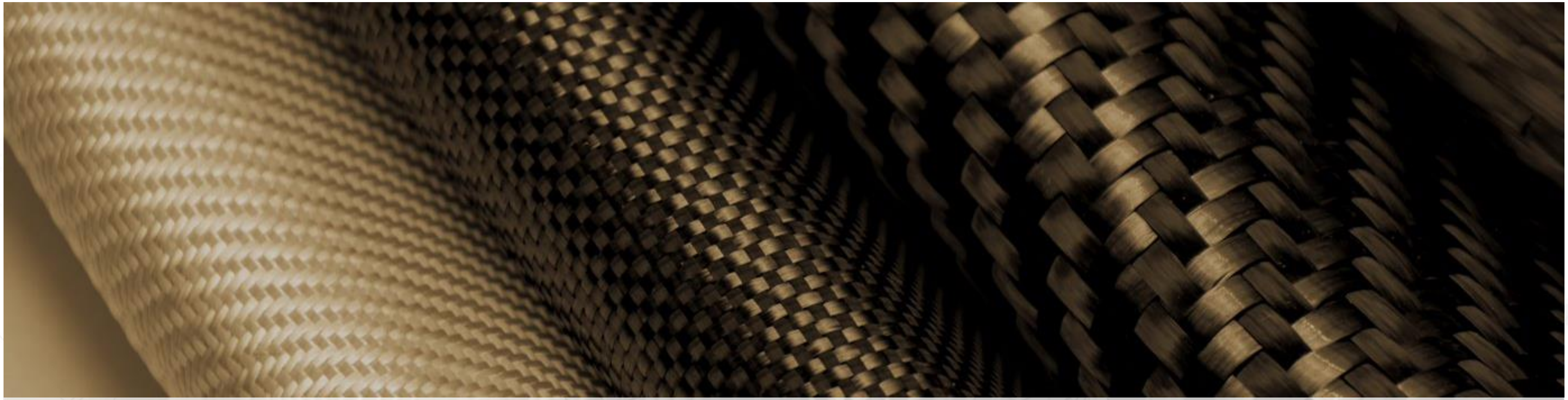
Finding Success with Composites in the Factory of the Future

Virtual Manufacturing of Composites



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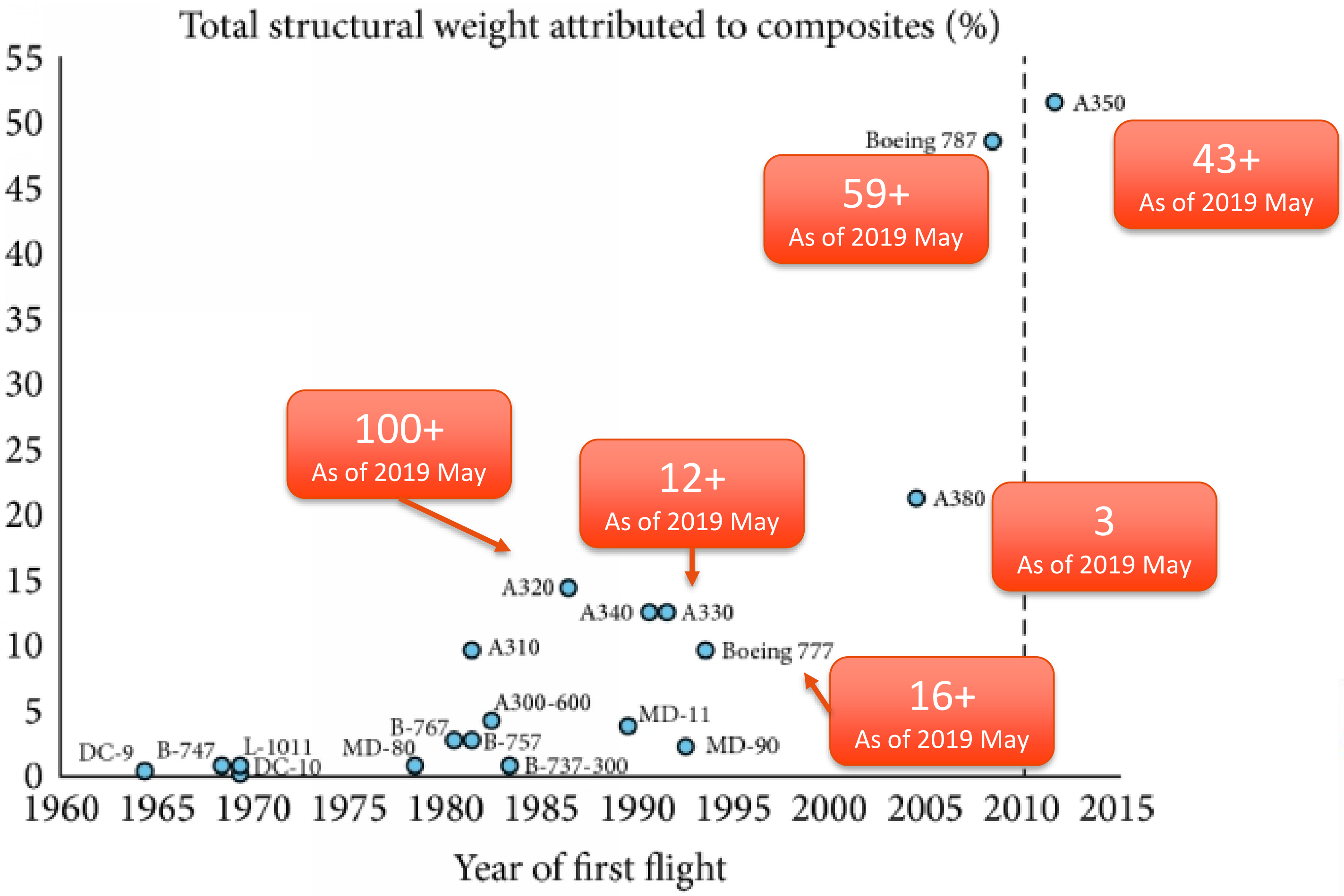
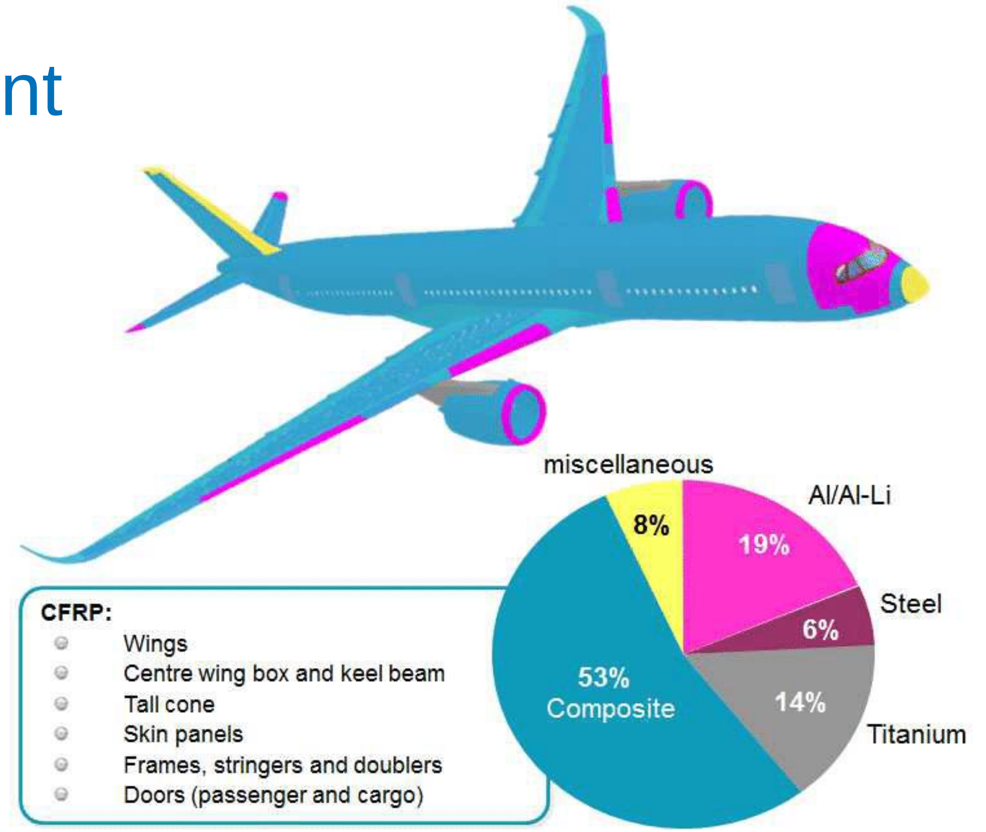
Paving Your Way Towards Zero Real Test and Zero Real Prototype

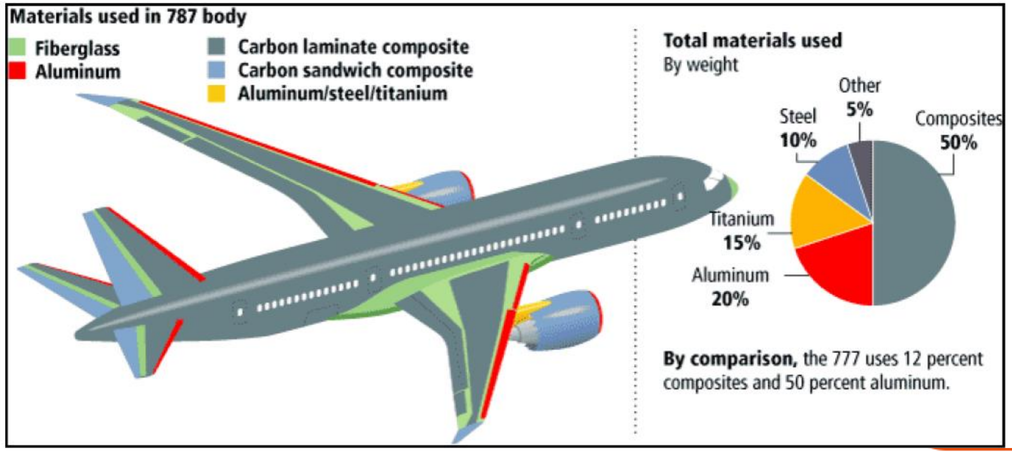
Image courtesy of Airbus

Get it Done - Get it Right: Around the world, wherever groundbreaking technologies for future mobility are developed, engineers and scientists count on ESI's virtual prototypes to experience, evaluate and pre-certify their designs throughout all development phases.

