DASSAULT SYSTEMES | The 3DEXPERIENCE® Company

TAKE OFF WITH REALISTIC SIMULATION

"Aerospace and defense manufacturers need to utilize simulation to gain more insight into product, system, or system of systems performance. Greater insight would help them avoid multiple prototypes and multiple rounds of testing, and that, in turn, would improve their rates of on-time and on-budget delivery." [1]

An integral part of the Dassault Systèmes **3D**EXPERIENCE® Platform, realistic simulation solutions are used by leading aerospace and defense OEMs and their suppliers as part of their integrated development environment to evaluate design alternatives, collaborate on projects, and leverage computing resources for more efficient analysis.

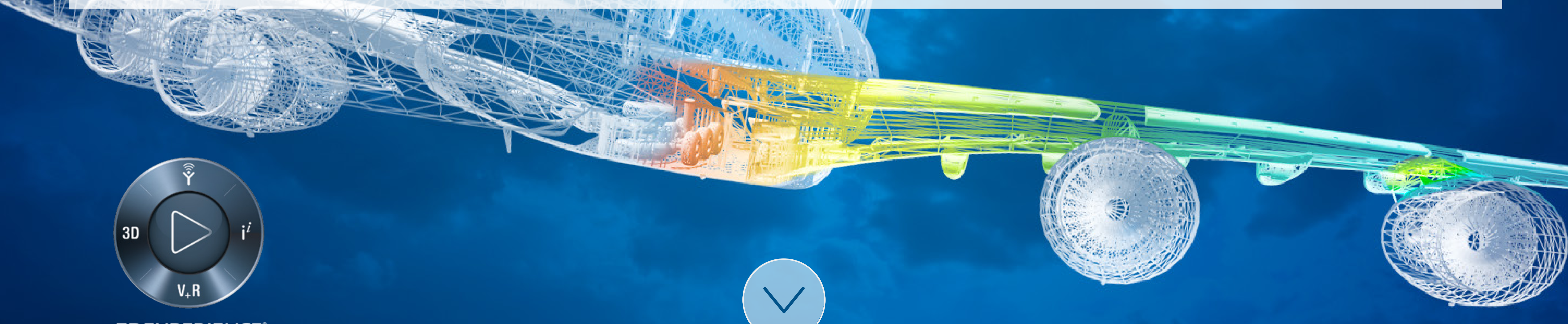
VOLUME 2: STRUCTURAL RELIABILITY

Volume 2 of this eBook series focuses on the structural reliability of aircraft parts and assemblies. Read papers from our customers that demonstrate how they use realistic simulation to:

- Predict structural reliability of components over time
- Identify weight saving opportunities while fulfilling multiple constraints
- Reduce manufacturing non-conformities

Continue reading to view these papers' abstracts—then **download the complete papers!**

[1] Lifecycle Insights: "Improve Program Execution with Integrated Simulation"



