SIMULIA
COMMUNITY NEWS

#21 May 2019

SIMULATION FOR URBAN AIR MOBILITY

DASSAULT SYSTEMES | The 3DEXPERIENCE® Company

In this **Issue**

May 2019

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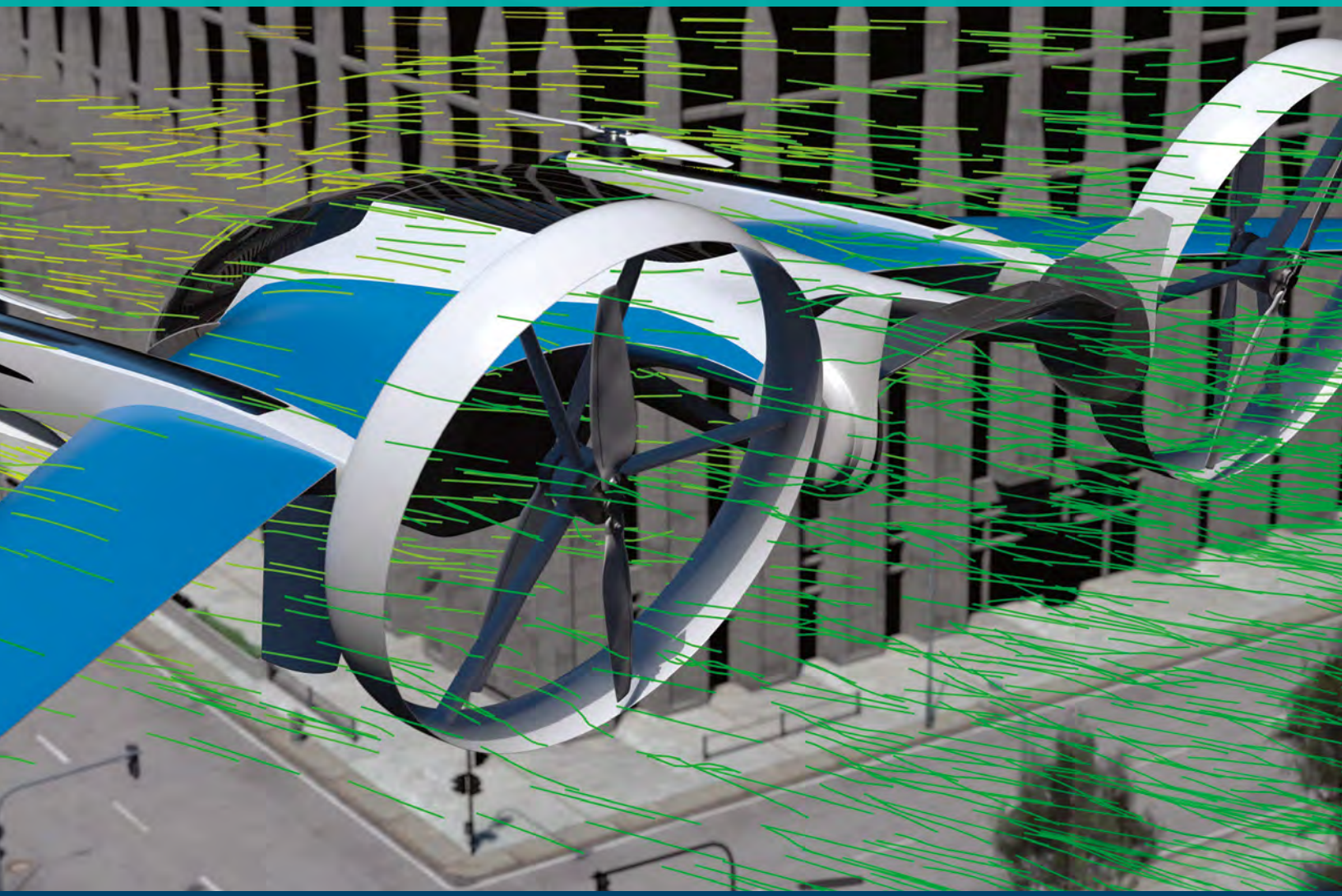


SIMULIA Community News is published by Dassault Systèmes Simulia Corp., 1301 Atwood Avenue, Suite 101W, Johnston, RI 02919, Tel. +1 401 531 5000, Fax. +1 401 531 5005, simulia.info@3ds.com, www.3ds.com/simulia; **Managing Editor:** Kristina Hines; **Strategic Advisors and Editorial Reviewers**: Subham Sett, Michelle Murray-Ross; **Guest Editors**: Rachel Fu, Bill Brothers, Zaki Abiza; **Contributors**: Clare Scott, Stephen Jorgenson-Murray, Parker Group; **Creative Director**: Todd Sabelli

On the Cover: CFD simulation results with PowerFLOW during take-off of an eVTOL (electrical vertical take-off and landing) concept addressing the challenges of reinventing the sky with new air-mobility services.

INNOVATING IN AEROSPACE: GROUNDED IN PROVEN TECHNOLOGY, THE SKY'S THE LIMIT

The aerospace industry is in constant evolution. Startups and industry leaders are rethinking everything, from aircraft to solar-powered agricultural drones and eVTOL (electric vertical takeoff and landing) to supersonic flight and autonomous doorstop delivery. I am thrilled that we are a key player in supporting our customers' in the aerospace industry renaissance. Our solutions reveal safe and sustainable answers to the challenges facing the ever-evolving aerospace community and our planet.

Considering today's innovative concepts, you may think that aerospace engineering and design processes have changed dramatically over time, but that's not necessarily the case. The aviation industry has always had to engineer aerodynamically efficient, structurally sound, robust and safe aircraft and today's concepts still need to obey the same fundamental laws of physics as well as adhere to the existing design and regulatory requirements. SIMULIA has a proven track-record providing end-to-end engineering solutions for aerospace applications and our powerful tools are ready to engineer the next aerospace renaissance.

We have long-standing partnerships with leading aerospace manufacturers that continue to bear fruit as we work together to develop new ways to create faster and more efficient aircraft. The **3D**EXPERIENCE platform connects all the dots allowing us to tackle holistically every issue in aerospace industry—at all stages from concept to certification. Instead of trying to solve problems in silos, our users work in an integrated environment, leveraging all the collective knowledge, company patrimony, generative design and engineering. Users can collaborate and design unique experiences that are safe and reliable without compromising passenger and community experiences.

This issue of ***SIMULIA Community News*** highlights our commitment to the future of aerospace engineering while demonstrating the powerful capabilities we've developed over years of working closely with our industry customers. Included in this issue:

- Our Future Outlook article on page 8 discusses incredible recent advancements in the eVTOL space, and how these innovations can be developed and certified with our range of all-physics simulation capabilities.
- The XSun Case Study (page 13) features a start-up UAV (Unmanned Aerial Vehicle) company that is engineering the most aerodynamically efficient designs possible using SIMULIA's accurate CFD simulations.
- A comprehensive products and solutions update starting on page 4 highlights all the latest enhancements we've made to our powerful technology offerings.

In this issue we also introduce SIMULIA aerospace solutions that benefit both startups and enterprises, either on cloud or on premise. We highlight how engineers can create robust designs focusing on structural integrity, communication system engineering, aerodynamic performance, aircraft community noise, and more—all in the **3D**EXPERIENCE platform.

Innovating for the future is always exciting and by leveraging simulation, we will together drive this evolution.

DAVID HOLMAN,
Vice President R&D, SIMULIA Brand Leader

R2019X: END-TO-END SUPPORT FOR YOUR UNIQUE INDUSTRY PROCESSES

From our very first version of Abaqus FEA to the rainbow of multiphysics tools now in the **3D**EXPERIENCE simulation family, we take pride in the growth and breadth of the capabilities we offer—and the ever-increasing levels of sophistication with which you, our customers, are using our tools.

Of course you continue to challenge us with new demands as the scope of what you want to accomplish with our software expands. We hope the release of the R2019X portfolio meets your expectations! We've made important enhancements in the applicability, efficiency and scalability of our digital physics offerings. But what we think you'll appreciate most is the ways in which all of our products work more closely together now.

You need a variety of powerful, complementary tools to capture all the complexities of all the physics relevant to your particular industry so you can produce a successful product. Whether you're creating cars, aircraft, cell phones, turbines or medical devices, there are many variables that affect your product outcome. The tools you work with have to be scalable, repeatable, and fully connected and integrated with each other in order for you to achieve the fastest, most cost-effective, quality results.

END-TO-END INDUSTRY PROCESS CAPABILITIES

Increasing numbers of you already have more than one SIMULIA product in your toolkit—but you still may not have all the capabilities you need to maximize your productivity. And each industry has its own flavor of processes for getting the job done right. Take automotive noise and vibration analysis in an electric vehicle (EV), for example. This involves everything from body-in-white design to airflow around mirrors, motor noise, tire noise, insulation-material performance, vehicle-frame vibration—and much, much more. And then on top of simulation you need to consider the engineering challenges of electric-drive performance, external aerodynamics, chassis suspension, thermal management, and so on. What's the full scope of work in your industry?

To help you stay on top of both the detailed simulation and the broad engineering aspects of innovation, we've created industry-specific process workflows that tackle many of the challenges you encounter in whatever field you're in. You'll find that R2019X delivers a high level of coordinated enhancements for "out of the box" end-to-end industry applications. Not only are individual functionalities more accessible and easier to use, they're performing better together for the smoothest user-experience yet.

As we always do, we've developed these industry-specific workflows through deep engagement with individual customers. That's because you understand your own product better than anyone else and you know what you want to achieve; the very best value you can get out of your software investment is when you use the right combination of tools that solves your problems in the normal course of business.

These enhancements to our industry workflows are timely: Model-based engineering, advanced manufacturing, 5G communications, and all the complexities of Industry 4.0 are already impacting companies everywhere, from large enterprises to energetic startups. Wherever your team is now, we're here to get you on board, help you take first steps, move from a walk to a run, innovate freely, and leap over your competition.

To further empower your journey you'll find visibility, collaboration and decision support on the **3D**EXPERIENCE platform.

HERE ARE SOME OF THE HIGHLIGHTS OF THE R2019X RELEASE

Power'By for Simulation

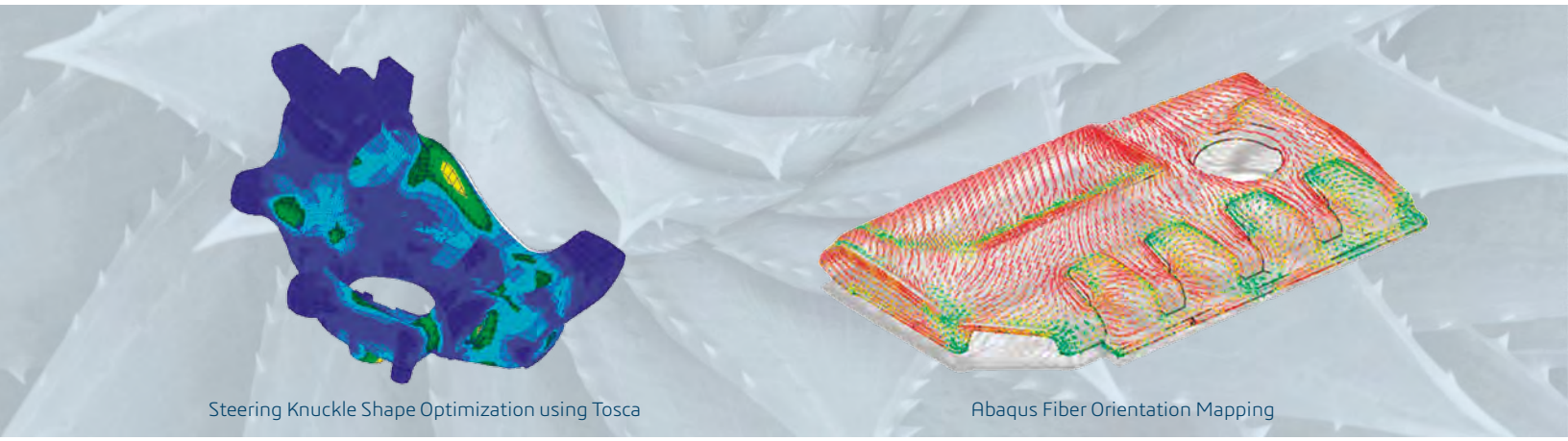
Users of existing SIMULIA standalone tools can benefit greatly by socializing your data, work and methods with the **3D**EXPERIENCE platform's social and PLM collaboration services. You can capture and publish best practices; launch simulation jobs (including on-cloud burst computing for Abaqus); view, optimize, share, track and collaborate on results and methods; and integrate fully with non-experts. Data, methods and simulation results are managed—and are more easily accessible, visible and valuable—throughout your workgroup and the enterprise with no disruption to your existing methods and tools.