Composites in Aerospace: Same but Different







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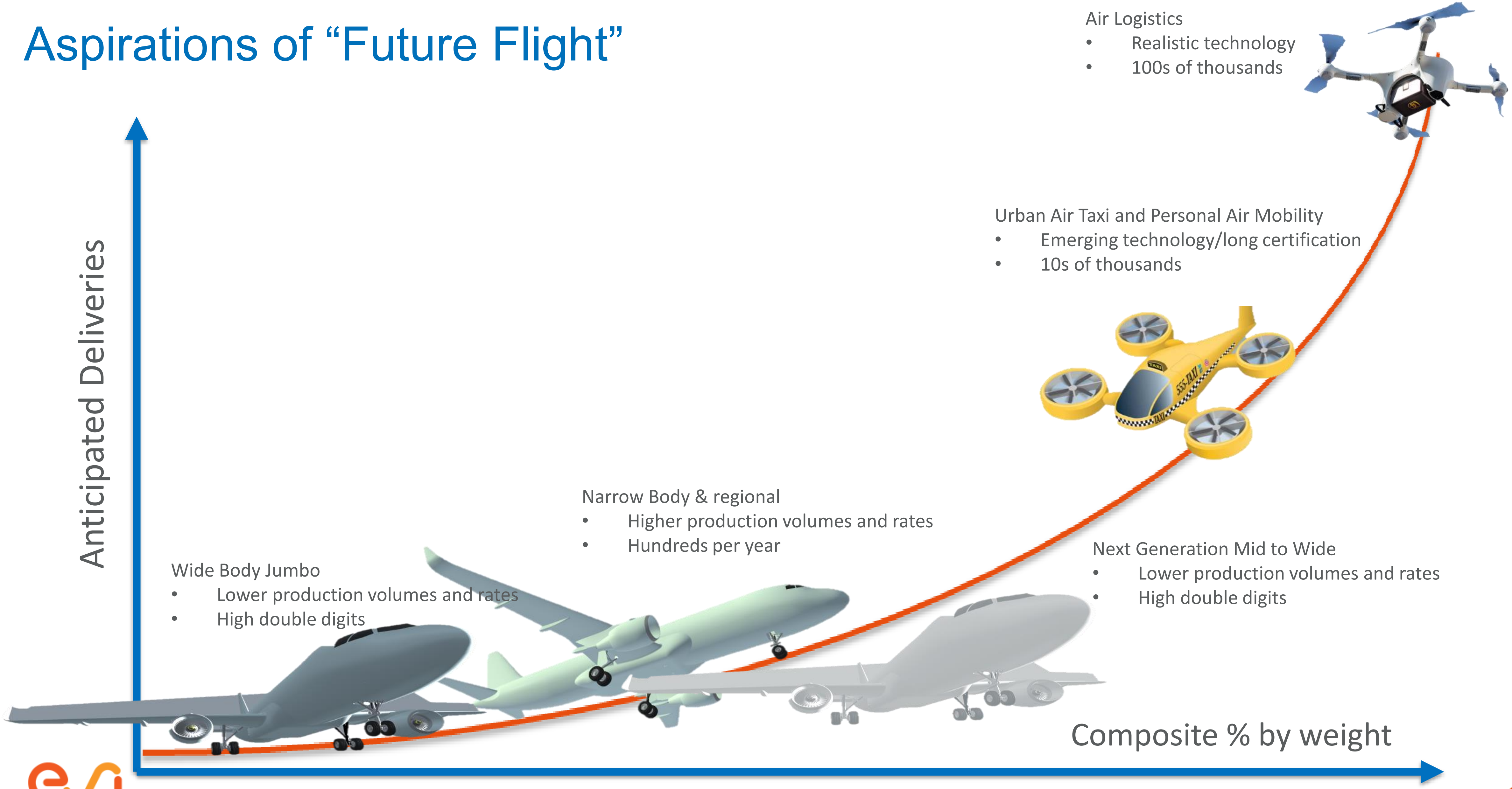
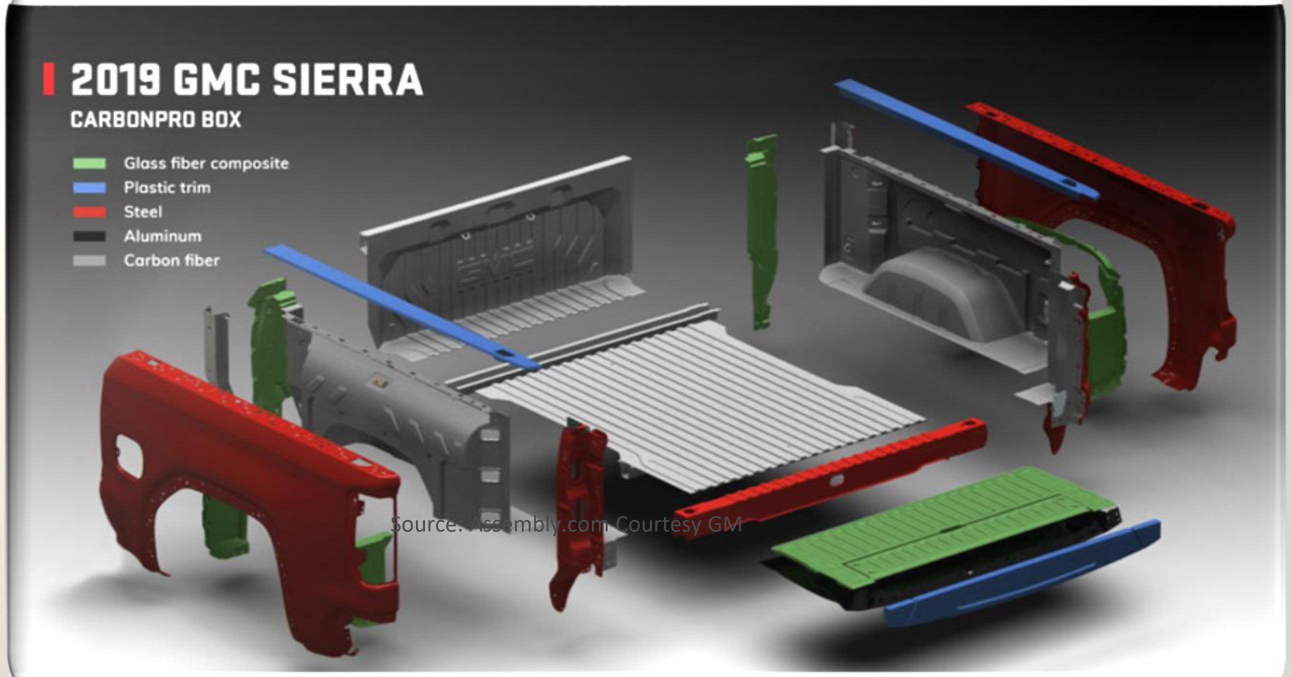
Aspirations of “Future Flight”

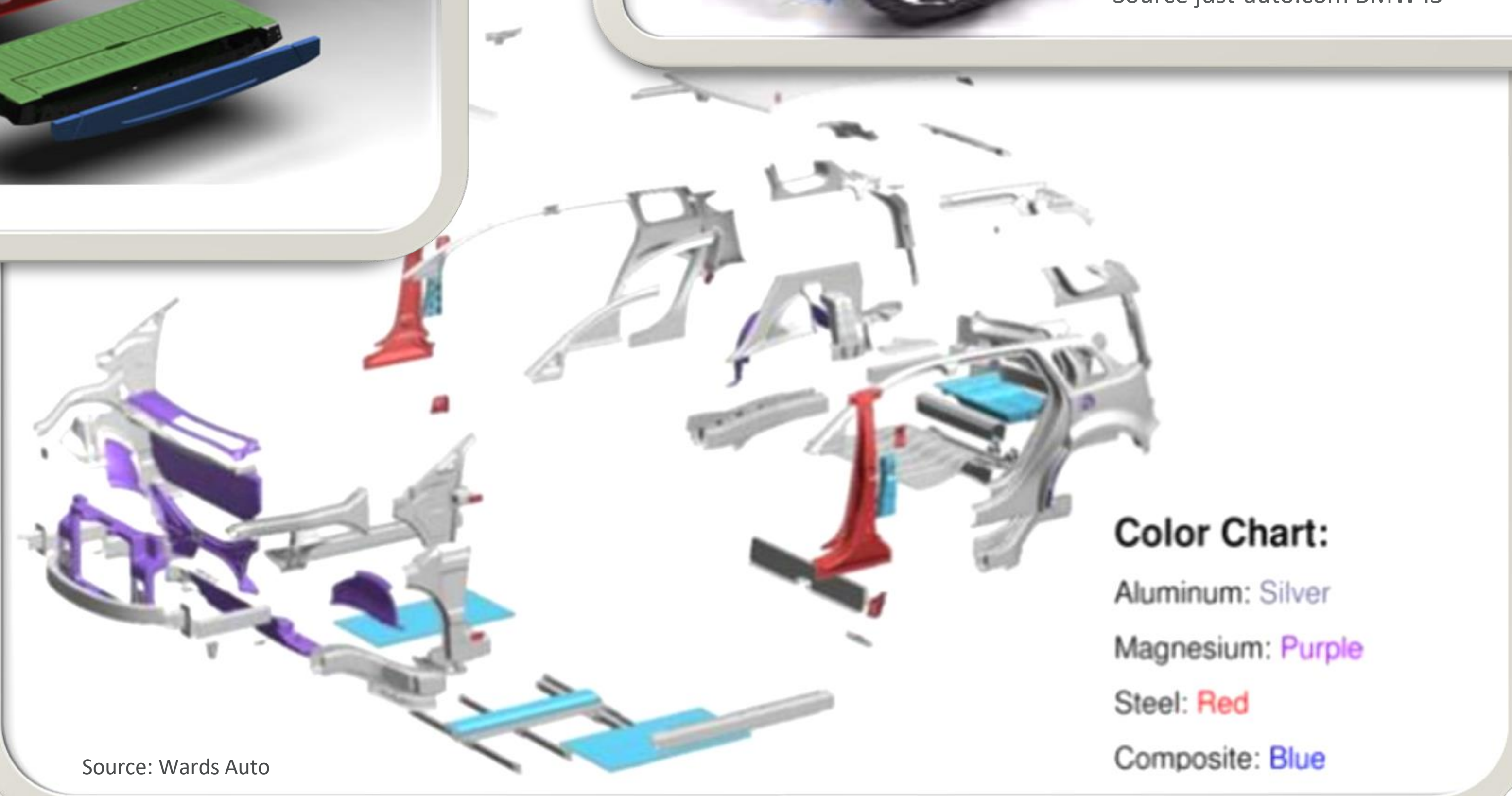




Source: Assembly.com Courtesy GM


Source just-auto.com BMW i3

Growth in composites applications for Automotive Sector



Source: Wards Auto

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Future of Mobility = New Composite Growth

- Previous barriers to wider composites adoption are shifting
  - Shifting needs in automotive and mass markets
  - Increasing value of cost per kilo reduction in mass
  - New methods with increased production rates
  - More diverse aviation products
- New Challenges
  - Smart Factory and Industry 4.0 pressures digital transformation to a largely manual production process
  - Increased volume through more automation in process

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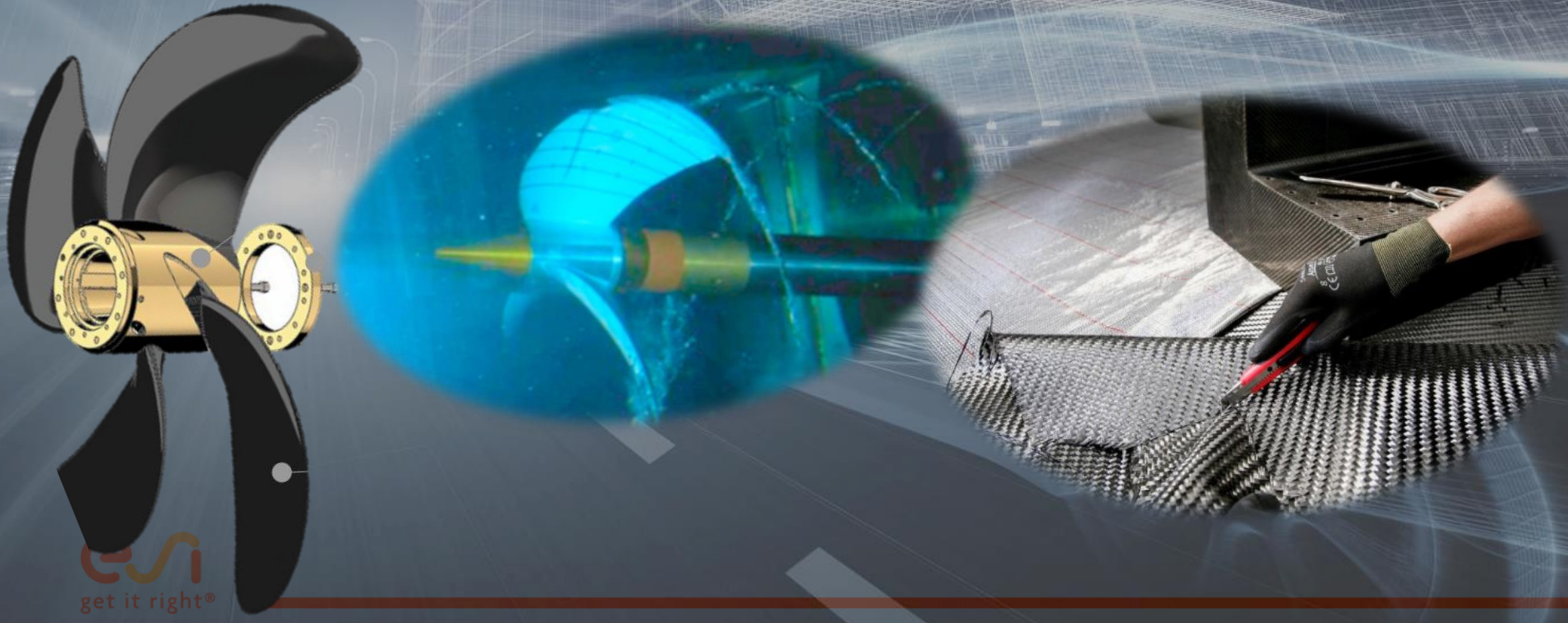
Composites in a conventional product development value stream

Product Design → Materials & Performance Engineering → Manufacturing Piloting & Prototyping → Testing → Production Tooling & Process