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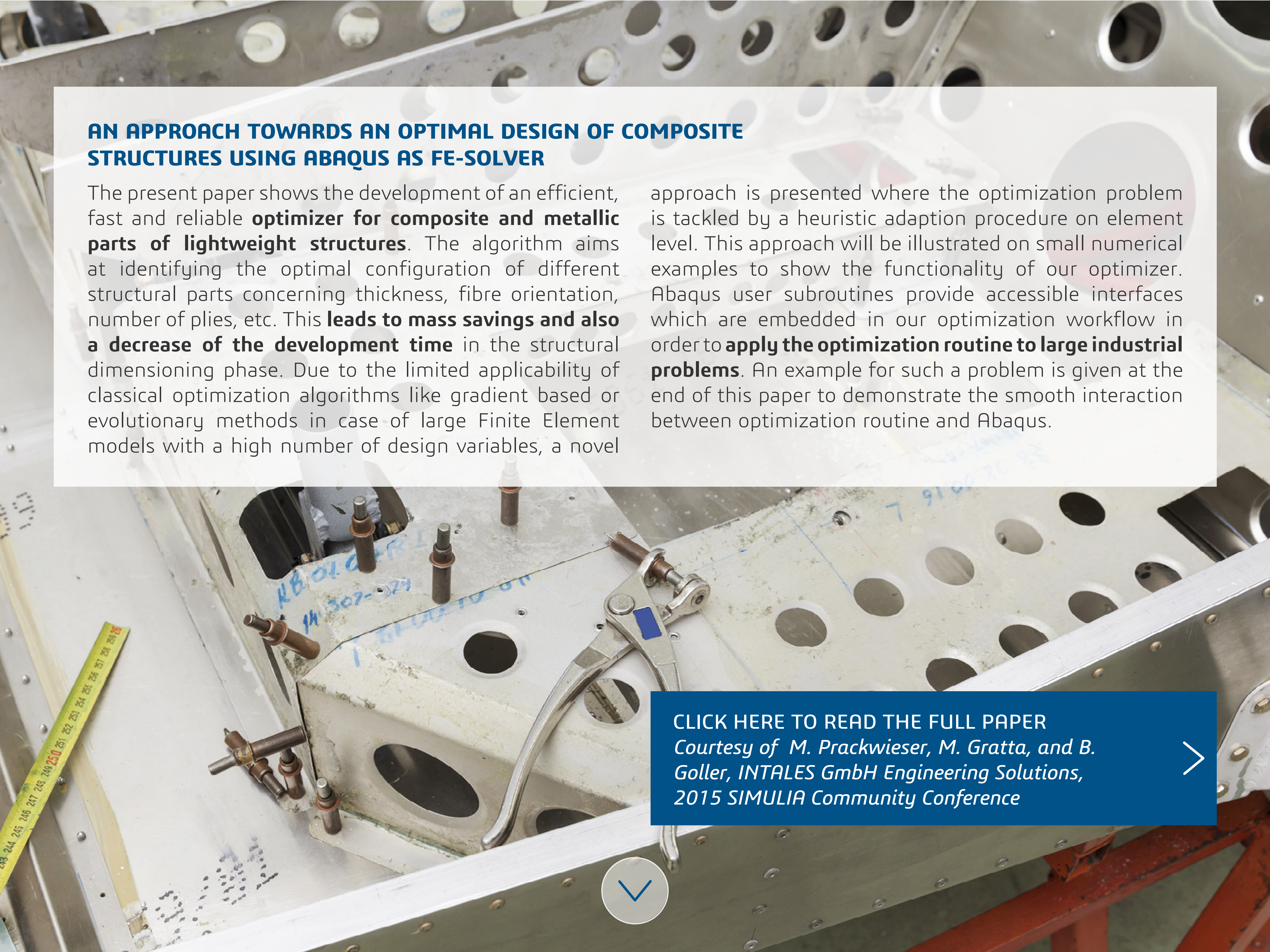

AN APPROACH TOWARDS AN OPTIMAL DESIGN OF COMPOSITE STRUCTURES USING ABAQUS AS FE-SOLVER

The present paper shows the development of an efficient, fast and reliable **optimizer for composite and metallic parts of lightweight structures**. The algorithm aims at identifying the optimal configuration of different structural parts concerning thickness, fibre orientation, number of plies, etc. This **leads to mass savings and also a decrease of the development time** in the structural dimensioning phase. Due to the limited applicability of classical optimization algorithms like gradient based or evolutionary methods in case of large Finite Element models with a high number of design variables, a novel approach is presented where the optimization problem is tackled by a heuristic adaption procedure on element level. This approach will be illustrated on small numerical examples to show the functionality of our optimizer. Abaqus user subroutines provide accessible interfaces which are embedded in our optimization workflow in order to **apply the optimization routine to large industrial problems**. An example for such a problem is given at the end of this paper to demonstrate the smooth interaction between optimization routine and Abaqus.