In R2019X you'll find 28 out of our 29 user roles available on the cloud. Specific enhancements include the ability to upload result data, plots, and animations for both XFlow Analyst (for fluid simulation) and Multibody Analyst (for multibody simulation with Simpack). There is also new user-subroutine support (i.e. the capability to extend Abaqus with your own materials, elements and methods) during on-cloud execution with Structural Mechanics Analyst for structural simulation with Abaqus, plus support for 3D CAD (CATIA) assemblies for electromagnetic simulation with CST Studio Specialist.

Fluid Simulation for Designers/Engineers

R2019X continues to enhance our computational fluid dynamics (CFD) portfolio, which covers both mainstream and industry-specific CFD simulation.

Mainstream CFD is delivered by the Fluid Dynamics Engineer role, which brings fast turnaround for steady state and long transient simulation and provides the same capabilities that are available to CFD experts. This new role combines the previous Fluid Mechanics Analyst and Fluid Dynamics Engineer roles for complete coverage of all the functionality you need. Fully automated customer simulation processes and reusable



Steering Knuckle Shape Optimization using Tosca

Abaqus Fiber Orientation Mapping

workflow templates in a unified environment will accelerate your product innovation.

The guided environment includes a new radiation solver, a whole-body human thermal comfort model, and e-cooling physics for cabin comfort (important in both transportation and aerospace industries). For powertrain engineering, enhancements include a patented M-method for automatic convergence rate update, increased stability with auto cell treatment, and reduced mesh cell count (up to 4X) with intelligent edge capture. In aerospace and defense workflows, a new coupled solver increases accuracy and performance for advanced shock capturing in high-Mach flows.

Industry-specific CFD simulation workflows are also available for high-value processes in Transportation & Mobility, Aerospace & Defense, Natural Resources and other industries.

Enhanced Digital Additive Manufacturing

The promise of additive manufacturing (AM) to deliver innovative, previously unimaginable designs must be balanced by the realities and complexities of this innovative technology. Dassault Systèmes is committed to delivering a complete end-to-end solution for digital AM on the **3D**EXPERIENCE platform to enable our customers to succeed on the entire AM journey, from functional generative design to manufacturing planning and part-performance evaluation.

Within this solution, the Additive Manufacturing Researcher role delivers a realistic, high-accuracy, thermo-mechanical simulation of the AM part during both material build-up and cool-down, predicting and accounting for any distortion. R2019X increases AM efficiency, usability, and confidence that your parts will "Print to Perform" with the following enhancements: assembly, support, thermal optimization, automated smooth-geometry reconstruction, an improved Eigenstrain method and a new voxel-based mesher to simplify complex geometries.

With native integration to the Functional Generative Design and Additive Manufacturing Programmer roles, the Researcher role provides you with digital continuity from design to process to manufacture, including integration with the new **3D**EXPERIENCE Marketplace. We're here to help you unlock the true power of additive manufacturing by increasing accuracy and output with best practices so you can maximize the ROI of your AM investment.

INDIVIDUAL PRODUCT HIGHLIGHTS

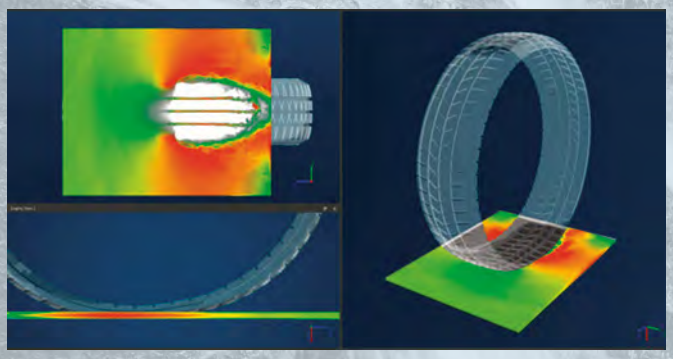
Abaqus—the complete solution for realistic simulation

For solutions to engineering challenges across a vast spectrum of industrial applications, the Abaqus Unified FEA product suite offers a powerful and complete simulation package for both routine and sophisticated problem solving. Best-in-class companies everywhere are taking advantage of Abaqus Unified FEA to consolidate their processes and tools, reduce costs and inefficiencies, and gain a competitive advantage.

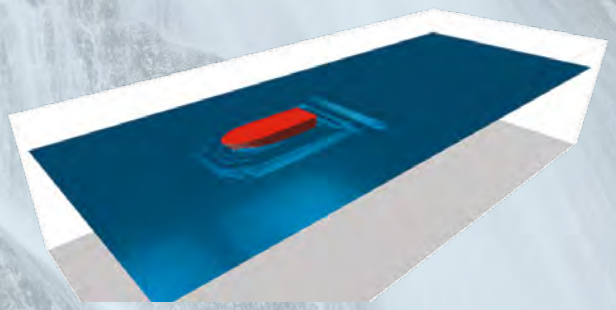
Highlights of what's new in Abaqus 2019:

- A new 2nd order tet element C3D10 in Abaqus/Explicit provides a larger stable time increment and is more computationally efficient than before
- A new shear-panel element SHEAR4 in Abaqus/Standard provides efficient modeling of reinforced thin-wall structures such as those in airplane fuselages
- Results transfer between Abaqus/Standard and Abaqus/Explicit is fully supported for workflows involving static preload followed by dynamic impact
- General contact in Abaqus/Standard now supports thermal and thermal-electrical procedures
- The bolt-contact capability in Abaqus/Standard more accurately represents threads without having to actually mesh them. This broader utility is applicable in analyses of powertrains, engines, flanges with threaded bolts, etc.
- In linear dynamics, SMP parallel processing is now supported for results recovery in mode-based procedures, making them more efficient
- Visualization of nodal tensor fields is now supported
- Parallel scalability of Abaqus/Explicit has been significantly improved, with performance gains approaching 50% observed
- Tosca: Shape optimization using adjoint sensitivities for nonlinear analysis

Product Update



XFlow 2019x Abaqus Cosimulation



XFlow 2019x Improved Iso surfaces

fe-safe—durability and fatigue simulation based on structural finite element analysis results

fe-safe is a powerful, comprehensive and easy-to-use suite of software for fatigue analysis from finite element models available with Abaqus through extended packaging. It is used with commercial structural analysis (FEA) software, to calculate where and when fatigue cracks will occur and whether they will propagate, and to predict service life variation (the "warranty claim curve"). Typical application areas include the analysis of machined, forged and cast components in steel, aluminum and cast iron, high temperature components, welded fabrications and press-formed parts. fe-safe is used by leading companies in automotive, heavy truck, off-highway, marine, defense, offshore, power generation, wind energy, medical engineering and many other industries.

Highlights of what's new in fe-safe 2019:

- Improved robustness of weld-line definitions for solid elements
- Enhanced nodal force method for Verity weld fatigue relaxes some of the meshing requirements
- The installer is unified with Abaqus

Isight/SEE—parameter optimization, process automation, design space exploration, and analytics for simulation processes

Isight is the industry-leading simulation process-automation and design-optimization software, providing solutions that enable users to reduce analysis time and costs while improving product performance, quality and reliability. SIMULIA Execution Engine (SEE) provides technology for distributing and parallelizing simulation process flows. Together these allow customers to build a web-based framework for distributing the execution of simulation processes to optimize computing resources and enable collaboration across the enterprise.

Highlights of what's new in Isight/SEE 2019:

- TomEE-Microsoft SQL Server-based SEE
- Web Dashboard in TomEE-based-SEE
- HTTPS support for Webtop and Web Dashboard in TomEE-based-SEE

XFlow—Fluids simulation to improve real-world performance

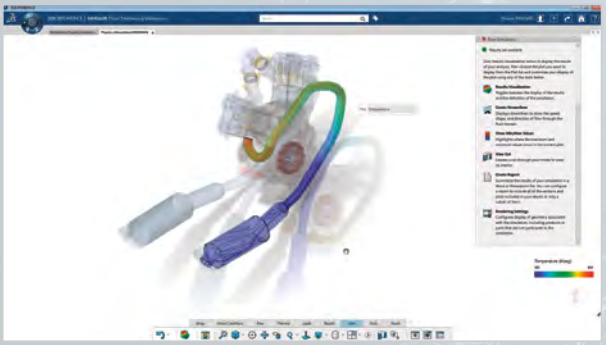
XFlow offers particle-based Lattice-Boltzmann technology for high fidelity Computational Fluid Dynamics (CFD) applications as a part of SIMULIA's Fluids Simulation portfolio. The state-of-the-art technology of XFlow enables users to address complex CFD workflows involving high frequency transient simulations with real moving geometries, complex multiphase flows, free surface flows and fluid-structure interactions at real-world conditions.

Highlights of what's new in XFlow 2019X:

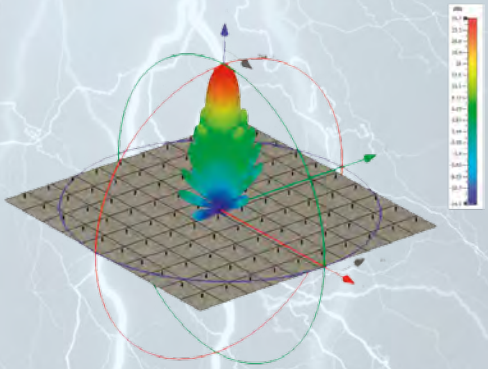
- Power'By enhancements enabling the possibility to upload numerical results of XFlow and the simulation model to the **3D**EXPERIENCE platform
- New XFlow-Abaqus one-way cosimulation capability for small fluid-induced structural deformations
- Enhanced XFlow-Abaqus two-way cosimulation capabilities
- Apply Volume Heat Source boundary condition and Conjugate Heat Transfer (CHT) boundary condition on the same solid
- Enhanced isosurface visualization for simulations with multi resolution lattice domain

PowerFLOW—Improving product design & development through simulation

SIMULIA PowerFLOW utilizes Lattice-Boltzmann technology to provide high fidelity CFD solutions for transient fluid problems. PowerFLOW has a strong presence the field of Transportation & Mobility, providing solutions in the areas of aerodynamics, aeroacoustics, thermal management, climate control, powertrain and soiling and water management. PowerFLOW also has a strong presence in the field of Aerospace & Defense, providing solutions in the areas of whole aircraft noise, high lift configurations and community noise, propulsion aerodynamics and engine thermal design.



FMK Guided Interface for Fluid Simulation



CST 2019-FD+Isolver Simultaneous Excitation

Highlights of what's new in PowerFLOW 6:

- Reduce community noise by accurately computing noise propagation from aircraft engine jets into the environment, especially landing and takeoff configurations
- Design noise signatures of Exhaust Systems and eliminate risk of undetected acoustic issues in vehicle HVAC and engine cooling systems
- Hybrid Transonic Solver—Advance airframe design by improving efficiency and reduce noise due to engine-airframe interactions
- Accurately and efficiently compute water-film-flow patterns from re-entrainment and water-ingestion patterns
- Selective Velocity Freeze—Drive innovative vehicle design and WLTP certification for larger number of vehicle configurations by accelerating aerodynamics and cooling airflow up to 4x

Simpack—Multibody simulation software for mechanical and mechatronic designs

Simpack is a high-end, multi-purpose MBS (Multibody Simulation) software used for the dynamic analysis of any mechanical or mechatronic system in time and frequency domains. It enables engineers to generate and solve virtual 3D models in order to predict and visualize motion, surface velocities, accelerations, coupling forces and stresses. From initial concept and design, through to production and redesign, Simpack helps engineers fully comprehend and optimize designs, reduce physical prototyping, decrease time-to-market and improve product quality and lifespan.

