COMPOSITE DESIGN

How SIMULIA products accelerate Composite Design process

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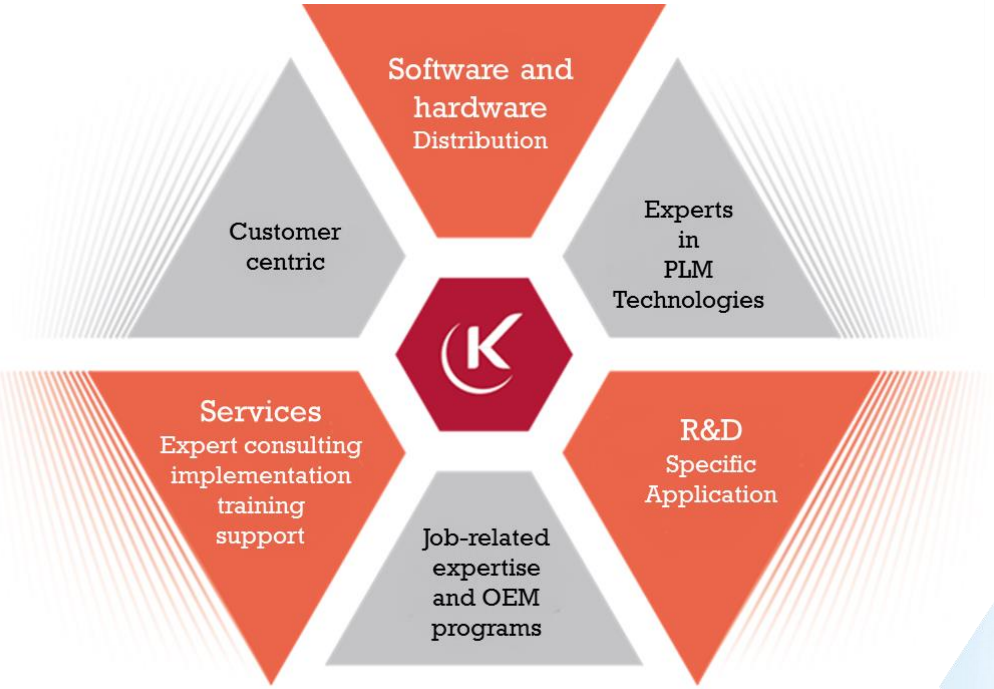
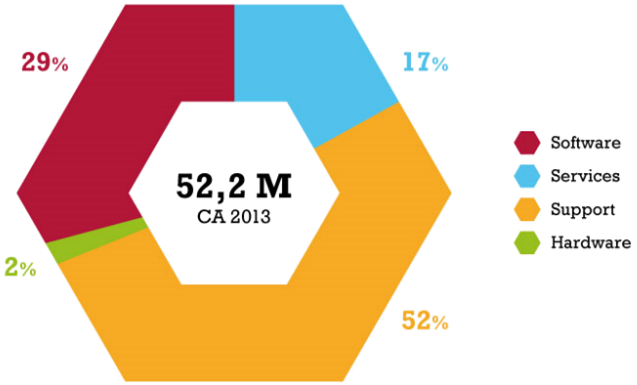
AGENDA

1. KEONYS
2. COMPOSITE CHALLENGE
3. CONCEPTUAL DESIGN
4. DETAILED DESIGN
5. ADVANCED SIMULATION
6. KEONYS OFFER

1 KEONYS
Our mission

- Keonys is a **Dassault Systemes Value Added Resseller** in Germany, France, Switzerland and Benelux.
- For over **20 years**, we have been supporting companies with the implementation of their **PLM and 3D projects**.
- Our expertise enables us to **help you to increase your skills** in all industry sectors.

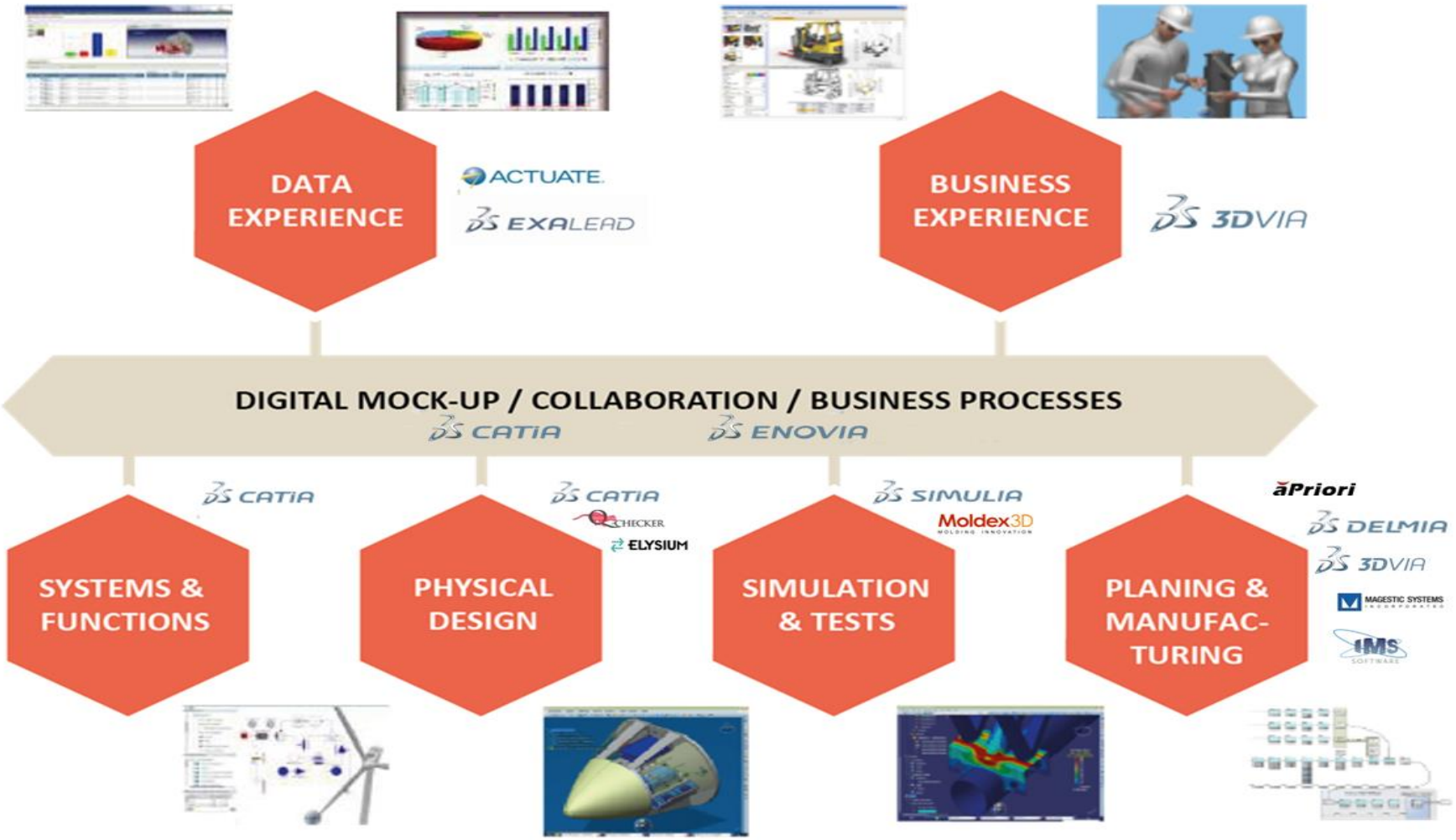




10 agencies - Present in 6 countries

KEONYS
A PLM Expert

KEONYS focuses on your entire product lifecycle.



KEONYS
A simulation expert team

DEDICATED EXPERTS TEAM TO SUPPORT YOU ON YOUR SIMULATION PROJECT

ADVISE
We are listening to our customers needs and offer the most efficient appropriate solution.

TRAIN
We offer a range of training to develop your knowledge and autonomy of these advanced technologies .

SUPPORT
We help you on your simulation projects, remote or on-site in order to maximize the mastery of your tools.

ADDITIVE MANUFACTURING

COMPOSITE

DESIGN OF EXPERIEMENT

CO-SIMULATION

OPTIMIZATION

MULTIPHYSICS

SCRIPTING

DURABILITY

NON LINEAR ANALYSIS

TOPOLOGY

MULTIBODY SIMULATION

SYSTEM ENGINEERING

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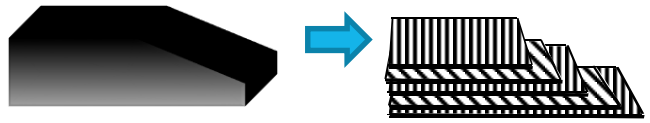
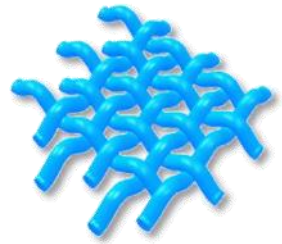
COMPOSITES DESIGN
Challenges

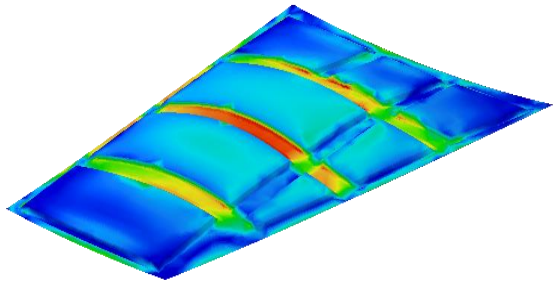
FACTORS TO TAKE INTO ACCOUNT IN COMPOSITE DESIGN:



- **Lots of datas** to manage
  - Material properties
  - Laminates definition (Fiber Directions, Stacking, etc.)
  - Geometry

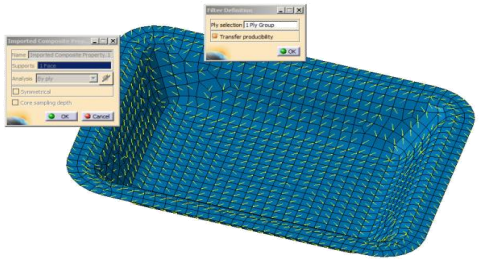


- **Balance** between **weight** and **design optimization**

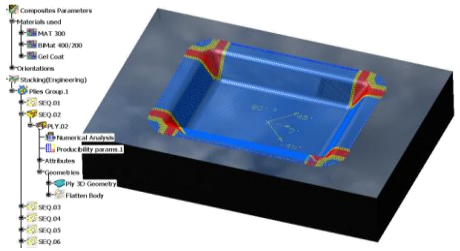


- Handle frequent design changes for **quick optimization**

- **Manufacturing** constraints must be **integrated** into the design model



- Simulate manufacturing during the design phase to **ensure designed intent and as-built model match**

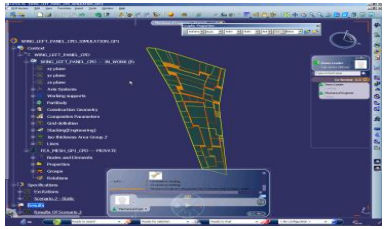


COMPOSITES DESIGN
Integrated solution: from design to manufacturing

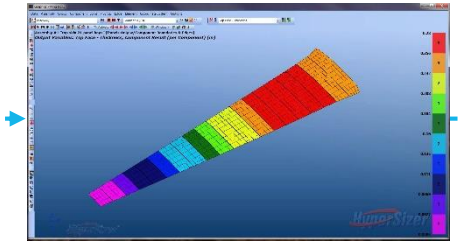
TRADITIONAL APPROACH:

design, analysis & manufacturing not integrated

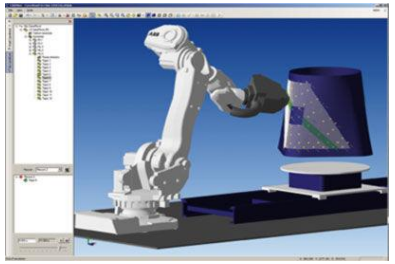
DESIGN | **SIMULATION** | **MANUFACTURING**



