CATIA
Composites Part Design to Manufacturing Process

Technical Overview Presentation

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Usual Challenges of Composites

- Long cycle time
- Cost (Raw Materials, Affordability)
- Lots of data to manage
- Lots of tedious geometrical tasks
- Lack of Mock-up Integration
- Lack of Concurrent Engineering
- Trial-and-Error in the Shop Floor
- No integration between Analysis and Design
- Hard to simulate the global behavior of the Part
- Lack of ability to predict manufacturing issues upfront
- No Integration with highly specialized manufacturing applications
- Environmental Issues (Regulations, Biodegradability, Recyclability, etc...)
CATIA PLM V5 Composites Solutions

- **End-to-end Composites Solution to address Industry challenges**
  - Native V5 Composites Solution from Design to Analysis and Manufacturing
  - Feature-based, specification-driven, dedicated Solution integrated to CATIA V5
CATIA Composites

- Modular and flexible packaging:
  - A “all-in-one” CATIA Composites configuration (CD3) including a full mechanical seat plus the CATIA Composites Part Design to Manufacturing (CPD) product
  - To respond to specific roles, two subset Composites products, CATIA Composites Engineering (CPE) and CATIA Composites Manufacturing (CPM)

**CPD scope: all in one solution for composite design**

**CATIA Composites Engineering 2** dedicated to preliminary and engineering detailed design

**CATIA Composites Design for Manufacturing 2** dedicated to manufacturing preparation
CATIA - Composites Engineering (CPE)

Productive process oriented environment dedicated from preliminary to engineering detailed design of composite parts

Benefits

- Fully integrated in the V5 environment
- Shortened part composite part design time period (up to ten times faster)
- **Fast plies generation from zones** (automatic management of the ply staggering and stacking rules)
- **Design right first time** by taking into account manufacturing constraints early in the design phase
- **Easy concurrent work** thanks to true collaborative composites engineering environment

Capabilities

- **Easy to use zone** (geometry and laminate) and transition zones modeling definition
- Powerful ply modeling tools based on 3D features
- Complex geometrical configuration support
- **Solid generation from zones and plies** (exact solid)
- **Complete composites inspection tools** (core sample and numerical analysis, ply table..)
- **Best-in-class fiber simulation** tools for early manufacturability assessment
- **Easy know-how and composites design features sharing and merging**
CATIA - Composites Manufacturing (CPM)

Productive process oriented environment dedicated to manufacturing detailed design of composite parts

Benefits

- Fully integrated in the V5 environment
- **Design right first time** by taking into account manufacturing constraints early in the design phase
- Easy collaboration between design and manufacturing offices enabling concurrent engineering
- Strong manufacturing partnerships ensure that composites solution can be used by any company, regardless of the manufacturing process and machine providers

Capabilities

- Dedicated manufacturing part modeling capabilities such as manufacturing shell swapping, material excess definition and 3D multi-splice
- **Best-in-class fiber simulation and flattening tools** for early assessment of manufacturability
- Effective manufacturing export capabilities and automatic shop floor documentation
- Powerful synchronization/collaboration mechanisms with engineering detailed design

One system to cover overall composite manufacturing along with DS leading partners
CATIA PLM V5 Composites Solutions (2)

- **CAA V5 Market-leading Partners Expertise to complement the V5 Composites Offering**
  - **Hand Lay-up Solution**: Advanced Fiber Modeler (Simulayt), Quickform (ESI), TruLaserView (Magestic), TruNest (Magestic), Composite Link (Simulayt)
  - **RTM Solution**: PAM-RTM (ESI Group)
  - **Tape Laying / Fiber Placement Solution**: Tormay (Mtorres), Tapelay (CIMPA), iCPS (Ingersoll), ACE V2 (Cincinnati)
Product Lifecycle Management

Improve Productivity

- Preliminary design
- Engineering detailed design
- Manufacturing preparation
- Downstream Manufacturing

Composites Design Tasks

- Early Conceptual modeling of Composites Parts
- Dedicated Composite Data Structure
- Specification-driven, feature-based Design Solution
- Automatic plies definition from zones

Composites Manufacturing Tasks

- Solid and IML generation from zones & plies
- Compliance with MBD and Engineering drawings
- Full Associativity for quick Design Change
- Concurrent engineering between Design & Mfg
- Feature-based Manufacturing Solution
- Reliable Fiber simulation and flat patterns
- Automatic shopfloor documentation
- Integration to Shopfloor systems