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Source NAKASHIMA Propeller

Composites in a conventional product development value stream

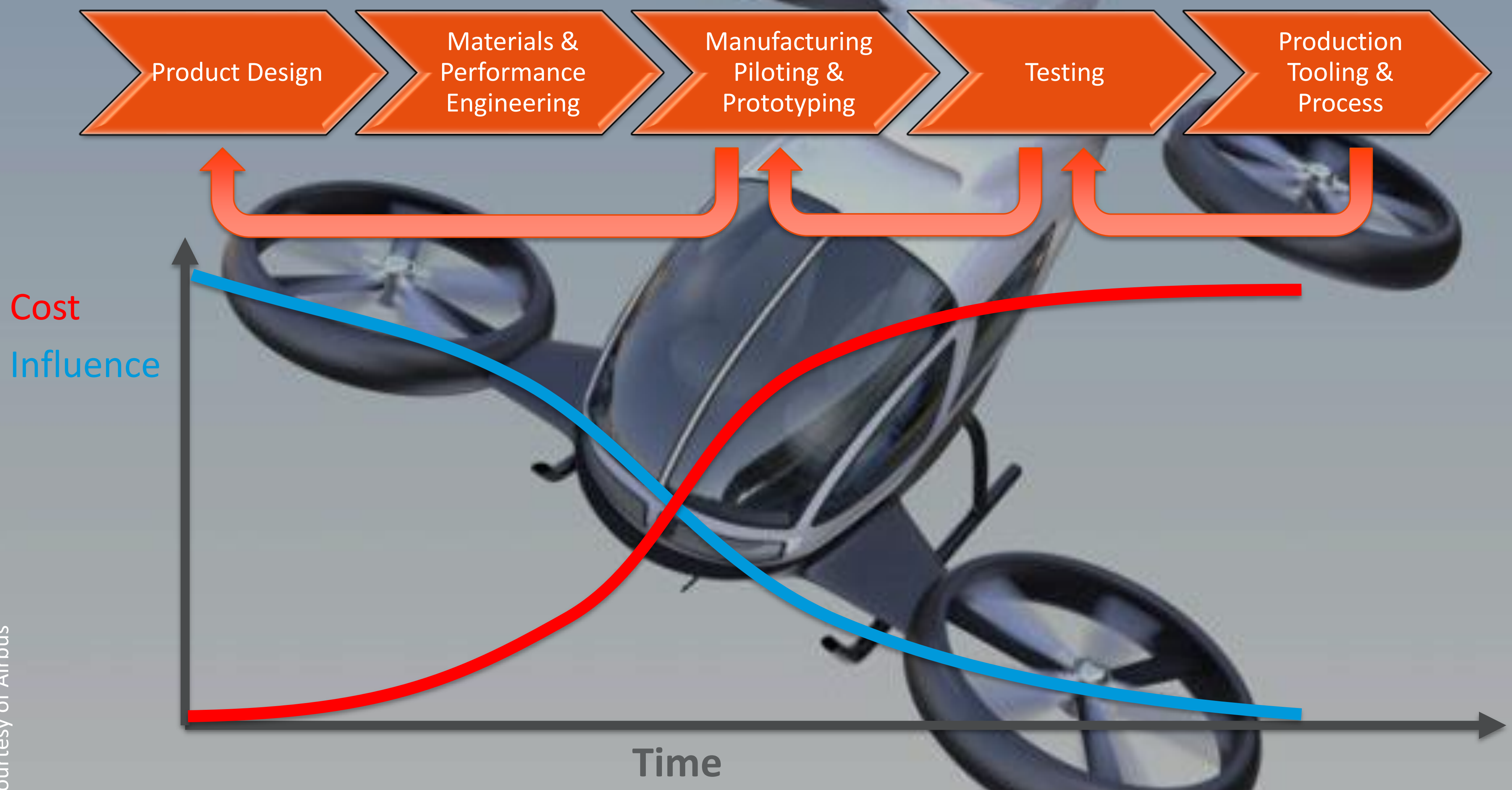

Image courtesy of Airbus

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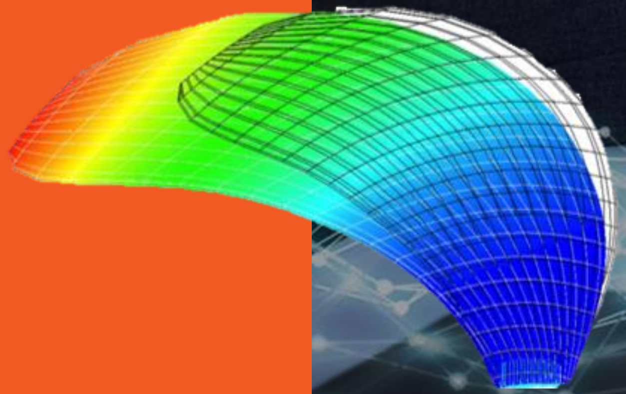
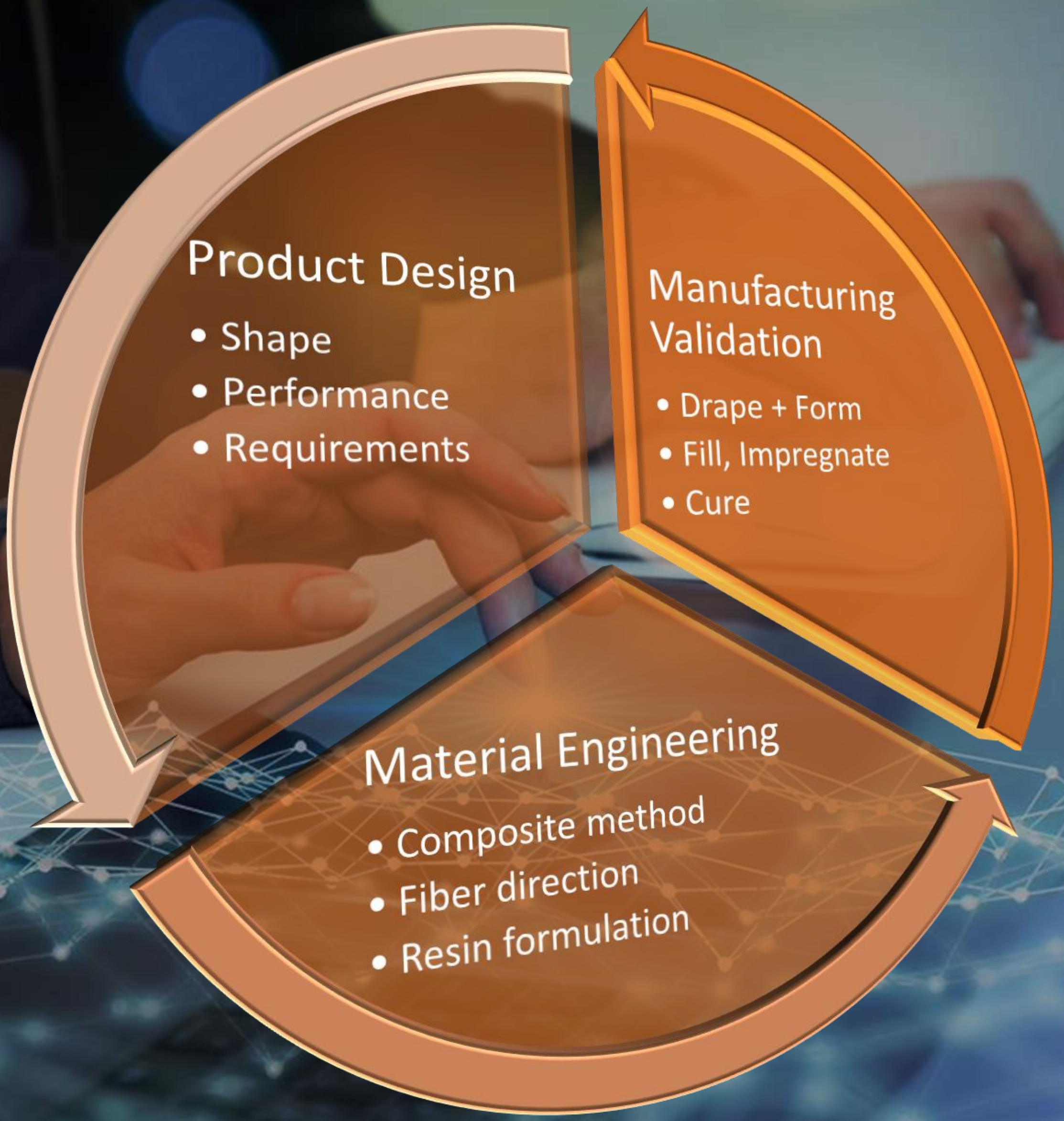
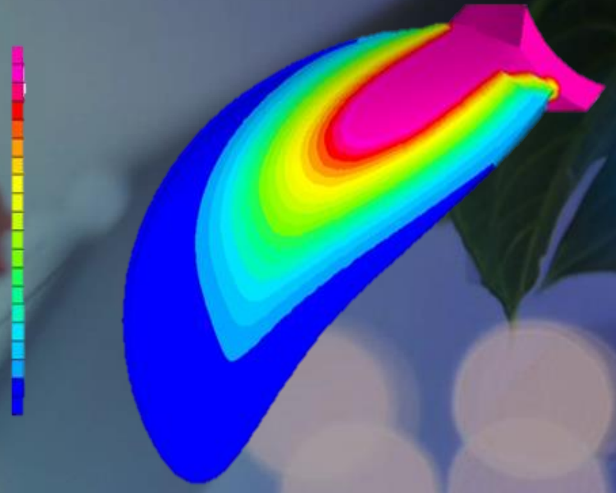
Digital Product-Performance Cycle







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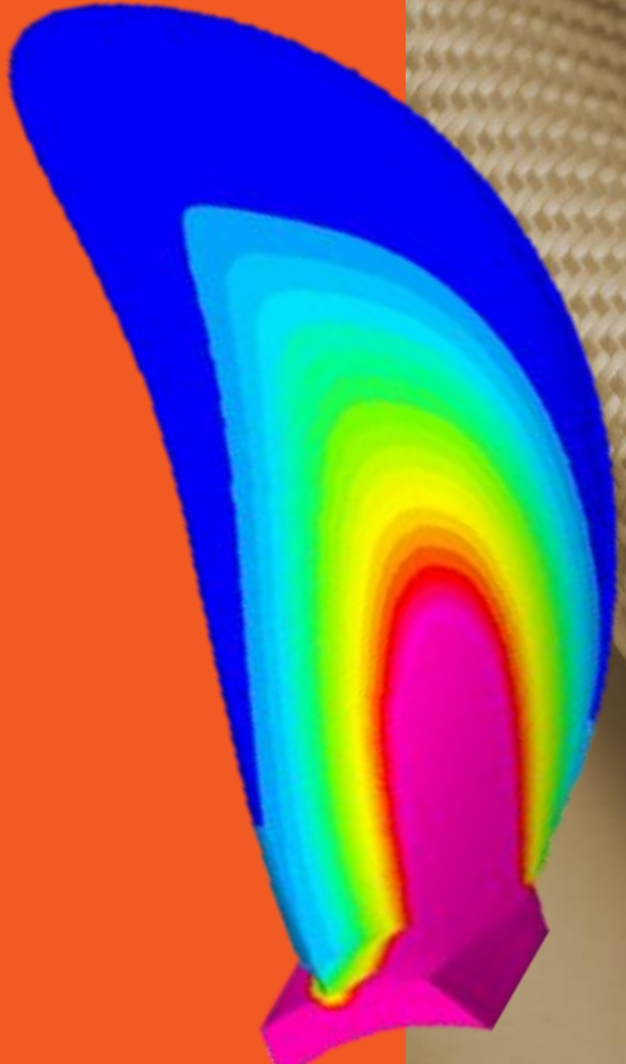
Quickly Find the Most Effective Solution for Mass Production



"It is now possible to understand and predict how carbon fibers are impregnated with resin in details by referring to the comparison of simulation result values and the values of a failed real-production. PAM-COMPOSITES is an essential tool and we are confident ESI will support us with excellent products and services."

Mr. Takaya Sakurai, Manager, Composite Business Department, NAKASHIMA PROPELLER CO., LTD.

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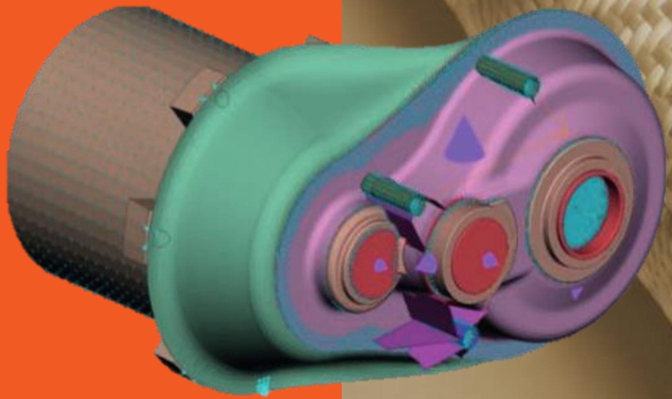
Quickly Find the Most Effective Solution for Mass Producing Mass Reducing designs

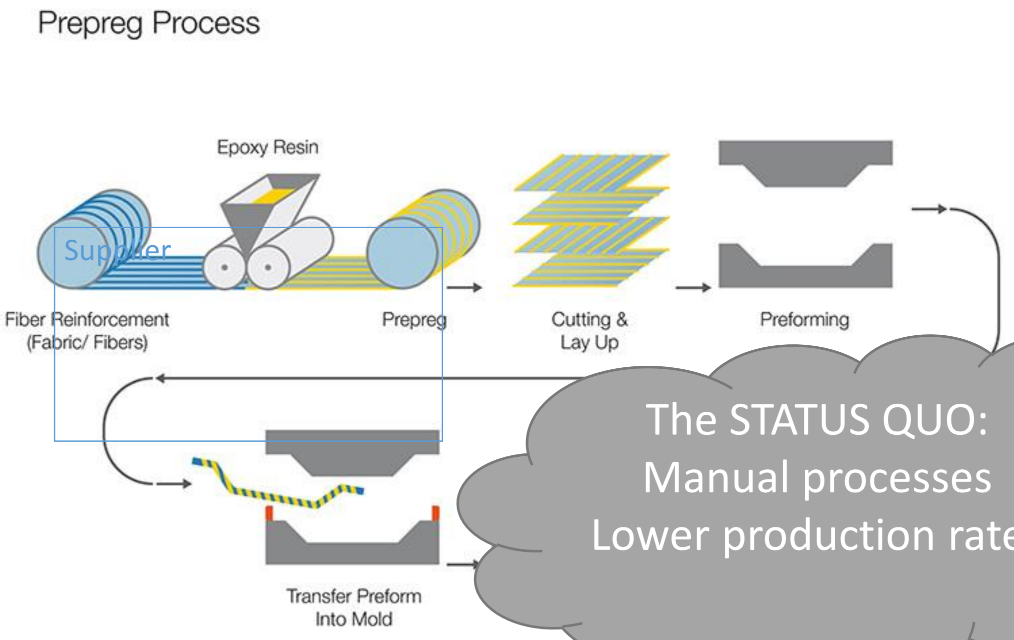
“In our gearbox project, we replaced the aluminum housing material of an electric transmission with fiber reinforced thermoplastic material. [Using] ESI’s composites manufacturing solution […] we achieved almost 30% mass savings.”

