get it right®

ESI Group

пионер и мировой лидер в области виртуального прототипирования

MECAS ESI s.r.o.

Stanislav Vondracek

Присутствие ESI на мировом рынке

- **95 M€** turnover (2011FY)
- over **1000 specialists** (31 January 2013)
- **17** subsidiaries
- **25** agents

Paris, France

Eschborn, Germany

Pilsen, Czech Republic

San Diego, CA, USA

Beijing, China

Tokyo, Japan

get it right®

Engineering Simulation for Industry

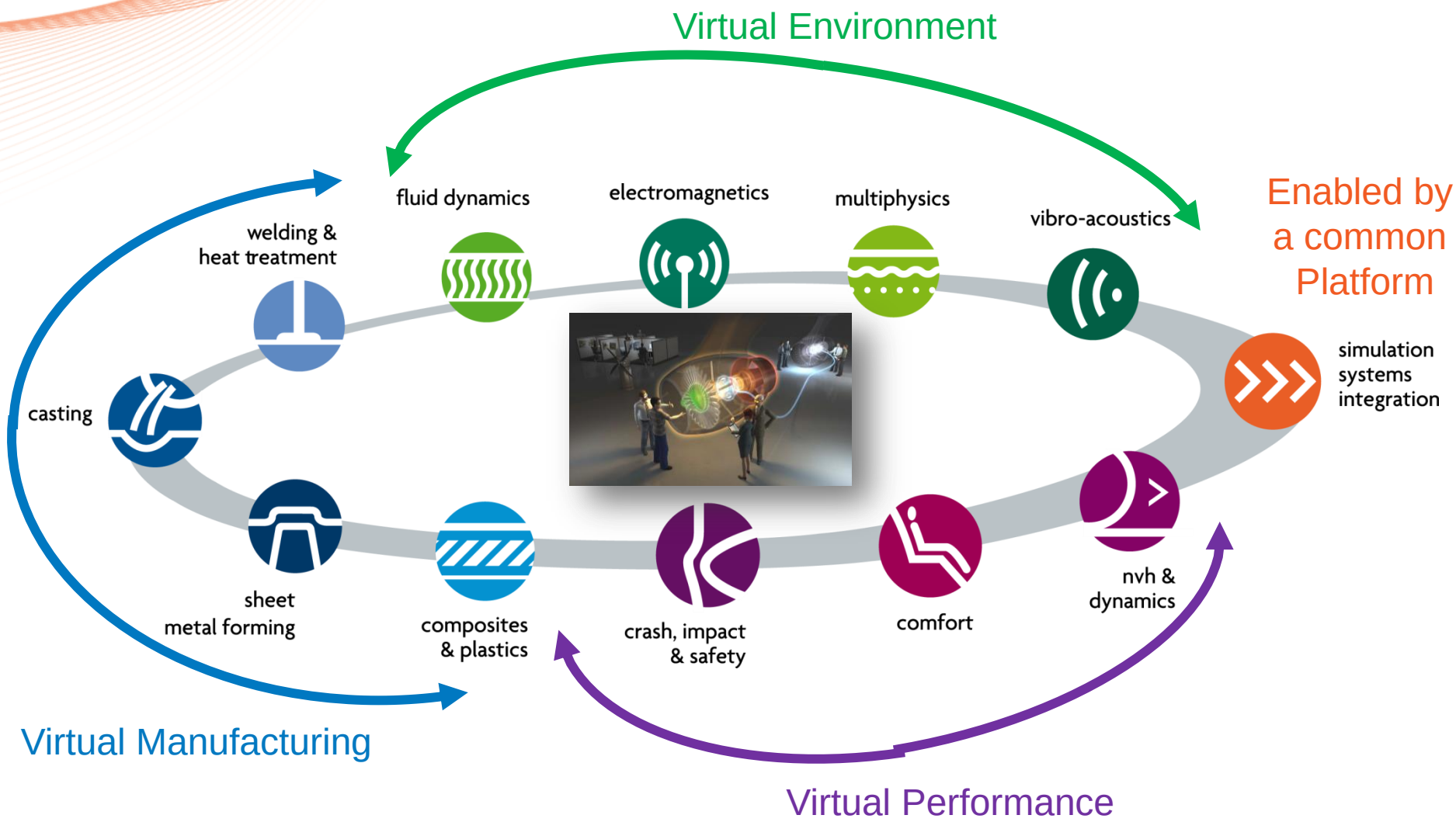
Инженерное моделирование для промышленности

