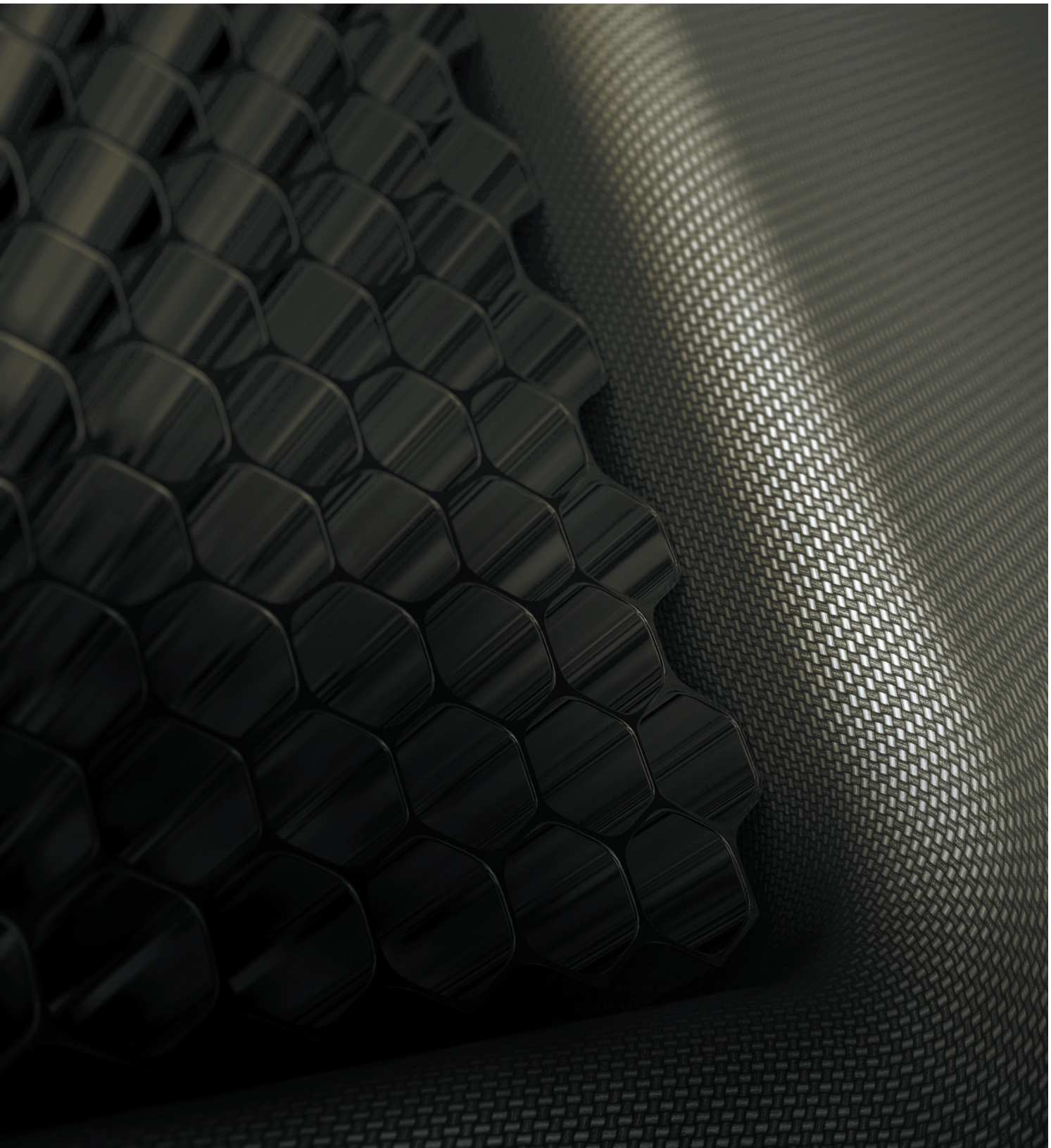
DASSAULT SYSTEMES

PLM SOLUTION FOR COMPOSITES

FROM BLACK ART TO INDUSTRIAL DISCIPLINE



WWW.3DS.COM/COMPOSITES

FROM AIRCRAFT FAIRING TO TRAIN NOSES, BOAT HULLS, AND WIND BLADES, COMPOSITES OFFER DRAMATIC OPPORTUNITIES TO MEET TODAY'S INCREASINGLY COST-DRIVEN MARKET REQUIREMENTS AND ENVIRONMENTAL CONCERNS.