MANUAL RECREATION

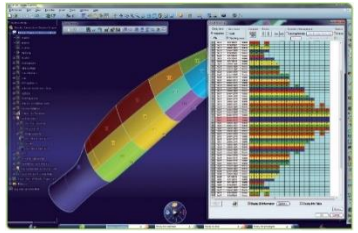


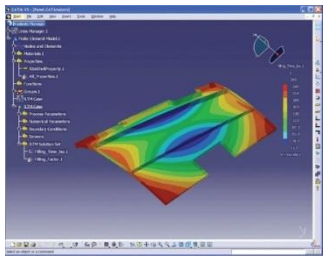
MANUAL RECREATION

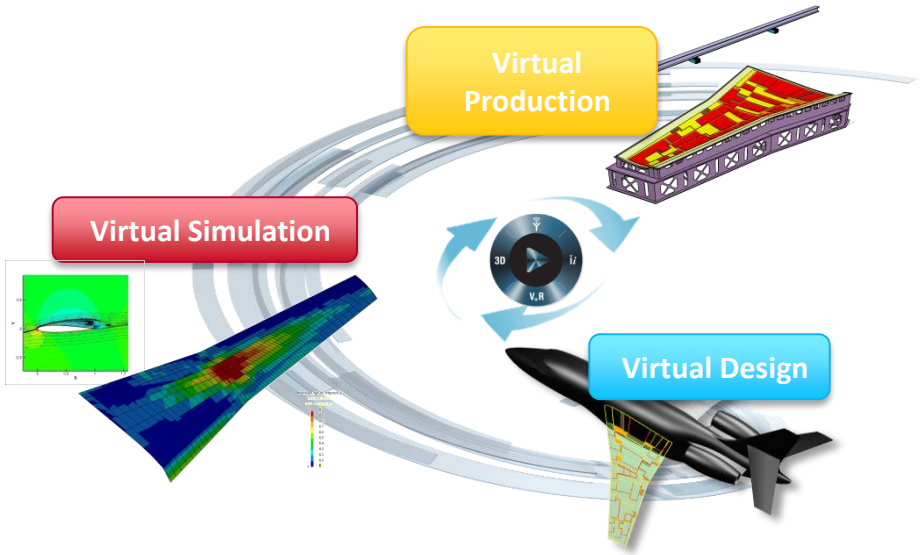


CATIA INTEGRATED SOLUTION:

allows to fully optimize the complete process

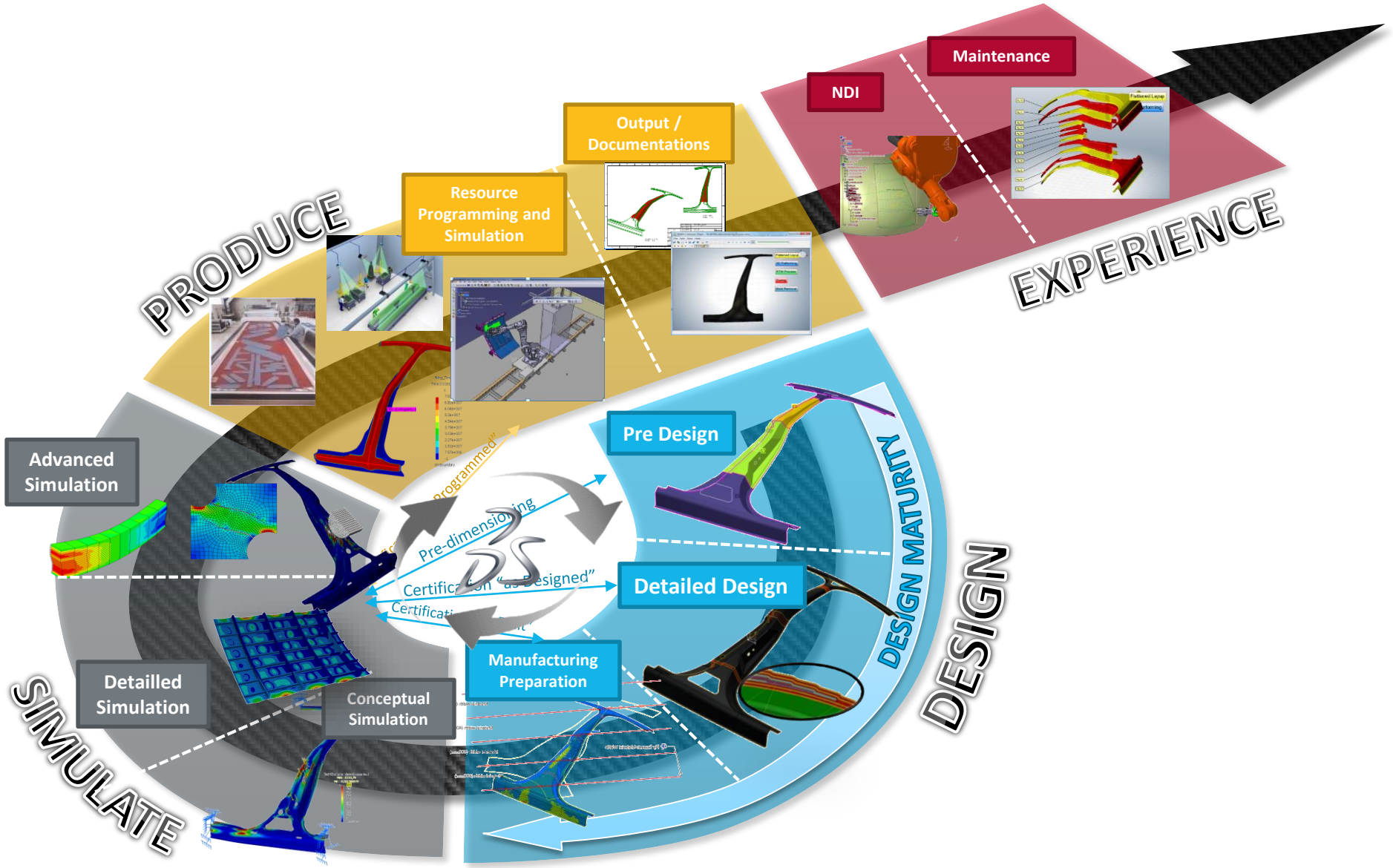






COMPOSITES DESIGN

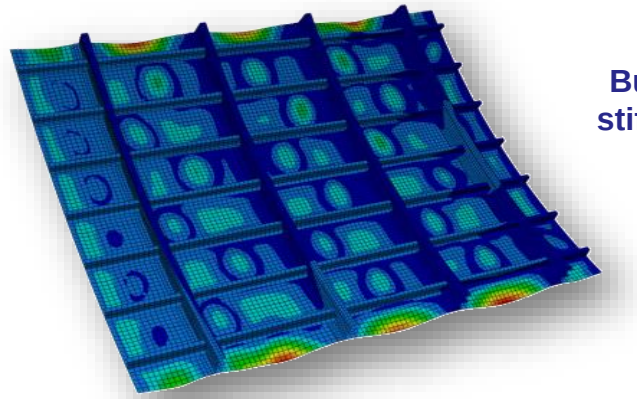
Integrated solution: DASSAULT SYSTEMES SOLUTION



3 COMPOSITE SIMULATION
Best-In-Class Design / Simulation Loops

Integrated Analysis with **CATIA Analysis**

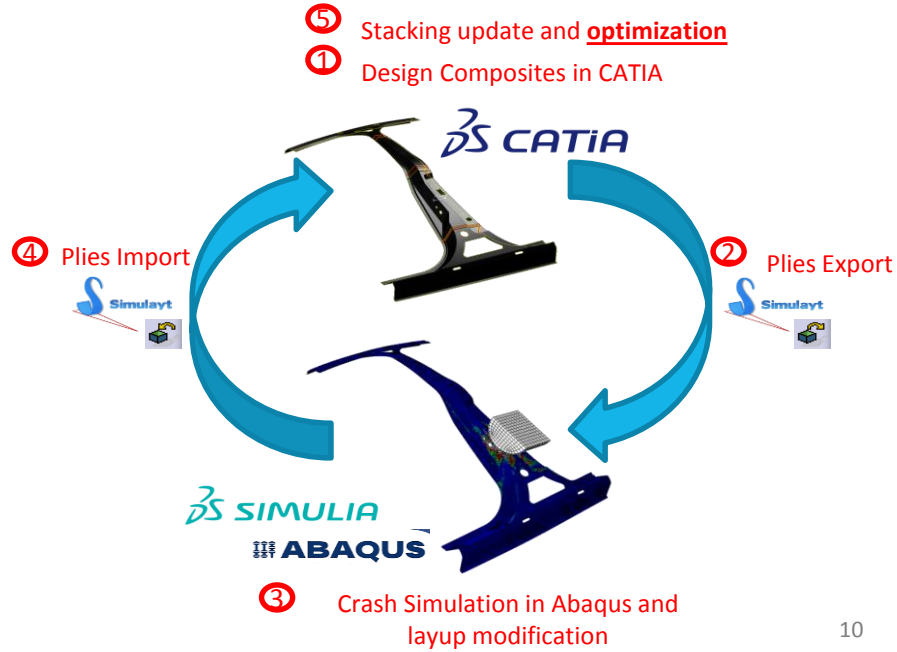
- V5 Integrated Link with FEA
- Automated composite properties transfer
- Linear and Non Linear Solver
- Embedded optimization tools
- Dedicated Post processing



Buckling of a stiffened panel simulated in Catia

Integrated Analysis with **Abaqus**

- CPD properties imported into ABAQUS CAE
- Bi-directional associativity between ABAQUS and CATIA
  - Ply definition modified inside ABAQUS CAE can be imported into CATIA CPD
  - Modification can be accepted or rejected by the CPD user through an easy-to-use interface
- Optimization capabilities with Isight



