace industry to focus on cost reduction and process improvement. To stay competitive, companies are adopting proven simulation solutions.

Additionally, OEMs (Original Equipment Manufacturers) are turning to trusted worldwide suppliers for product and product development services, making the need for efficient communication and streamlined data sharing more critical than ever.

As the original developer of the highly trusted simulation solutions used by the aerospace industry, MSC Software is closely engaged with all major OEMs and their suppliers. Thus, MSC's suite of technology solutions is designed to address the industry's broad and ever-changing spectrum of CAE requirements. Scalable solutions work for you to cut design and development time, meet certification requirements, and test the latest in materials... all before building the first prototype.

Technology

- A broad spectrum of Computer Aided Engineering (CAE) software tools to analyze, validate and optimize designs virtually
- Tools to manage complex and comprehensive CAE data to reduce redundancy while increasing innovation and profit
- Technology partnerships with leading CAE and HPC providers so you can achieve higher productivity and higher returns on your software and hardware investments

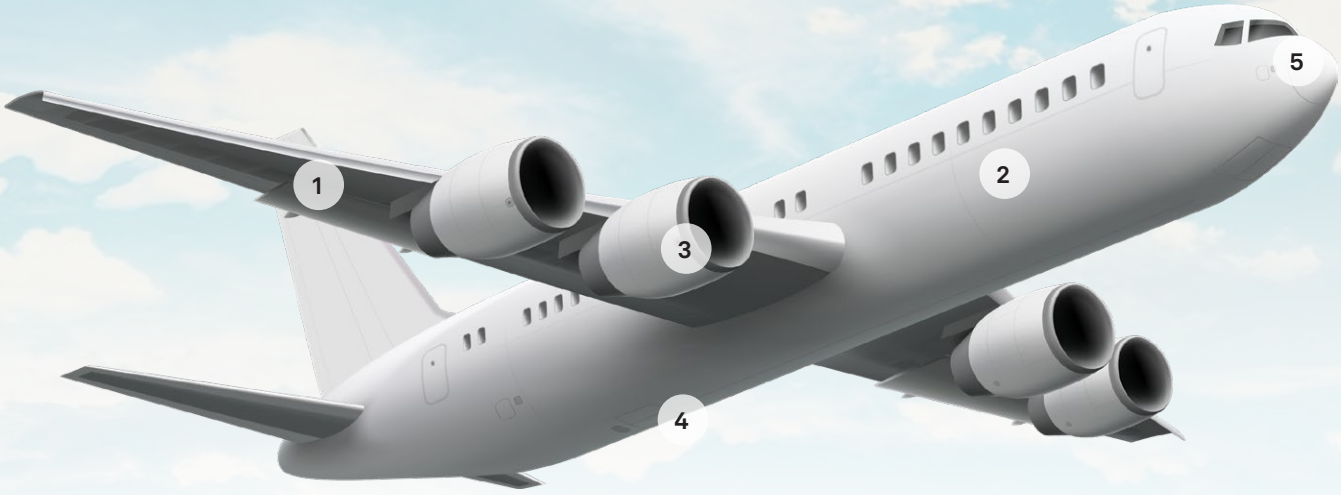
Processes

- Customized and out-of-the-box automation tools to improve simulation processes across groups and suppliers
- Optimal CAE methods to incorporate into your development and design process to meet regulations and achieve
- Certification consistently and reliably

People

- More than fifty years of experience partnering with automotive companies to solve challenging problems
- A transfer of knowledge and expertise, customized to your organization so you can operate at maximum efficiency
- Affordable learning through in-person and online structured programs suited to your needs

Simulate the complete aircraft engineering process



1. Wings
Static and dynamic aeroelastic and trim
Advanced and Explicit Linear and Nonlinear | Fluid Structure Interaction | Durability & Fatigue
Materials | Manufacturing Process
Thermal
Multibody Dynamics
modeling, simulation, analysis & optimization

2. Fuselage
Static and dynamic aeroelastic and trim
Advanced and Explicit Linear and Nonlinear | Fluid Structure Interaction | Durability & Fatigue
Materials | Manufacturing Process
Thermal
Multibody dynamics
modeling, simulation, analysis & optimization

3. Engine
Rotor Dynamics | Thermal | Explicit Nonlinear Acoustics | NVH | Explicit Dynamics and Fluid Structure Interaction
Durability and Fatigue Materials modeling, simulation, analysis & optimization

4. Landing gear
Multibody Dynamics | Nonlinear
Fatigue and Durability modeling,
simulation, analysis & optimization

5. Avionics
Control System Analysis
Structural Dynamic and Impact Analysis
Thermal | Durability | Joule Heating |
Coupled Thermal-Structural

Complete aircraft analysis

Minimise risk, maximize return: Explore interactions between components, assemblies systems and manufacturing process to design safer, stronger, lighter, and cheaper.