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Courtesy of M. Prackwieser, M. Gratta, and B. Goller, INTALES GmbH Engineering Solutions, 2015 SIMULIA Community Conference

TIME-ACCURATE SIMULATION OF AEROELASTIC FLAP DEPLOYMENT WITH FREE PLAY

Today, **numerous aeroelastic structures are deployed over a finite time period**, such as flaps, spoilers, control surfaces, and wheel bay and bomb bay doors. These devices must be both divergence and flutter free. Current state-of-art simulations verify this by applying a quasi-steady assumption that does not require the system to physically deploy within the computations. That is, the structure is assumed elastic but does not possess the "large" motion associated with the device's path of travel. While these simulations have strong technical merit, especially in the case where a structure is inadvertently locked in a partially deployed position, they are unable to capture all of the relevant physics. When a component is deployed over a finite period, the **flow physics include additional unsteady aerodynamic effects** that are lost without considering the large motion of the device; in addition to the unsteady aerodynamics, the structure has inertial terms that cannot be correctly accounted for with the quasi-steady assumption. It will be demonstrated that by coupling Abaqus/Standard, which simulates the elastic response and flexible multibody dynamic articulation, to the CFD solver Star-CCM+ via SIMULIA's Co-Simulation Engine (CSE), **a time-accurate response to flap deployment can be achieved**. This is compared to results from a simulation utilizing the quasi-steady assumption.

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Courtesy of Nicolas D. Reveles and George Antoun, ATA Engineering, Inc. and James Fort, Dassault Systems Simulia Corp., Space, 2015 SIMULIA Community Conference

BIRD STRIKE ANALYSIS FOR IMPACT-RESISTANT DESIGN OF AIRCRAFT WING KRUEGER FLAP

Bird strike is a severe high velocity impact load case for all forward-facing aircraft components and a major design driver due to the high energies and the strict safety requirements involved. This paper summarises an experimental and numerical study to **design a bird strike-proof lightweight metallic Krueger flap** as a high-lift device concept for a laminar wing leading edge of a single aisle short range aircraft. The whole design process was based on numerical optimisations for static load cases in combination with high velocity bird impact simulations, with the focus on accurate modelling of the fluid-like bird projectile, the plasticity of the aluminium material and the failure behaviour of the structural hinges and fastened joints. Finally, **a full-scale Krueger flap prototype was manufactured and tested under bird impact loading**, validating the numerical predictions and impact resistance.

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Courtesy of Sebastian Heimbs, Wolfgang Machunze, and Gerrit Brand, Airbus Group Innovations, and Bernhard Schlipf, Airbus Operations GmbH, 2015 SIMULIA Community Conference

METHODOLOGY FOR THE ANALYSIS OF TOLERANCES IN THE ASSEMBLY PROCESS OF A WING TORSION BOX THROUGH FE SIMULATIONS

This work presents a methodology for the analysis of deviations that might be produced during the **assembly process of aircraft components** using the finite element method as calculation tool. The methodology allows determining the effect that different deviations in the constituent parts may have on the final tolerances of an assembly considering the influence of the joining techniques and the different operations that are usually carried out during such processes. This permits to evaluate **if certain deviations in some parts would maintain the final assembly** within the specified tolerances or, conversely, may accumulate/propagate negatively generating a non conformity. In addition, the simulations performed allow analysing the possible **effect of deviations coming from the assembly tooling or different fastening sequences**. In this sense, the work performed demonstrates that the finite element method can be used effectively to **improve the processes commonly used in the manufacturing of components** constituted by several parts and with tight tolerances.

This work is part of the activities performed within the project "284961 CLEAN SKY, Simulation of the assembly tolerances for composite aircraft structures – SATCAS", led by ITAINNOVA and performed under the supervision of Aernnova Engineering Division as Topic Manager. SATCAS is a sub-project associated to the activity of Assembly Simulation defined in the work-package WP 3.2.1.2 of BLADE – SFWA - Clean Sky programme, led by Airbus.

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Courtesy of A. Chiminelli, R. Breto, E. Duvivier, J.L. Núnez, M.A. Jimenez, Instituto Tecnológico de Aragón – ITAINNOVA, F. Martín de la Escalera, Aernnova Engineering Solutions Ibérica, and L. Lizarduy, Aernnova Manufacturing Engineering, 2015 SIMULIA Community Conference

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