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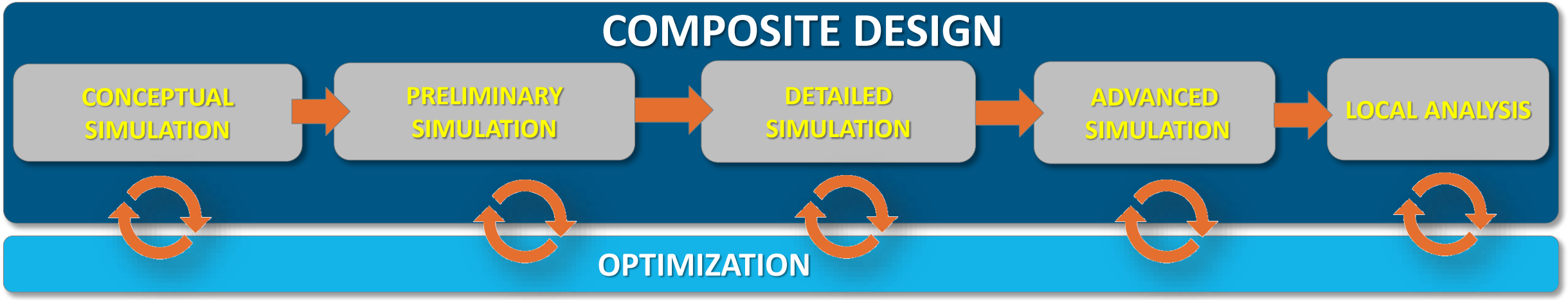
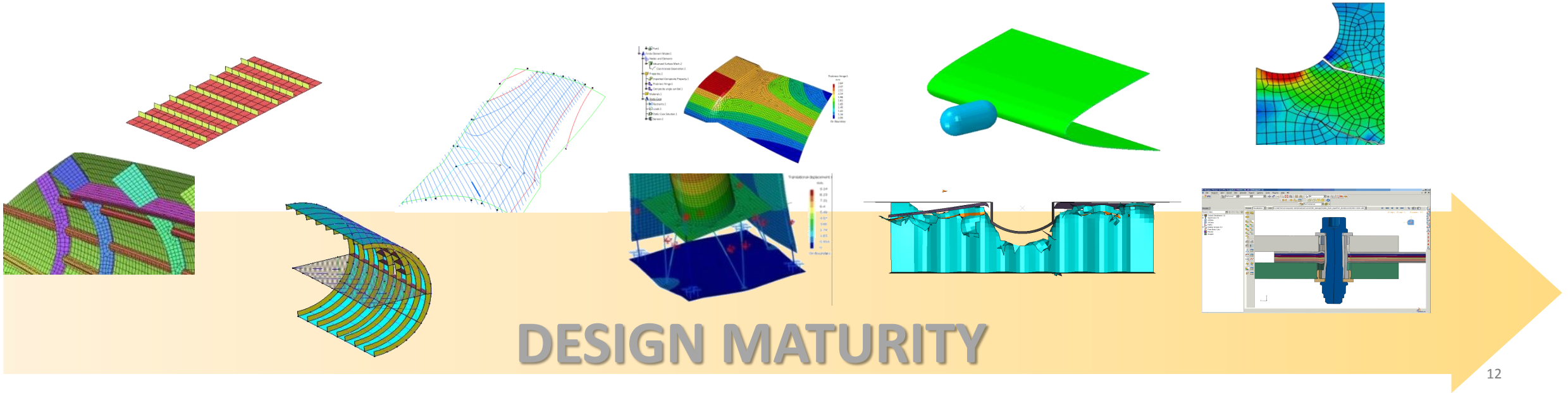
3 COMPOSITE SIMULATION
Keonys proposal workflow

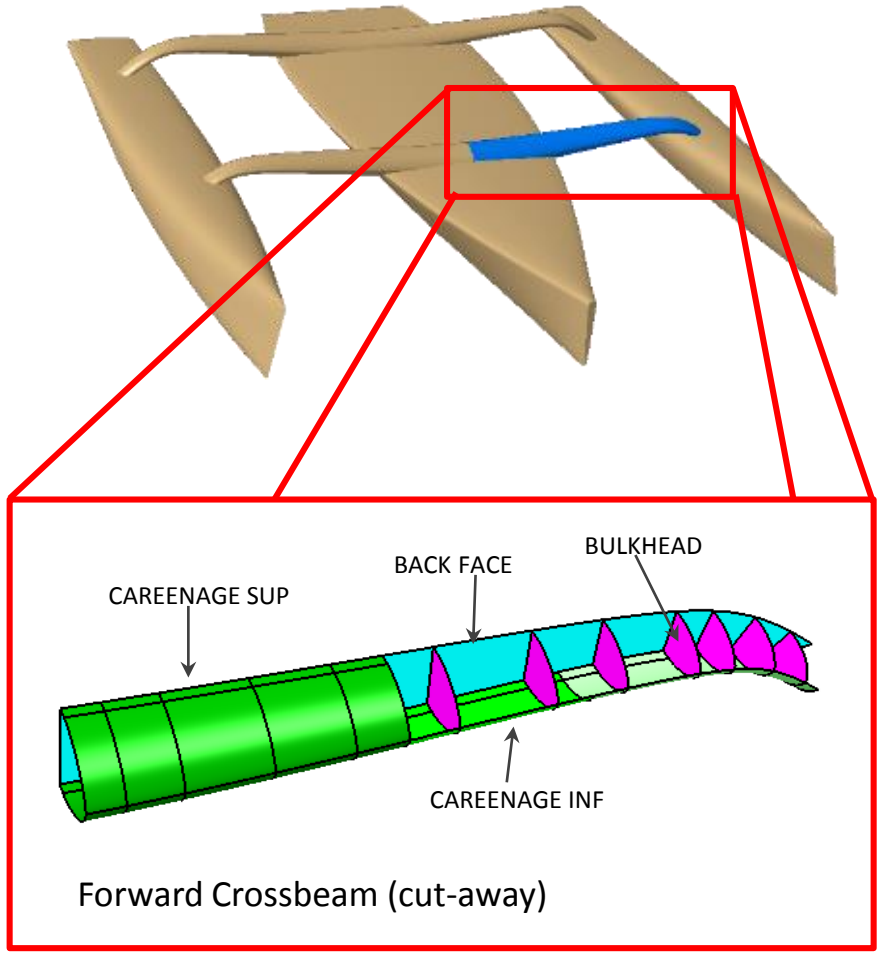




TRIMARAN CROSSBEAM DESIGN

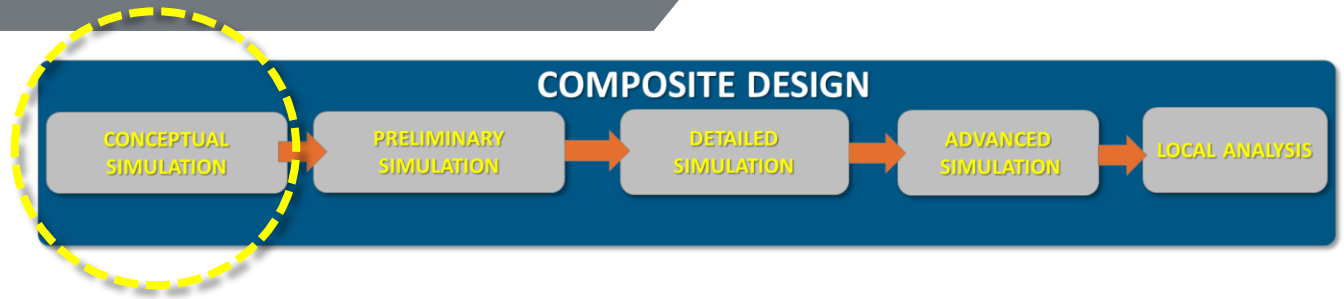
Trimaran crossbeam design will be used to illustrate the composite workflow.

- Step 1 : Conceptual design
  - Define the concept: shape and concept (laminate, sandwich panels)
- Step 2 : Detailled design
  - Take into account plies, stacking and draping
- Step 3: Advanced design and local analysis
  - Simulate advanced analysis (Impact, delamination, dynamics….)
  - Local analysis (joint and connexion)



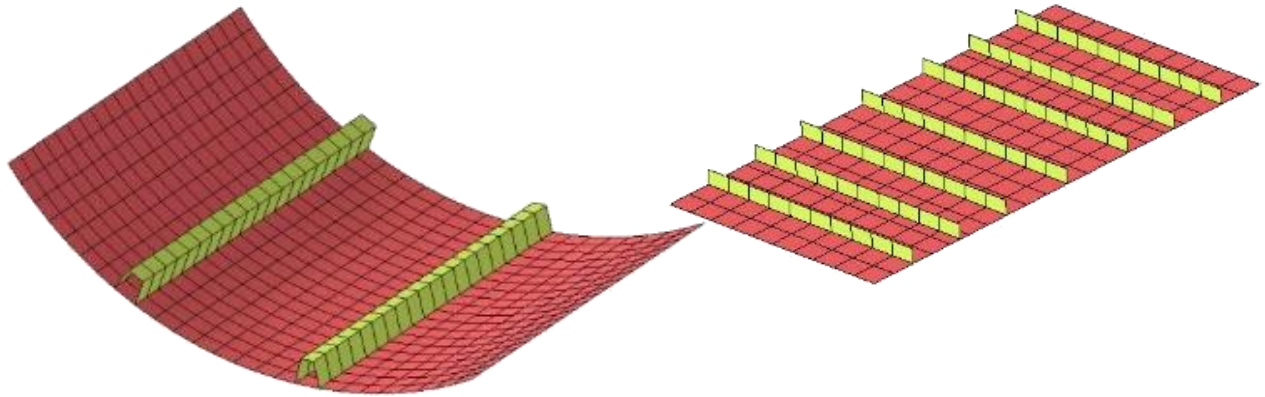
Forward Crossbeam (cut-away)

3 COMPOSITE SIMULATION
Conceptual simulation - overview



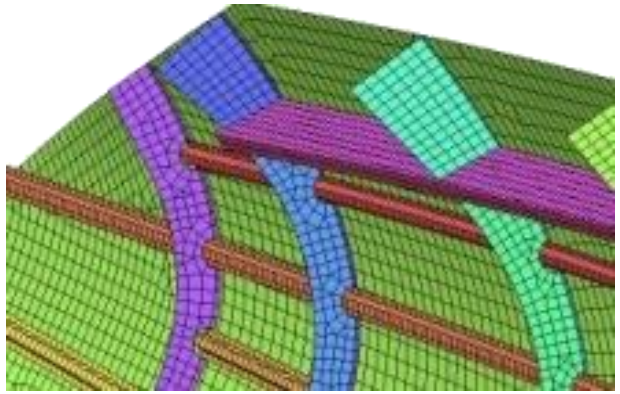
Goals :

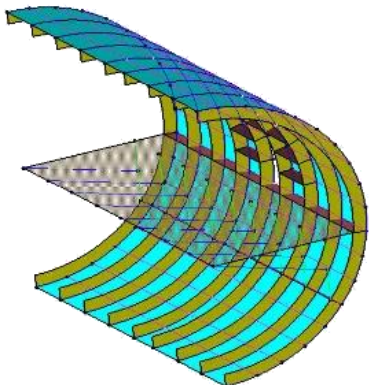
- 1st iteration of design
  - Conceptual models
- 1st iteration of Structural Simulation:
  - Linear static analysis, modal analysis, buckling
- Stacking not taking into account



Key values

- Quick evaluation between various alternatives
  - Shapes, materials
  - Stacking, plies number, fiber orientations, plies thickness
  - Etc.
- Avoids inappropriate Designs
- Solution easy to implement
- Full CATIA solution

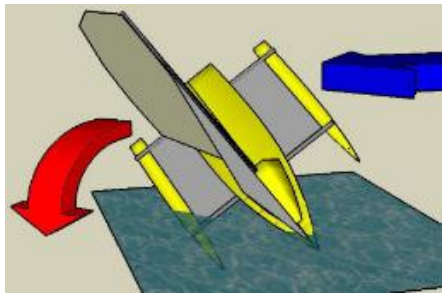


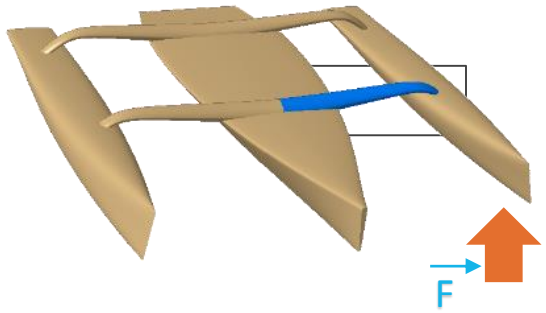


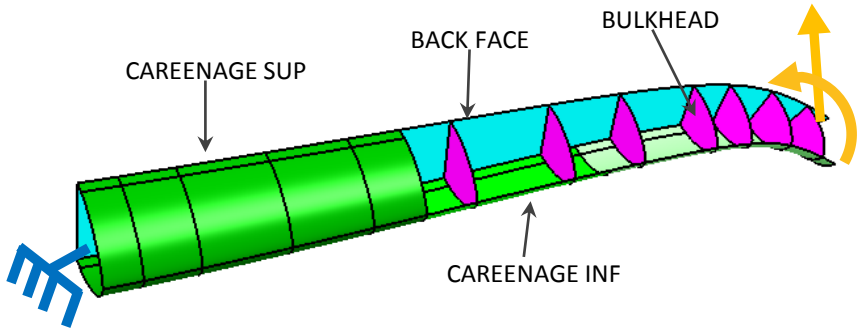
Software :