Integrated multiphysics

Get it right the first time: Test multiple physics simultaneously for high-fidelity results to streamline testing and analysis.

Composite virtual allowables

Reduce time and cost for material characterization: Accelerate the insertion of new composite material systems and explore new material possibilities.
Engineering lifecycle management

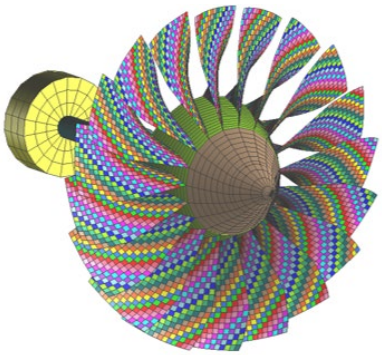
Don't reinvent the wheel: Track and manage all materials data and simulation data and process to retriveve easily and use for future projects.

Solutions for structural analysis

An aircraft's structural components must be designed to withstand the static and dynamic loads experienced during various stages of flight throughout its lifespan. MSC Software's proven solutions enable aircraft engineers to accurately simulate the structural behavior of parts, assemblies and complete systems, while meeting the stringent reporting requirements of certification agencies around the world.

Achieve certification faster:

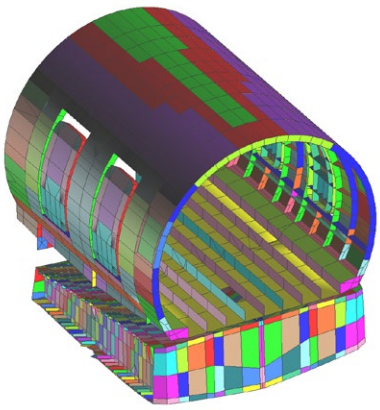
- Compute loads experienced by the full vehicle and assemblies during the entire flight envelope during all payload conditions and flight maneuvers.
- Leverage high-performance computing and reusable superelements to perform full vehicle studies with efficient use of computing resources.
- Perform durability studies integrated with stress analysis and design long-lasting products more efficiently.



Pre-Stressing of fan blades (implicit nonlinear)

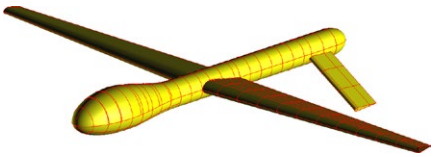
Tackle complex challenges:

- Perform stress analysis of all stuctural components and assemblies.
- Accurately simulate the materials used in design, including metals, elastomers, plastics, shape, memory alloys, composites and other customized materials.
- Perform coupled, uncoupled, and chained simulations to account for multiple physics experienced by structures.
- Perform coupled simulation to predict as-manufactured part performance.



Multidisciplinary structural analysis - fuselage section and wingbox

> **Considering the magnitude of the analysis challenge and the potential for error in both the analyses and the test, the MSC Nastran results correlation is excellent."**
>
> **D.J. Taylor,**
> Aerovironment



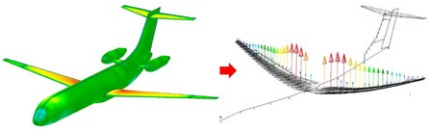
Model of an unmanned aerial vehicle

Optimize aeroelasticity

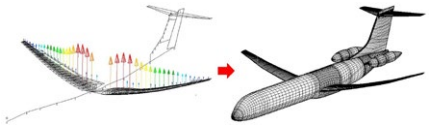
Structural design and control system analysis involves understanding the performance of the flight vehicle under aeroelastic loads, aerodynamics and flutter. MSC Software's integrated capabilities perform static aeroelastic, dynamic aeroelastic, and flutter analysis of structures at subsonic and supersonic speeds.

Incorporate certification early:

- Investigate the possibility of static aeroelastic instabilities.
- Analyze the aerodynamic load distribution and consequent modifications to aerodynamic stability.
- Perform modal flutter analysis for subsonic and supersonic unsteady aeroelastic scenarios.
- Generate results data that can be submitted to certifying agencies like FAA and JAA.



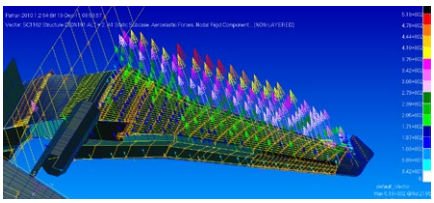
Spline technology to transfer CFD load to structure



Computation of structural displacements

Improve flight safety and performance:

- Conduct dynamic aeroelastic response analyses of the system subjected to prescribed loads including atmospheric gust fields, high speed landing laods and in-flight store ejection loads.
- Perform supersonic aeroelastic analysis of structures that experience unsteady supersonic lifting surface aerodynamics such as high-speed transports, launch and re-entry vehicles, air combat vehicles and missiles.
- Optimize flight vehicles for aeroelastic loads, flutter, strength, vibration frequencies and buckling characteristics.