Productivity Gain

- Reduce initial design time by 40%
- Cut design modifications cycle by 60%
- Cut manufacturing design time in half
- Reduce lay-up time by 70%
Facilitate Innovation

- Eliminate basic repetitive design work to focus more on innovation
  - Specification-driven process and feature-based approach help reduce tedious tasks
  - Add knowledge-based engineering to your design to capitalize on your know-how: Design rules and checks, parameters and formulas, Design optimization,…
  - Capture your design intent into Automation Templates and reuse this knowledge across the families of parts or features: User Defined Features, Powercopy, Part Templates,…
  - Benefit from the openness of the Composites architecture to further customize the process (CAA V5, VB)

Reduce design cycle by 200% using Templates
Cut Trades Studies time by half
Integrate the Company know-how to improve competitiveness
Apply Company Standards
Ensure Manufacturability, Quality

- Eliminate the Trial & Error and costly change orders
  - Early incorporation of Manufacturing constraints
  - Upfront Simulation of Manufacturing Procedures (Lay-up, Laser Projection, NC, Resin Injection …)
  - Direct Integration with the Shop Floor systems

- Optimize Parts Quality
  - Full associativity from Design to Manufacturing ensures data consistency
  - Integrated FEA properties transfer helps avoid errors and shortens optimization cycles to eliminate overdesign
  - Reliable Producibility Analysis and Flat Patterns Generation significantly reduce material waste

Decrease the number of change orders by over 90%
Cut material waste by 35%
Optimize Weight and Strength
CATIA - Composites Design (CPE)

**Preliminary Design**

**Key Features:**
- Composite Parameters definition: V5 Catalog of Composite materials, Fiber Directions
- Zones definition: Structural Zones Geometry, Laminate Import, Transition Zones definition for drop-off areas
- Design Checks: Connection Generator
- Solid & Top Surface from Zones

**Key Benefits:**
- Conceptual Definition very early in the lifecycle of the program
- IML generation for concurrent Engineering on sub-structures
- Ability to generate intermediate surfaces needed as support for further tasks (ex: core creation for core stiffened panel)
- Solid generation for DMU, FTA, Drafting purpose
- Link the Composite Design to FEA at the Preliminary Design stage
CATIA - Composites Design (CPE)

From Conceptual to Detailed Design

Key Features:
- Stack-up file export: Stacking Order optimization, Logical zones combinations
- Plies creation from Zones with Tapers: Direct Staggered definition
- Plies with Staggering value: Assisted staggering of Plies, Staggering Report, Dedicated features, Variable drop-off, Plies Crossing

Key Benefits:
- Automated plies generation from Zones
- Staggered definition of plies using tapers, or user-defined staggering with report and dedicated features
CATIA - Composites Design (CPE)

Engineering Detailed Design

Key Features:
- Manual Plies Groups, Plies (Adhesive, Bonding strips) and Core Creation
- Design Checks: Core Sampling, Numerical Analysis, Stacking Table
- Export to external Files
- Exact Solid and Smooth IML from Plies
- Exploded Surfaces

Key Benefits:
- Second entry-level in the Composites process for non-structural entities
- Dedicated Features for Data Integrity and Design Validation
- Refined Solid from Plies for DMU
- Smooth IML for Tooling and Relational Design
CATIA – Mechanical Design

**Engineering Drawings**

- **Key Features:**
  - Drawing views and section cuts creation
  - Generative View style options to visualize solids, plies boundaries and/or exploded surfaces, flat patterns and Export to external Files
  - Annotation Templates for Plies and Cut-pieces labelling
  - Embedded Sheets for Ply Table, Core samples, Numerical Analysis, etc…

- **Key Benefits:**
  - Associativity of 2D Composites Drawings with 3D Design
  - Dedicated Labeling of Composites entities
CATIA – Product Review (DMU)

Enabling Model Based Definition

**Key Features:**
- Browsing the complete Stacking data structure: List of Plies Groups, Plies, Cores with associated attributes
- Visualization of all Composites Geometries, Exploded Surfaces, Solids and IMLs
- 3D Dynamic Sectionning, On Solids and / or Exploded Plies Surfaces
- 3D FTA Annotations

**Key Benefits**
- Composites Data can be visualized from a Low-end-Viewer as V5 native data by without a Composites license.
- Seamless Communication with cross-functional Disciplines such as Stress, NC or Tooling.
CATIA – Structural Analysis (GPS/EST)