с учетом международной системы управления качеством ISO 9001:2001

➔ **Быть ведущим мировым игроком в области MCAE для**

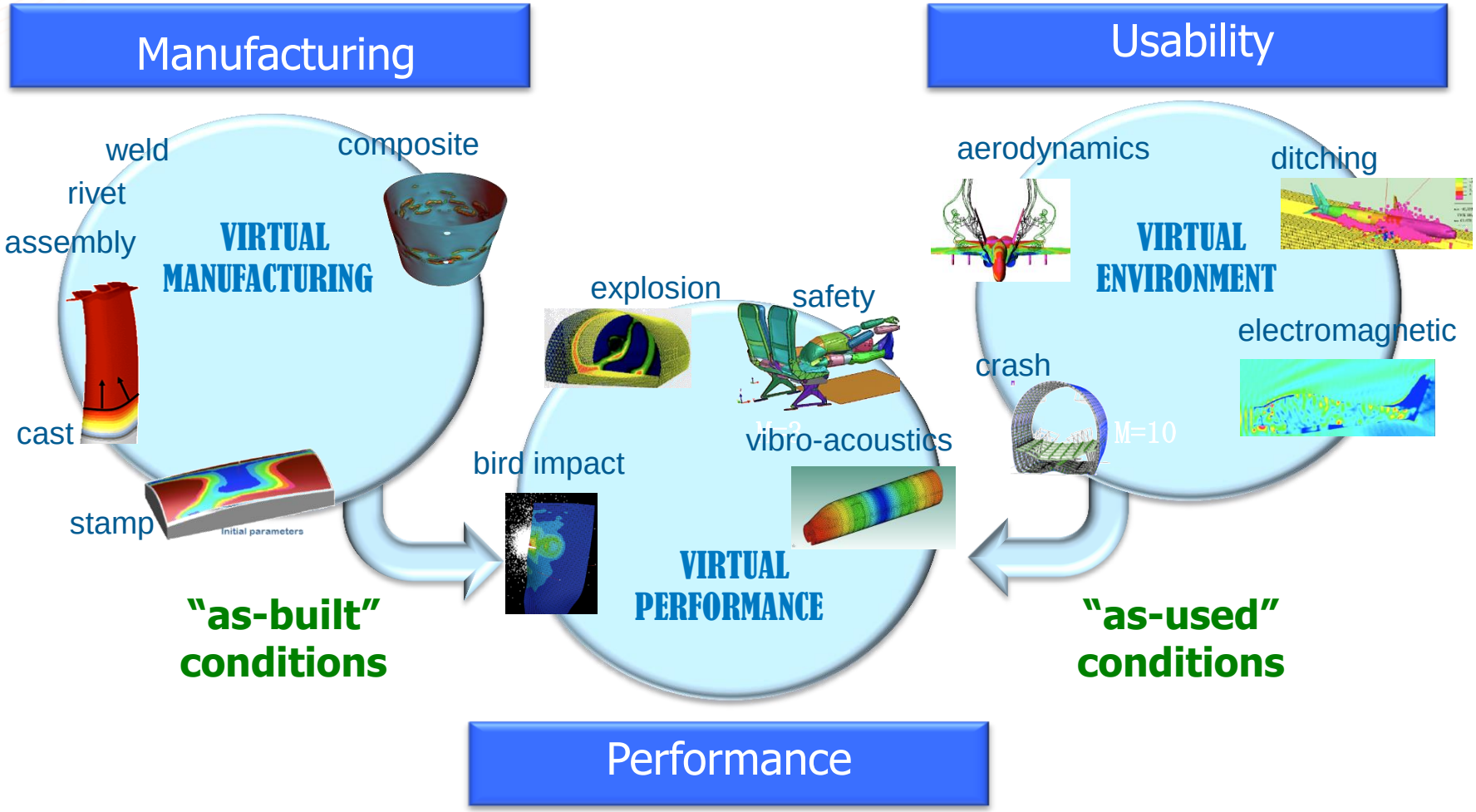
‘реалистичного моделирования‘

ESI trade solutions



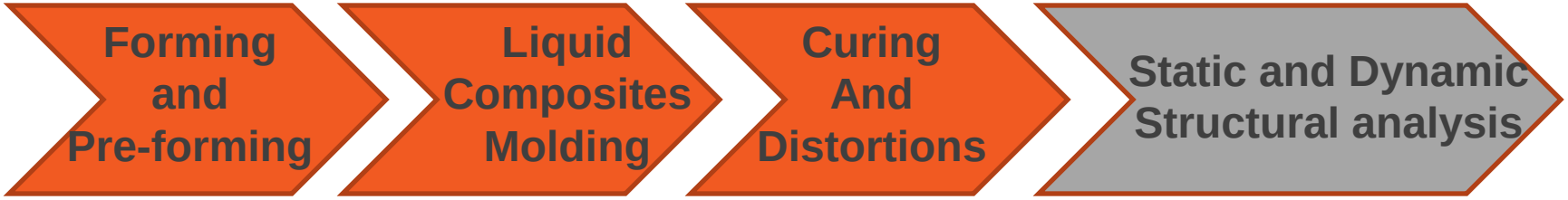
Aeronautics Engineering

- **End to End Modeling: include manufacturing effects in model**



Manufacturing of composites part

ESI Composites Suite



Pre-forming and forming simulation

- Simulation can evaluate
  - Different forming strategies:
    - Stamping, diaphragm (single or double) forming, thermoforming
    - Clamping conditions, process parameters (tool velocity, temperature, pressure…)