Effect of deflected spoiler on displacements

> **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"**

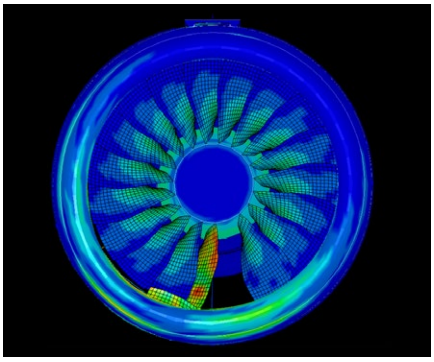
Robert Lind,
The Loads Group (TLG)

Refine rotor dynamics

Rotating systems such as engine turbines and helicopter rotors must perform smoothly to maintain a vehicle's safety. MSC's comprehensive solutions enable engineers to analyze rotor systems, individual or for the complete vehicle, to determine system instability and calculate safe operating ranges.

Improve engine performance:

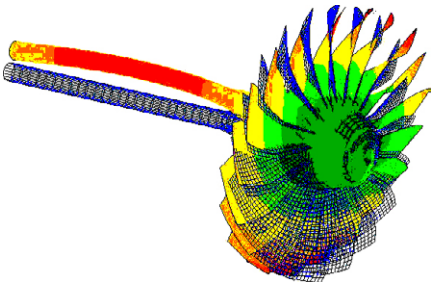
- Analyze and optimize rotating systems with 1-D, axisymmetric or 3-D models based on the desired accuracy.
- Design bearings to eliminate noise and vibration and calculate safe operating ranges and conditions.
- Use external superelements to incorporate multiple rotors in the system with reduced modeling effort.
- Calculate critical speeds and whirl frequencies
- Predict damaging rotor rubbing early in the design cycle



Fan blade out analysis

Reduce risk and improve safety:

- Simulate critical loading scenarios such as inbalance response.
- Perform linear and nonlinear transient analyses to study engine blade-out and subsequent wind milling.
- Identify system instabilities and investigate solutions to eliminate damage-causing vibrations from various maneuvers.



Modal analysis of rotating rotor

> **"The rotor dynamics code (in MSC Nastran) allows us to run the test in a virtual environment and ensure the physical test is passed the first time."**
>
> **Dr. Charles Lawrence,**
> Glenn Research Center, NASA

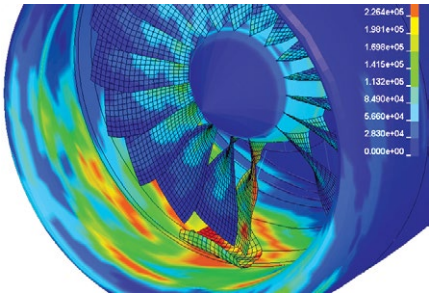
Multiple rotors with external superelements

Solutions for safety

Safety is of utmost concern in the design of any aircraft as failures of a single component or system may lead to catastrophic consequences. MSC Software provides solutions to study the various systems and entire crafts under a variety of difficult scenarios: crash landing/drop test, hydroplaning, foreign body impact/bird strike, and store ejection.

Design for durability:

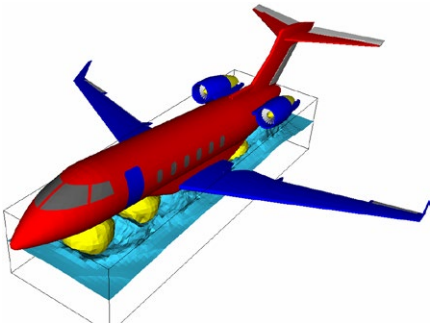
- Design systems with reduced chance of unexpected failures and improve occupant survival.
- Study how the influence of component/sub-system failure can effect the performance of the entire system.
- Perform accident investigation to improve future designs.



Fan blade out due to foreign body impact

Prepare for the unexpected:

- Perform foreign body impact on single-layered or multilayered structures.
- Analyze the effects of blast, crash, and other fast events on vehicles and their occupants.
- Simulate events like bird strike, water landing and crash landing to meet certification requirements.



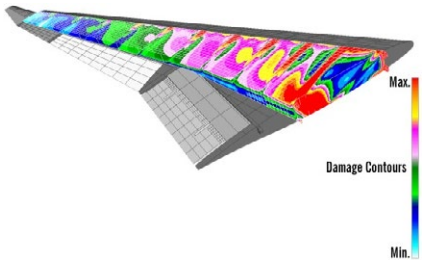
Aircraft water landing

“Shorter time-to-market, lower investment costs, lower lifecycle costs, and last but not least, the minimization of technical risk were the positive outcomes of this development project (i.e. turboprop training aircraft).”