Herve Motte, R&D Innovation Manager, ARRK Shaper



Composite Manufacturing Processes: CFRP Methods

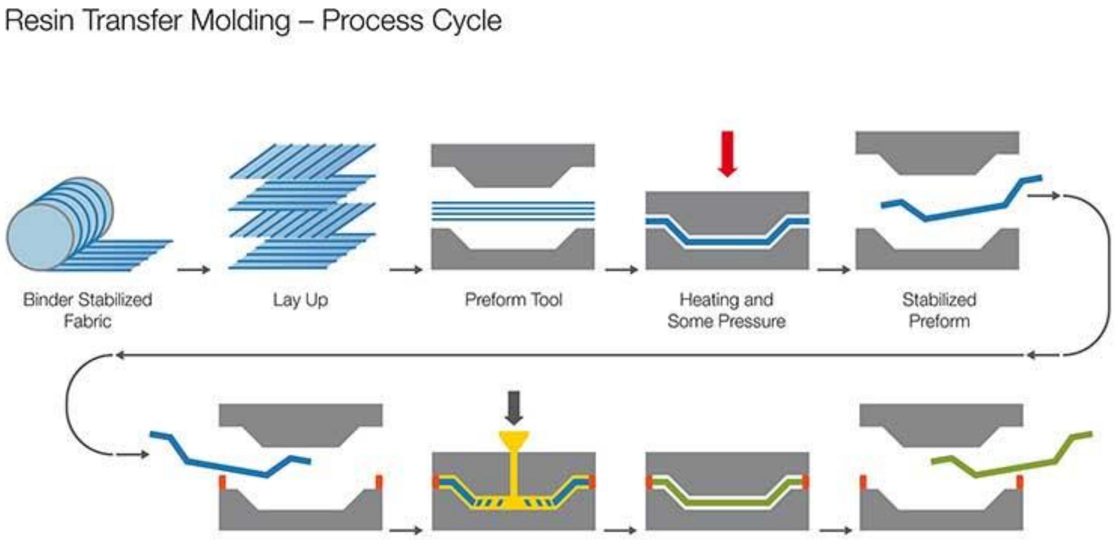
Pre-Impregnated semi-product (Prepregs)



The STATUS QUO:
Manual processes
Lower production rates

- 2 steps
  - Thermoforming
  - Curing/Cooling

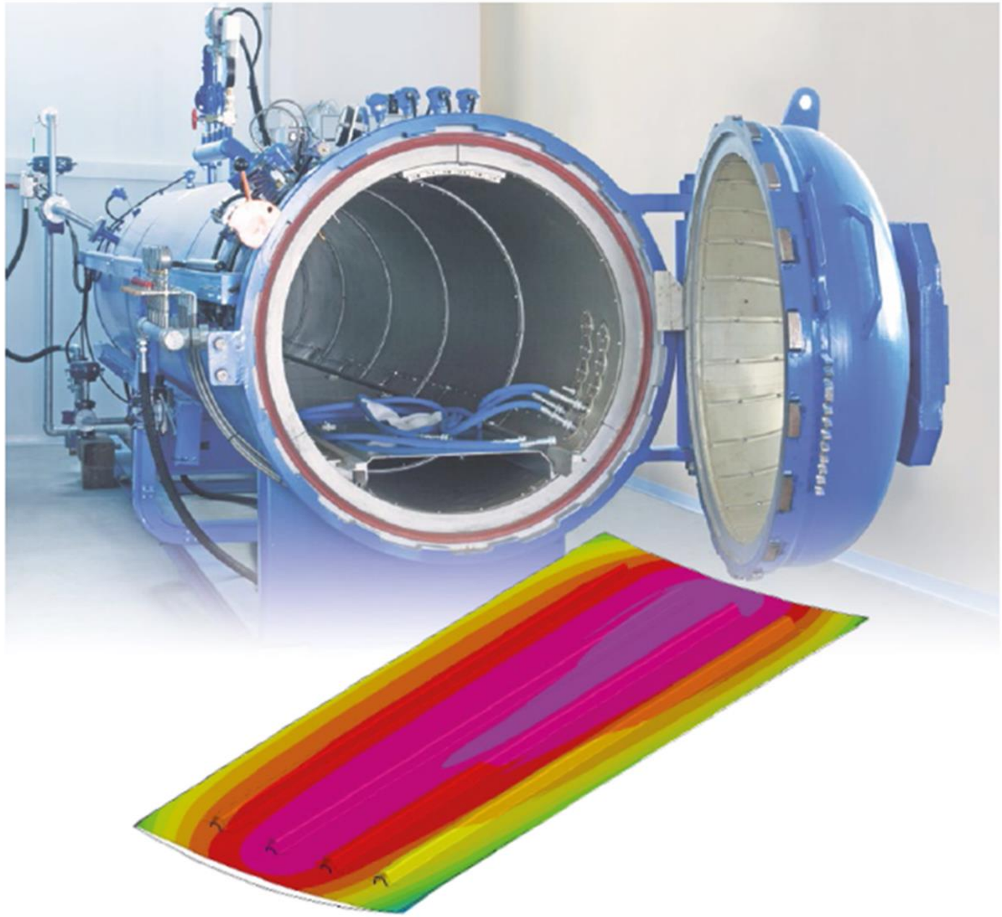
Liquid Composite Moulding (LCM)



- 3 steps
  - Preforming
  - Impregnation
  - Curing/Cooling

Infusion
RTM
C-RTM
VARTM

Production Ramp-up to larger volumes

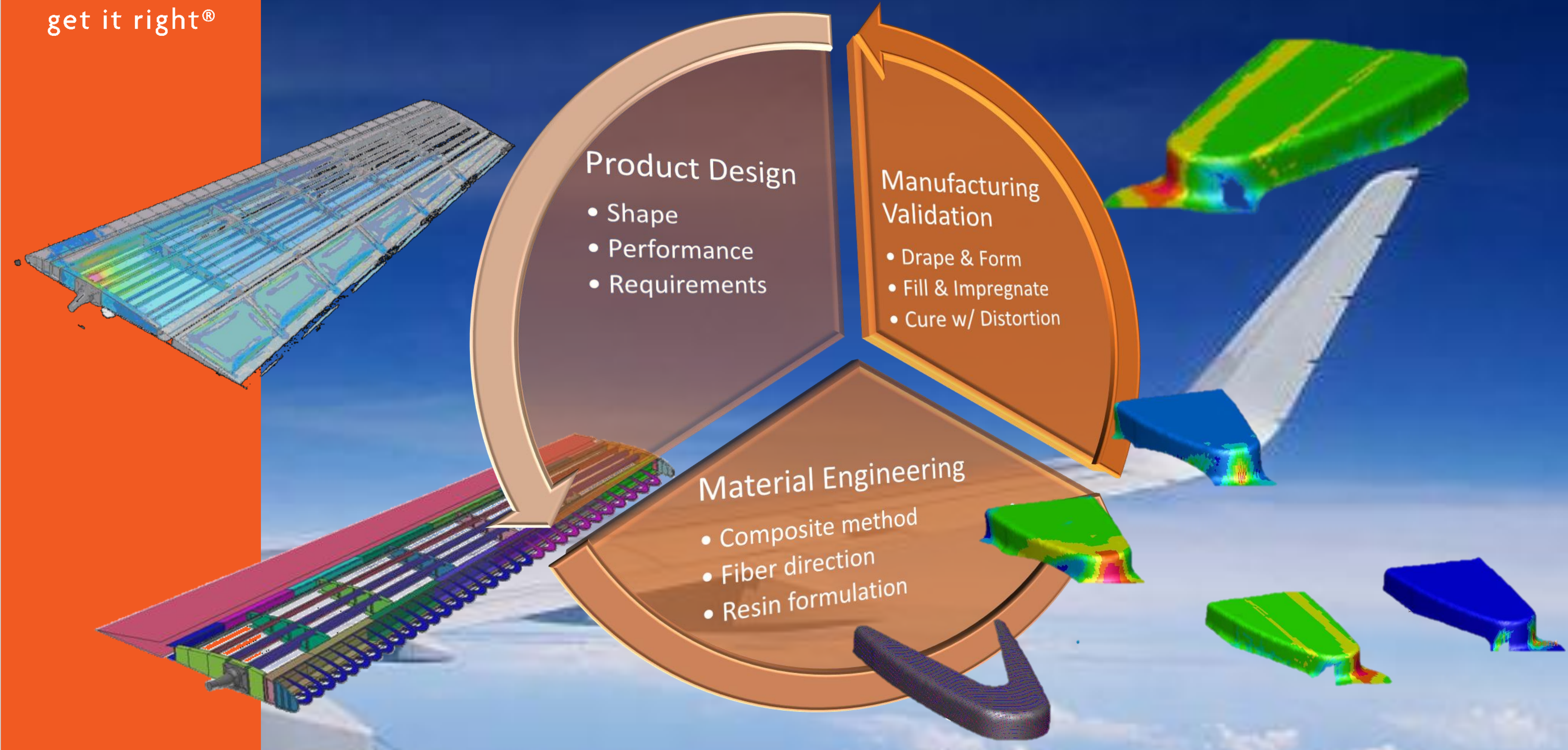


- Processes dependent on longer-term temperature regulation to accelerate curing or prevent aging
  - Higher production rate materials with faster cycle times require more reactive formulations which increases production costs (storage without reaction)
  - Materials with less volatility require longer process times driving up production costs
- Processes well suited for mass production require more due diligence in process planning, definition, and control since manual adjustments are not possible
- Defect potential from ill planned processes are harder to detect without 100% inspection or individual process control

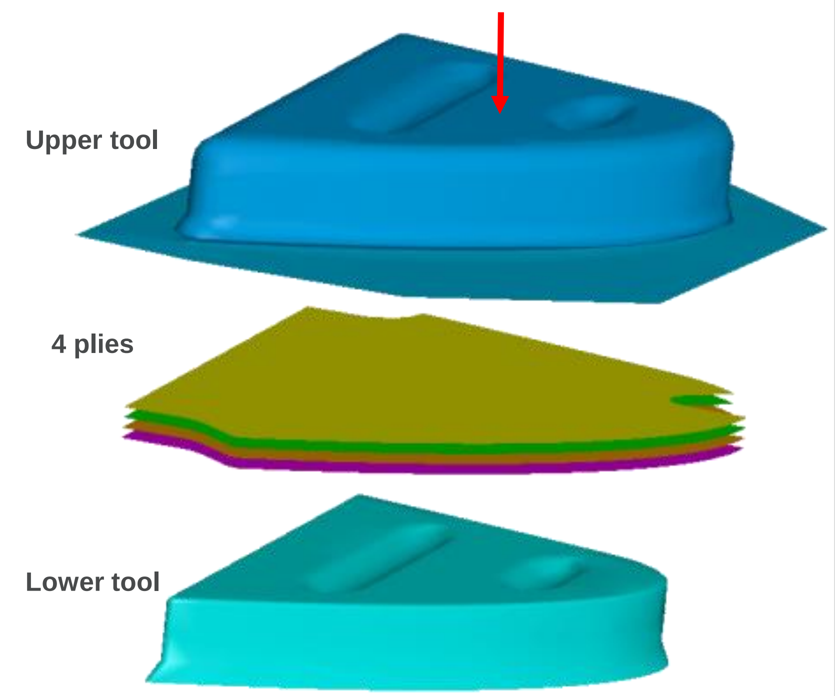
Some processes are impractical for large parts