- Design: **Catia**
- Simulation : **Catia** Analysis
- Optimization: **Catia** Optimizer

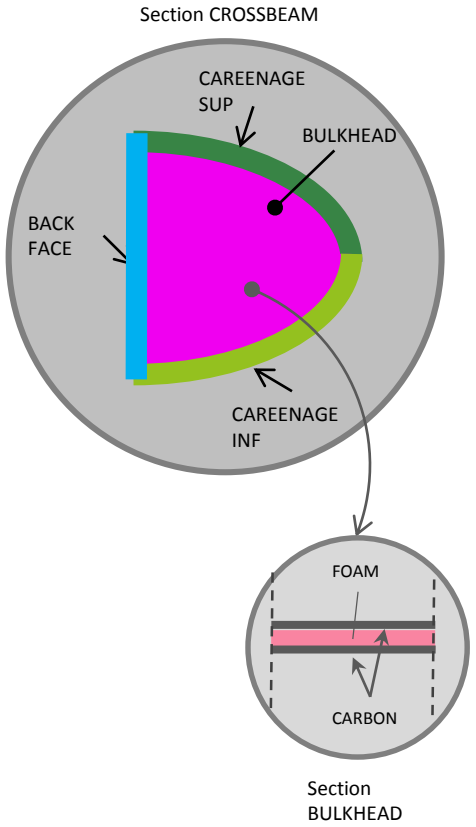
3 COMPOSITE SIMULATION
Conceptual simulation – Design iterations



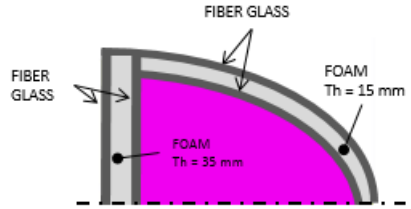




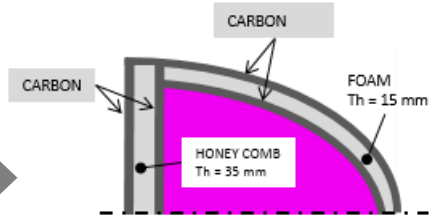
Forward Crossbeam (cut-away)



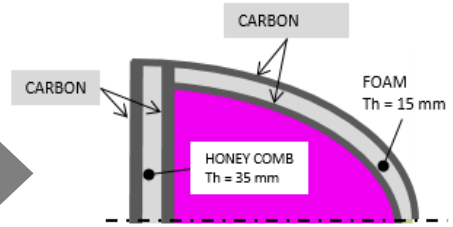
1st ITERATION



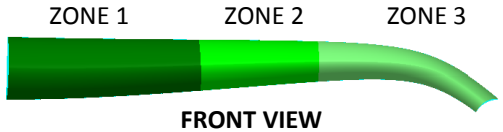
2nd ITERATION
Change Materials



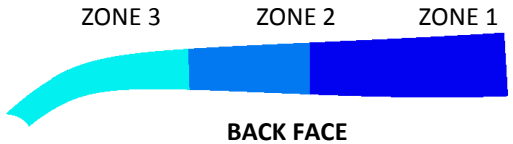
3rd ITERATION
Change Stacking Back Face



3 COMPOSITE SIMULATION
Conceptual simulation – Quick iterations



FRONT VIEW



BACK FACE

Back Face & Careenage Zone 1
[45,-45,0,0,0,45,-45,0] s

8	0	FOAM ISO Back face	35
7			
6			
5			
4			
3			
2			
1			
Pli N)			

Back Face & Careenage Zone 2
[45,-45,0,0,45,-45,0] s

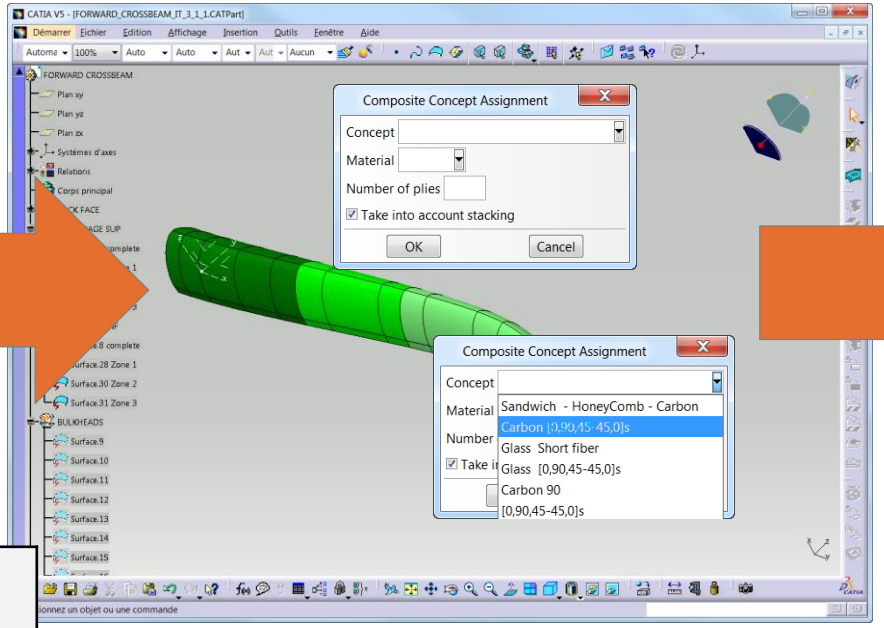
7	0	FOAM ISO Back face FOAM ISO Careenage	35 15
6			
5			
4			
3			
2			
1			
Pli N)			

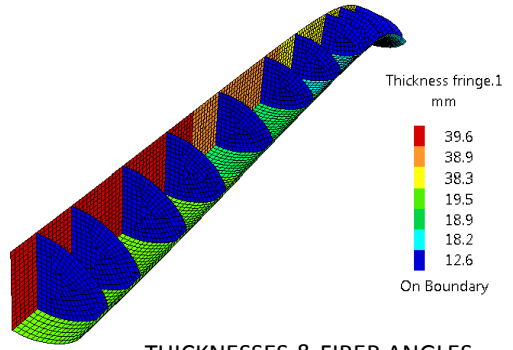
Back Face & Careenage Zone 3
[45,-45,0,45,-45,0] s

6	0	FOAM ISO Back face	35
5	-45		
4	45		
3	0		
2	-45		
1	45		
Pli N)	θ		

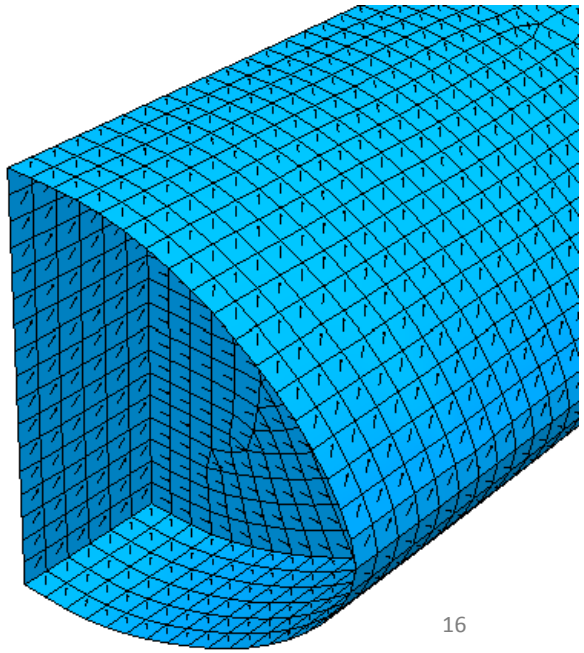
All Bulkheads [0,90,45-45,0]s

5	0	FOAM ISO	10
4	-45	Carbon HR Fabric	0.325
3	45	Carbon HR Fabric	0.325
2	90	Carbon HR Fabric	0.325
1	0	Carbon HR Fabric	0.325
Pli N°	θ	Material	Th (mm)

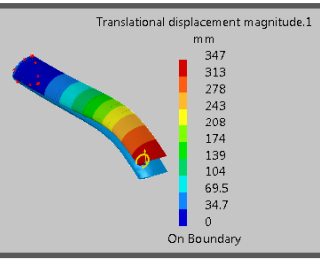
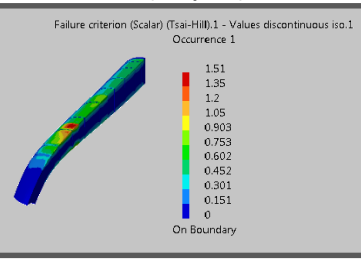
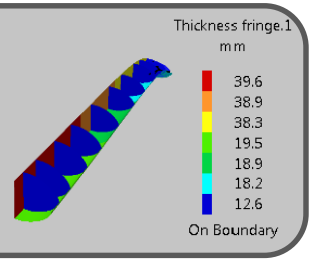
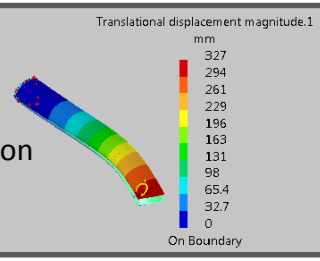
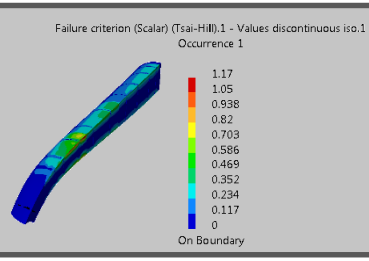
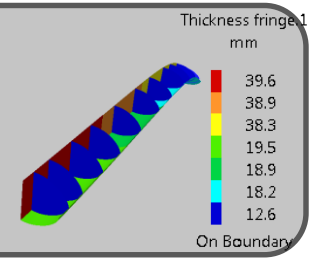
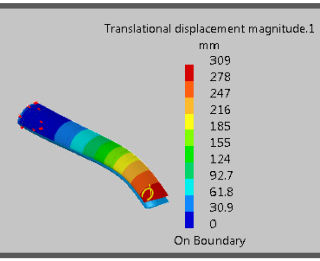
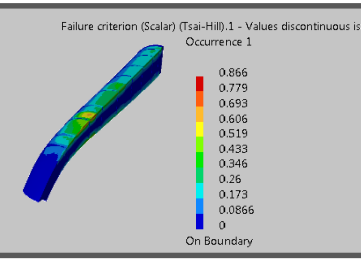
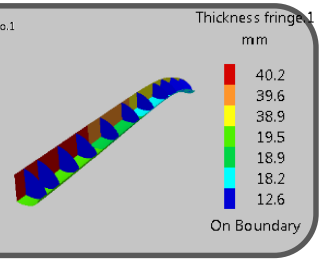




THICKNESSES & FIBER ANGLES



3 COMPOSITE SIMULATION
Conceptual simulation – Iteration 1,2,3, Results

		DEFORMED & UNDEFORMED CROSSBEAM	TSAIL-HILL CRITERIA : ENVELOPE (All plies)	THICKNESSES
1st Iteration	• Known material selection • Stacking based on experience			
2nd Iteration	• Change materials • Substitute Fiber Glass with Carbon			
3rd Iteration	• Change Stacking • Add 90°plies on Back Face			