Leonardo Manfriani,
Pilatus Aircraft

Increase strength and decrease failure

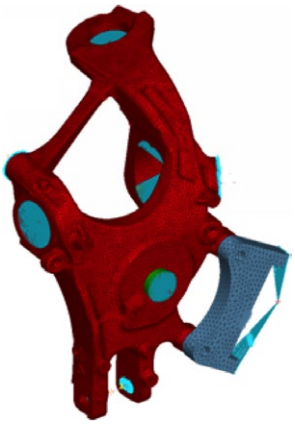
Failure of aerospace structural components can lead to catastrophic outcomes. MSC's powerful technology provides understanding of material behavior to accurately predict and improve design life and reduce maintenance and warranty costs.



Composite wing

Perform end-to-end durability studies:

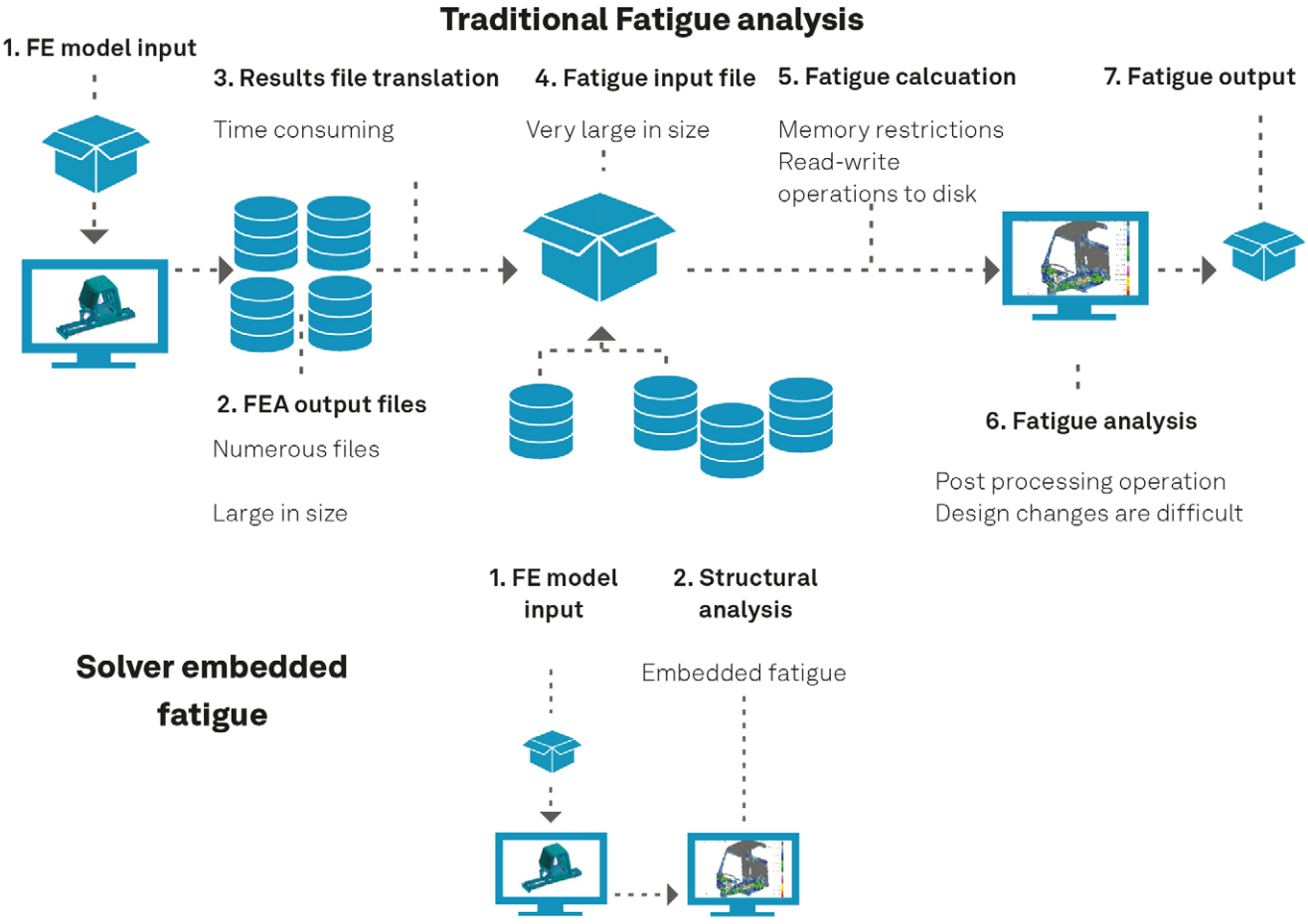
- Use solver enmbedded fatigue analysis for faster results.
- Perform virtual fatigue studies for durability analysis.
- Optimize design with fatigue life as a design objective
- Conduct detailed fatigue analyses of structures under vibratory loads



Wheel carrier; Fatigue analysis process time cut by 90%

Predict and manage failures:

- Evaluate the damage progression in materials to accurately estimate the life of components.
- Evaluate various damage mechanisms in composites, including matrix and fiber failures delamination
- Predict the growth of cracks in structures to avoid critical failures.