Highlights of what's new in Simpack 2019X:

- Enhanced Abaqus cosimulation for flexible bodies
- Consideration of premature meshing impact for gear pairs
- New result element Accelerometer
- Gauge widening for cartographic rail tracks

CST Studio Suite 2019—best-in-class software package for EM and multiphysics simulation

Electromagnetic (EM) components are crucial to the success of an ever-increasing range of products. With solvers that span the frequency spectrum, CST Studio Suite offers a complete technology package for design, analysis and optimization. Used by leading technology and engineering companies around the world, CST Studio Suite provides a realistic system to analyze product performance and verify legal electromagnetic compatibility (EMC) and exposure limits.

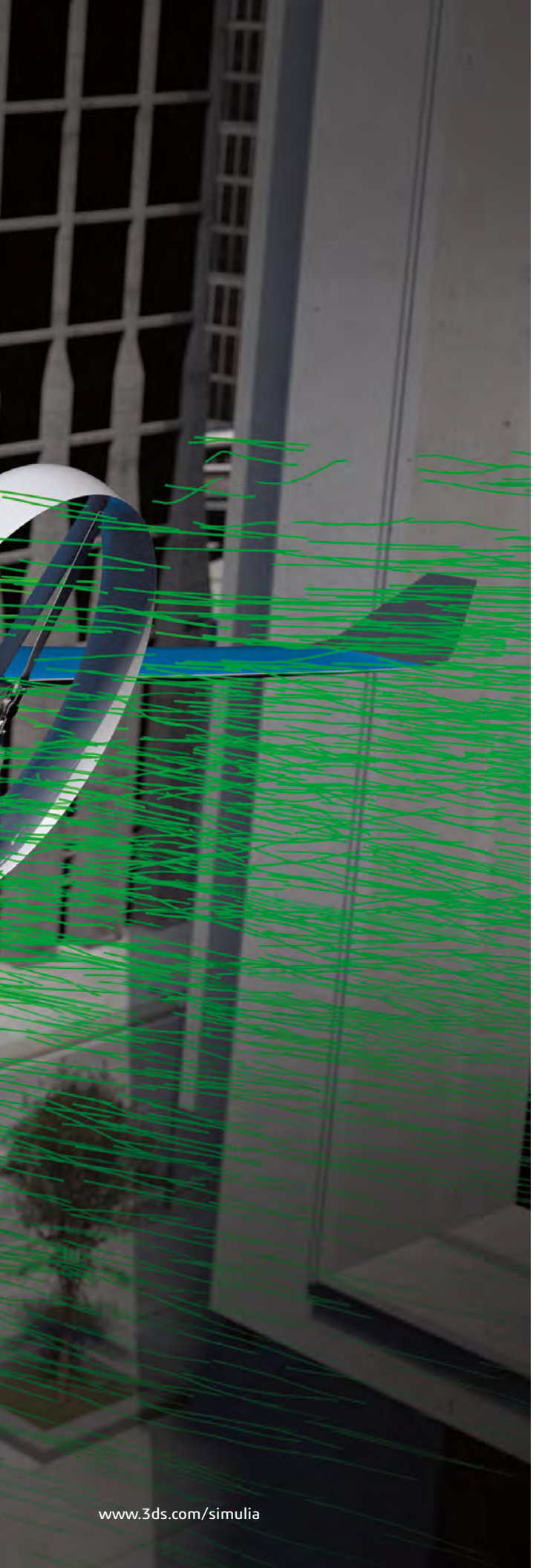
Highlights of what's new in CST Studio Suite 2019:

- Support for 3D CAD assembly design for CST Studio Suite assembly mode
- Encryption of CST models for securely sharing data (IP protection), available for Transient Solver only
- System Assembly Modelling (SAM) Array Task allows post-processing optimization in full array
- Merge time improved for high frequency distributed computing
- 3D rotational motion (LT) added for low frequency simulation
- New E-Static PIC Solver (for slow movements, e.g. plasma)
- Simplified definition of cable bundles in 3D
- For circuit simulation, a new schematic editor with improved performance and usability
- Cadence Virtuoso plug-in for chip interface

For More Information

For your complete details about all SIMULIA Products, please contact your Dassault Systèmes representative or go to: www.3ds.com/products-services/simulia/products/3dexperience/whats-new

FUTURE OUTLOOK: TAKING URBAN TRAFFIC TO THE SKIES



BY THE END OF THIS CENTURY SOME 80 TO 90 PERCENT OF THE PEOPLE ON THIS PLANET WILL BE LIVING IN CITIES, ACCORDING TO A REPORT ISSUED BY THE UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. THE CURRENT WORLD POPULATION OF 7.6 BILLION IS PREDICTED TO REACH 8.6 BILLION BY THE YEAR 2030, 9.8 BILLION BY 2050 AND 11.2 BILLION BY 2100.

Traffic everywhere is going to get a lot worse. Already today, every large urban center around the world—while providing amazing sights and cultural experiences—endures bouts of rush-hour congestion. The issue isn't with any single vehicle, but with the entire system of vehicles and roads that connect city inhabitants to their destinations. Public transportation helps, but when you are adding 83 million new humans a year, the world is on track to a gridlock nightmare well before 2100.

How to address the challenges of ground-level urban transportation? One way is to move into the skies. Urban Air Mobility (UAM), aka the 3rd Aerospace Revolution, is a hot topic these days. Centered on Environmental Sustainability (electrification, low-noise, recyclable parts, etc.), the main ambition of UAM is to extend urban transportation from 2D to 3D by means of safe, clean and affordable concepts. This has caught the attention of aerospace and automotive industries around the globe, which are investing considerable time and funds into developing personal and/or air-taxi vehicles that will get people moving ***above the streets***.

There are currently more than 50 companies developing UAM technology, with Uber planning for initial air-taxi service in Dallas and Los Angeles by 2023. If you attended the Consumer Electronics Show (CES) this year, you saw exhibits from Bell, Volocopter, and SureFly, in addition to Dassault Systèmes.

Many of the air vehicles that leading companies (and some innovative startups as well) are introducing in the nearer term rely on hybrid-electric propulsion systems, since electric-battery energy storage technologies are still maturing. But the all-electric, Vertical Take-off and Landing (eVTOL) vehicle is the holy grail for everyone, given its low emissions and lower-noise potential, a winning combination in a crowded city. On a smaller scale, another important UAM application is unmanned air vehicles (UAVs), especially "delivery drones" that can help cut down on car traffic by bringing goods directly to the consumer's door. Whatever the vehicle, while many of them share physical similarities with existing rotorcraft like helicopters and tiltrotors, they also have unique propulsion and guidance parameters dictated by the close quarters of urban space.

There are many challenges involved in designing such vehicles and proving out their robustness within the huge complexity of the urban environment. Multidisciplinary analyses need to be undertaken—aeroacoustics, aeromechanics, fluid-structure interaction (FSI) etc.—and strict performance standards (optimized over thousands of regulation-dictated flight miles) need to be met. The sheer volume of data involved requires highly integrated project management that empowers virtual prototyping and all-physics simulation on a collaborative platform.

Let's take a closer look at some of these challenges facing designers and engineers as they create aircraft mobility for the fast-approaching future.

QUIETER, PLEASE!

A high priority for UAM is vehicle acoustic simulation. Cities throb and hum at all hours of the day and night and no one wants to add even more noise to all that with air vehicles. Uber made their position on this issue very clear when they stated, "We are going to bludgeon the industry about community noise, because that is the doorway to the market."

If you were at the Science in the Age of Experience last year, or any of the regional users meetings, you probably saw the presentations from SIMULIA demonstrating how complex airflow comes off of a multirotor personal transport vehicle. There was also a video of an aircraft flyover simulation in which you could hear the simulated noise caused by the airflows (including engine exhaust) around a commercial airliner. A time-animated contour of noise over the land surrounding an airport let you hear what the aircraft would sound like to an observer on the ground.

Inherent to optimizing a vehicle's flight path as it relates to noise is assessment of the altitude and velocity of the vehicle at every stage, i.e. takeoff velocity of 4 m/s until 50 feet, then adding 2 m/s forward velocity by tipping the rotors 3 degrees, and so on. This information is not only useful for minimizing noise, it can be input into subsequent analyses to maximize battery life, minimize wear, and support safety both inside and outside the vehicle.

Simulation becomes even more interesting when you consider the possibility of using Lattice Boltzmann Methods (LBM) that simulate the unsteady aerodynamics required to accurately understand noise sources and propagation. These can be extremely useful when designing aircraft to be flown within a dense urban environment where noise is reflected through complex structures and terrains. In the long run, having fully optimized paths like this would enable autonomous eVTOL aircraft.

The noise from a VTOL craft comes primarily from the impact of the main rotor blades with vortices shed from the preceding blades. This in turn is strongly dependent on the trajectory of the vehicle itself, which requires propulsion optimization, coupled flight dynamics, and aerodynamics and aeroacoustics simulations. The problem becomes even more complex when you consider that vehicles often have many rotors, some of which may be coaxial and counter rotating, often tilting and variable speed, resulting in complexity beyond the capability of traditional computational fluid dynamics (CFD) techniques. The more efficient Lattice Boltzmann techniques are available in SIMULIA's PowerFLOW and XFlow today. If you will be attending the 75th annual forum of the Vertical Flight Society you will see our presentation on blade vortex interaction that shows the importance of incorporating deformable blades within the flow analysis.

Acoustics and aerodynamics are closely related in a rotorcraft. The simulated operation of complex mechanical systems such as the main rotors used in a VTOL is a hallmark of SIMULIA's multibody dynamics solver, Simpack. This allows for integrated, very high fidelity simulations that are accurate into the acoustic range for gear transmission assemblies, and are also well suited for the analysis of complex flight control mechanisms.

Propulsion brings its own challenges, structural as well as acoustical. From the earliest stages of design, i.e. determining the optimal insertion of a fan stage in a duct, to optimizing the design of variable speed rotors over a large range of advance ratios and flow incidences, CATIA manages the parametric geometry models needed for the optimization cycles of propulsion units.

LESSONS LEARNED FROM AUTOMOTIVE

Every aircraft needs to be optimized for passenger comfort; here is where SIMULIA's Reynolds-Averaged Navier-Stokes (RANS) CFD analysis methods, as well as automatic topology optimization, can address topics such as cabin ventilation via flow channels.

Passenger safety is everything, of course; the interior must protect the occupants from hard landings and other potential

mishaps. Our automotive customers have been using the native SIMULIA explicit dynamics solver technology to address almost exactly the same internal physics problems that the designers of air vehicles are now looking at.

The goal is clearly to extend to this new airborne business the production paradigms employed by the car industry. Series production of fiber material structures is the main challenge in this respect; aircraft must be structurally robust as well as lightweight. SIMULIA has been the leader in composites simulation for the aerospace industry for more than a decade, since Boeing selected Abaqus in 2004 for commercializing the then state of the art VCCT composites simulation technology.

Advanced materials alone do not tell the full story. As any vehicle designer would say, it's not how much material you have, it's putting the material you do have in the right location. SIMULIA's comprehensive topology optimization capability examines and sculpts components in an assembly in response to multiple nonlinear loads. Often times these topologically optimized parts look very organic, such as you would find in a bird (the ultimate VTOL user!). The technologies of SIMULIA and CATIA then work together to recraft such designs for manufacturability; even additive manufacturing limitations such as overhang constraints and support structures can also be addressed through these technologies.

BATTERIES AND ELECTRONICS

The battery is, of course, a critical energy source for these newer air vehicles. Inside each cell is a laminated composite material encapsulated in a gel matrix; mechanically this structure is not so different from an elastomeric bearing or tire, both industries in which SIMULIA has maintained a long record of success. Simulations here require the ability to solve thermal, structural, electrical, and chemical problems. For example, an analyst can use SIMULIA solutions to find out what happens when a metal spike is driven into a fully charged gel battery.

Full electromagnetic simulation of urban air vehicles is essential: All these low-flying aircraft need to reliably communicate and coordinate in order to safely operate in an air transportation system. Antenna placement will be an important factor so as not to interfere with the aerodynamics of the vehicle. In addition to antenna placement, there are issues of co-site interference, lightning strike, electromagnetic environmental effects, and more.