- Through the prediction of
  - Wrinkling
  - Bridging
  - Thickness (laminate thickness, thickness per ply)
  - Optimum flat pattern
  - Final fiber orientation
  - …

Liquid Composites Molding Simulation

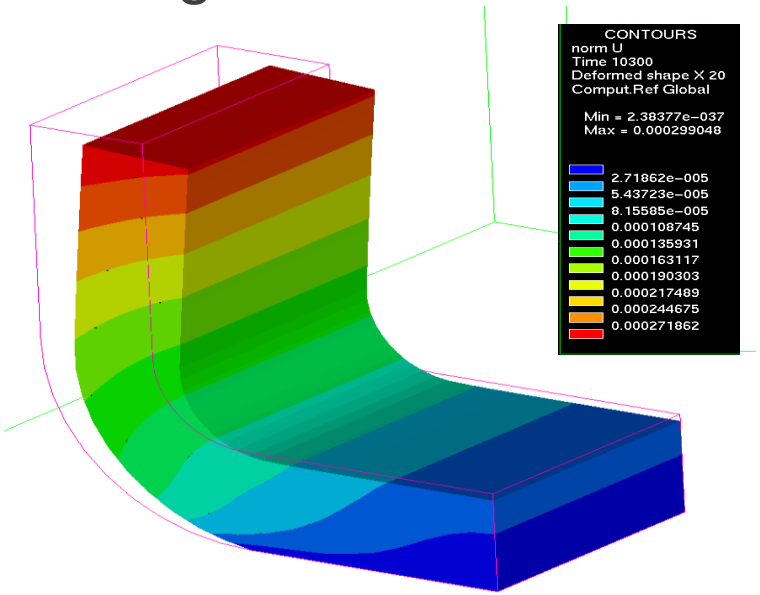
Forming and Pre-forming → **Liquid Composites Molding** → Curing And Distortions → Static and Dynamic Structural analysis

- **Simulation helps to define and optimize**
  - Injection strategy (**RTM, VACUUM INFUSION, VARTM**…)
  - Injection pressure and flow rate
  - Injection gates, vents and vacuum ports location
  - Molding temperature
  - Flow media
- **Through the prediction of**
  - Dry spots, porosity and micro voids
  - Filling and curing times
  - Flow front velocity / Fiber washing
  - Pressure in the mold
- **Taking into account**
  - Fiber angle variation (permeability variation) of the preform

DISTORTION SIMULATION (AUTOCLAVE)

ACE+: CFD analysis

SYSPLY: Curing and distortion analysis



Autoclave process and induced distortions

Forming and Pre-forming → Liquid Composites Molding → **Curing And Distortions** → Static and Dynamic Structural analysis

Draping

Curing

Demolding

Factor known to affect shape distortions and residual stresses

- Laminate lay-up
- Draping effect

- Thermal expansion
- Chemical shrinkage
- Cure temperature
- Mould thermal expansion

Defect
- Warpage
- Delamination

Internal stresses generation

Local material properties modification

Stress release

The specific issues with Autoclave

- Design
  - Selection of the Autoclave
  - Sizing of the Autoclave (diameter, length, loading space, etc)
  - Fixing of performance parameters (ventilator of the heat exchanger)
- Part Manufacturing
  - Autoclave loading: how many & how to install the tooling and the parts inside the Autoclave
  - Cycle definition and optimization: how to ensure quality and wanted thickness

→ Lots of interacting parameters and physics

STRUCTURAL ANALYSIS in order to…

- Save cost by reaching the expected performance with the first real prototype: reach the target on the first shot
- Quickly evaluate multiple designs
- Manage components fatigue

Examples:

✓Dynamic Impact analysis

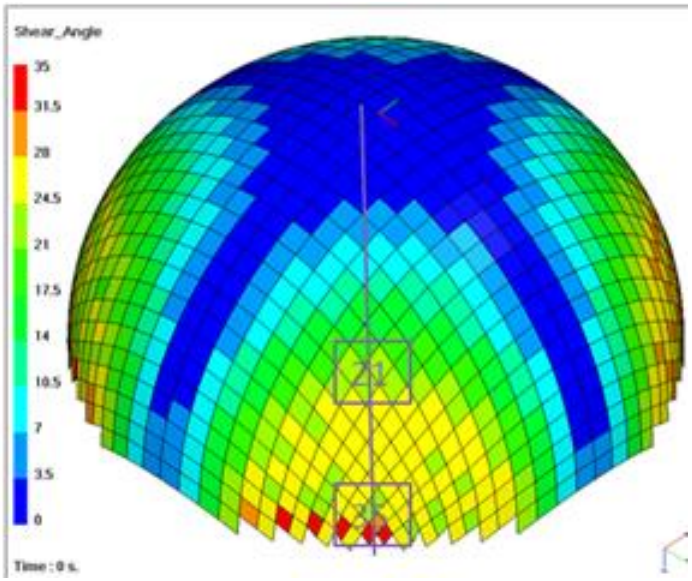
✓Failure analysis

✓Static loading analysis

Aero-space composite examples

Example of Antenna Reflector

TAPE LAYING
AND DISTORTIONS

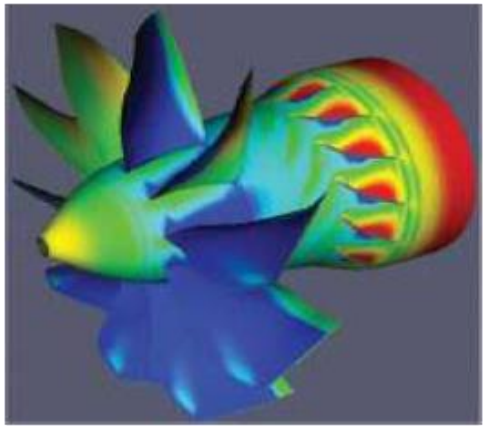


Engineering Research & Flow Technology for Composites

Making tomorrow's engines come true

- CFAN, Texas: International, joint venture Snecma & GE Motors
- **LEAP56**™ "*Leading Edge Aviation Propulsion*", new engine for a demanding market
- New-generation composite fan blades made by **RTM** ("Resin Transfer Molding")

LEAP56™ engine



Flow simulation

Composite fan blade

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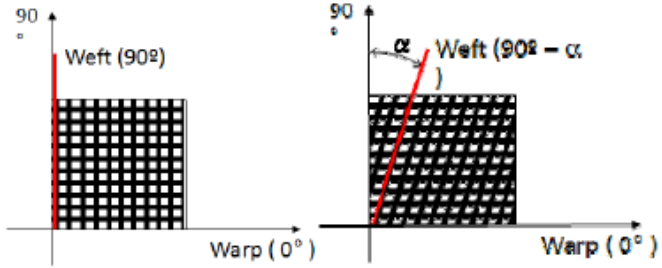
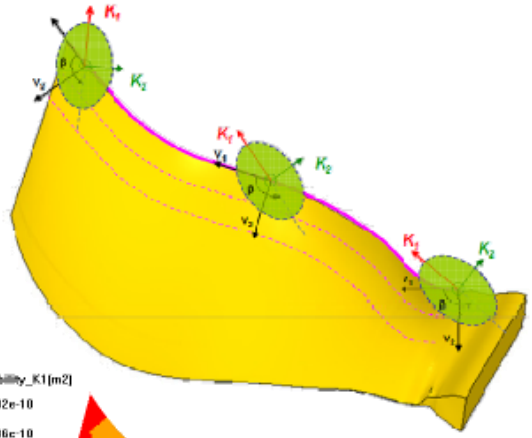
Engineering
Research &
Flow
Technology for Composites