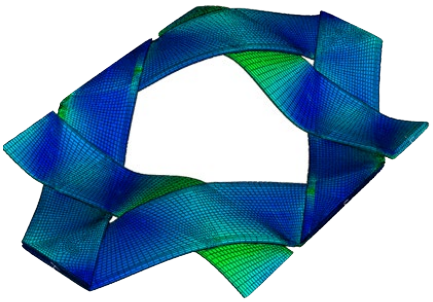


Design lightweight structures

Weight directly impacts the fuel costs and payload capacity of aircrafts and spacecrafts. New materials provide potential for lighter, more durable and cost efficient structures but they must be tested extensively. MSC's award winning technology simulates behavior of revolutionary materials and can be used with design optimization tools, enabling engineers to:

Design with new materials:

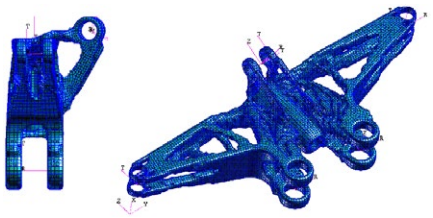
- Investigate and predict composite materials behavior with computational models.
- Improve manufacturing processes for lightweight designs and reduced failures.
- Gain insights into composite laminate response, damage progression and failure.



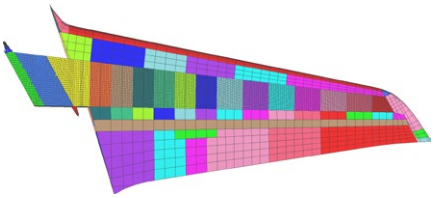
Solar heating of automobile dashboard

Innovate cost-effectively:

- Optimize laminate lay-up configuration for improved structural performance.
- Reduce weight, cost and time-to-market with high-performance designed composite industrial parts.
- Improve component and system designs quickly while satisfying certification criteria with design sensitivity and optimization studies.
- Optimize designs across multiple disciplines simultaneously with Multi-Model Optimization (MMO): strength analysis, dynamics, flight loads performance and flutter.



Thermal Analysis of a disc brake



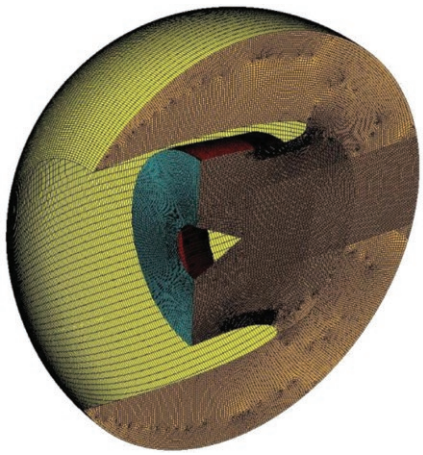
Muffler

"The introduction of a dedicated computer-aided environment, as Digimat-VA, in regulations can have clear potential in terms of reduction in coupon tests by more than 65%"

Salvatore Russo,
New Airframe Technologies, Finmeccanica

Optimize acoustics

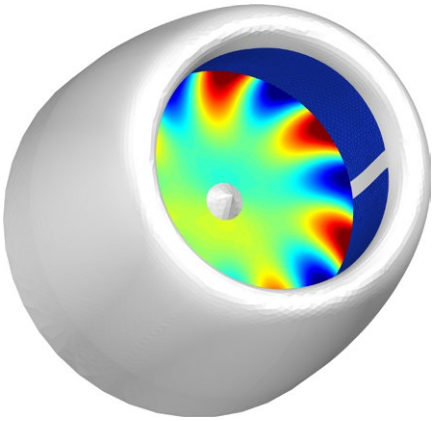
Aircraft noise certification and passenger comfort are critical aspects of aircraft design. The ability to control noise and vibration contributes to a vehicle's performance in a considerable way. MSC's trusted, proven solutions address engine generated and aero-acoustic noise to:



Actran acoustic mesh of fan intake

Reduce noise and meet regulations:

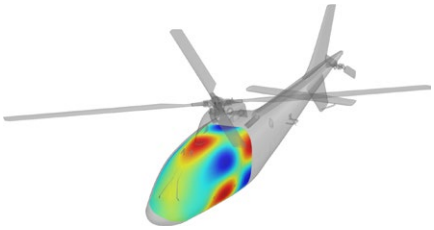
- Optimize acoustic liners for aircraft engines inlet and outlets.
- Study the aeroacoustic noise generated by flaps, slats, and landing gears.
- Evaluate the ramp noise due to auxiliary power units.
- Use parallelization to get results faster and analyze multiple design variations.