- If these are the finished parts
  - Imagine what complete tools and press would have to look like
  - Automating these processes is less necessary as volumes are low enough to allow
- Same processes that are acceptable for these would not be for mass produced products

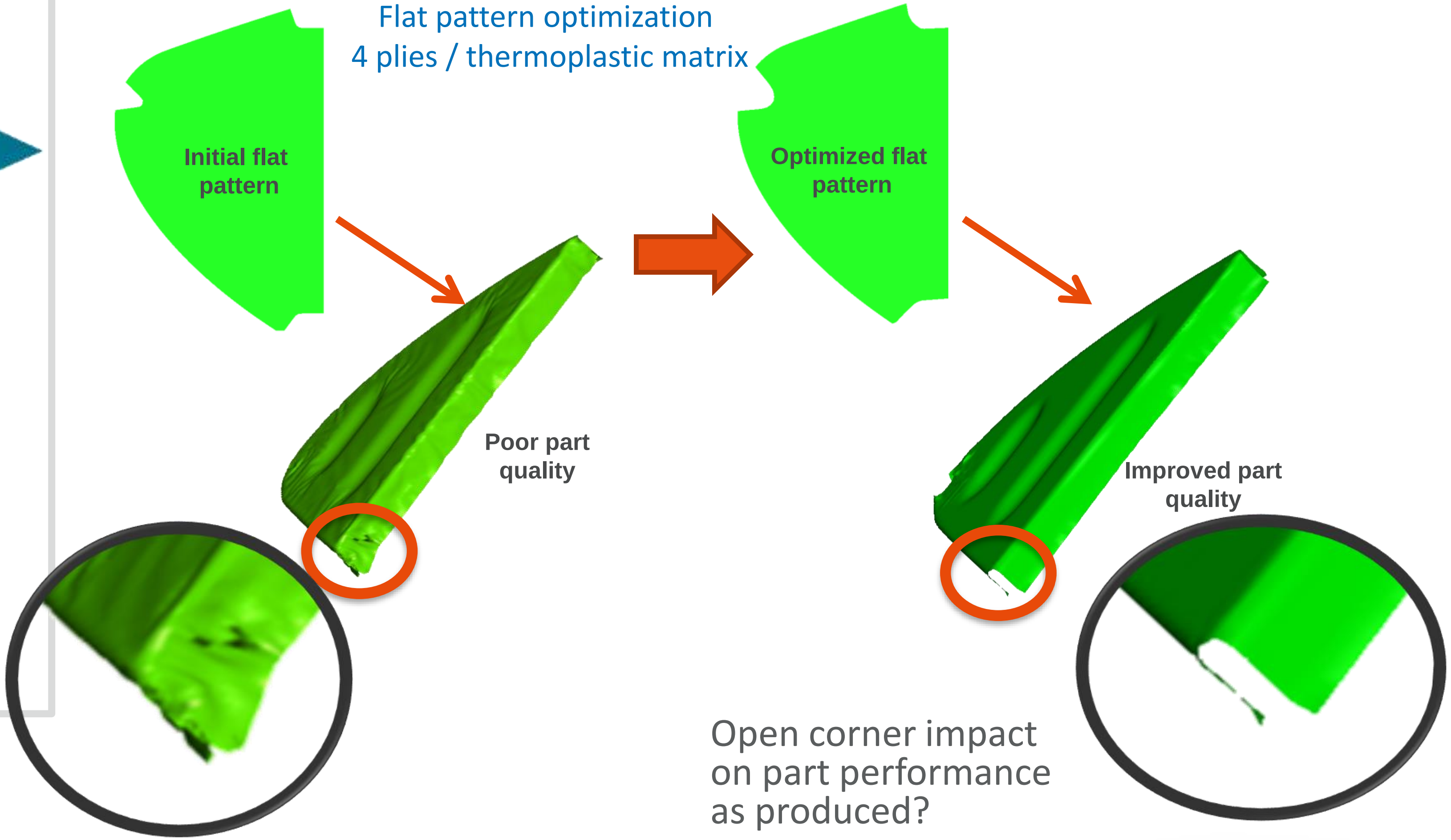
Product-Performance Cycle



Forming Dry Sheets and Plies



Simulation setup



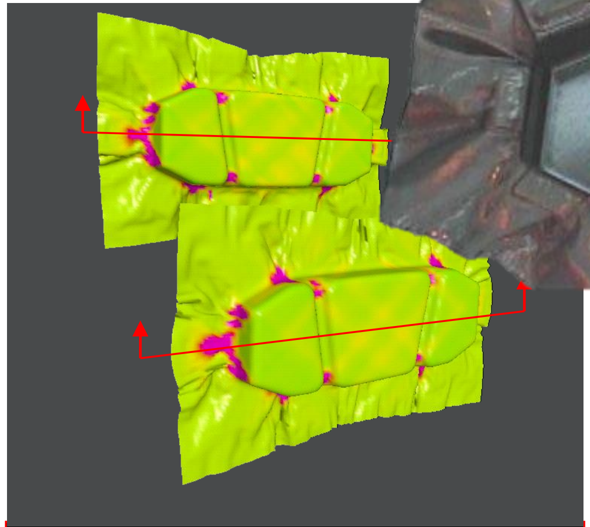
Closed corner importance on part performance as engineered?

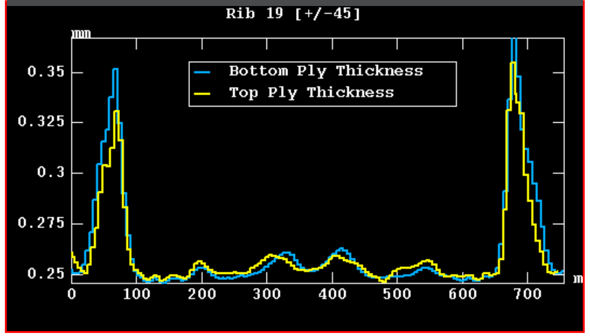
Open corner impact on part performance as produced?

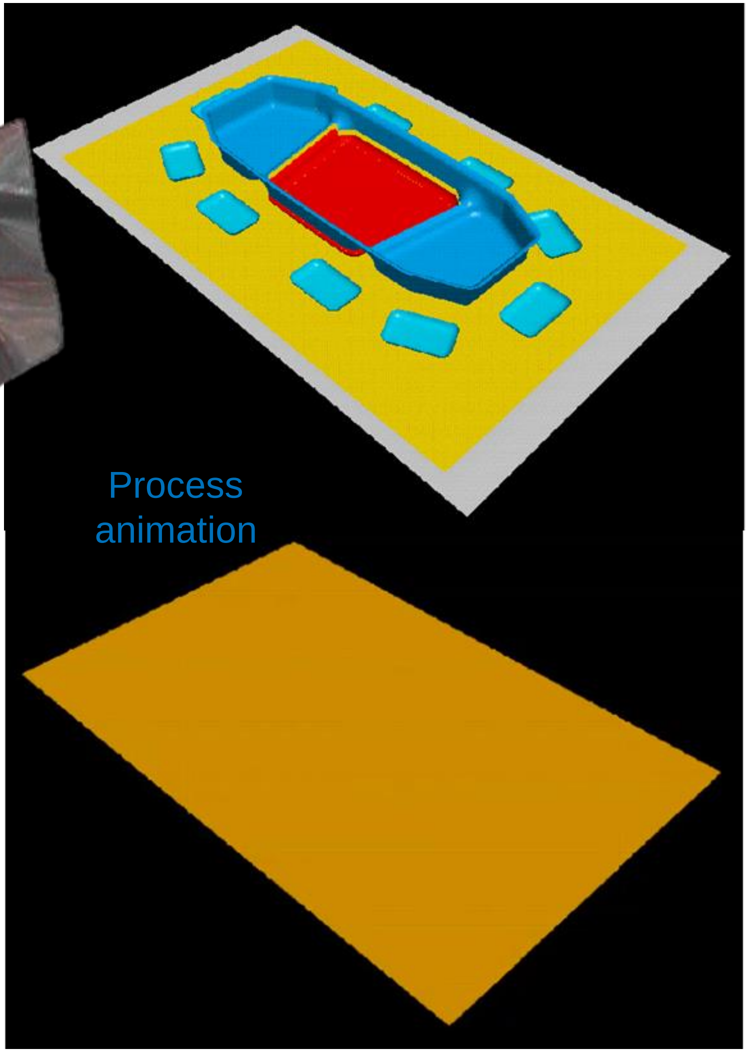
Modeling behavior and thickness per play