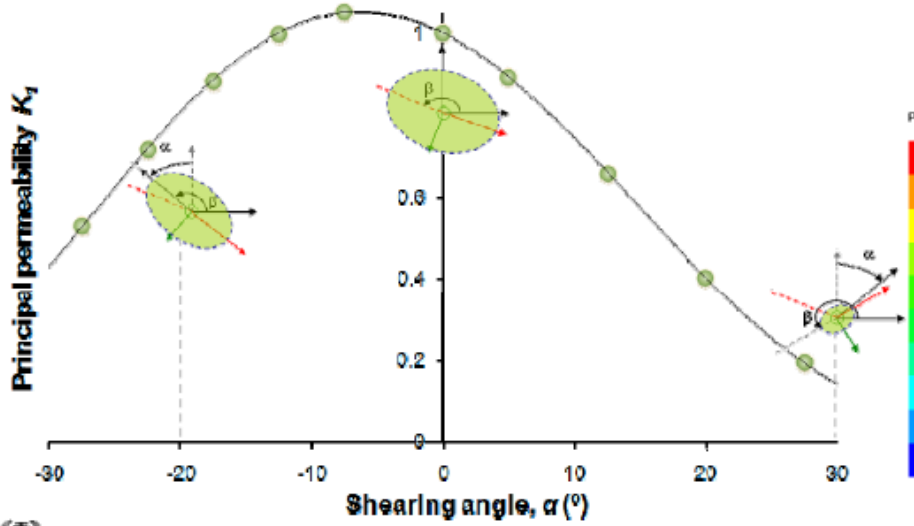
Fibers permeability

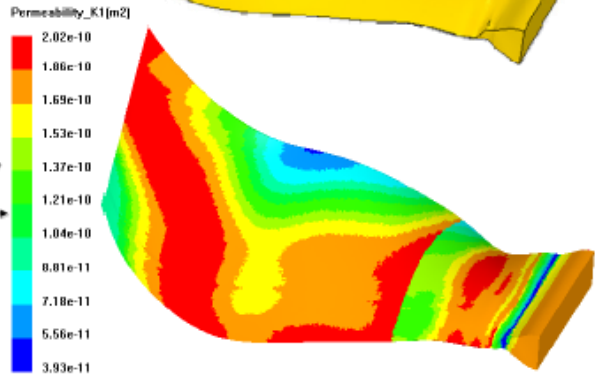
Draping of fabric



Draping of blade reinforcement



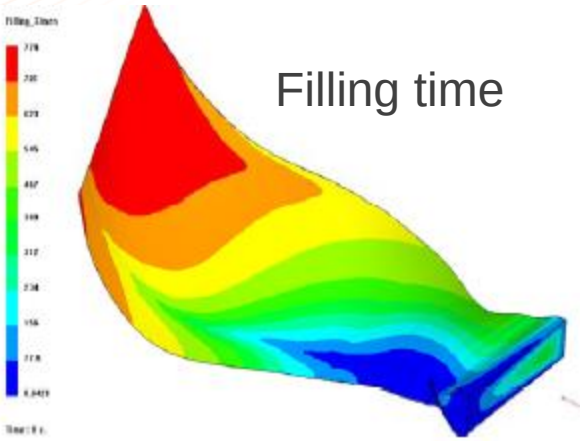


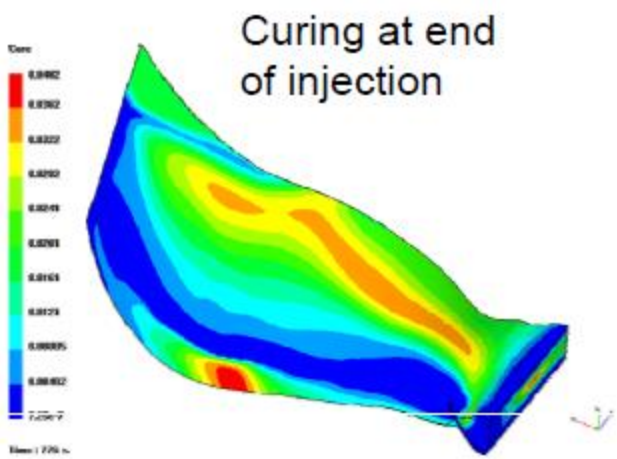


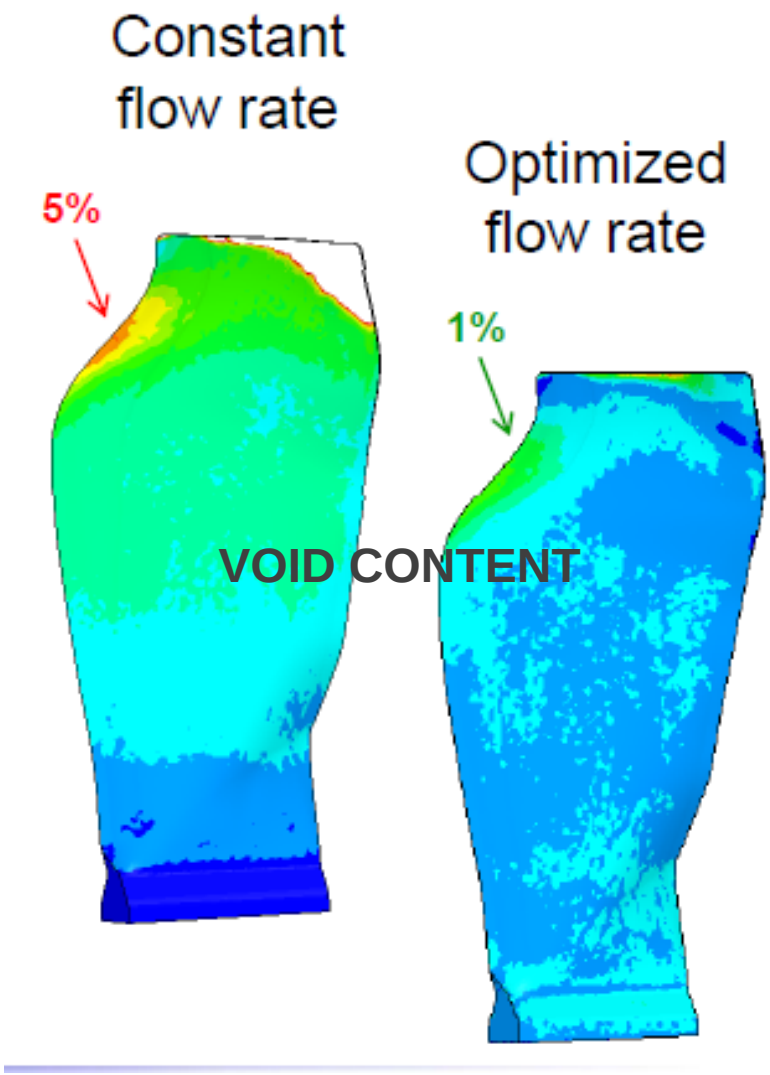
ÉCOLE POLYTECHNIQUE MONTRÉAL
bruno.dambrine@snecma.fr / edu.ruiz@polymtl.ca
Snecma Groupe SAFRAN