COMPOSITE SIMULATION

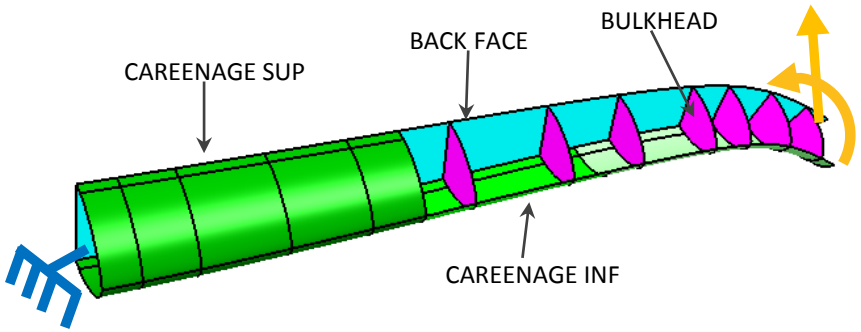
Conceptual simulation – CATIA optimization - Definition

Goals :

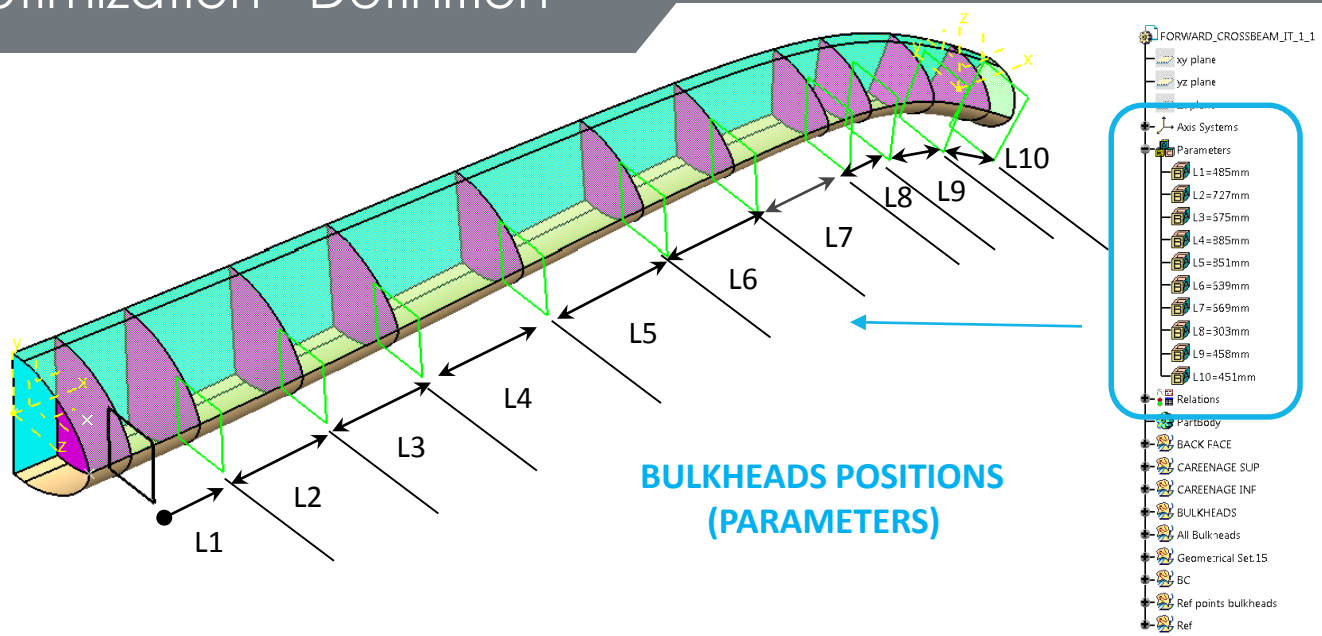
- Find the best design with optimization algorithms.
- All Catia parameters can be optimize

Key values

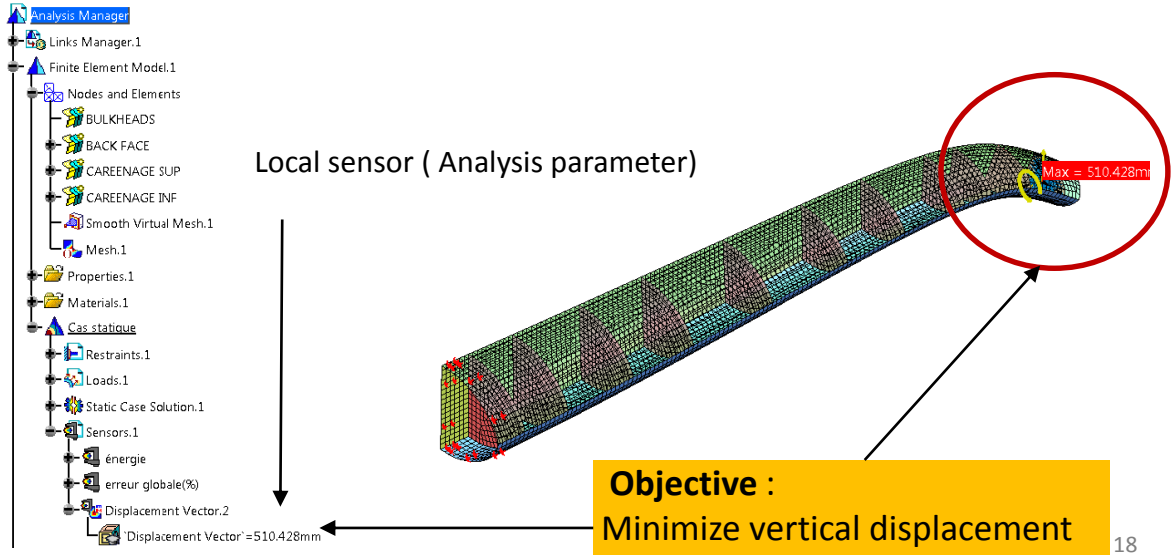
- Product Engineering optimizee tools integrated into catia
- Automatic evaluation
- All Catia parameters can be optimize
- Full CATIA solution



Forward Crossbeam (cut-away) boundary conditions & loads



BULKHEADS POSITIONS (PARAMETERS)



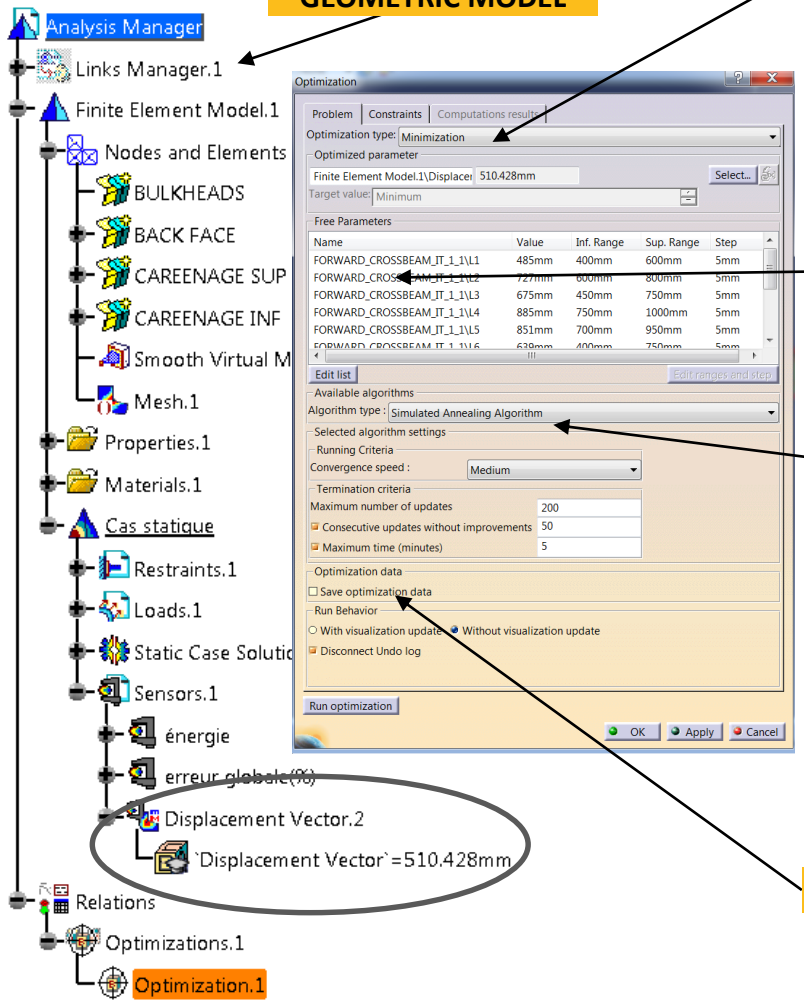
Objective :
Minimize vertical displacement according to Li parameters

3 COMPOSITE SIMULATION

Conceptual simulation – CATIA optimization - Setup

SETUP

ASSOCIATIVITY WITH GEOMETRIC MODEL



OPTIMIZATION TYPE

- Maximization
- Target Value
- Only constraints

Parameter to Optimize: Bulkheads Positions

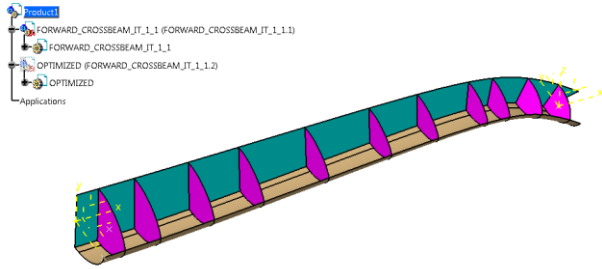
Algorithms type

- Local Algorithm For Constraints and Priorities
- Gradient Algorithm With Constraint(s)
- Algorithm for Constraints & Derivatives Providers
- Gradient Algorithm Without Constraint

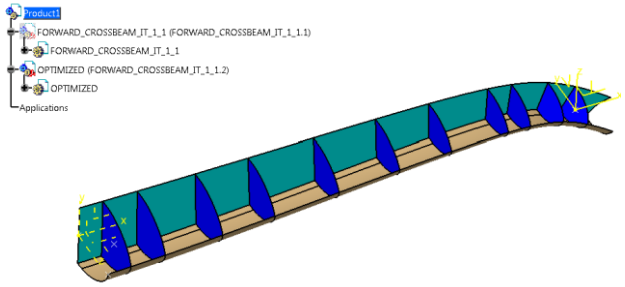
Save data in Excel file

EXECUTE

ORIGINAL BULKHEADS POSITONS



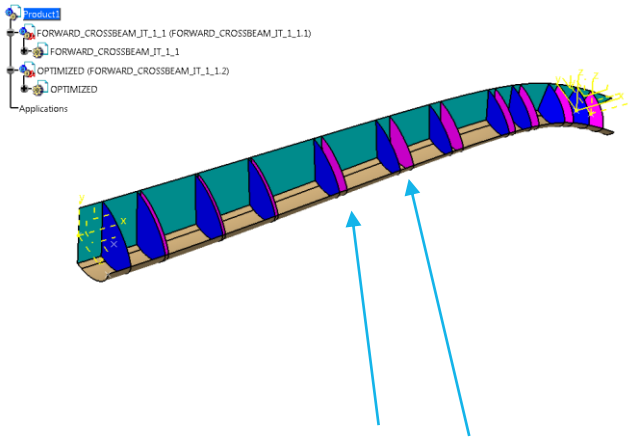
OPTIMIZED BULKHEADS POSITONS : (BULKHEADS ARE COLOURED IN BLUE)