WORKFLOWS FOR URBAN AIR MOBILITY

These are just a few among many of the challenges the automotive and aerospace industries are tackling as they work to design urban air vehicles that will help solve future mobility on a crowded, urbanized planet. The powerful products, technologies, and features within SIMULIA are highly relevant to this exciting field. Dassault Systèmes has now gathered all these capabilities into a series of industry workflows, available on the **3D**EXPERIENCE platform, that encapsulate the necessary physics and provide the proper tools for each stage of this process. Highlights:

- **Dimensioning of lifting and propulsion systems**
- **Communication and detection system performance**
- **Vertical/horizontal flight aeromechanics**
- **Conversion aeromechanics and aeroacoustics**
- **Aircraft community noise**
- **System optimization**
- **Battery engineering**
- **Lightweighting**
- **Passenger comfort**
- **Safety**

For More Information

To learn how your team can work better together using industry workflows, please visit www.3ds.com/products-services/simulia/trends/urban-air-mobility

AIRBUS AND DASSAULT SYSTEMES EMBARK ON STRATEGIC PARTNERSHIP TO CREATE THE EUROPEAN AEROSPACE INDUSTRY OF TOMORROW

Airbus and Dassault Systèmes have signed a five-year Memorandum of Agreement (MOA) to cooperate on the implementation of collaborative 3D design, engineering, manufacturing, simulation and intelligence applications. This will enable Airbus to take a major step forward in its digital transformation and lay the foundation for a new European industrial ecosystem in aviation.

Under the MOA, Airbus will deploy Dassault Systèmes' **3D**EXPERIENCE platform, which delivers digital continuity, from design to operations, in a single data model for a unified user experience, making digital design, manufacturing and services (DDMS) a company-wide reality for all Airbus divisions and product lines.

DDMS paves the way for breakthroughs in new product design, operational performance, support and maintenance, customer satisfaction and new business models, as it represents a move from sequential to parallel development processes. Instead of first focusing on product performance, Airbus will be able to co-design and develop the next generation of aircraft with the manufacturing facilities that will produce them, reducing costs and time-to-market.

> "The **3D**EXPERIENCE platform will accelerate the digital transformation of Airbus. Airbus can capture insights and expertise from across its ecosystem to deliver new experiences that only the digital world makes possible."
>
> —Bernard Charlès, Vice Chairman and CEO, Dassault Systèmes

"We are not just talking about digitalization or a 3D experience, we are rethinking the way aircraft are designed and operated, streamlining and speeding up our processes with customer satisfaction in mind," said Guillaume Faury, President, Airbus Commercial Aircraft. "DDMS is a catalyst for change and with it we are building a new model for the European aerospace industry with state of the art technology. Our target is a robust production setup that offers a reduction in product-development lead time."

"Nothing exemplifies the intersection of technology, science and art more than aviation. When we reflect on how the industry has evolved to where it is today, it's a blend of technical prowess, digital precision and inspiration," said Bernard Charlès, Vice Chairman and CEO, Dassault Systèmes. "The Aerospace industry has a proven track record of fast transformation, faster than in most industries. It delivers high quality innovation and new services for operations in highly complex and regulated environments. The **3D**EXPERIENCE platform will accelerate the digital transformation of Airbus. Airbus can capture insights and expertise from across its ecosystem to deliver new experiences that only the digital world makes possible."

Chasing the Sun on the 3DEXPERIENCE Platform

French start-up company XSun adopts Dassault Systèmes cloud-based solutions for its design and simulation needs

If Benjamin David has anything to say about it, the term "bird's eye view" is about to take on a much broader meaning. The chief executive officer and founder of XSun in Guérande, France, Benjamin is developing the next generation of UAV (Unmanned Aerial Vehicle), more commonly known as a drone. But where most people associate drones with battlefield reconnaissance and peeking into the neighbor's backyard, Benjamin is designing cost-efficient, autonomous flying machines that give farmers better real-time crop knowledge (smart agriculture), help fishermen avoid the capture of unwanted species (smart fishing), and aid fire crews in putting out forest fires (environment protection).

It's nothing new to Benjamin, who has spent the better part of two decades looking for better ways to look down at the Earth. After graduating from Polytech Nantes in 2001, he served internships with the Centre National d'Études Spatiales (France's National Centre for Space Studies) and then the European Space Agency (ESA). He went on to work for Airbus Defence and Space, first as a flight engineer with the British military's SKYNET5 project, followed by site manager responsible for control systems on the ESA's Galileo satellite constellation.

Case Study

In 2016 he embraced a new challenge. Together with a team of engineers and technical advisers, Benjamin built a company that has a unique vision: to deploy a fleet of smart solar-powered UAVs capable of staying aloft for days, weeks, or even months. What's more, these drones will be autonomous, without the need for human guidance, and carry a host of sensors and cameras able to map, monitor, or measure virtually any point on the Earth's surface below. "It is a plane inspired by satellite design, except that it won't be expensive to launch," he explains. "It will use the sun's energy to charge a set of onboard batteries, just like a satellite does, and perform many of the same functions. That is our goal."

> "The **3D**EXPERIENCE platform on the cloud is a very deep resource, with capabilities we haven't even touched yet."
>
> —Andrea Viti, Aerodynamic Engineer, XSun

JOINING FORCES WITH DASSAULT SYSTEMES

The tools XSun uses to make this dream a reality? The cloud-based **3D**EXPERIENCE design and simulation platform. "We needed a multidisciplinary engineering software solution that could support material structures, aerodynamics, the electrical systems and energy consumption—pretty much everything needed to get an aircraft off the ground and keep it there for long periods of time," Benjamin says. "Based on my experiences at Airbus, I knew that CATIA and SIMULIA would be part of that solution."

Benjamin's team applied for and was accepted into Dassault's **3D**EXPERIENCE Lab, an accelerator program designed specifically for startups like XSun. The Lab supports and nurtures cutting-edge companies through a network of collaboration, innovation, and leadership, sponsoring projects that include robotic wheelchairs, energy-producing seaborne membranes, 3D-printed electric violins, and asteroid-hunting telescopes that could one day save the human race from extinction.

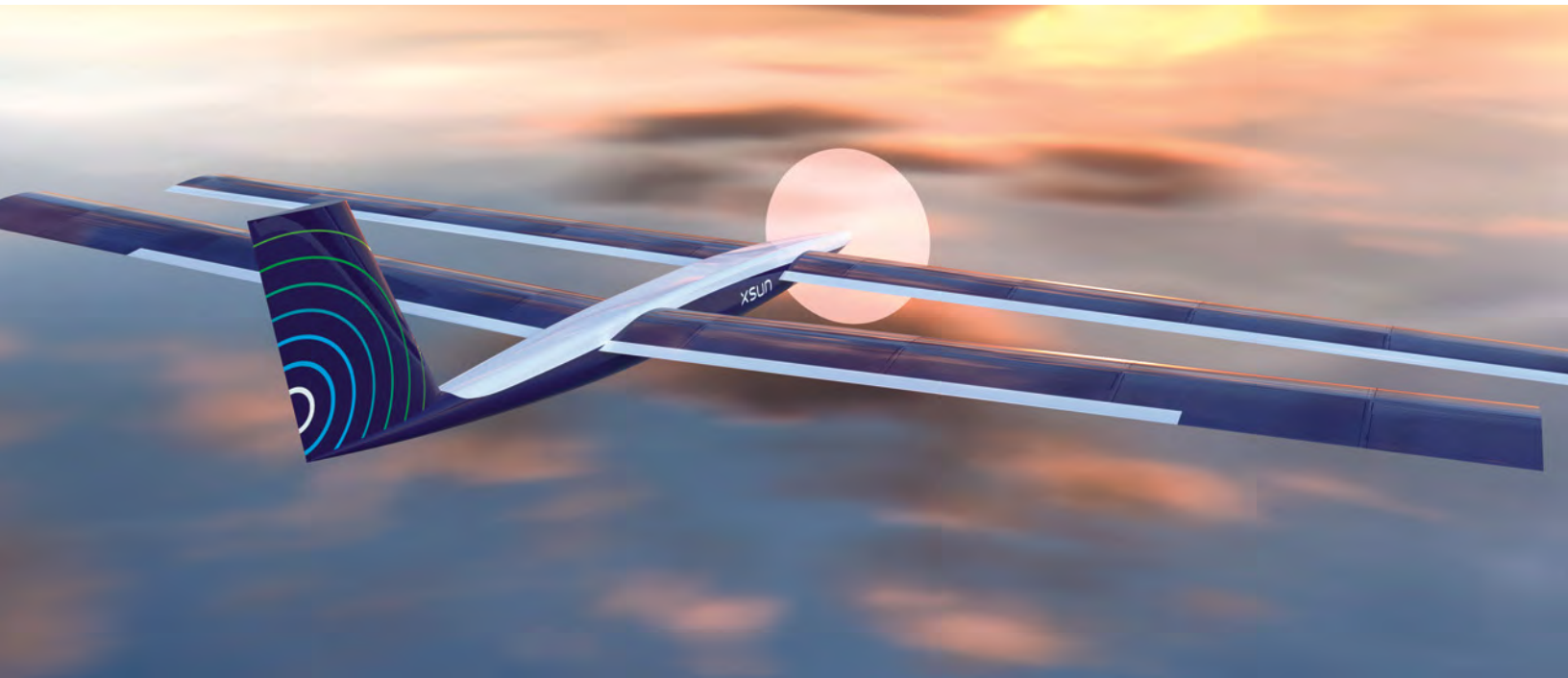
"I was very happy to be included as part of the **3D**EXPERIENCE Lab," says Benjamin. "Although access to a suite of excellent software tools was quite important to us, there was much more to it than that—there was the mentoring we received, the training and events we were invited to, and the possibility of sharing ideas with other entrepreneurs. It's been a really good experience for us."

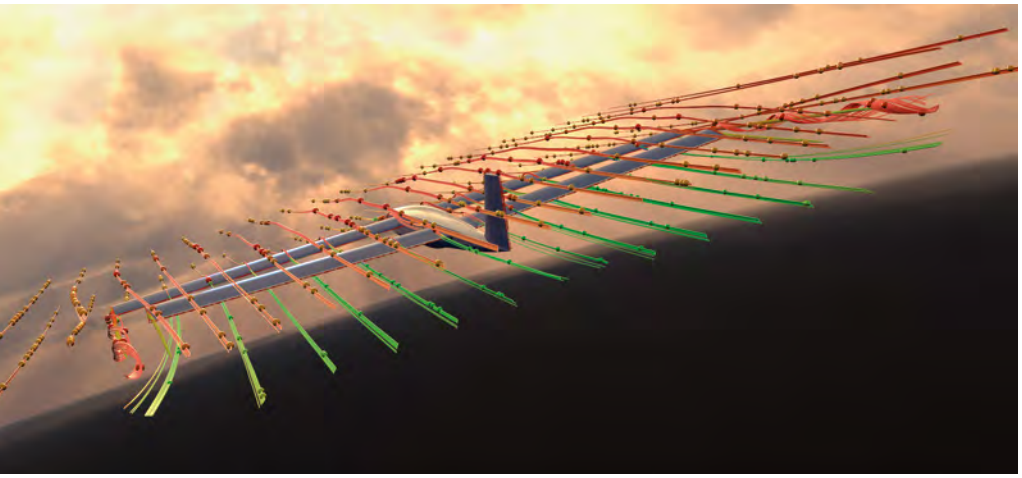
AUTONOMOUS FLYING MACHINES

Though the XSun team continues to put the finishing touches on their revolutionary UAV—dubbed the SolarXOne—they are understandably proud of the seventeen missions flown thus far, with more in the works. Their double-wing design boasts a 4.6-meter (15 ft.) wingspan, a length of 2.6 meters (8.5 ft.) a total mass of less than 25 kilograms (55 lbs.), and carries an impressive display of instruments, including a high-performance camera, infra-red imaging capabilities, and a "miniaturized hyper-spectral" sensor for measuring soil composition and other tasks. There's also an onboard LIDAR (Laser Imaging, Detection And Ranging) able to create highly accurate digital 3D-images of the terrain and structures below.

The final capability to be launched is the solar part of the equation—the SolarXOne is currently powered by rechargeable batteries—and Benjamin says that's about to change. "The SolarXOne is able to fly for extended periods on batteries alone, but our next prototype will charge those batteries in flight, using power from the sun. Once that milestone is reached, I anticipate it won't be long before we deploy a larger fleet of autonomous machines with more and more capabilities."

Whatever you call it, Benjamin says their UAV isn't all that different (at least in structural concept) than the world's first heavier-than-air powered aircraft—the Wright Brothers' Flyer I, which took to the skies over Kitty Hawk, North Carolina in 1903.