Prediction of fan inlet noise

Improve passenger comfort:

- Perform vibro-acoustic analysis of aircarft interiors.
- Analyze sound absorption of trim materials inside fuselage.
- Apply typical excitations such as turbulent boundary layers.
- Study the influence noise sources like engines and auxiliary power units

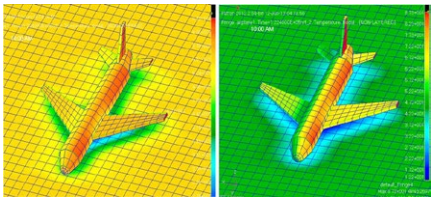


Helicopter Interior acoustics

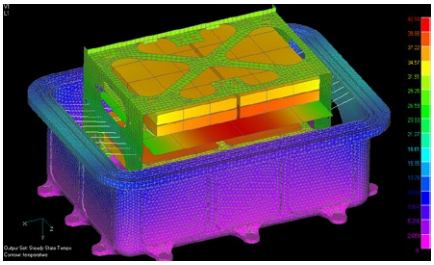
> **Actran is the only simulation tool able to accurately model the main physical phenomena for engine nacelle radiation"**
>
> **Jean-Yves Suratteau,**
> Airbus

Solutions for thermal analysis

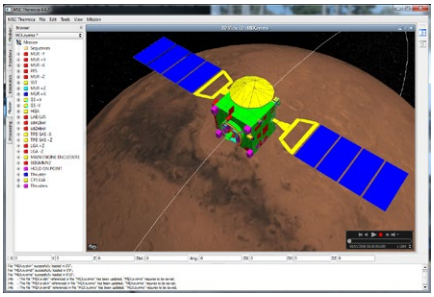
Aircrafts and spacecrafts experience numerous extreme environmental conditions during their lifetime. They must be designed to withstand these cycles without degrading performance. MSC's comprehensive thermal analysis solutions help engineers understand the response and performance of structures subjected to a diverse set of environments and operations.



Aircraft on concrete runway



Data Storage Device on Satellite, Cooling



Orbital Heating, Thermal Radiation and Temperature Results during complex orbit and spacecraft maneuvers

Design for extreme environment:

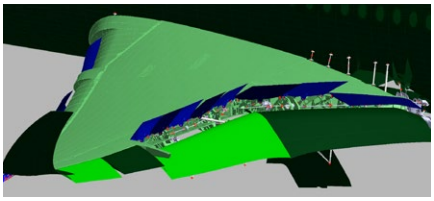
- Model all modes of heat transfer (conduction, convection and radiation) and study temperature gradients in transient and steady state.
- Perform fast radiation view factor computations to improve solar panel efficiency.
- Model terrestrial heating for solar loads on aircraft with solar radiation/orientation data anywhere in the world.
- Enhance aircraft safety by improving its anti-icing performance.

Improve thermal performance and product life:

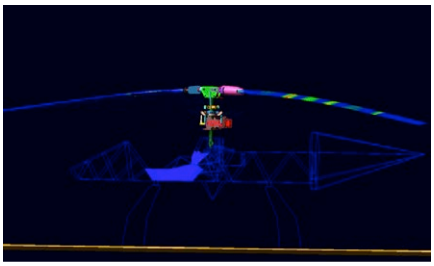
- Study and improve performance of jet engines, nozzles, and avionics.
- Explore design options to extend life of satellites and aerial vehicles with smarter, efficient solar energy systems.
- Enhance efficiency and operating range of engine components with robust design investigations.
- Improve occupant comfort with faster virtual studies of alternative designs.

Analyze and validate full systems

From a rough sketch to a detailed model, aircrafts and spacecrafts undergo numerous design iterations with an increasing level of refinement. Design changes at the component and sub-system level can affect the entire system. MSC Software's robust solutions help you investigate complete systems with multidisciplinary solutions and coupling between multibody dynamics structural FEA and controls.