- Application: Wing box thermoforming

Thickness per ply



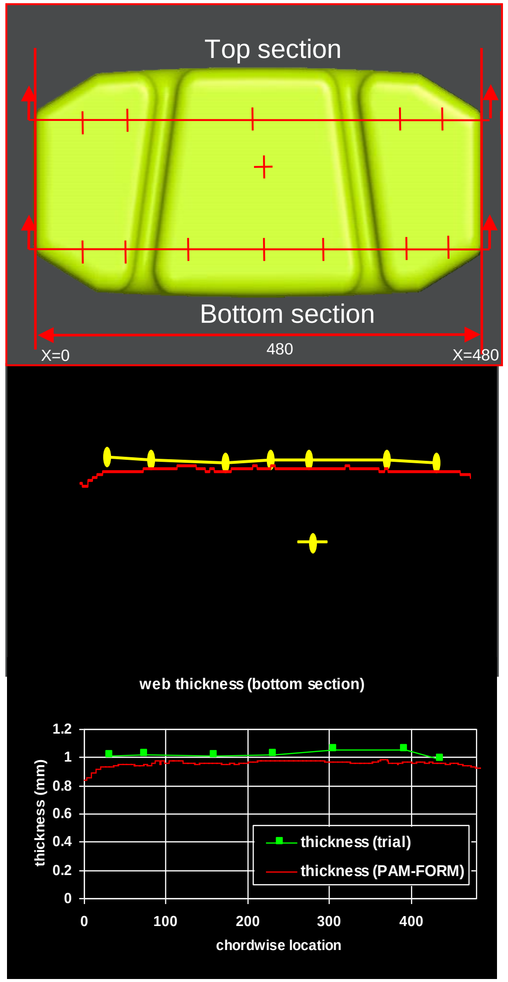




Process animation

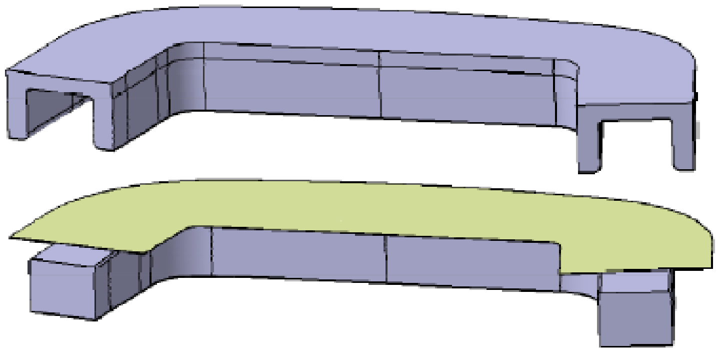
Laminate thickness

Ultrasonic measurement versus simulation

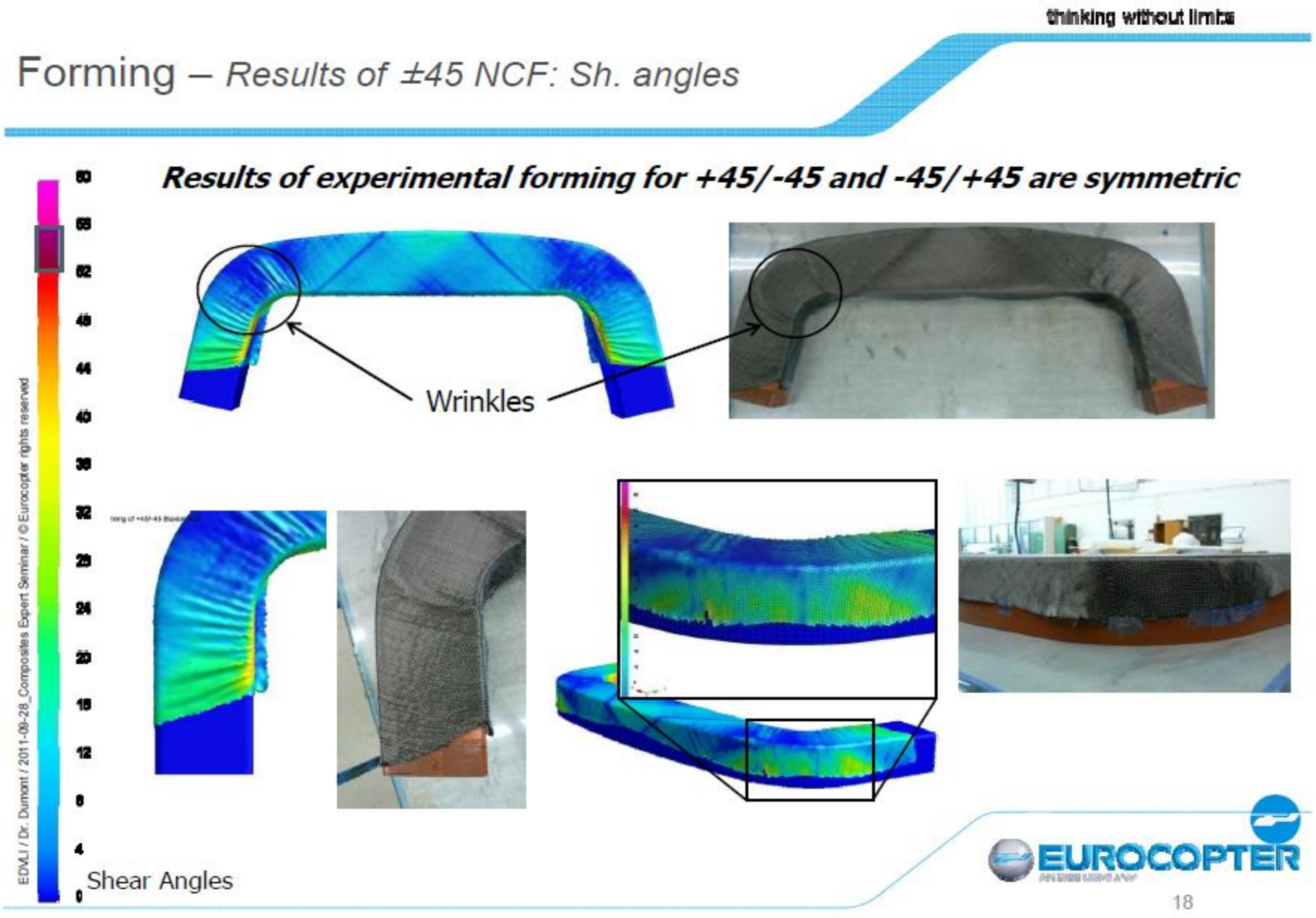


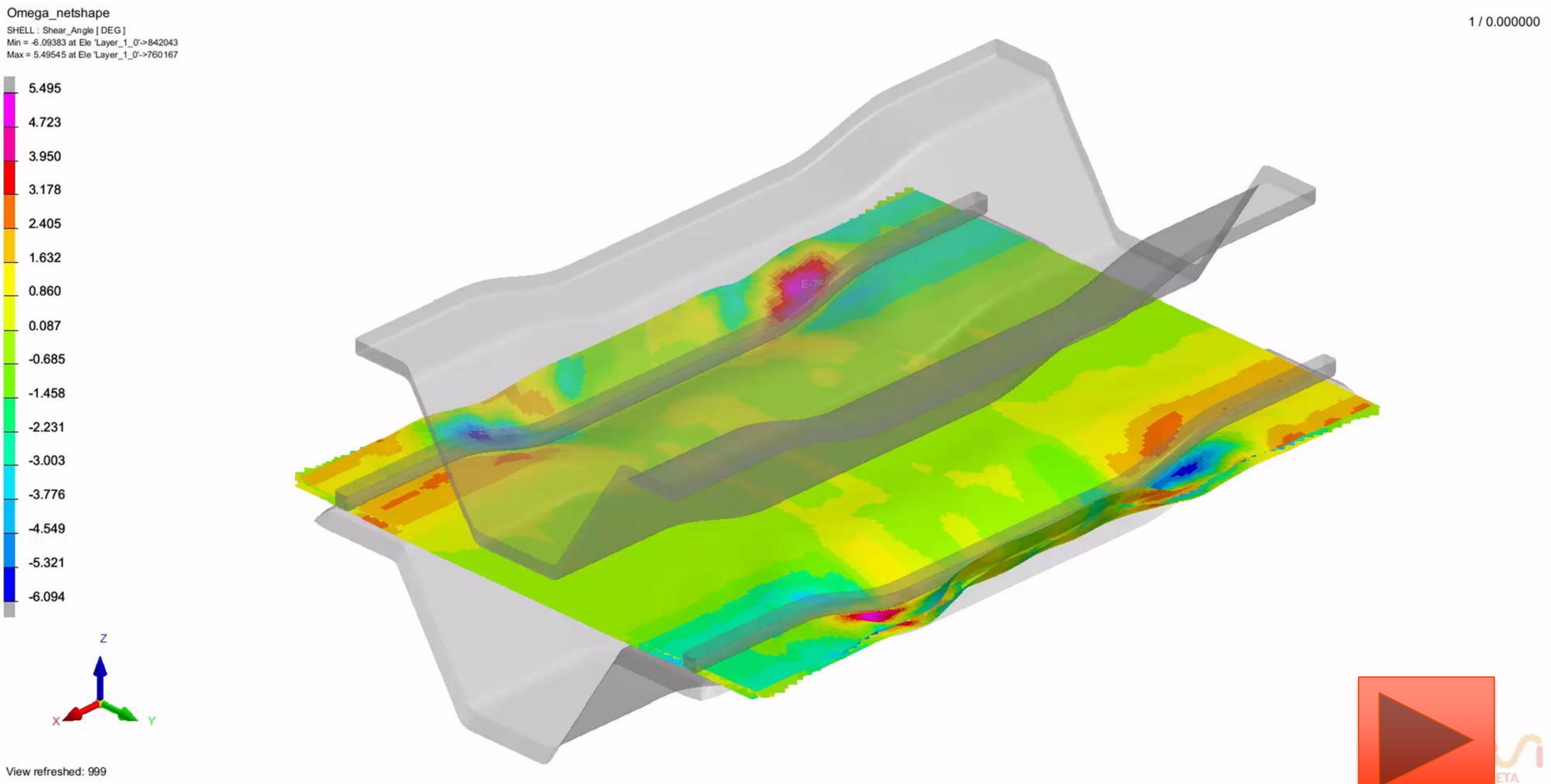
Draping and Forming Glass Sheets for Fiber Reinforce Resin composite

- Preforming application: Fabric shearing and wrinkle prediction



Stamping tools and reinforcement





netshape_forming_shear_angle.mp4

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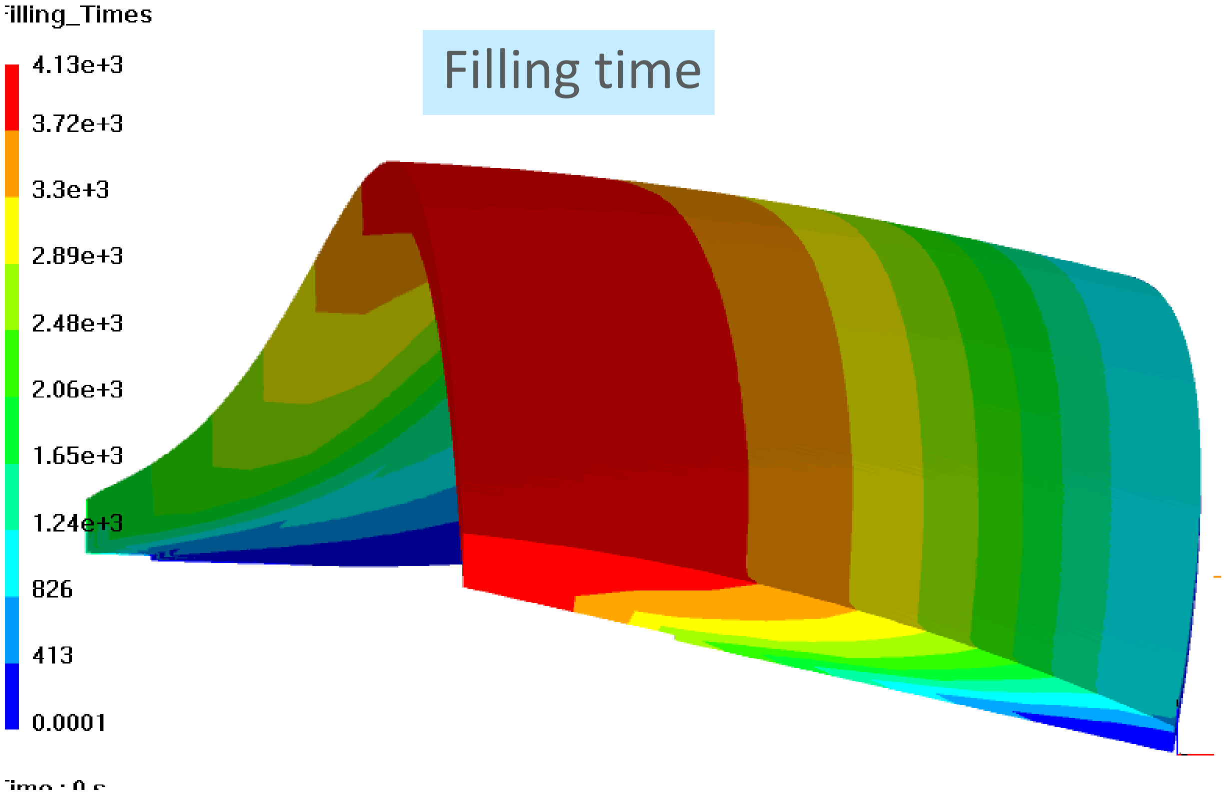
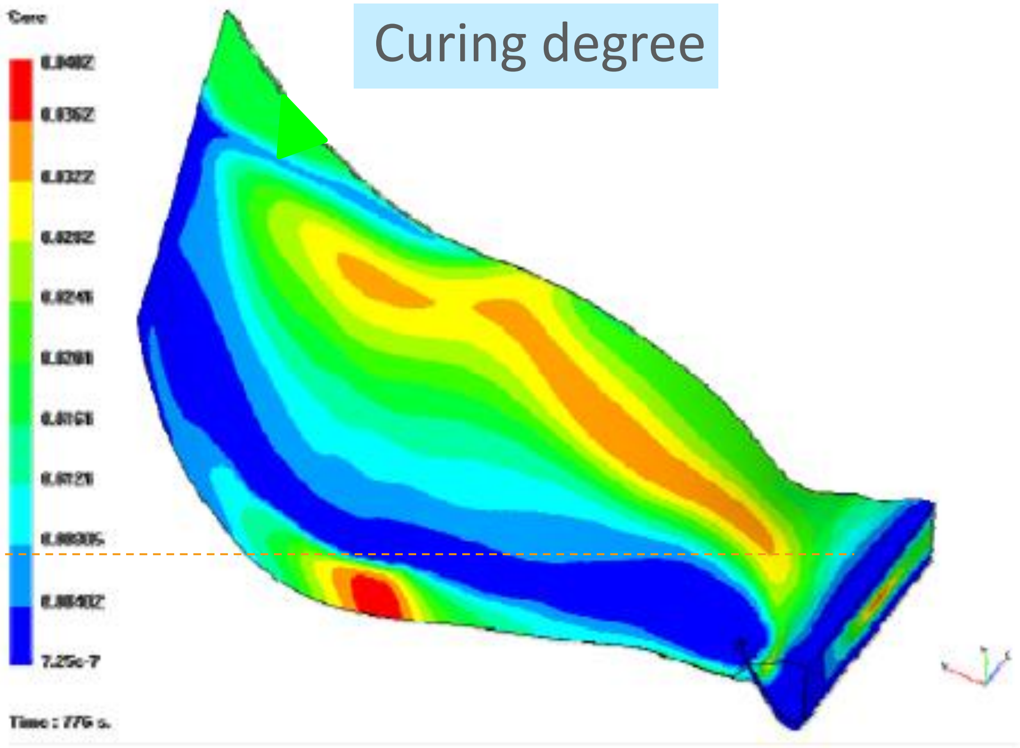
- Infusion application: Large dimension parts