But where the now-ancient Flyer's wings were positioned one above the other, the SolarXOne carries wings both fore and aft. This tandem wing design provides larger surface for the solar array than is otherwise possible, and therefore more potential electrical power. Having two wings provides aerodynamic benefits as well, such as greater stability in rough weather, and makes it easier to attain a lower aircraft weight for a given amount of lift—by comparison, the Wright Brothers' plane had a wingspan of 40 feet and weighed more than 600 pounds.

"Most UAV designs favor a single 'superwing' approach, so we are unique in this respect," notes Benjamin. "That said, finding the right proportions was challenging. At one point we found it easiest to just go back to square one and begin with a blank page. CATIA and SIMULIA helped us in this respect, as we were able to test many iterations very quickly. Our current design was the result."

LOOKING TO THE CLOUD

Aerodynamic engineer Andrea Viti is part of XSun's drone-building team, a team that spans multiple countries and continents. Like his boss, he'll tell you that Dassault's **3D**EXPERIENCE cloud capabilities have made collaborating with people hundreds or even thousands of kilometers away much easier and more productive, never mind the fact that both are big fans of the software.

"We are doing design work that is quite simply mind-numbing," Viti says. "The surface quality, the aerodynamics, the overall geometry of each component—everything has to be perfect or the aircraft won't fly. CATIA does that for us. It's used all over the world, especially by those with mission-critical requirements like ours. I think it's the best 3D CAD product available."

Realistic simulation is also critical. For this, Andrea and his colleagues rely on the SIMULIA software portfolio within **3D**EXPERIENCE. The ability to model their craft using different materials, test various wiring configurations, model wind flow and check structural integrity—these are just a few of the design-engineering functions made available to them working with the **3D**EXPERIENCE Laboratory. "Designing this aircraft is a huge task," says Andrea. "It's been very important to have very good software to address all the multiphysics involved."

The team soon realized that heat dissipation and turbulence were important areas to focus on. In each case, SIMULIA tools helped them determine the optimal design, and understand the performance of each design iteration, thereby minimizing the need for physical testing. With the tight integration between CATIA and SIMULIA, simulation models were updated automatically with each new design revision.

"The **3D**EXPERIENCE platform on the cloud is a very deep resource, with capabilities we haven't even touched yet," Andrea says. "It's been extremely helpful to have this kind of multidisciplinary analysis available to us, plus the fact that we can collaborate on problems over long distances, even by smart phone or tablet. And in those instances where we run into something we can't figure out, Dassault is there to mentor us. All in all, it's been a really nice solution."

PREPARING FOR LAUNCH

Benjamin is anticipating the further evolution of his prototype. His long-range plan is to build a fleet of drones, a centralized control center (and ultimately, more than one), and for XSun to offer services to whomever needs relatively low cost, real-time surveillance, analysis, and digital mapping of both land and sea; where an airplane or helicopter will cost many thousands of dollars per flight, he says, XSun's will be much more competitive.

"Our operational costs will be much lower than any of the other UAV solutions out there, and we'll have greater flexibility as well," he says. "I encourage anyone looking for this type of service to give us a call. Now that we've arrived at a mature design, we're definitely looking for new business opportunities."

His aerodynamic engineer agrees that the base design is optimized and ready to start chasing the sun. "The nice thing about the tandem wing is that it's very flexible yet stable—even more stable than conventional aircraft," says Andrea. "Thanks to the **3D**EXPERIENCE platform, we proved that it can work in a variety of weather conditions and terrains and, once the solar panels are installed, we'll be able to stay aloft for as long as is needed. It's flying well."

For More Information

https://3dexperiencelab.3ds.com/en/projects/life/xsun

AIRCRAFT AERODYNAMIC PERFORMANCE

Complex Flow Phenomena Accounting for Detailed Aircraft Geometry

Most people are used to flying, and few of us think about the many factors that affect an aircraft's performance. We spend hours in the air experiencing a smooth ride with minimal turbulence. For the engineers and designers responsible for creating these aircraft, however, an immense amount of work goes into ensuring that flying is as safe and smooth as possible, with optimal speed and efficiency.

It is critical that engineers assess an aircraft's performance at every stage from takeoff to landing, including its behavior on the ground, while gaining altitude, cruising and descending. Engineers assess how the aircraft will react to wind gusts at high speeds, for example, or the effects of drag on the landing gear. As aircraft are designed to be faster and more efficient, designers and engineers must also anticipate how they will perform at higher speeds and with lighter weights.

To certify a new aircraft, the manufacturer has to demonstrate that it can fly safely in its entire flight envelope. The aircraft has to be tested for as many as 100,000 distinct configurations. Traditional Computational Fluid Dynamics (CFD) methods can cover only a fraction of these. For the vast majority of configuration, physical testing—particularly expensive and time-consuming wind-tunnel tests—is still the only option.

SIMULIA fluids solutions include Lattice-Boltzmann solvers for unsteady simulations providing a true breakthrough in this field. For the first time it is possible to expand the use of CFD to the entire flight envelope, potentially replacing thousands of wind-tunnel tests for high-lift configurations, high-speed buffet, and many other configurations requiring unsteady simulations. Lattice-Boltzmann-based CFD methods are many times faster than traditional unsteady CFD methodologies, allowing the expanded use of high-fidelity CFD methodologies in early development stages. Compared to physical testing, these highly efficient simulation solutions enable significant cost savings and risk reductions.

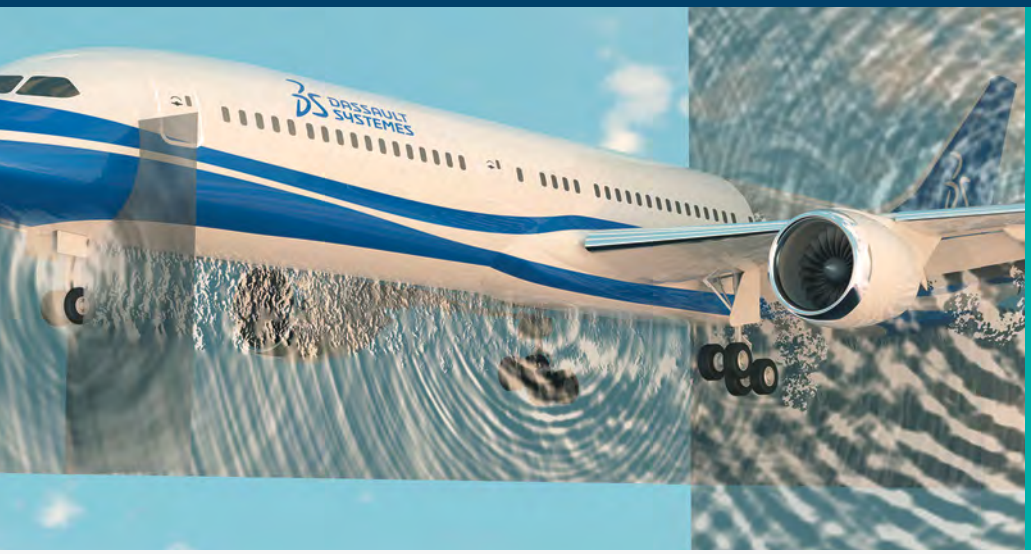
Using SIMULIA fluids solutions, engineers can feel confident in the real-world performance of an aircraft before it ever enters the flight-test phase, the most expensive phase of aircraft development. Almost every major new aircraft program over the past two decades has encountered significant delays during flight test, often due to unexpected aerodynamic effects that were not discovered during wind-tunnel testing. SIMULIA fluids solutions help reduce the risk of unexpected delays by predicting complex physics prior to flight testing, including those involved in takeoff, landing and climb performance, stall characteristics, stability and control, maneuverability, ground handling characteristics, and high-speed buffet.

SIMULIA fluids solutions offer a complete portfolio of appropriate fidelity computational fluid dynamics methodologies, including Navier-Stokes-based solvers for cruise conditions in addition to Lattice-Boltzmann based methods for unsteady flows. These solutions are in the process of becoming fully integrated with the **3D**EXPERIENCE platform, and are currently available on the SIMULIA Cloud for easy access without the need for hardware. Companies of any size can benefit from using comprehensive simulation technology without making a major investment.

As the aerospace and defense industry continues to grow, air travel is predicted to double in the next 15 years. New companies are challenging the big corporations that have dominated the industry for decades. Regardless of size, companies have to constantly improve and leverage the best tools to remain competitive. SIMULIA fluids solutions and the **3D**EXPERIENCE platform offer solutions that cover every aspect of an aircraft and its movement, continuously striving and meeting industry requirements to help our customers reach their full business potential.

For More Information

www.3ds.com/products-services/simulia/solutions/aerospace-defense/aircraft-aerodynamic-performance



AIRCRAFT COMMUNITY NOISE

Predicted Acoustic Pressure from All Aircraft Components

The noise produced by aircraft on takeoff and landing is a significant obstacle to aviation growth and a cause of resistance from the communities around airports. An increasing number of jurisdictions are placing noise constraints on airports, such as limiting the number of flights per hour, operating hours, and the size of aircraft that are allowed. Quieter aircraft would be less affected by these noise restrictions, opening up new opportunities for airlines while improving airports' relationships with the surrounding community

There are several sources of noise on aircraft, both tonal (around a single frequency) and broadband (filling the audible spectrum). The engines are an obvious source of noise from the fans and the jet, but turbulent air flow around projecting components such as the landing gear and flight control surfaces can also generate significant noise.

Because these details make a difference to an aircraft's sonic signature, accurate noise prediction requires the full geometric details of all aircraft components. The combination of Dassault Systèmes software on the **3D**EXPERIENCE platform allows engineers to perform noise assessment of the virtual aircraft without a physical prototype, using the highest geometric fidelity to include all available noise sources.

SIMULIA fluids solutions provide Lattice-Boltzman CFD solvers that allow users to solve transient and compressible flow in order to simulate directly and quickly pressure waves' generation and propagation, as well as turbulence-induced noise. This state-of-the-art solver technology can accurately and directly simulate the acoustic field without any simplified acoustic source or acoustic-propagation models commonly used by traditional CFD technologies.

These SIMULIA solutions allow users to identify noise sources and provide insight into how design adjustments affects noise output and how to best optimize prototypes. The unique ability to perform far-field noise simulations also allows engineers to assess community noise levels and noise metrics produced by moving or fixed planes. Customers using SIMULIA fluid solutions to improve the noise characteristics of landing gear and flaps have been able to achieve a 3 dB reduction over a wide frequency range, equivalent to a 50% decrease in noise intensity.

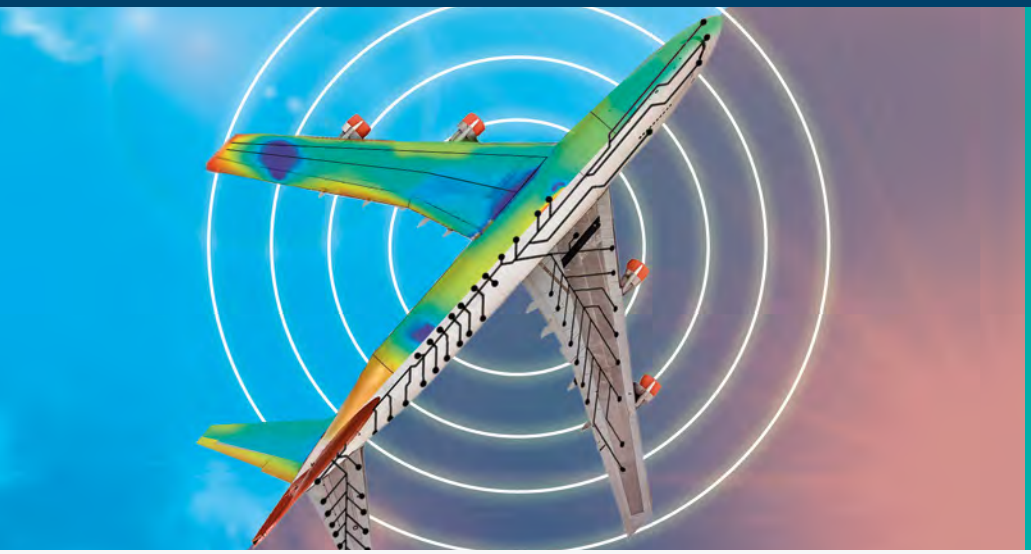
The passenger experience can also be simulated with the same tools, using signal processing to analyze and generate audio signals providing a direct aural evaluation of noise quality. The noise transmission feature evaluates interior wind noise levels as well as noise transmission.