Stronger and Lighter

Ultra light, strong, highly resistant and durable, composites are ideal for producing lightweight structures with tremendous performance capabilities. Yet, designing and mass-producing complex production-ready composites parts is highly complex and expensive.

Traditional Composites solutions cover the design, analysis, and manufacturing of Composites parts in a sequential, time-consuming, non-collaborative process burdened by heavily manual operations. Already in use at the major aircraft and helicopter manufacturers and suppliers, Formula 1 teams, as well as yacht designers and builders, Dassault Systèmes' complete set of process-oriented solutions to design, simulate, and manufacture composite structures on a single virtual platform helps companies to:

- Keep composites development and build cost under control
- Reduce fabrication cycle time and shorten ramp-up time throughout the process, from initial design to manufacturing preparation and shop floor processing
- Manage the vast amount of data, large number of specifications, and the hundreds of plies generated, from design to manufacturing
- Predict global behavior in order not to over-design the part, undermine the initial lightweight properties, and incur additional cost
- Perform tedious, complex ply design while ensuring manufacturability by taking manufacturing constraints into account and generating the necessary output
- Communicate efficiently, promote concurrent engineering, and manage numerous interactions between composites engineering and manufacturing teams or cross-functional disciplines to prevent misunderstandings, errors, and delays

"Composite materials make up around 80% of our racing car parts. Lightweight, stress and erosion resistant, composites can be molded into innovative shapes, but are expensive. PLM has enabled Dome to streamline composite part design and manufacturing, freeing resources for innovation and developing creative solutions in response to customer demand. This is critical for continued success in our market."

Akihiro Oku
Technical Director, Dome Co., Ltd

Developed in partnership with industry leaders, DS end-to-end PLM solution for composites combines, on a single platform, the power of CATIA for virtual product definition, SIMULIA for virtual testing, DELMIA for virtual production, and advanced specialized solutions from a extensive network of highly qualified CAA partners, to support the expanded use of composites and address the advanced needs of the community to reduce the risks and costs associated to the development of composite structures.

At the heart of the solution, CATIA provides a dedicated environment for the design of composite structures, including:

- Full definition from conceptual to engineering detailed design and manufacturing preparation
- Dedicated functional contexts to integrate structural, assembly, and manufacturing requirements early in the design phase
- Collaboration between cross-functional teams through powerful synchronization mechanisms
- Knowledge-based engineering

SIMULIA provides advanced simulation tools and composites-specific methodologies to improve the design, increase the value of virtual testing, and significantly reduce the reliance on physical testing while meeting regulatory and competitive requirements.

DELMIA supplies digital manufacturing capabilities from planning to simulation-based validation, work instruction authoring, and actual delivery to the shop floor.

DS has also developed a set of partnerships with market leading providers and machine makers to supply solutions tailored to specialized technologies from Hand Lay-up and RTM to automated Tape Laying and Fiber Placement processes.

"CATIA Composites Design is fundamental to our success and makes working with composites, which requires new software, new machines, a whole new way of working, much easier."

Youyi Wen
Director of Composites Dept.,Chengdu Aircraft Industrial Group.

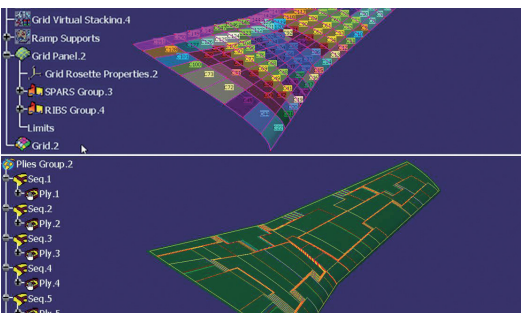
FROM BLACK METAL TO OPTIMAL USE OF COMPOSITES

CATIA Composites Design

The goal of the DS PLM integrated environment for Composites is to provide unique capabilities for the designer to work in a functional context, get accurate feedback from simulation and manufacturing, and even anticipate and avoid problems early in the process. The core design solution, CATIA Composites Design (CPD) offers dedicated design in context environments to make sure that parts meet structural constraints (analysis context) can be manufactured (manufacturing context), and assembled (assembly context).

Along with a dedicated infrastructure to capture and store the appropriate information inside the design environment, CPD delivers dedicated creation and modification features for each context as well as tailored simulation capabilities to enable the designer to easily simulate how the part behaves structurally or what is going to happen on the shop floor.