Composite Stress Analysis

Key Features:
- Associative Meshing & Pre-processing in CATIA V5
- Composite Properties Import, from Zones or Plies
- Integrated Elfini Solving & Post-processing: Deformation, Displacements, Stress, Strain, etc...
- Create Reports and optimize the Part if needed
- LMS Virtual Lab add-on for Nastran deck creation
- Simulayt Composite Link bridge to Abaqus solver

Key Benefits:
- Automatic Composites Properties Transfer from the Design model to the mesh, at Zones level for Pre-dimensionning or at Plies level for Design certification
- Link with Elfini, Nastran and Abaqus solvers
CATIA - Composites Manufacturing (CPM)
Manufacturing Preparation

- **Key Features**
  - Swapping feature to account for Spring Back
  - Material Excess and Extended EOP
  - Splicing feature for Material Roll Width with butt-splice and No-splice areas definition

- **Key Benefits**
  - Early incorporation of Manufacturing constraints
  - Split between Engineering & Manufacturing Parts provides easier Data Management
  - Concurrent Engineering between teams improves Productivity
CATIA - Composites Manufacturing (CPM)

Key Features
- Dedicated Producibility Analysis capability
- Several display modes: Shear Deformation and Fiber Deviation/Rotation
- Several Propagation types: minimum distortion and symmetry
- Thickness Update accounts for draping sequence
- User Defined Darting features
- Inspection Tool
- Plies Flattening
- 2D/3D and 3D/2D Geometry Transfer

Key Benefits
- Early assessment of Fiber Deformations and Deviations in plies
- Reliable Flat Patterns generation eliminates trial and error in the shop floor
CATIA - Composites Manufacturing
Key partnerships for Fiber Simulation / Flattening

**Advanced Fiber Modeler (AFM)**
- **Key Features**:
  - Seed Curve and Order of Drape specification
  - Optimized propagation types
  - Instant flat patterns display
  - Accounts for surface topology, draping sequence and darts
- **Key Benefits**:
  - Cutting-edge add-on for advanced Producibility and Flattening, fully integrated to CATIA V5
  - Simulates fabric draping on complex surfaces

**Pam-Quickform**
- **Key Features**:
  - Unique Unidirectional Simulation with control of maximum shearing angle and spreading
  - Seed Curve specification
  - Instant flat patterns display
- **Key Benefits**:
  - Dedicated Bidirectional and Unidirectional Fiber Simulation and Flattening Solution, fully integrated to CATIA V5
Key Features

- 2D Ply Book
- 3D Dynamic Ply Book to support 3D Master
- Neutral DXF and IGES export of all 2D Flat Patterns and 3D Geometry
- CAA V5 TruNest (Majestic Systems)
- CAA V5 Panogen (CIMPA)
- CAA V5 TruLaserView (Majestic Systems)

Key Benefits

- Automatic 2D and 3D Shopfloor documentation
- Neutral Export to the Shop floor systems
- Dedicated CAA V5 Partner applications for Nesting/Cutting and Laser Projection to address major production systems
CATIA - Composites Manufacturing
Downstream Manufacturing for Automated Processes

- **Key Features**
  - CAA V5 PAM-RTM (ESI Group) to predict the filling of a mold during RTM process and control injection parameters such as time, pressure or temperature.
  - Dedicated Solutions to address the main Tape Laying and Fiber Placement machines Providers:
    - **Integrated CAA V5 Pan-PRT Solution (CIMPA) for Tapes Design & Manufacturing**
    - **Integrated CAA V5 TORLAY (MTorres)**
    - **Integrated CAA V5 iCPS (Ingersoll)**
    - **CAA V5 ACE V2 Interface (Cincinnati)**

- **Key Benefits**
  - V5 Integrated Resin Injection Simulation Solution
  - Integration with highly specialized Manufacturing Applications to address Automated Composites Processes
CATIA - Manufacturing
Tooling, NC Machining & Digital Simulation

- Key Features
  - CATIA V5 Tooling Solutions
  - CATIA V5 NC programming and Machining from 2 to 5 axis for Trimming, Drilling, Cutting operations
  - DELMIA V5 Digital Simulation of processes
    - Assembly Process Simulation
    - Laser Projection Simulation
    - Tape Laying / Fiber Placement simulation

- Key Benefits
  - Unified Platform from Design to Tooling and NC Machining
  - Composites Process optimization in context of Product Definition and Resources
  - Digital Simulation of all Composites Processes
Any Questions?