A350-900 XWB left wing including all control surfaces



Multiple-flexible-parts method for blade simulation

Helicopter crash landing)

Use virtual prototyping to save time and resources:

- Analyze the forces and moments on structural systems during various maneuvers.
- Optimize vehicle performance with entire vehicle dynamics studies.
- Explore subsystems design and their influence on overall vehicle dynamics.
- Conduct stress and displacement studies of wing-flag mechanism
- Simulate the takeoff and landing process (soft and hard)

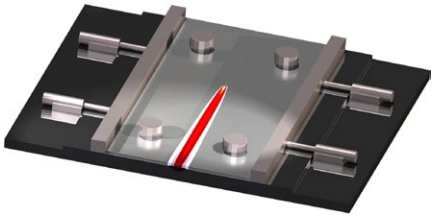
Improve quality and reliability:

- Analyze the aircraft systems and controls
- Study and optimize landing gear retraction and extension mechanism.
- Investigate the performance of rovers during landing and maneuvering on extraterrestrial terrains
- Make design decisions confidently with integrated modeling of control systems into structural and dynamic and environmental system models.

> **"The replacement of the physical A350-1000 wing bending test with simulation of the effects of deflection on the flight controls saved Airbus about €3 million and 4 months on the certification process for the A350. Most of these savings were achieved by eliminating the need to build test fixtures."**

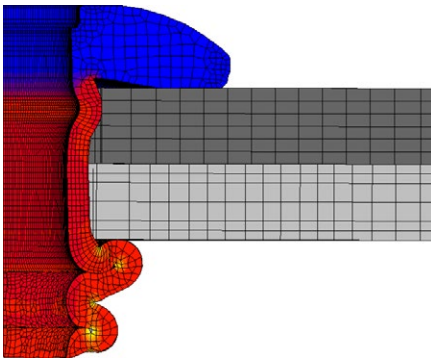
Michael Vetter,
Airbus

Optimize manufacturing processes



Laser welding

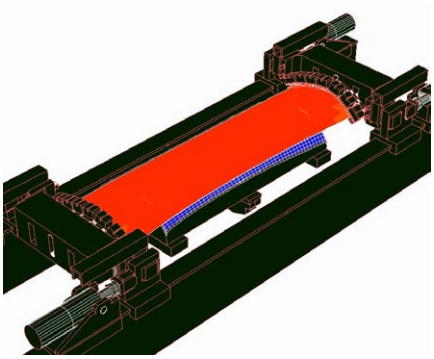
The ability to identify manufacturing issues and maximize manufacturing processes before the first part is forged is critical for saving time and reducing both short and long term costs. MSC's technology analyzes and optimizes complex manufacturing processes to offer valuable insights that improve tool life, save material costs and extend product life.



Riveting

Innovate virtually:

- Predict thickness distribution and manufacturing process parameters in forming operations like sheet forming, hydroforming and thermoforming.
- Simulate multi-stage forging and forming operations and adjust process parameters for material savings.
- Predict the forces and final deformed shapes during joining operations like self-piercing rivets.
- Study the effects of various welding sequences, speeds, heat input and stop times.



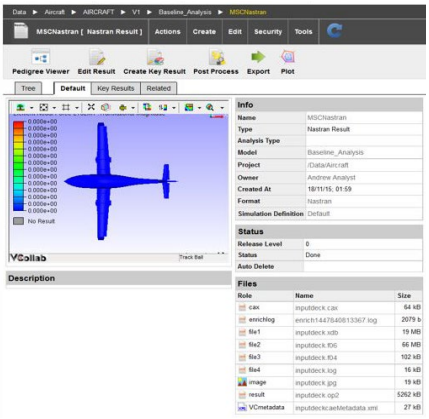
Sheet forming

Improve productivity and product life:

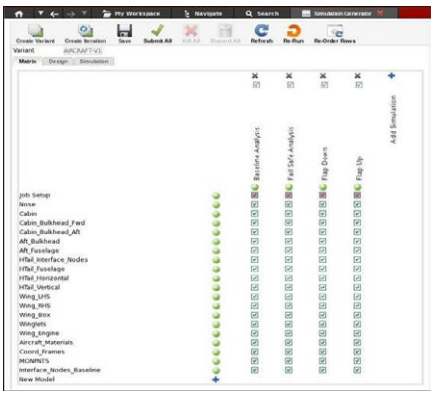
- Analyze tool wear and design for longer life.
- Predict distortions and residual stresses during and after all stages of forming and welding and test alternatives before process implementation.
- Accurately estimate the performance and life of structural components.

Manage engineering lifecycle

Organize and preserve valuable knowledge acquired to meet certification requirements and time spent on report generation. Recover this data anytime to save crucial time and resources with a single integrated system that enables you to.



Process management of aerospace design



Pedigree of aerospace design

Capture and reuse simulation knowledge:

- Reduce manual execution of intensive, repetitive simulation tasks and processes through automation.
- Trace processes through Audit Trail of simulation processes, inputs and outputs.
- Search terabytes of data quickly to answer design questions

Collaborate effectively:

- Manage data in a central, searchable environment with permission based access.
- Configure to support multiple global locations.
- Manage proprietary and public material data ensuring full traceability across the enterprise and throughout the product lifecycle

Efficiently manage projects

- Keep projects on schedule through work requests and workflow notification.
- Generate customized reports faster to meet documentation and certification requirements.
- Integrate multiple tools and applications, including MSC, 3rd party and in-house applications.