DESIGN IN ANALYSIS CONTEXT



Predict part behavior for quality and optimization

Among the different ways to start the preliminary design of a composite part, zone-based design is ideal to capture analysis constraints and predict the behavior of the part inside the design environment by importing thickness laws from stress. CPD provides easy-to-use dedicated zone (geometry and laminate) creation and modification features. Zone-based modeling contributes to significant time savings with the ability to generate conceptual solids or IML surfaces for early integration of the composites parts in the mock-up, and enable concurrent engineering with mating parts. Moving from preliminary to detailed design, CPD provides highly productive automatic ply generation from zone capabilities with automatic management of the ply staggering and stacking rules. The ability to quickly and automatically transition from zones to plies while keeping full associativity, allows the designer to focus on the design intent and helps dramatically reduce the number of geometrical tasks required to design the part. To facilitate the weight and strength optimization of the part and the simulation of its behavior while reducing design cycle time, the design in analysis context delivers an integrated link between design and FEA. Integration with the CATIA V5 Linear Elfini solver provides fast design-analysis iterations in full associativity with the zones and plies definition, taking true fiber angles into account. Simulayt's Composites Link enables communication between CPD and Abaqus/CAE at both the conceptual and detailed design stages. Designers and analysts can efficiently communicate during the composites development process, saving time, improving product quality, and preventing costly errors.the part behaves structurally or what is going to happen on the shop floor.

DESIGN IN ASSEMBLY CONTEXT

Optimize complex structures definition

CPD also provides composites designers with the ability to capture the assembly information within the design environment. From wing panels or fuselage barrels to boat hulls, the grid-based approach is a breakthrough technology enabling designers to automate and optimize the definition of large and complex structures in context of their mating sub-structures. Dedicated features are available in this context to define the preliminary grid:

- Positioning of stiffeners and frames as reference elements
- Staggering and clearance constraints applied to these elements
- Import of stress input – stacking sequences or thickness laws – for each cell of the grid

As the designer is ready to create plies from the grid, further optimization of the design can be accomplished by choosing among various algorithms, plies shapes, and customizable drop-off patterns. Powerful ply modification features are also available to tailor the design, whether by swapping ply edges to optimize drop-offs and ply shapes, rerouting sets of plies along a preferred path, easily compute or modify sections of local drop-offs.

DESIGN IN MANUFACTURING CONTEXT

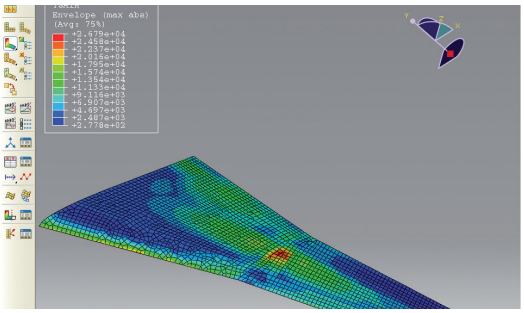
Anticipate issues upfront and avoid trial and error in the shop floor

No matter how good designs are, it is necessary to make sure composites parts can be built easily, consistently, in an affordable way, and that they meet initial requirements. Dedicated features are therefore also available to account for manufacturing constraints early in the design process.

- Material Excess accounting for trim allowance
- 3D Multi-Splice to accommodate material roll width
- Darts to remove significant fiber distortions from plies
- Minimum Tape Length accounting in case of automated Process
- Ramps and drop-offs automation to address machines limitations

The design in manufacturing context provides the ability to assess fiber deformations in plies, take corrective action early in the process, and generate the right output (such as flat patterns) the first time to eliminate trial and error on the shop floor. The fiber deposit context can be captured inside the design environment, supporting enhanced fiber deposit strategies, such as guide curve or sectors, and various propagation modes.Advanced Partner Solutions – Simulayt's AFM and ESI Group's Pam-Quickform – complement the CATIA Composites process for best-in-class fiber simulation. In all cases, on-the-fly flat patterns visualization during the producibility simulation helps the user make informed decisions.