	VERTICAL DISPLACEMENT
ORIGINAL MODEL	**510.428 MM**
OPTIMIZED MODEL	**454.332 MM**

ANALYZE

SUPERPOSITION OF THE TWO MODELS

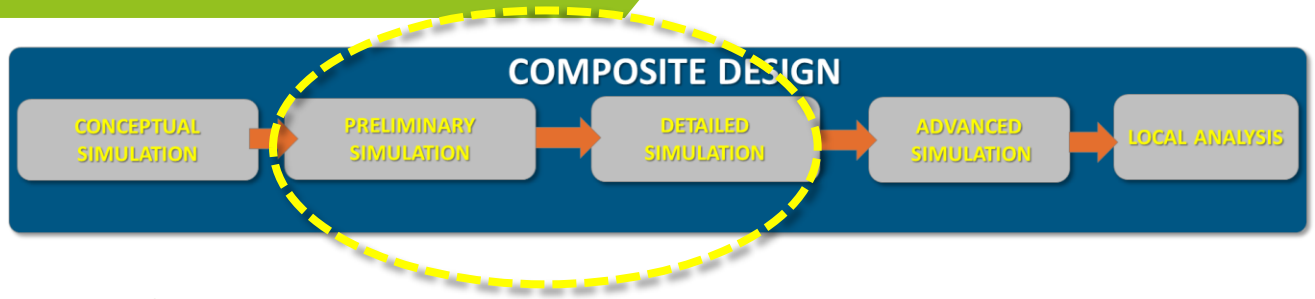


Old position (magenta)
New position (blue)

AGENDA

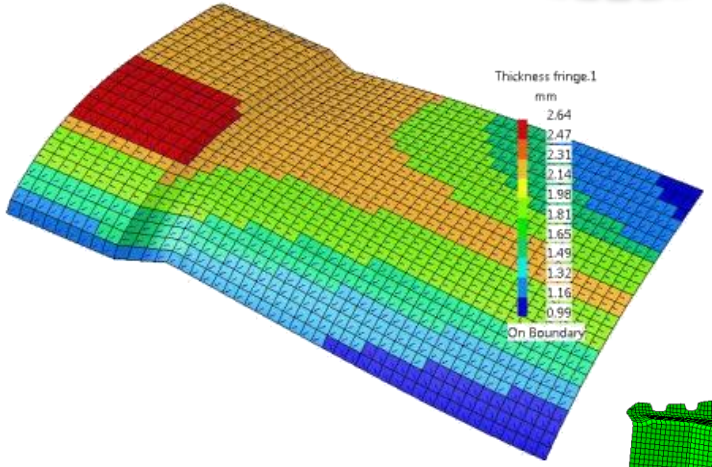
1. KEONYS
2. COMPOSITE CHALLENGE
3. CONCEPTUAL DESIGN
4. DETAILED DESIGN
5. ADVANCED SIMULATION
6. KEONYS OFFER

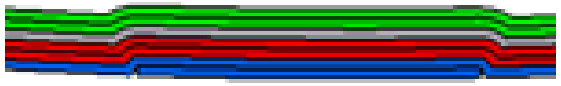
COMPOSITE SIMULATION
Detailled simulation – Overview



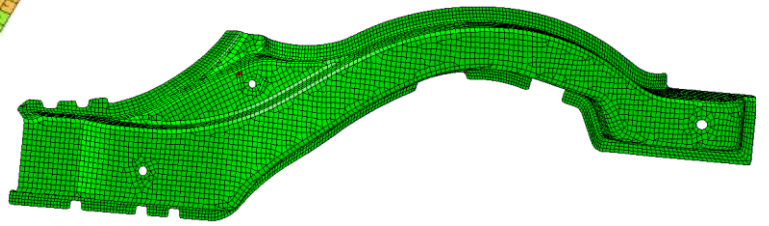
Goals:

- Parts with advanced maturity design
- Take into account manufacturing constraints:
  - Real fiber orientations
  - Check Drapability
- More complex analysis
- Ply drop-off and stacking defined



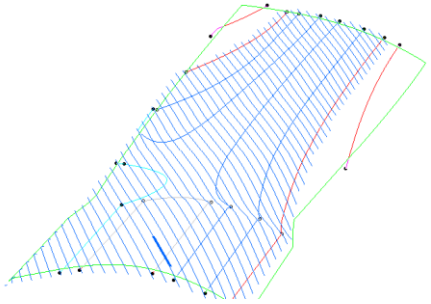


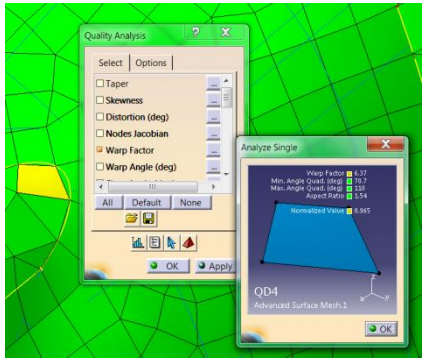
- Advanced meshing and simulations
  - Static linear or non linear
  - Thermal analysis
  - Pre-stresses static.
  - multi-step with complex loading.



Software :

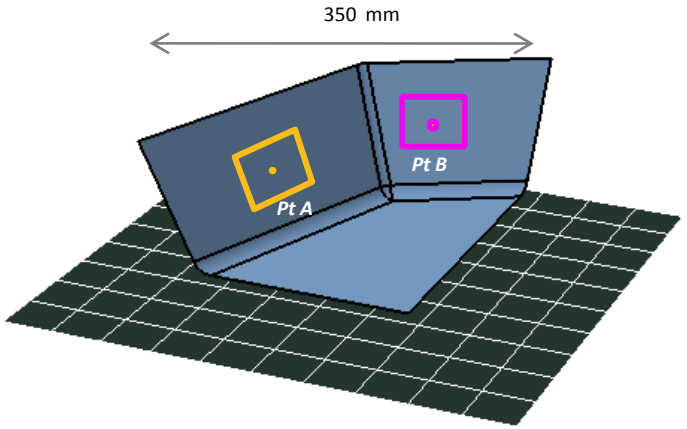
- Design: **Catia**
- Simulation : **Catia** Analysis (FMS-FMD-ANL-ATH) or ABAQUS
- Optimization: **Catia** Optimizer or ISIGHT

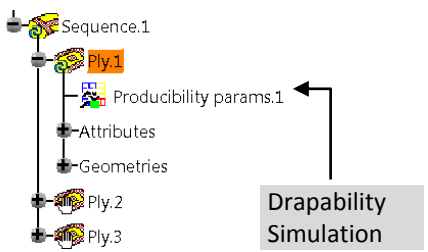


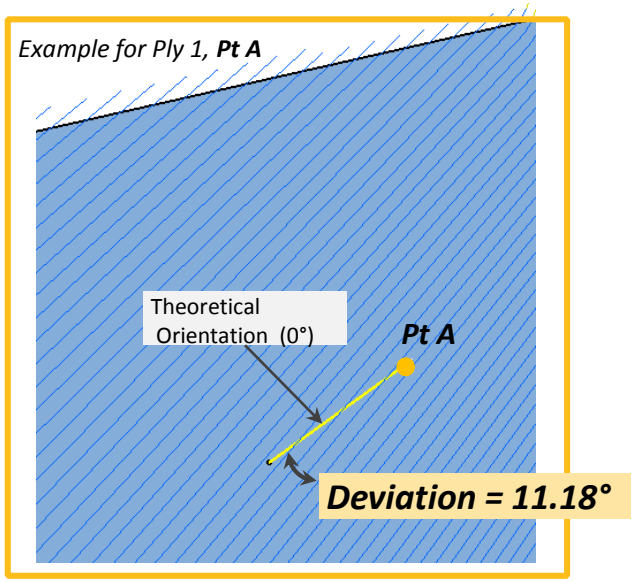


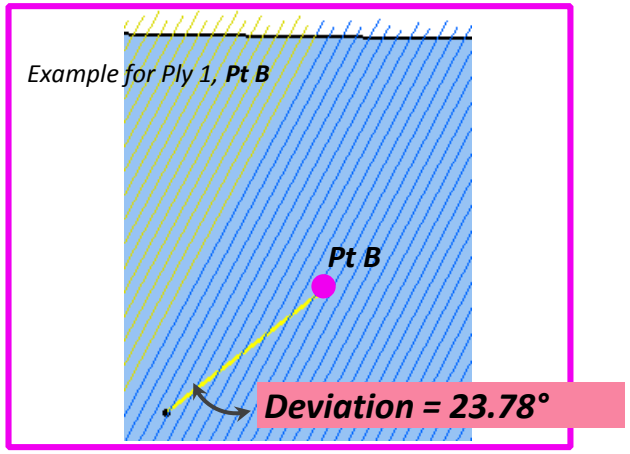
COMPOSITE SIMULATION
Detailled simulation – Draping

Taking in account real fiber orientation in simulation is so important ?

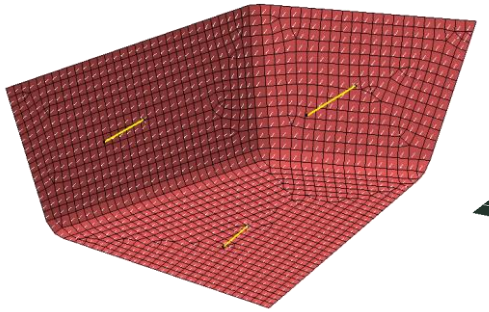


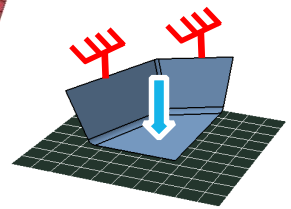


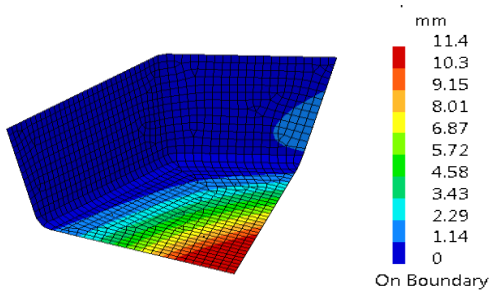




Real Orientation

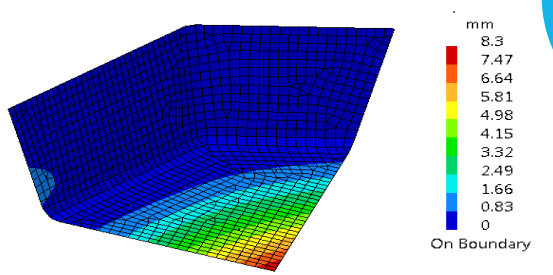






With theoretical orientations

ERROR 27%



With real orientations

AGENDA

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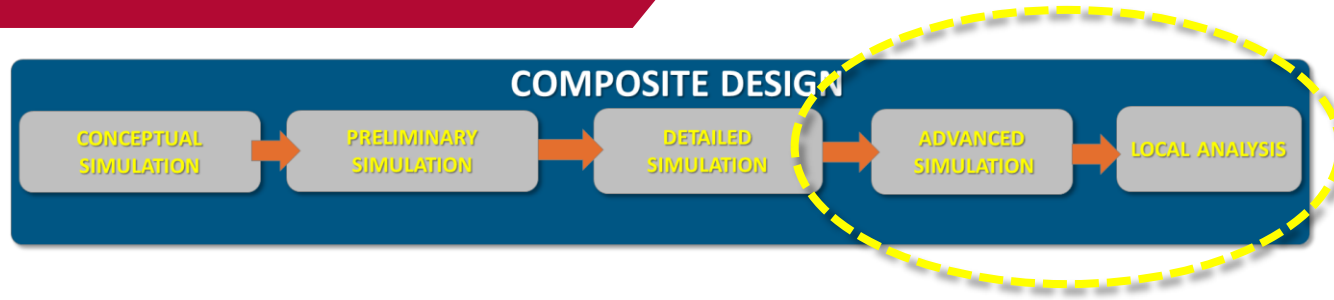
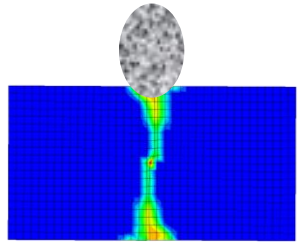
6. KEONYS OFFER