In combination with Dassault Systèmes Aircraft Aerodynamic Performance offering, noise abatement strategies can also be analyzed from an aerodynamic perspective to ensure that aircraft performance is not compromised.

SIMULIA provides modules to analyze and post-process acoustic signals, to simulate noise transmission through surfaces, to assess community noise with far-field acoustic simulations, as well as detect noise sources to pinpoint and redesign the components inducing this noise. By simulating the acoustic characteristics of aircraft, engineers can pinpoint and redesign potential noise sources early in the design process, before committing to constructing a physical prototype. This can reduce the risk of noise problems emerging during test flight and certification, when redesigning aircraft components is not only expensive but risks causing delays to the whole project. This provides strong support to aerospace manufacturers looking to reduce their noise profile and produce aircraft that are more attractive to both airlines and the airports.

For More Information

www.3ds.com/products-services/simulia/solutions/aerospace-defense/aircraft-community-noise



AIRCRAFT COMMUNICATION & DETECTION SYSTEM PERFORMANCE

Aircraft Antenna Placement and Installed Performance

Flight safety is dependent on pilots knowing exactly what is happening around them, both on the ground and in the sky. For this kind of situational awareness, flight crews are dependent on radio links to nearby aircraft and air traffic control, and on radar and transponders to detect other aircraft, terrain and storms. All these systems rely on antennas. Since positioning of the antenna on the aircraft, and interference from other nearby radio systems, can affect the performance of the antenna, engineers installing communication and detection systems need to consider the entire aircraft and all the relevant systems. The electromagnetic (EM) simulation solutions of Dassault Systèmes can calculate antenna performance in realistic environments early in the design process, reducing the risk of critical problems arising during the testing stage.

Several design objectives have to be balanced when designing an aircraft antenna system. Size, weight, robustness and aerodynamic performance are always critical for airborne applications, but the limited space on an aircraft platform puts further limitations on antenna placement. It is critical that the risk of radio frequency (RF) interference events that could lead to device malfunctions is limited, and the device must pass the certification tests required by the legal standards (e.g. EMC compliance standards such as DO-160 (RTCA), EURO CAE/ED-14, DEF-STD-59-411, MIL-STD-461). In some cases it is also important to optimize aircraft detectability by radar systems.

With SIMULIA CST Studio Suite, the EM simulation solution from Dassault Systèmes, aircraft systems engineers can evaluate any configuration of antennas and quickly analyze their installed performance without physical testing. The design tool Antenna Magus offers a large library of antenna designs that can be modeled for specifications such as frequency and polarization. Using Antenna Magus and CST Studio Suite in tandem, application-tailored customized antenna designs can be performed very rapidly.

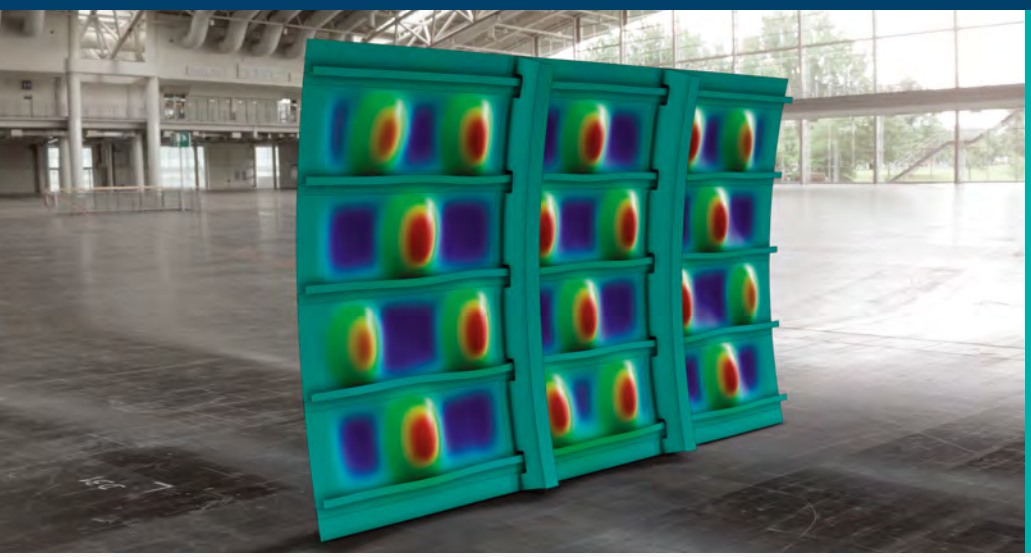
CST Studio Suite is linked to the **3D**EXPERIENCE platform and can import data directly from CATIA. This means that the antenna system analysis makes use of the latest up-to-date models, and allows real time collaboration between electronic and mechanical designers and efficient communication between departments and with suppliers. Input from a wide variety of sources, including CAD files from the mechanical department, antenna models from Antenna Magus, and measured antenna patterns from suppliers can be integrated into a single simulation model. Real time collaboration between electronic and mechanical designers means that changes can be made to the model in minutes instead of waiting hours or days for updated designs.

By simulating and optimizing antenna performance earlier in the design cycle, radio and radar systems can be integrated into other parts of the design process—for example, antenna radomes can be included in aerodynamic analysis. Characterizing antenna performance in advance also reduces the risk of issues such as interference emerging at the flight testing stage, thus reducing the number of costly prototypes and measurements required to ensure 100% compliance with the required certification and safety standards.

Aviation is set to become even more connected in the coming decades, and the number of antenna systems on aircraft will increase to satisfy not only regulatory requirements but also customer demands for fast, high-bandwidth communication and in-flight streaming. With SIMULIA's electromagnetic simulation tools, manufacturers are better placed than ever to meet these demands and produce the aircraft of tomorrow.

For More Information

www.3ds.com/products-services/simulia/solutions/aerospace-defense/aircraft-communication-detection-system-performance



SUBSYSTEM LEVEL STRUCTURAL VALIDATION

Composite Panel Buckling

The aerospace and defense industry is facing new challenges today that are more pressing than they have been in the past. Timelines for designing and manufacturing aircraft are becoming more and more compressed, and manufacturers are being challenged to minimize costs as much as possible while maximizing productivity. In addition, certification requirements are becoming stricter and more complex.

Engineers would have an extremely difficult time meeting these time, cost, and certification requirements without simulation. Designing and certifying an aircraft requires structural simulation at many levels, from full aircraft structure down to coupon level. Transferring loading conditions and modeling practices between these levels can be difficult, as the process often requires complex data management and integration of different simulation capabilities.

If the industry had integrated tools that could seamlessly manage simulations at these different levels, it could leverage the Digital Thread to compress design timelines, increase certification confidence, reduce expensive and challenging physical tests, and enable simulation-driven design decisions. The Digital Thread is an approach to product development in which manufacturing and lifecycle support use a digital model and simulation for first-time quality and reliability. The Digital Thread provides connectivity of all data, and the Digital Twin offers a digital representation of any product at all stages of development, manufacturing and in-service.

Dassault Systèmes offers offers technology for the management of data, simulations, and results for the different levels of structural simulation required for aircraft design. This technology includes multi-scale model generation and usage, as well as high-performance visualization and computing capabilities. SIMULIA technology helps users manage global to local load transfer and substructures, as well as access to advanced simulations using best-in-class Abaqus solver technology. Engineers can benefit from a scalable simulation solver and efficient post-processing of large-scale simulation data.

SIMULIA technology is fully integrated with the **3D**EXPERIENCE platform, providing a single source of truth and traceability. There are numerous advantages to this integration. Users can import fasteners directly from CATIA Fastening and reuse CATIA Composite design data in a structural model. Design and analysis iterations are reduced by leveraging Automated Modeling capabilities such as batch meshing, midsurface generation, and the ability to automatically update a simulation model when CAD geometry is updated, without needing to completely redefine the model setup.

The collaborative nature of the **3D**EXPERIENCE platform helps engineers spend less time looking for geometry, part assembly information, fastener data and so on. CAD-integrated tools that can cover all levels of simulation allow simulation to be used earlier in the design process to guide decision-making, which leads to higher product performance and reliability.

One prominent customer that uses SIMULIA simulation tools to improve its aircraft design is Airbus. The company's engineers use the technology to perform realistic nonlinear analyses and predict, very early in the design process, the strength and behavior of the aircraft's structure. Based on CATIA design information, large simulation models are created to gain deeper understanding of how the structure would actually perform in a given situation.

Simulation in aircraft design has become a rather conventional practice, but by making it more efficient, SIMULIA technology allows engineers to dedicate less time to simulation tasks and more time to new innovations.

For More Information

www.3ds.com/products-services/simulia/solutions/aerospace-defense/sub-system-level-structural-validation

MULTI-DISCIPLINARY TRADE-OFF ANALYSIS

Concept Vehicle Evaluation

As technology advances, aircraft are becoming more and more complex, with more new technology integrated into their design. The development of today's aircraft includes hydraulics, flight dynamics, structures, avionics, noise and environmental aspects. The growing complexity of modern aircraft design means that it is difficult to predict and trade off performance across complicated multidisciplinary workflows. Engineers face the risk of missing complex interactions between disciplines and lacking an overall picture of all aspects affecting the design.

As the technology incorporated into aircraft evolves, however, so does the technology that is used to manage the design process. The **3D**EXPERIENCE platform allows engineers to connect the disciplines throughout the design process, from fluids, structures, electronics and controls, to requirements catalogs, project management, and production planning. Project managers and engineers can keep track of development at all stages and immediately evaluate the impact of any engineering decision on the entire project.

In the early days, aircraft development was carried out using test models, which were time-consuming, costly and even deadly if something went wrong with this trial and error approach. Today's technology, in contrast, allows engineers to virtually develop an entire aircraft and immediately assess its structural components, safety and flight performance.

The use of simulation technology results in the reduction of development times from the earliest stages of design. Virtual development allows for the rapid evaluation of multiple design variants while accounting for and fulfilling requirements, resulting in lightweight, quiet and fuel-efficient aircraft.

SIMULIA offers a complete portfolio of appropriate fidelity computational tools that include structural mechanics, fluid simulation, electric and electronic components, systems engineering and optimization. Compared to physical testing, these simulation solutions provide greatly reduced turnaround time with highly efficient computations.

The benefits of SIMULIA's technology include the ability to select the right vehicle architecture and optimize overall vehicle performance and quality by, for example, improving fuel economy and range and reducing noise. The technology enables engineers to design the aircraft correctly on the first try, minimizing the risk of late design changes, as well as the requirement of physical designs and prototypes.

SIMULIA's technology is integrated into the **3D**EXPERIENCE platform, which allows managers, designers and engineers across disciplines to collaborate on architecture and conceptual design. Users of the platform can easily evaluate the reliability and robustness of concepts with sensitivity analyses and what-if scenarios. All stakeholders can access all data at any time, accelerating innovation and reducing engineering cycle time per iteration.

Saving time and money is at the forefront of every aircraft manufacturer's mind these days as competition grows fiercer—but this cannot be allowed to compromise safety or quality. SIMULIA's technology allows these manufacturers to rapidly respond to customers' demands and stay competitive, while at the same time adhering to strict aircraft-industry standards.

Regulatory requirements, in fact, are made part of the design specifications, and automatic analysis tools track the fulfillment of these requirements, providing automatic alerts if they are not met. This way, safety and quality are always foremost, even as the same technology speeds up development and reduces cost.

Simulation models enable engineers to quickly evaluate thousands of models and develop reliable, robust designs by accounting for variation in materials, loads, tolerances and operating conditions. For detailed body structure engineering, as an example, engineers can evaluate 10 times more concepts than with traditional methods. Meanwhile, turnaround time can be reduced from three to five days to a mere 30 minutes.