REALISTIC COMPOSITES SIMULATION

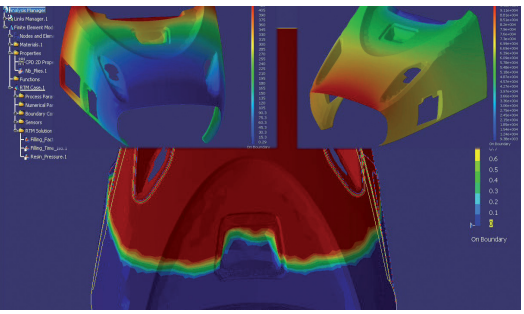


Influence the design

The verification of composites structures requires time-consuming testing and usually occurs too late in the development cycle to have meaningful impact on the design. To accurately predict the complex structural behavior of such parts - and early enough in the development cycle to influence design - the entire Composites dataset can be analyzed with SIMULIA's Abaqus FEA product suite and other major solvers.

SIMULIA's Abaqus FEA provides engineers with state-of-the-art capablities for simulating realistic composites behavior including delamination and damage through cohesion elements and VCCT. Abaqus/CAE provides advanced composites model building and also seamlessly integrates with CPD through the Composites Link product developed by Simulayt. This connection allows designers and analysts to communicate efficiently during the development process, saving time, improving product quality and preventing costly errors.

In parallel, CATIA Structural Analysis for Designers provides fast associative design-analysis iterations. Featuring an automatic transfer of Composites Properties with true fiber angles, it enables thermo mechanical analysis, frequency and buckling analysis with dedicated failure criteria.

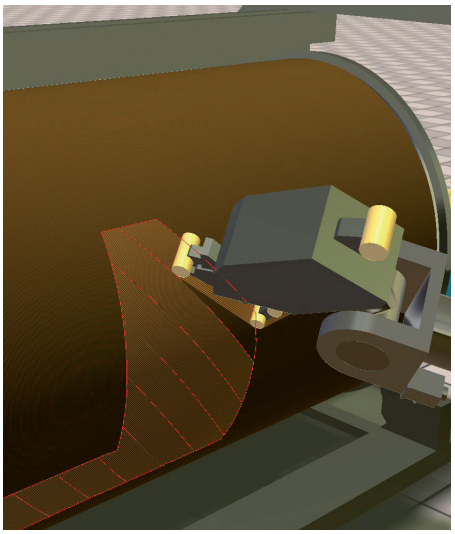


Solve complex manufacturing situations

Feedback from as-built manufacturing can also help refine and secure the process. Composites manufacturing information from automated placement solutions such as Ingersoll's iCPS can now be certified in Abaqus/CAE, accounting for actual fiber path.

Non-linear curing simulations with Abaqus thermal-mechanical capabilities can also solve issues such as incomplete or unstable cure, spring back and residual stresses. Lastly for RTM, VARTM or infusion, dedicated simulations can be performed with ESI Group's PAM-RTM to optimize the injection process upfront. It allows tracking resin flow parameters, filling time, verifying pressure field and helps find the best positions of inlets and vents to avoid dry spots.

DIGITAL MANUFACTURING TO OPTIMIZE PRODUCTION



All shop floor processes can be virtually simulated and optimized upfront to reduce costly scrapping of parts, whether for Lay-up simulation, Laser Projection, NC, Tape Laying or Resin Injection.

Downstream activities for traditional hand lay-up include nesting, cutting and laser projection operations.

Composites data can easily be linked to nesting systems such as TruNESTfrom Magestic Systems and the integrated Panogen solution from CIMPA. In addition, for hand lay-up the integrated Magestic's TruLASER View solution feeds all major Laser Projection systems directly from inside CATIA Composites Design. A key advantage of TruLASER View is the ability to preview and optimize laser projection on-screen before actually reaching the shop floor, to eliminate trial-and-error.

Leveraging DELMIA's ability to handle Composites Products, Processes and Resources in a single environment, DS is working directly with Tape Laying and Fiber Placement machine providers to ensure that the process flow will be seamlessly tailored to their machines. Such solutions include:

- INGERSOLL: iCPS for Designer and iCPS for NC Programmer
- MTORRES: Torres Layup
- CIMPA (Forest Liné machines): Tape Generation and Tape Manufacturing
- CINCINNATI: ACE V2 Interface

Finally, different approaches are available for shop floor documentation: either a traditional drawing-based ply-book or a digital DELMIA ePly-Book to dynamically interrogate the 3D master with all associated operations and work instructions.

"The fuselage components we designed in CATIA fit together exactly as designed and exactly as simulated. That accuracy helped us maintain a testing and production schedule that keeps us on track to meet our goal of getting the Phenom 100 into the air mid 2007 and into full service in 2008."

Humberto Pereira
Director of Development Engineering, Embraer

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