Example 2

Example of the SNECMA new composite blade
JEC 2010 (15 April)
ESI Simulation Forum

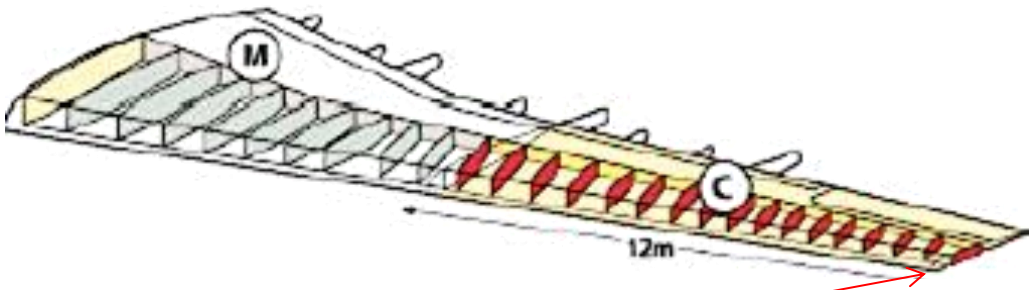


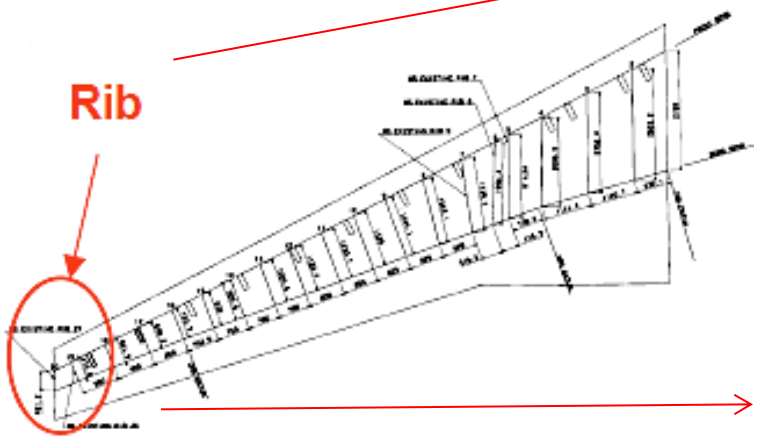


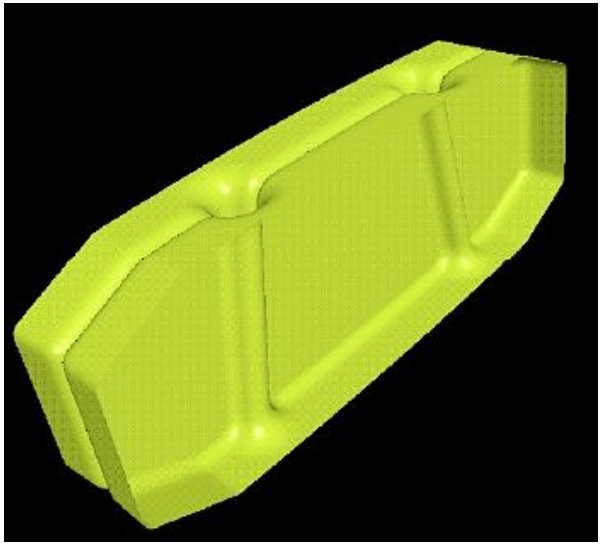


Example of Solution

- **Composite Part Forming**
  - Feasibility assessment of using composite material for rib manufacturing