Expand engineering expertise

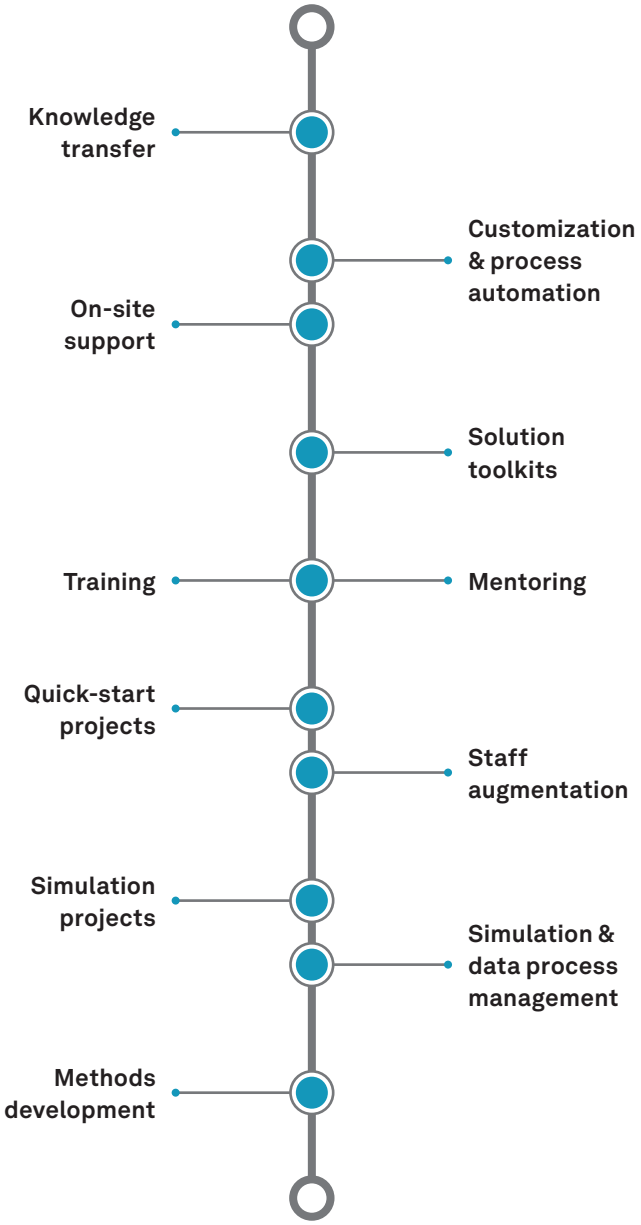
MSC Software's worldwide team of experienced engineers has diverse and extensive knowledge and skill sets specific to the automotive industry. We are your partner to guide, advise and help you solve challenges for your precise needs and requirements. MSC's broad range of services include:

Transfer of knowledge:

- Multiple training options that suit your requirements, from instructor-led classroom setting to online e-Learning.
- Custom training for your engineers to maximize the returns on your software investment.
- Customization and process automation to standardize your simulation process and improve productivity.

Methods development:

- Mentoring on-site or online available for your teams to help them rapidly gain expertise.
- Consulting services to tackle your toughest problems.
- On-site resources to augment your current staff.



MSC products

MSC Apex	Integrated Solutions	Solver Solutions	Mid-Sized Business Solutions	Modeling Solutions	Simulation Process & Data Management
Modeler & structures Modeler structures	Adams Multibody dynamics simulation	MSC Nastran Structural & multidisciplinary	MSC Nastran Desktop Multidiscipline simulation for the desktop	Patran FE modeling & pre/post processing	SimManager Simulation process & data Management
	Actran Powerful acoustic simulation software	Dytran Explicit nonlinear & fluid structure interaction	SimDesigner CAD-embedded multidiscipline simulation	SimXpert Multidiscipline simulation environment	MaterialCenter Materials lifecycle managment
	Digimat The nonlinear multi-scale material & structure modeling platform	MSC Fatigue Fatigue simulation			
	Easy5 Advanced controls & systems simulation	Sinda Advanced thermal			
	Marc Advanced nonlinear & multiphysics				
	Simufact Manufacturing process simulation				
	SimXpert Multidiscipline simulation				

Hexagon is a global leader in digital reality solutions, combining sensor, software and autonomous technologies. We are putting data to work to boost efficiency, productivity, quality and safety across industrial, manufacturing, infrastructure, public sector, and mobility applications.

Our technologies are shaping production and people-related ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon's Manufacturing Intelligence division provides solutions that use data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.