For More Information

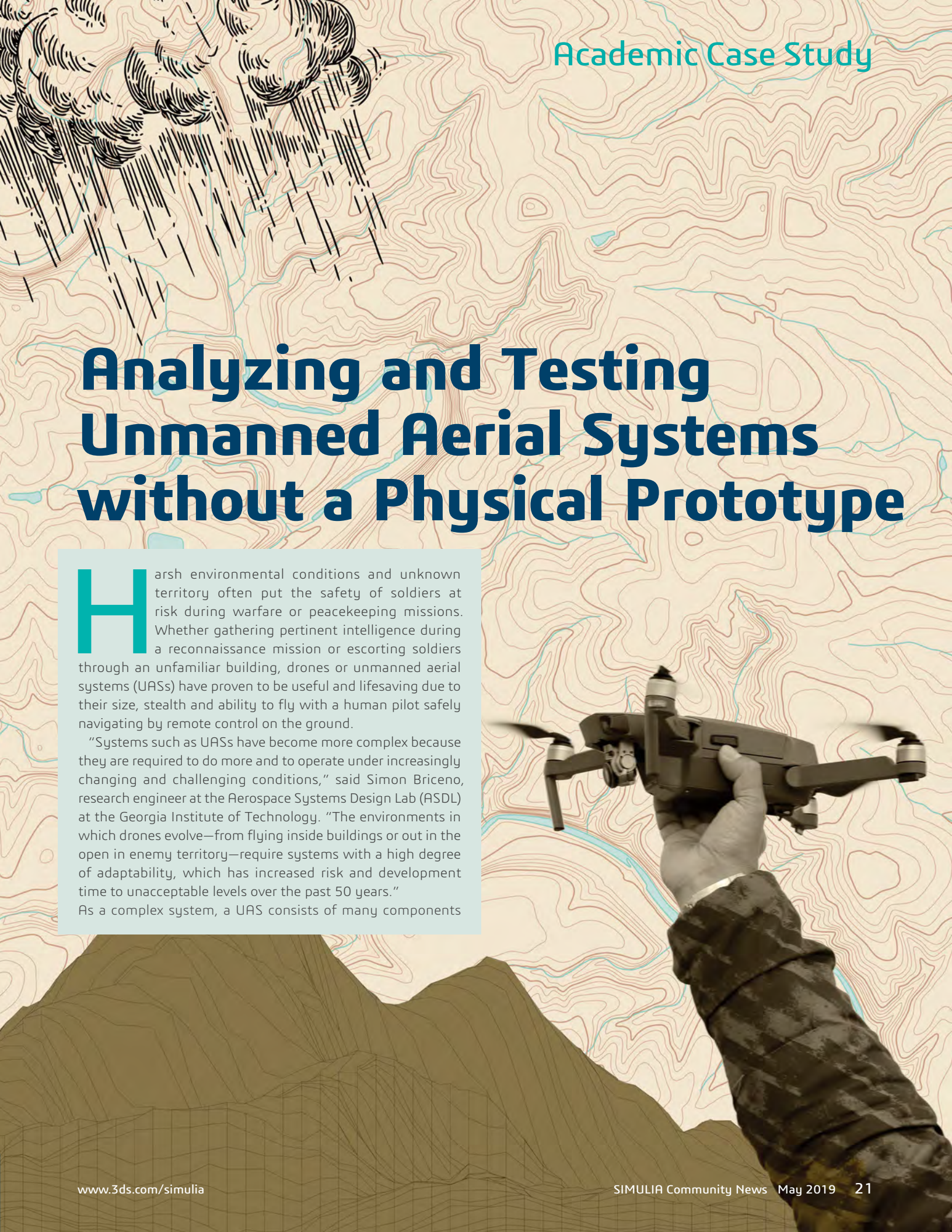
www.3ds.com/products-services/simulia/solutions/aerospace-defense/multi-disciplinary-trade-off-analysis

Analyzing and Testing Unmanned Aerial Systems without a Physical Prototype

Harsh environmental conditions and unknown territory often put the safety of soldiers at risk during warfare or peacekeeping missions. Whether gathering pertinent intelligence during a reconnaissance mission or escorting soldiers through an unfamiliar building, drones or unmanned aerial systems (UASs) have proven to be useful and lifesaving due to their size, stealth and ability to fly with a human pilot safely navigating by remote control on the ground.

"Systems such as UASs have become more complex because they are required to do more and to operate under increasingly changing and challenging conditions," said Simon Briceno, research engineer at the Aerospace Systems Design Lab (ASDL) at the Georgia Institute of Technology. "The environments in which drones evolve—from flying inside buildings or out in the open in enemy territory—require systems with a high degree of adaptability, which has increased risk and development time to unacceptable levels over the past 50 years."

As a complex system, a UAS consists of many components



with numerous interactions between these components that dictate the behavior of the system as a whole. Since thousands of situations exist for which thousands of drone configurations can respond, Briceno and his students at ASDL wanted to bring more information, more knowledge and more detailed aspects of those conditions into the concept phase prior to physical prototyping to save time and cost.

"Past methods of building and testing physical prototypes for each design are just too expensive and time consuming," said Briceno. "We needed to reduce the design, integration and testing time of UASs. The way we do this is by creating, analyzing and testing our design and behavior in a virtual environment."

Sponsored by the U.S. Army Research Laboratory, ASDL aimed to develop a UAS to relay real-time intelligence at a squad level. Working with other academic and industrial research organizations, ASDL created a virtual prototyping framework to integrate a series of multi-disciplinary tools for designing, simulating, analyzing and predicting behavior for one or more UASs in a very large concept space and for a variety of missions. However, the team's challenge was to execute the framework in an efficient manner and establish traceability of requirements.

WINNING WITH THE 3DEXPERIENCE BUSINESS PLATFORM

The ASDL team required a platform to bring together the disparate framework. They used Dassault Systèmes' **3D**EXPERIENCE platform and the Winning Concept Industry Solution Experience for aerospace and defense that is comprised of applications from ENOVIA, CATIA, SIMULIA and 3DVIA. The Winning Concept solution provides a platform to optimize conceptual design studies and allows knowledge capture of the end-to-end proposal process allowing repeatability and reusability on future concepts.

The Winning Concept provided the backbone of the virtual prototyping framework and methodology because it had integrated design, manufacturing, analysis and verification features with the capability to virtually identify, plan, design and configure the right concept that meets customer requirements in a short amount of time.

"As systems make up the products, it's very important that we don't just think about shape but we also consider the complexity of the systems and how they fit into the overall design."

— Simon Briceno, research engineer, Aerospace Systems Design Laboratory, Georgia Institute of Technology

Georgia Tech's Aerospace Systems Design Lab used Dassault Systèmes' Winning Concept to design, analyze and test an unmanned aerial system (UAS).

ASDL focuses its research on conceptual design, bringing more information earlier in the design stage to ensure there are no downstream manufacturing or certification surprises in the real world. "As systems make up the products, it's very important that we don't just think about shape but we also consider the complexity of the systems—the components and relationships between them—and how they fit into the overall design," Briceno said. "Virtual prototyping is a more cost effective way to see the total picture."

The Winning Concept gave the students a chance to work in an integrated environment with many applications, and not with disparate solutions. The students learned very quickly, and even had fun with the system during their free time in the evenings. They were eager to showcase their creativity and to try new things using all the different features.

BENEFITS OF AN INTEGRATED FRAMEWORK

A high priority for ASDL was the ability to not only track requirements but also understand the configuration that responds to those requirements. Powered by the ENOVIA application, Winning Concept flags when requirements are altered through the design process, so designers can trace how those changes will impact the system and identify if simulations need to be re-run for requirement compliance.

The traceability feature comes in handy for managing engineering changes and product evolutions, allowing users to see and understand how changes in requirements affect the components selected or what a concept would look like if certain changes were made.

In order to help explore all possible UAS designs, the SIMULIA application automatically proposes an iterative number of configurations that best respond to the requirements based on the library of smart components stored in ENOVIA.

The systems trade study feature allowed the lab to limit exploration from an astronomical number of combinations to a manageable quantity. "At this point, we don't necessarily know exactly what the concept will physically look like but we know it has to function a certain way and that there's a certain logic to this functionality," said Briceno.

The virtual world also allows ASDL to have confidence in their designs. Programming intelligence into components, virtually building the system and testing it with SIMULIA gives them confidence early on in the process that the concept could actually be built and perform as expected once they got to the physical prototyping stage, making them confident to commit to what could be done.

Briceno's team uses Winning Concept's component-based approach to design UAS's smart cyber-physical components with features from the CATIA application. These components include more than just geometrical CAD information; they can include behavioral characteristics or whether they are manufactured on the market or produced in-house. By storing these components in ENOVIA, ASDL can also reuse them for future projects, which reduces design time and ensures the component's intellectual property remains available for future students.

Once Briceno and his students are ready to construct a 3D environment to test the adaptability of the UAS, they use the 3DVIA application to create a test mission for the drone. 3DVIA enables the students to visualize the virtual environment and gather the physics and other associated data into CATIA to analyze. "All applications are completely integrated and fully compatible, which helps harmonize teamwork and streamline data exchange," Briceno said.

Building on teamwork, ENOVIA ensures the most up-to-date data is available so that project teams can collaborate together and work simultaneously on the same model in real time. "Moreover, we can allocate different tasks over time to the team and define what everyone's role is, what the project milestones are and the deliverables that are expected of each team member," Briceno added.

Once a concept is finalized, the Winning Concept can help assure the customer that all the requirements have been met and it will function as promised in the real world. "Designers can address many aspects concerning the design from the conceptual side of requirements all the way through the preliminary detailed analysis. We can walk our customers through our concept visually to show them that we have addressed their requirements. We also know from the earliest stages that we can deliver the customer's solution on budget and time," said Briceno.

LOOKING AHEAD TO CERTIFICATION

The lab is also working with Dassault Systèmes to introduce certification into the early design decision-making stages. "We have a team that engages in certification-driven design," Briceno said, "because we consider certification a critical component to the overall cost of any complex system. We thought that it was important to not only look at performance and economics, but to also look at what aspects of certification or means of compliance will play a role in the system and the components that are selected for a particular concept."

Demand for UASs continues to grow for both consumer, commercial and military purposes. As the next 50 years will prove, the technology and methodology will continue to refine. "Now, with the ability to move decisions to the concept phase, our virtual prototyping framework is integrated on one platform," Briceno concluded.

For More Information

www.3ds.com/customer-stories/single/georgia-institute-of-technology

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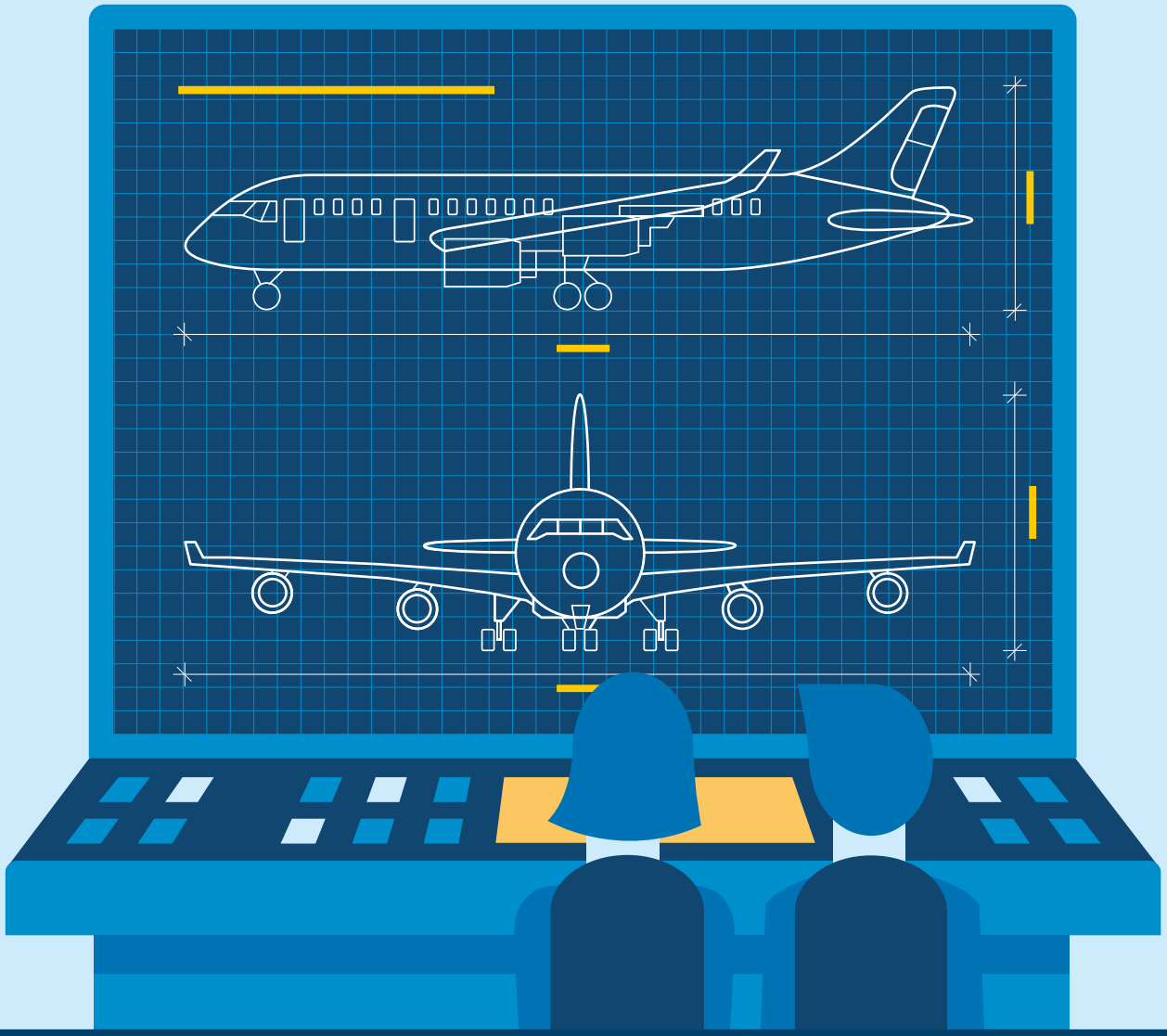