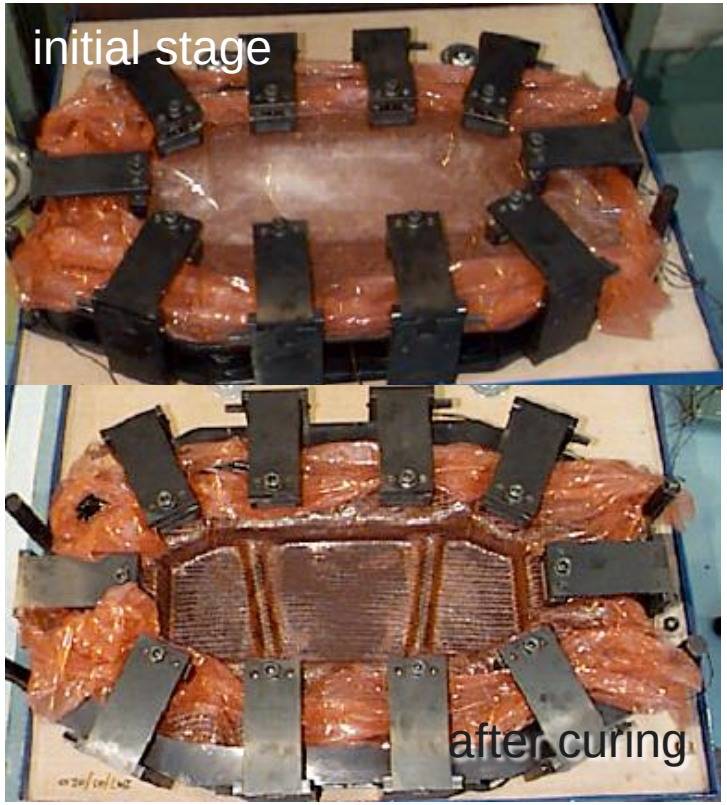


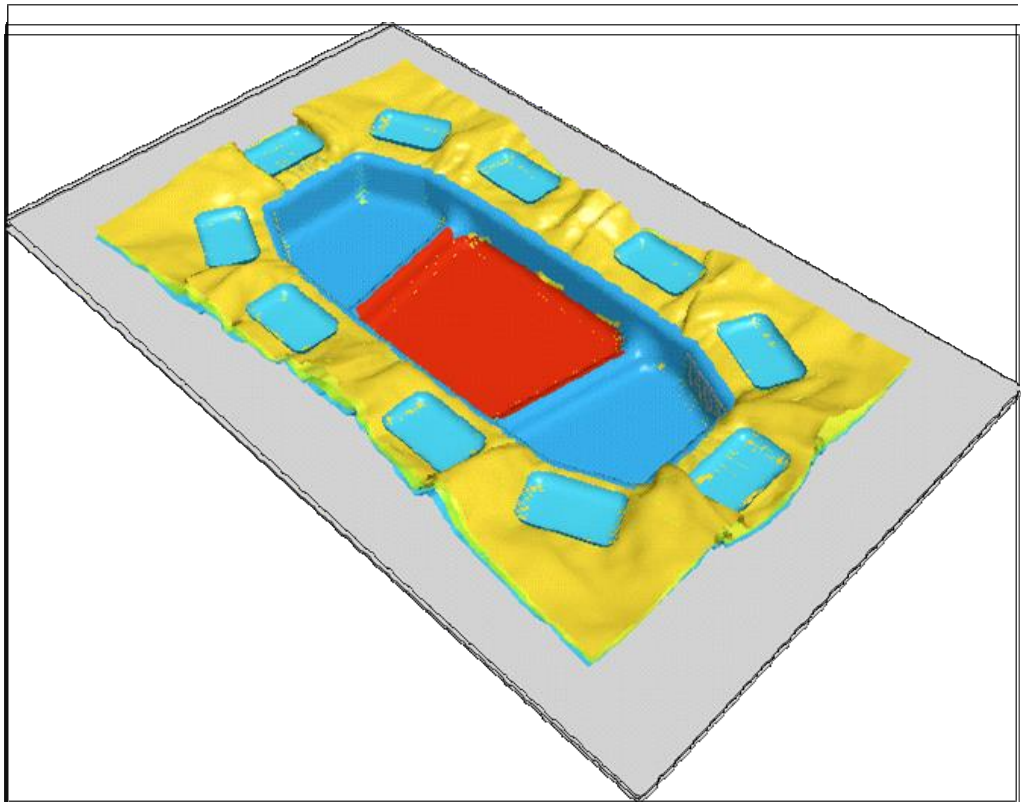


PAM-FORM

Example of Solution

- **Composite Part Forming**

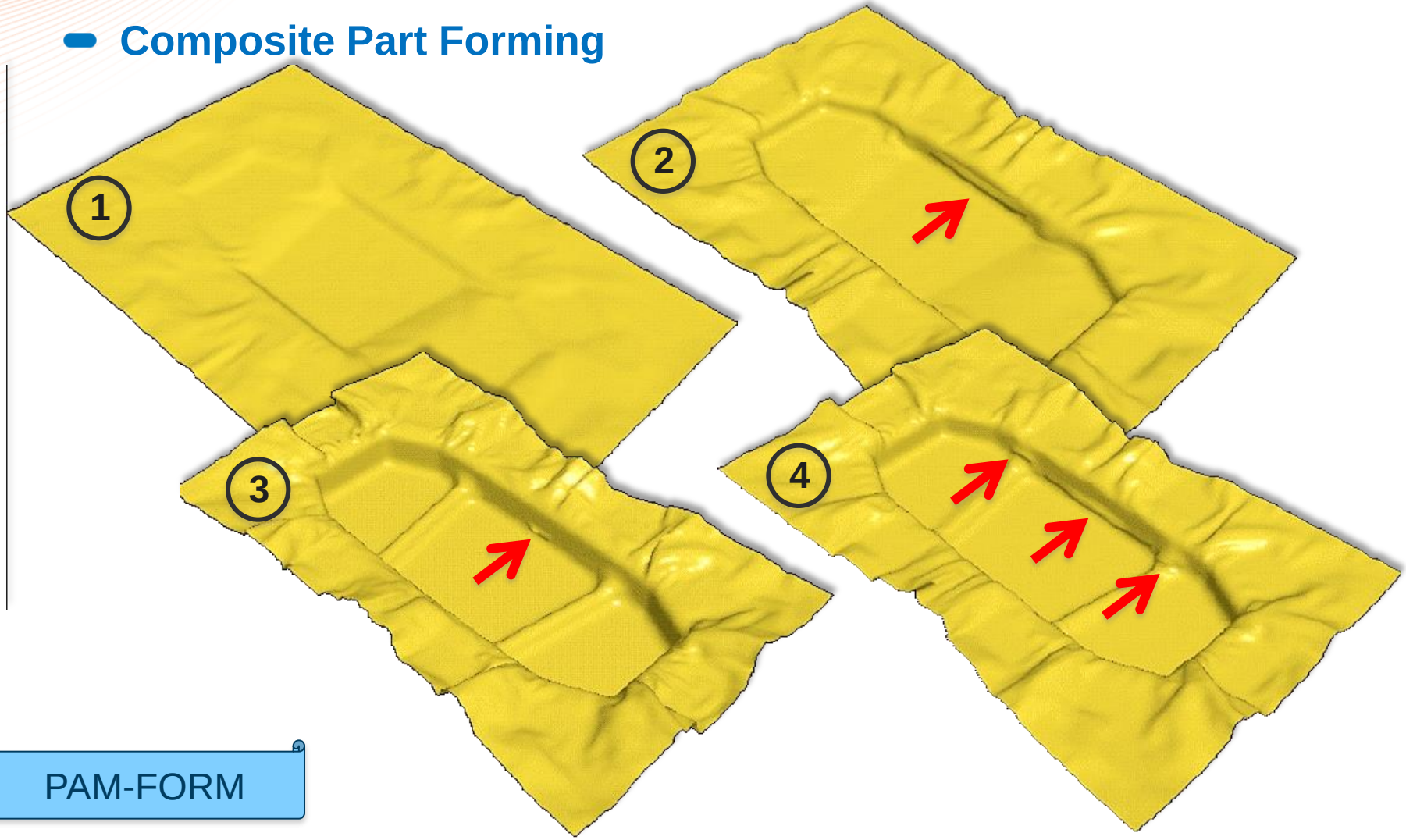




PAM-FORM

Example of Solution

- **Composite Part Forming**



PAM-FORM

Composite Solution Customers

- EADS (France)
- BOEING (Australia)
- SNECMA (France)
- PRATT & WHITTNEY (Canada)
- DASSAULT (France)
- SAMC (China)
- Several AC plants (China)
- BOMBARDIER (Canada)
- ASTRIUM (France)
- EUROCOPTER (Germany)
- MHI (Japan)
- FGUP VIAM (Russia)
- TSAGI (Russia)
- Kazan AI (Russia)
- Perm STU (Russia)

Mission

Provide to industry **virtual solutions** for design and manufacture of products in order to **eliminate physical prototypes** that require high consumption of time, raw materials and energy.

Vision

Be the **leader of virtual prototyping** spurring **innovation of products and processes** to reinforce the **social value** of our customers' products (safety, comfort, performance,…).

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www.esi-group.com