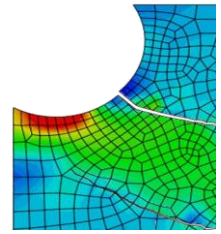
5 COMPOSITE SIMULATION
Advanced simulation – Overview

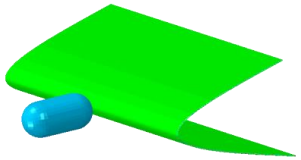


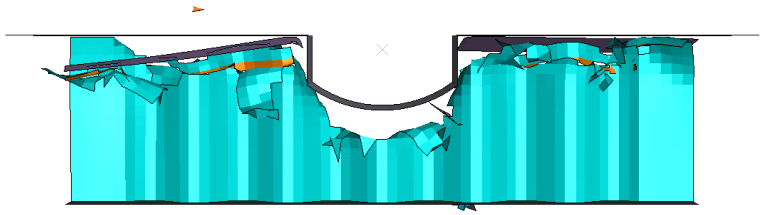
Goals:

- Parts with Final maturity design
- Take into account manufacturing constraints:
  - Real fiber orientations
  - Check Drapability
- Advanced analysis:
  - Buckling NL
  - Crash (Explicit)
  - Contact
  - Failure and damage analysis
    - VCCT, XFEM, Hashing, cohesive elements….
  - Multiphysics:
    - SPH, CEL, FSI



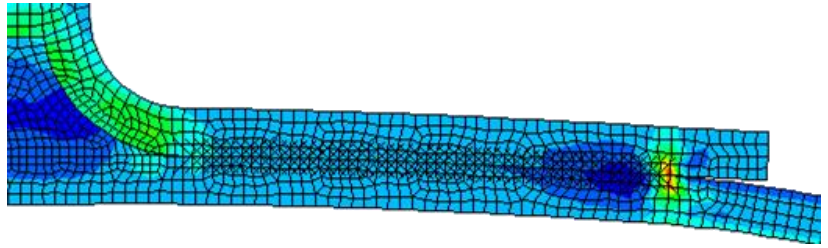






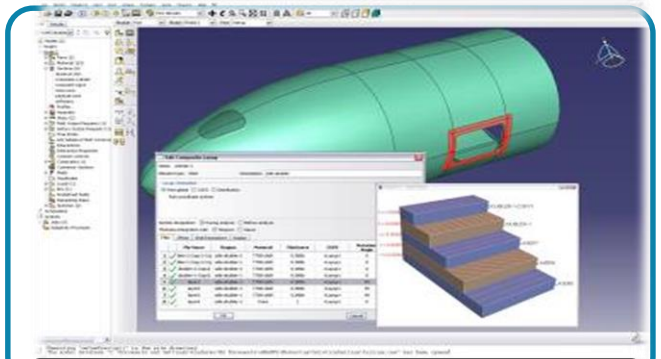
Software :

- Design: **Catia**
- Simulation : ABAQUS with Composite Link and CMA
- Optimization: ISIGHT



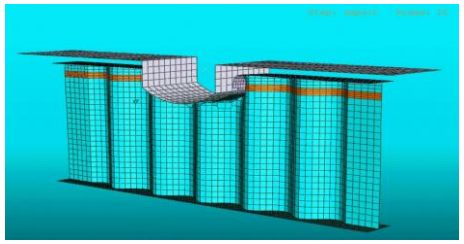
ABAQUS
Best in class solution

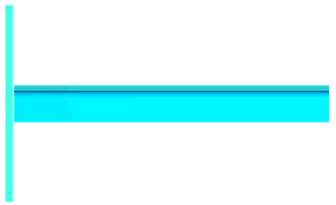
- Advanced technology for realistic composite simulation
  - Ply modeling
  - Draping
  - Hashin damage
  - Cohesive elements
  - Subroutines and (V)UMAT
  - Material elements
  - Contact
  - VCCT – XFEM
  - SPH
  - CEL
  - ….



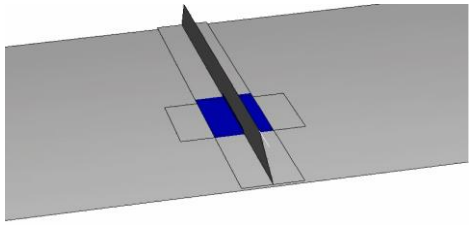
Composites Pre / Post in Abaqus/CAE

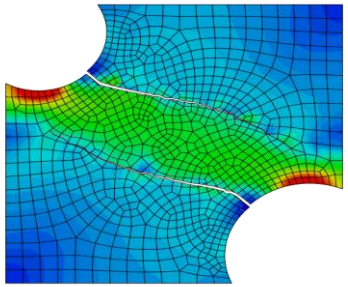
Composites Crush

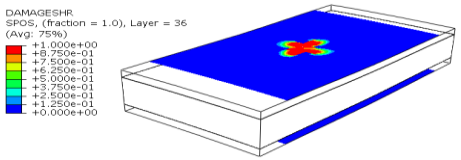




Delamination and Crack Propagation (VCCT- XFEM)