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THE SOLUTION: SIMULATE ACROSS THE ENTIRE PROGRAM LIFECYCLE

Contract Bidding
Simulation provides insights that develop winning bids

Concept Design
Simulation ensures that requirements are met for the concept baseline

Deliver Insights
By connecting spreadsheets, simulations and other data – at all phases of the program's lifecycle

Prototyping and Testing
Simulation identifies secondary and tertiary failure modes that can be addressed simultaneously

Detailed Design
Simulation offers performance insights for design decisions

5 WAYS TO ADD VALUE

1. Increase accuracy of performance prediction with multi-disciplinary simulations
2. Automate the finding of optimal designs using trade studies
3. Make sense of multiple analysis results with Simulation Intelligence
4. Use low and mixed fidelity simulations to provide early stage results and a route to higher fidelity models
5. Track everything with Simulation Data Management

Program delivered on time, on budget

ASSESSING CRACKS: WILL IT BREAK?

Cracks in metal components affect many industries including aerospace, power, chemical process, petroleum, pipelines, and heavy equipment. When cracks are found, two common questions are: will it break, and how soon will it break? When considering potential cracks, how large of a crack will cause failure? These questions are addressed using fracture mechanics analysis, (refer to the API 579/ASME FFS-1 standard [1]). Aerospace structures can be made from a variety of materials, and being able to assess cracks in the metal components helps engineers ensure safe and reliable structures.

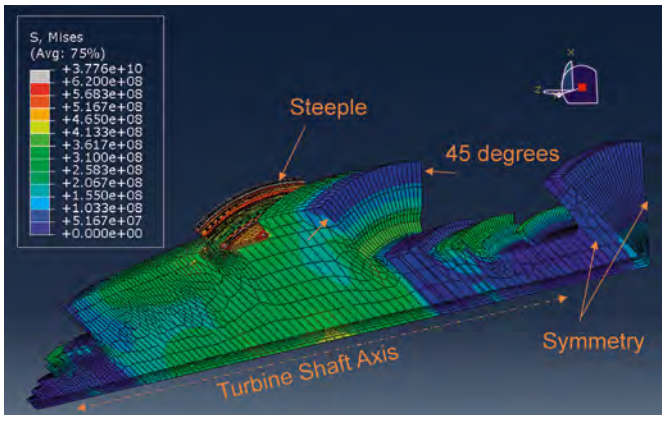
CRACK MODELS

For some geometry and crack shapes, solutions may already exist, or custom crack models can be created for finite element analysis, such as the turbine model shown in the first image [2]. Several crack locations were examined using a symmetric model of the turbine shaft. An important feature of a crack model is the focused mesh region, shown in the second image. Abaqus uses the concentric contours of brick elements to compute the J-integral values along the crack front, and allows comparison of each contour's value, helping to assure accurate results.

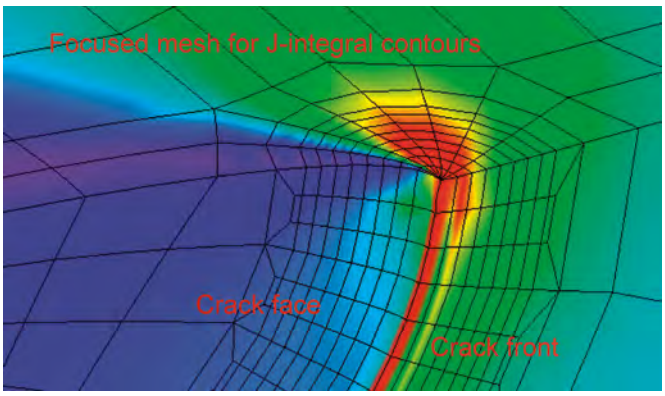
CRACK ASSESSMENT

To assess cracks for failure, several approaches are available, including the Failure Assessment Diagram (FAD), crack driving force, and ductile tearing instability. The FAD method was used for the turbine assessment, and the third image shows an FAD plot comparing the assessment points for two crack sizes. The 10 mm crack is stable (below the FAD curve), and the 12 mm crack is unstable (above the FAD curve) and predicts failure.

A typical workflow to obtain the FAD is to create the overall geometry and mesh using Abaqus/CAE, then partition the model where the crack mesh will be added. The next step is to import the partitioned region into FEACrack, select crack mesh



Turbine shaft, one-eighth symmetry 45 degree model with cracks examined at several locations.



Close-up of the focused mesh along the crack front for Abaqus to compute J-integral results in each contour.

refinement, apply material and boundary conditions, and generate the crack mesh. The crack mesh is either combined with the larger model or run as a sub-model. To obtain the needed J-integral results for the crack assessment, increase the loading magnitude over several analysis steps in an elastic-plastic analysis to allow crack front plasticity to develop. Use enough mesh refinement to capture the crack front blunting. Use the J-integral results to determine the reference stress, which gives the FAD Lr assessment point value. Also run an elastic analysis of the crack model to obtain the stress intensity K values, and determine the FAD Kr assessment point value.

A limiting crack analysis varies the crack size until the assessment point is on the FAD curve at the limit of stability. Knowing the limiting flaw sizes helps to plan for inspections and the minimum size of a crack that needs to be detected.

SOFTWARE FEATURES

Using the combination of Abaqus and FEACrack benefits engineers by addressing the challenges of creating crack models and quickly generating the numerous crack meshes needed for assessments. The fatigue module computes crack growth due to cyclic loading. Abaqus provides important features for cracking analysis, such as tied contact to connect the crack mesh to the larger model, general contact to model crack face closure, non-linear material, sub-model, and J-integral calculation.

Videos of cracking analysis examples are available on the SIMULIA Learning Community. If you are interested in knowing more about cracking analysis, please contact G.Thorwald@QuestIntegrity.com.

REFERENCES

1. API 579-1/ASME FFS-1, June 2016 "Fitness-For-Service", The American Society of Mechanical Engineers and the American Petroleum Institute, API Publishing Services, 1220 L Street, N.W., Washington, D.C. 20005
2. G. Thorwald, V. Garcia, R. Bentley, and O. Kwon, "Steam Turbine Critical Crack Evaluation and Ranking Cracks to Prioritize Inspection", SIMULIA User Meeting at Science in the Age of Experience conference, June 18-21, 2018, Boston.

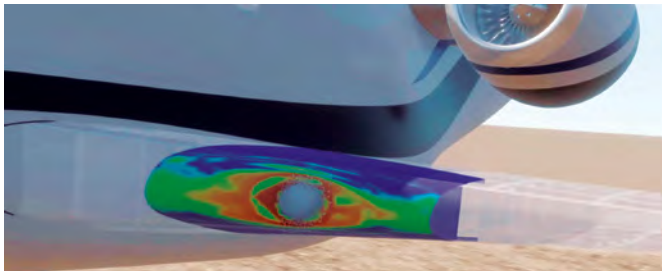
For More Information

www.questintegrity.com/software-products/feacrack

A STRATEGY FOR BIRD STRIKE SIMULATIONS USING ABAQUS/EXPLICIT

A bird strike is classified as a high-velocity soft body impact because the stresses, which are generated in the contact region, are significantly greater than the strength of the bird but lower than the strength of the impacted structure. High deformability of the impactor (bird) causes spreading of the impact load over a certain area of the structure that requires the use of special strain-rate-dependent material models.

If the structure is deformable, the impact load depends on the structural response that, in turn, depends on the impact load. Experiments show that bird strike is characterized by the following three phases: (1) shock wave stage; (2) pressure release stage; and (3) steady-state flow pressure stage [1]. Important parameters, which are obtained from the experiments, include the peaks of the impact forces and pressures and the steady flow pressure.



MATERIAL MODELING

The bird material is described by the so-called "elastic-plastic hydrodynamic" material model, which is widely accepted in the literature. At high pressures, the hydrodynamic pressure-volume behavior of the bird can be modeled in Abaqus/Explicit using: (a) the Mie-Grüneisen form of the equations of state with the linear Hugoniot relation between the shock wave in the bird, Us, and the particle velocity, Up, or (b) a tabulated equation of state, which provides greater flexibility in modeling the hydrodynamic response of materials.

Additionally, the Abaqus ductile damage criterion is used to prevent excessive distortion of Lagrangian elements and associated failure of the analysis, which is caused by the anticipated physical behavior (flow) of the water-like homogenized bird, through the deletion of bird elements. Element deletion also brings the results of the simulation closer to reality.

BIRD-STRUCTURE INTERACTION

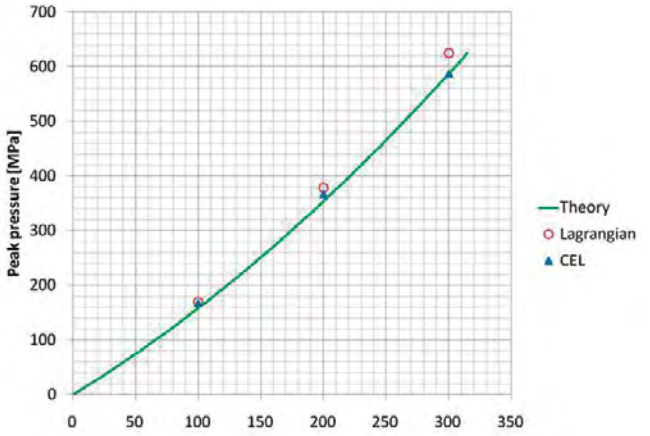
The pressure distributions over the structure with due regard for the nonlinear coupling between the bird and the target can be effectively modeled by means of the general contact capability of Abaqus/Explicit. The penalty method used in the general contact algorithm allows for accounting of the differences in the mechanical properties of the contacting bodies.

APPROACH: LAGRANGIAN OR COUPLED EULERIAN-LAGRANGIAN (CEL)

The meshing task is significantly simplified for the CEL approach because there is no need to mesh the soft projectile. Instead, a simple uniform finite element mesh is constructed from Eulerian elements so that the projectile is fully contained within the mesh boundaries throughout the analysis. This can be achieved either by creating an immovable Eulerian mesh, which is large enough to encompass the entire trajectory of the projectile from the beginning to the end of the analysis, or by creating a moving Eulerian mesh, which is capable of following, expanding, and contracting to enclose the projectile as it moves in space.

RESULTS

The use of a cylindrical projectile permits a direct comparison with the analytical predictions of the pressure peaks and steady flow pressures. Good correlation is observed between Abaqus and theoretical values, for both the Lagrangian and CEL methods.



Comparison between the theoretical, CEL, and Lagrangian peaks of pressure for the cylinder

CONCLUSIONS

The validated Abaqus soft projectile models can be directly used to analyze a given structure/structural part without having to perform a complicated and time-consuming calibration task. All the models described herein are available from SIMULIA in the Abaqus model data base format. The user needs only to substitute the rigid target in these data bases with the structure to be analyzed and run the analysis.

For More Information

Detailed results can be found in the complete Best Practices document: Article ID: QA00000008149; Abstract: Best Practices for Bird Strike Simulations with Abaqus/Explicit; Link: https://onesearch.3dS.com/mashup-ui/page/document?q=docid:QA00000008149

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