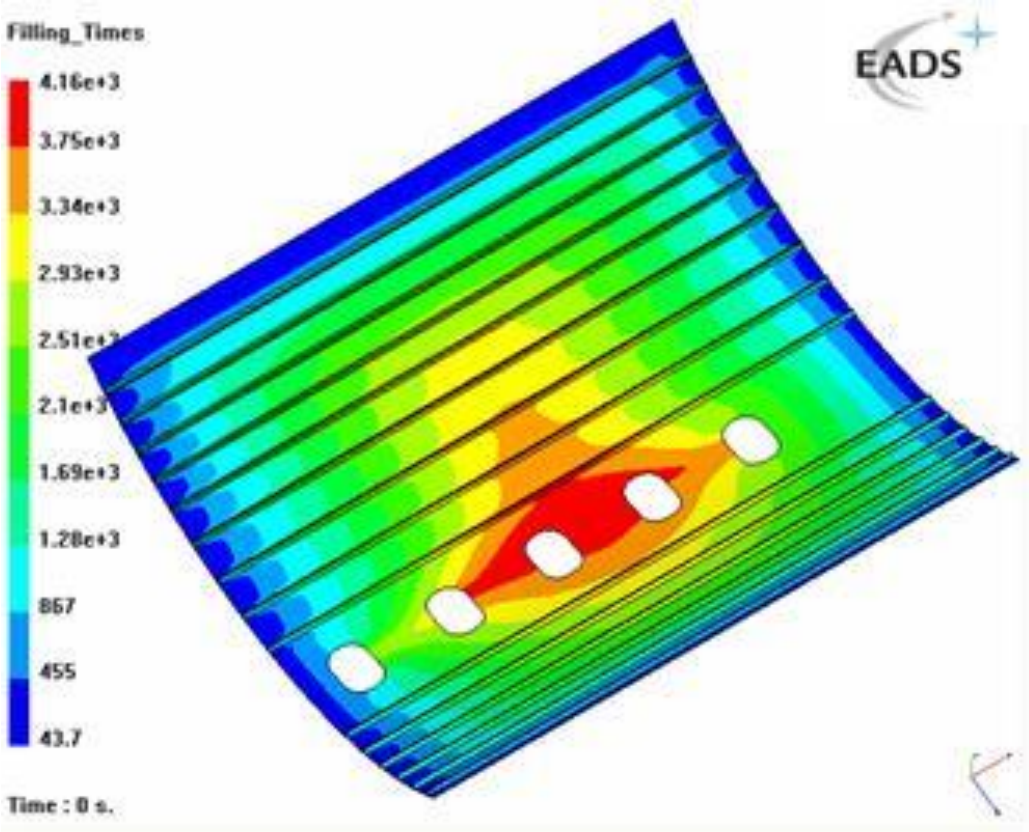


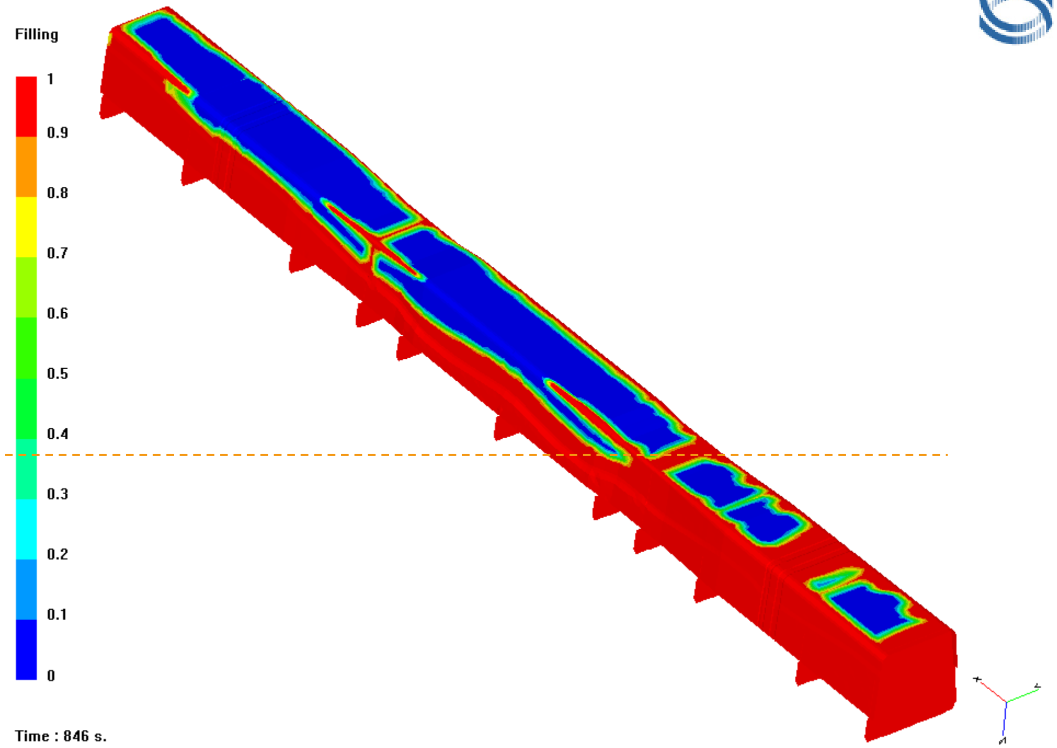


- Will it fill completely before curing degree makes it too viscous to flow
- Will all fibers in the component get fully infused with resin
- Will the dry fabrics maintain alignment during filling and wetting of fibers

ESI PAM-COMPOSITES

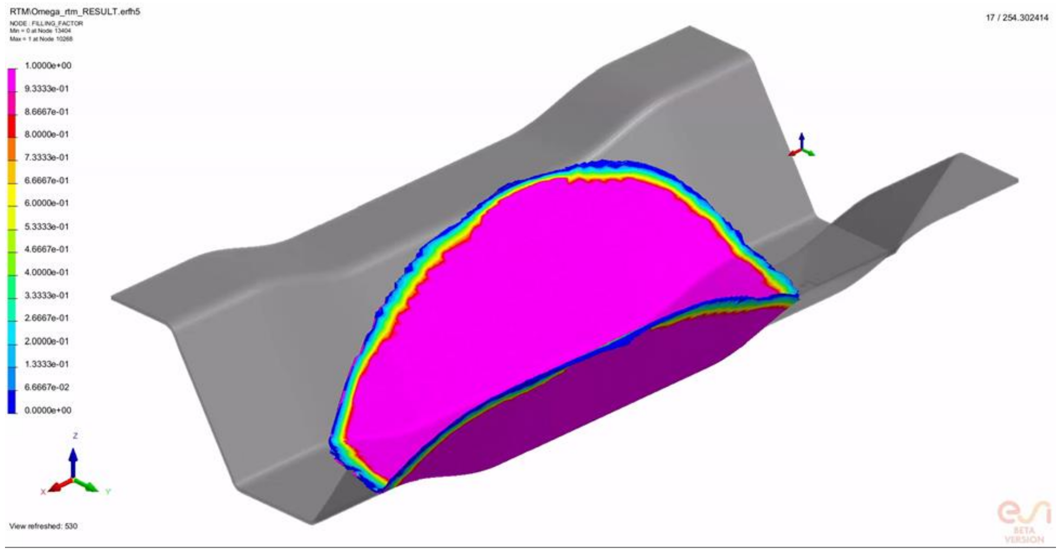
- Infusion application: Large dimension parts

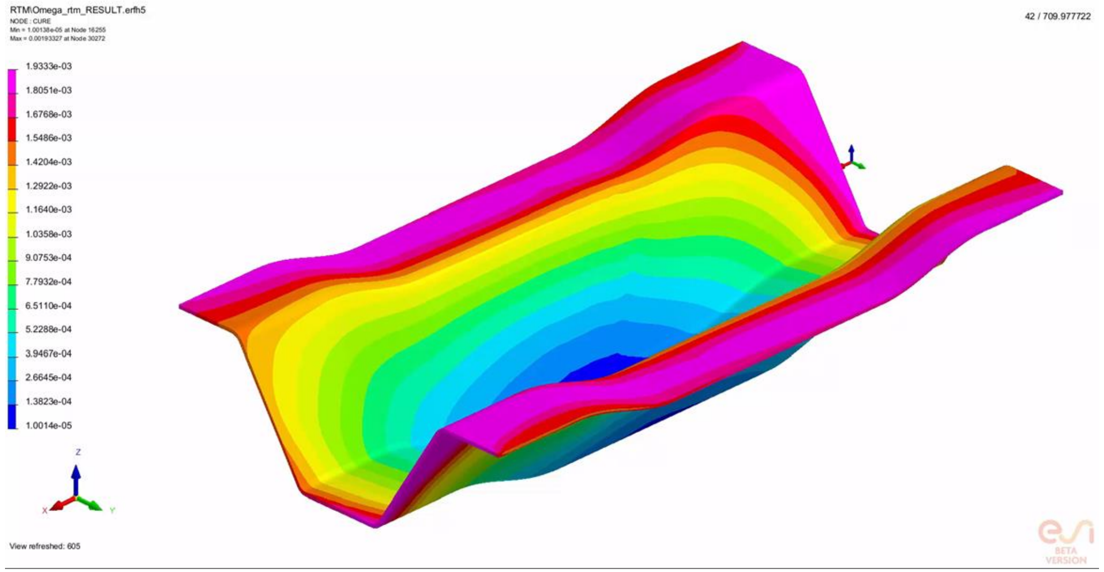


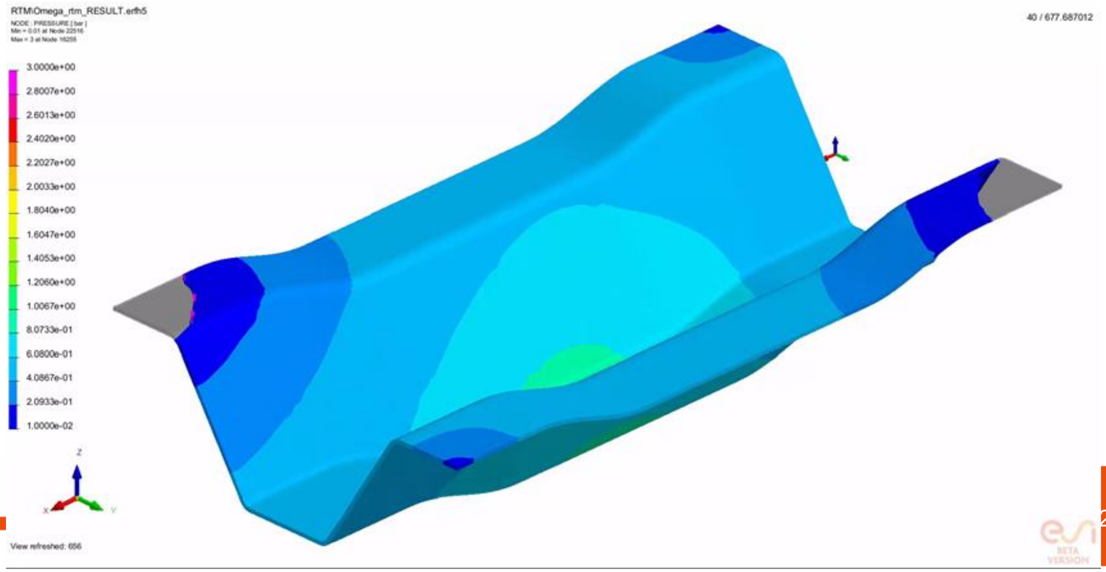


AIRBUS

Fuselage panel infusion





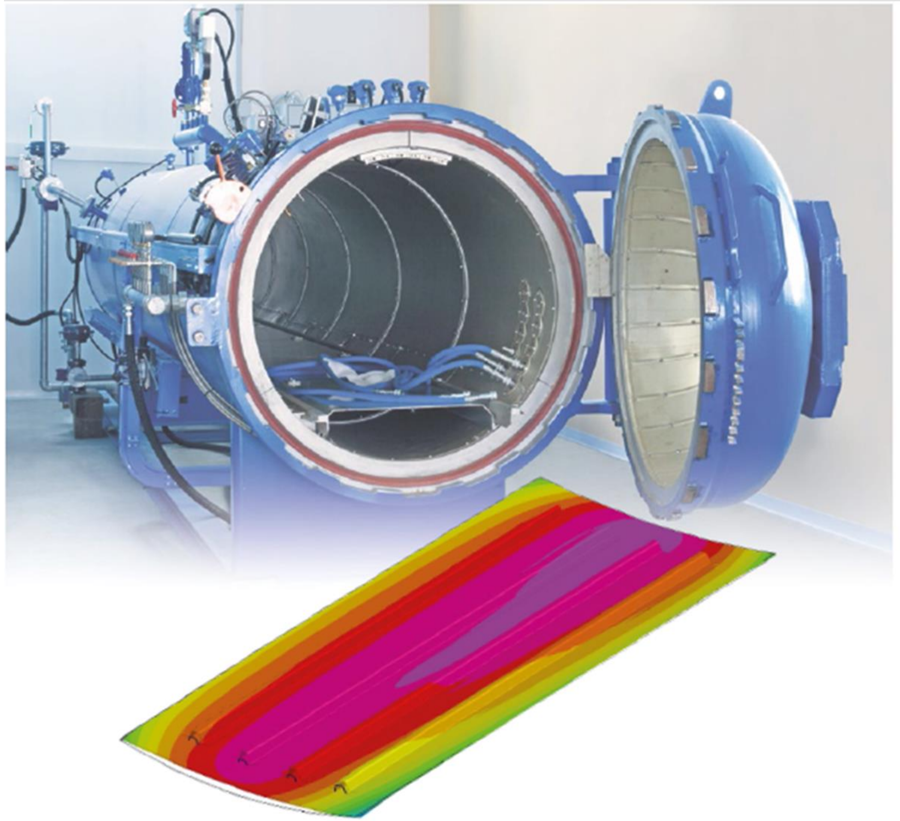


- RTM_Filling_factor.mp4
- RTM_CuringDegree.mp4
- RTM_pressure.mp4

What's next?