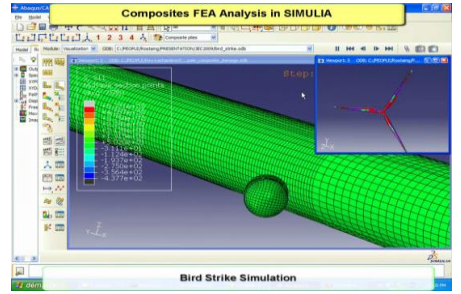






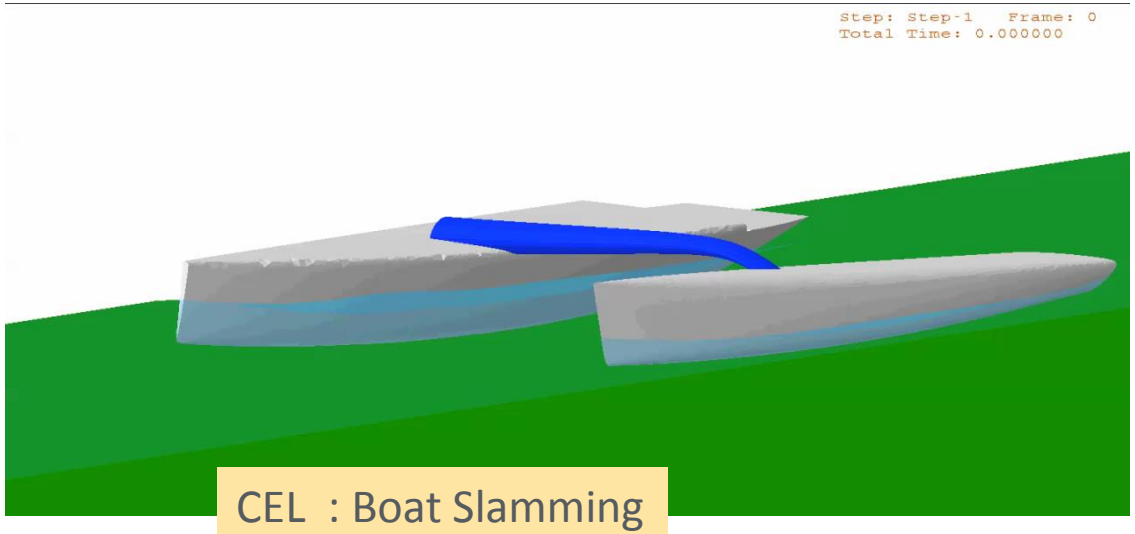
Barely visible impacts

Ballistic Impact

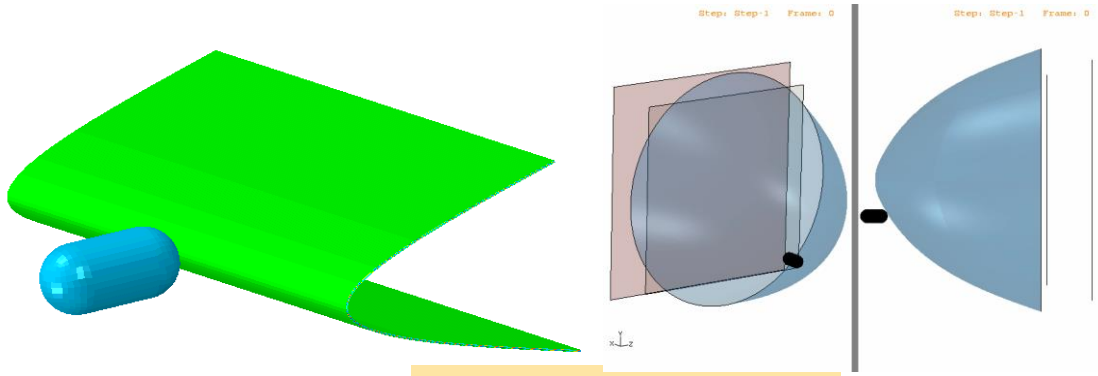


COMPOSITE SIMULATION
Advanced simulation – Abaqus

ADVANCED ANALYSIS

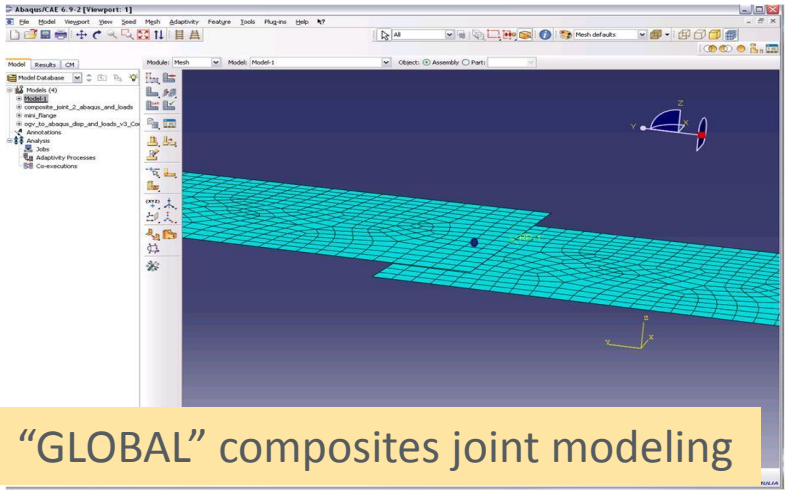


CEL : Boat Slamming

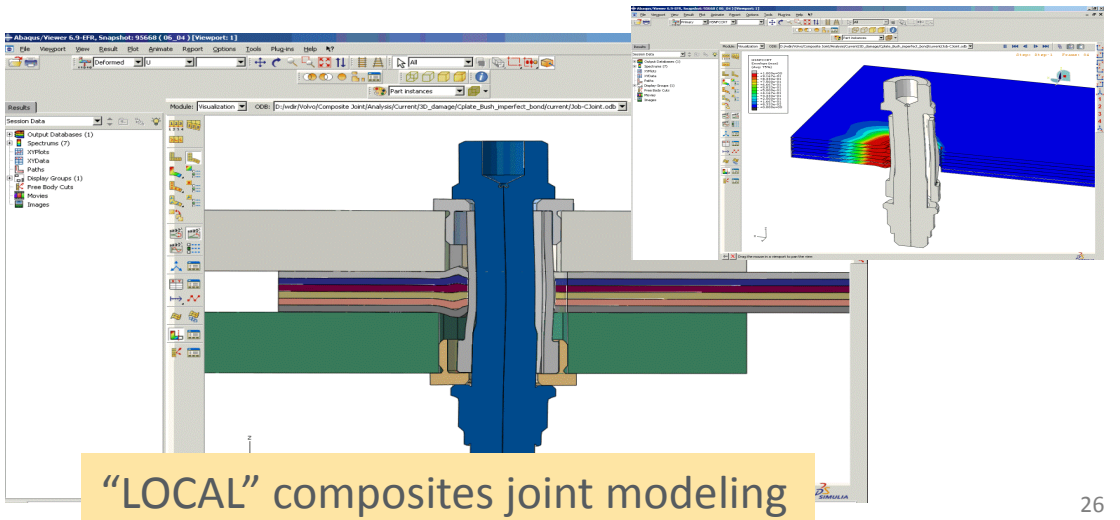


Impact and damage

LOCAL MODELING

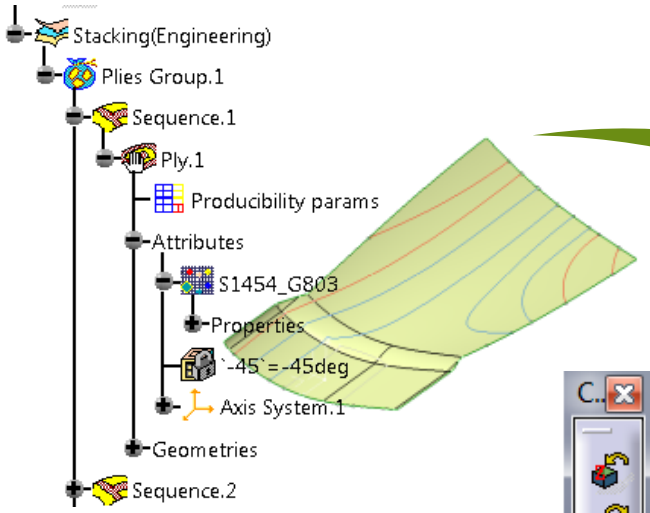


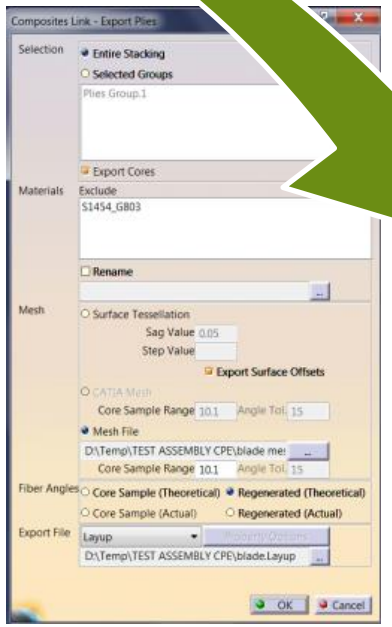
“GLOBAL” composites joint modeling

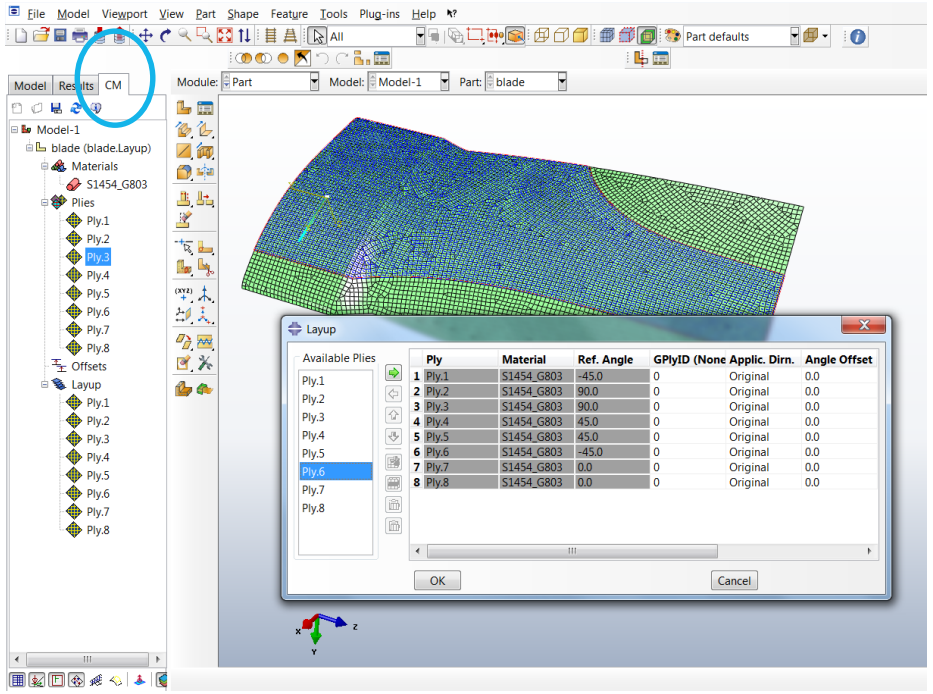


“LOCAL” composites joint modeling

COMPOSITE SIMULATION
Advanced simulation – Draping into Abaqus/CAE





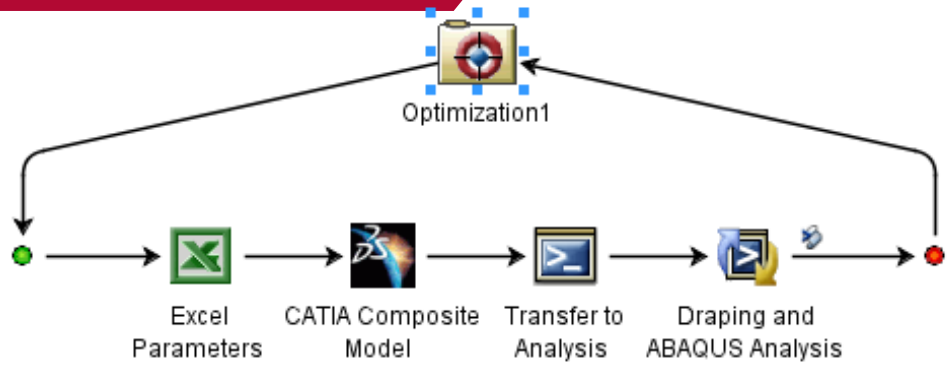


Composite Link and Composite Modeler for Abaqus allows a bi-directionnal link between CATIA Composite and ABAQUS.

COMPOSITE SIMULATION

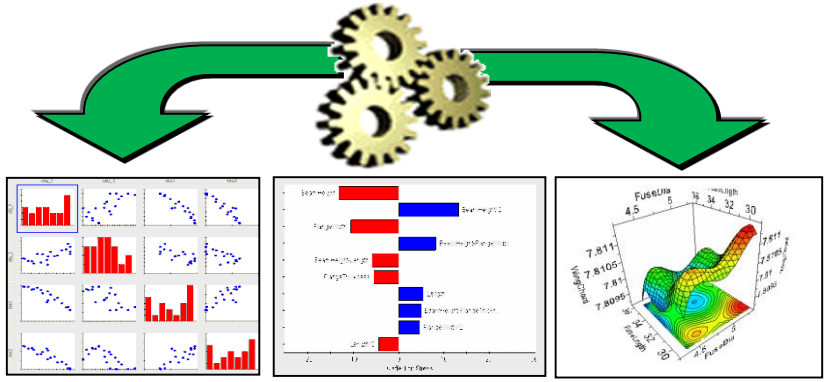
Advanced simulation – Isight Technology Overview

COMBINING THE POWER OF CATIA, ABAQUS and ISIGHT

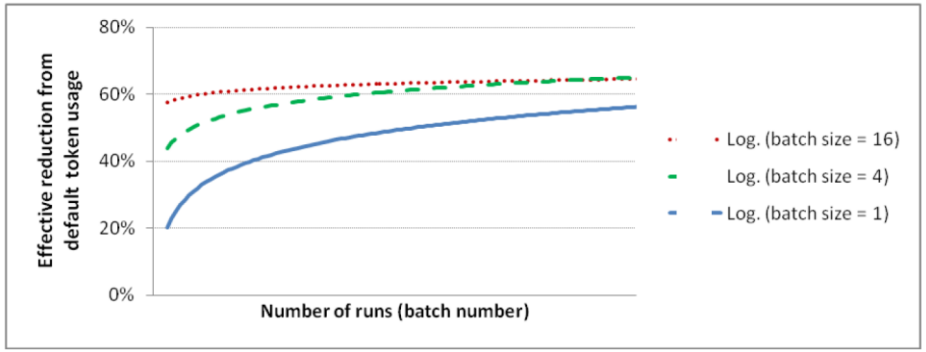


ISIGHT

- Integration & execution of current tools
- Full suite of powerful exploration tools
  - Optimization
  - Design for Six Sigma
  - Design of Experiments
  - Reliability and Robustness
  - Approximation models
  - Nested exploration / MDO



- Interactive visualization to analyze alternatives
- **Abaqus jobs controlled by Isight use less tokens !**



AGENDA

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6 KEONYS OFFER
Training and Support: Solution deployement

DEPLOY COMPOSITE SOLUTION

DRAPING SIMULATION

SYMULAYT TRAINING

- REAL FIBER ORIENTATION
- ADVANCED FIBER MODELER (AFM)

COMPOSITE IN ABAQUS

ADVANCED COMPOSITE ABAQUS
- COMPOSITE LAYUPS USING ABAQUS/CAE
- SANDWICH COMPOSITE STRUCTURES
- PROGRESSIVE DAMAGE AND FAILURE
- DELAMINATION OF COMPOSITE STRUCTURES

LINK DRAPING TO ABAQUS ABAQUS
- ABAQUS LINK WITH CATIA (CL5)
- COMPOSITE MODELER FOR ABAQUS (CMA)

SIMULATE COMPOSITE WITH CATIA

PRELIMINARY DESIGN WITH CATIA ANALYSIS
- INTRODUCTION TO CATIA ANALYSIS
- INTRODUCTION TO GPS, GAS, EST, FMS CATIA ANALYSIS MODULES
- PRELIMINARY ANLAYSIS DESIGN
  - CPE TO ANALYSIS
  - XML METHODS FOR FAST ITERATION

DESIGN COMPOSITE WITH CATIA

SETUP COMPOSITE DESIGN IN CATIA CPE
- PLY, ZONE AND GRID BASED METHOD

SETUP COMPOSITE MANUFACTURING IN CATIA CPM
- ANALYSE PRODUCIBILITY
- GENERATE PLY BOOK.

COMPOSITE THEORY

UNDERSTANDING COMPOSITES CHALLENGES AND BEHAVIOR

MATERIAL PROPERTIES
COMPOSITE PROCESS
ABD MATRIX
INTRODUCTION TO COMPOSITE FEM MODELISATION IN CATIA OR ABAQUS

PROJECT COACHING

DEFINE METHODOLOGY
Create Best Practices
Methods
DEPLOY METHODS
Engineering/ methods
/manufacturing

INDUSTRIAL PILOT
Coaching and Support
for each industrial step

DEFINE INDUSTRIAL PILOT
Define parts
for the « end to end » project
Plan pilot respect to the
industrial calendar

AUDIT
project and process classifications
Define priorities

6 CONCLUSION

- DASSAULT SYSTEMES OFFERS BEST IN CLAS TECHNOLOGY FOR DESIGN COMPOSITE:
  - ALLOW PRODUCT DESIGN? VIRTUAL TESTING AND ENSURE MANUFACTURABILITY
  - END TO END INTEGRATED ROCESS
  - SCALABLE SOLUTIONS
  - 3D EXPERIENCE WILL EXTEND A MORE INTEGRATED SOLUTION BY EMBEDDING CATIA, ABAQUS and ISIGHT

- CORRECT SIMULATION TOOLS NEED TO BE USED SIMULATION AT THE GOOD TIME:
  - IT'S NOT NECESSARY TO USED ADVANCED SOLVER AT EARLY DESIGN STAGE

- KEONYS WILL HELP YOU TO DEPLOY THE FULL COMPOSITE SOLUTION

THANK YOU