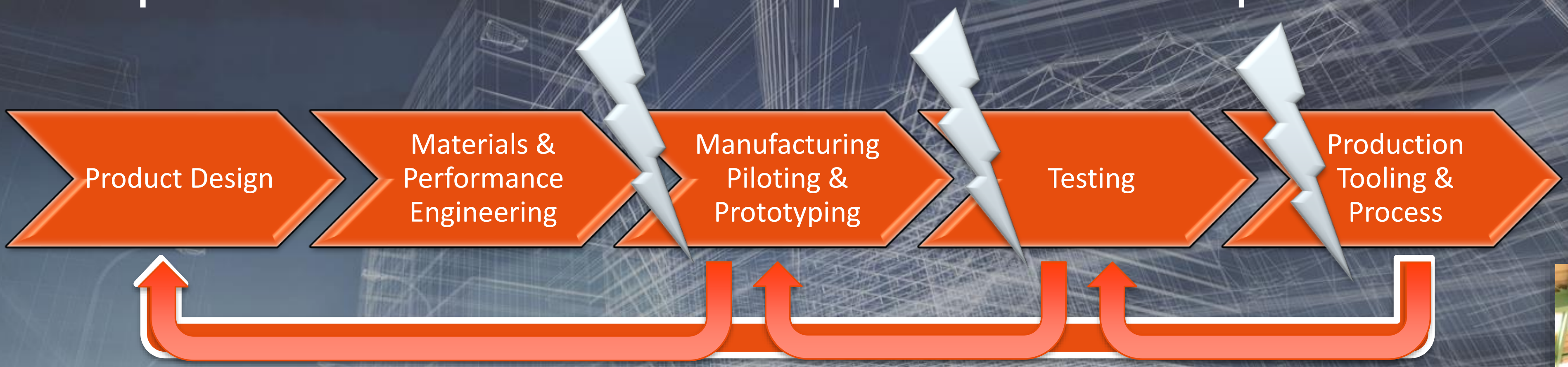
For Dry fibers filling and infusion then curing

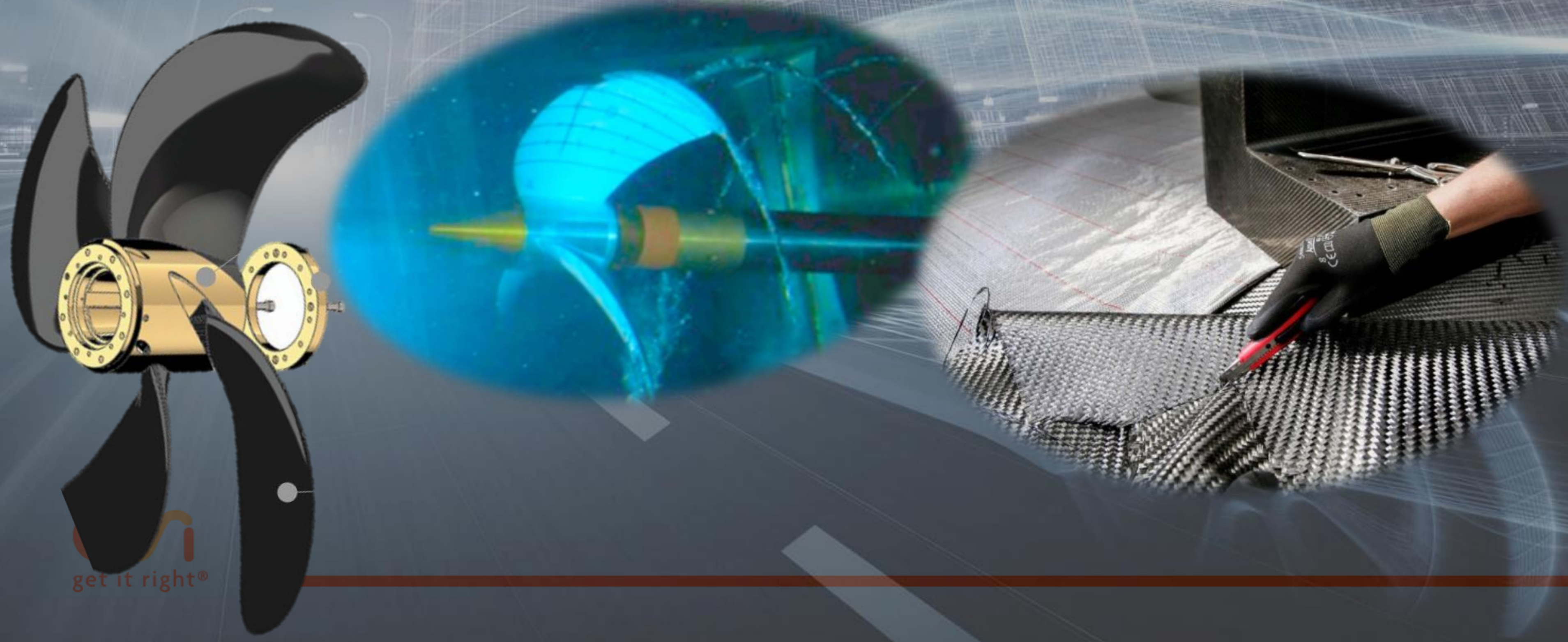
Curing for thermoset pre-preg



Curing_cure_degree.mp4

Composites in a conventional product development value stream





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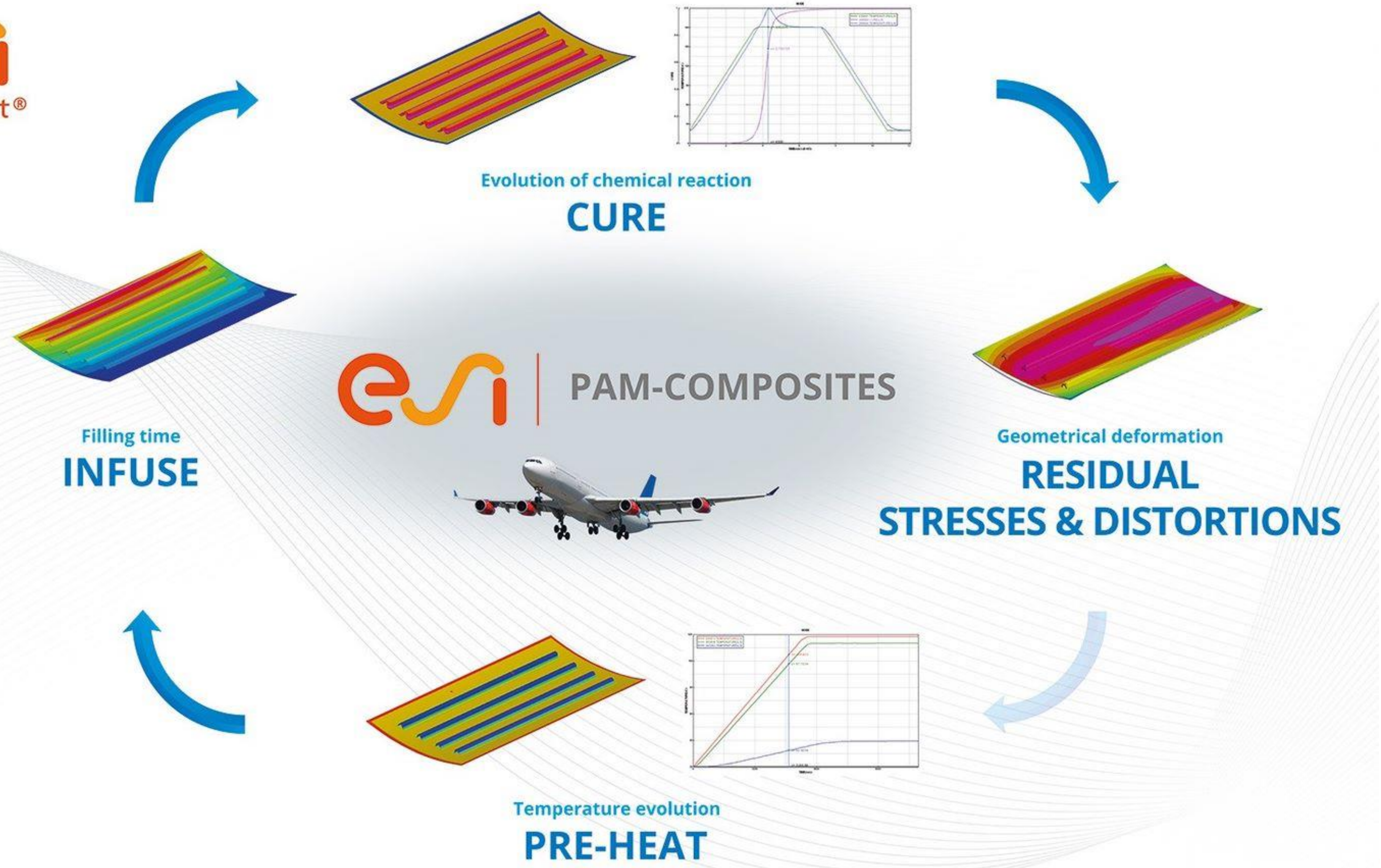
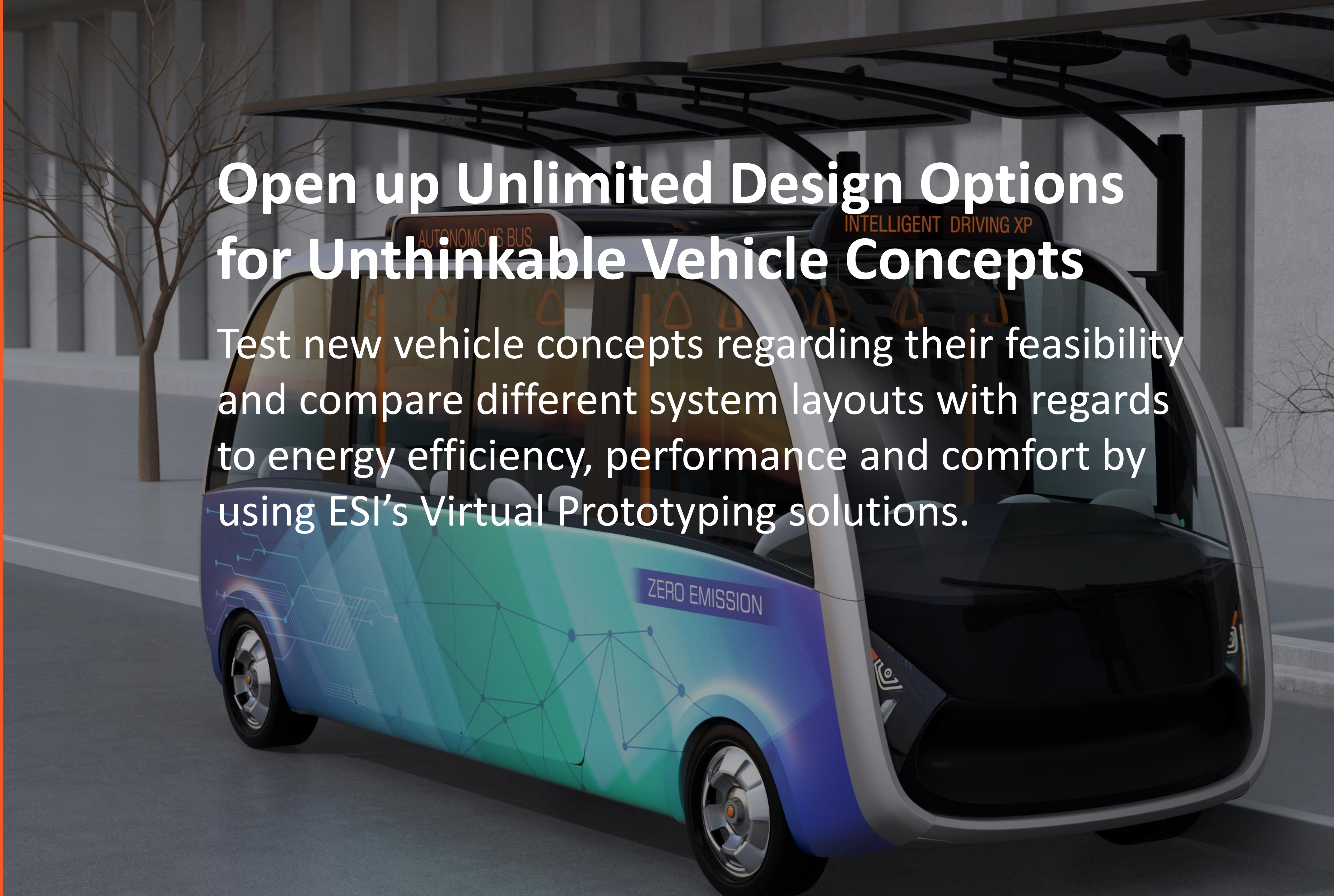


Evolution of chemical reaction
CURE
PAM-COMPOSITES
Filling time
INFUSE
Geometrical deformation
RESIDUAL
STRESSES & DISTORTIONS
Temperature evolution
PRE-HEAT

get it right®

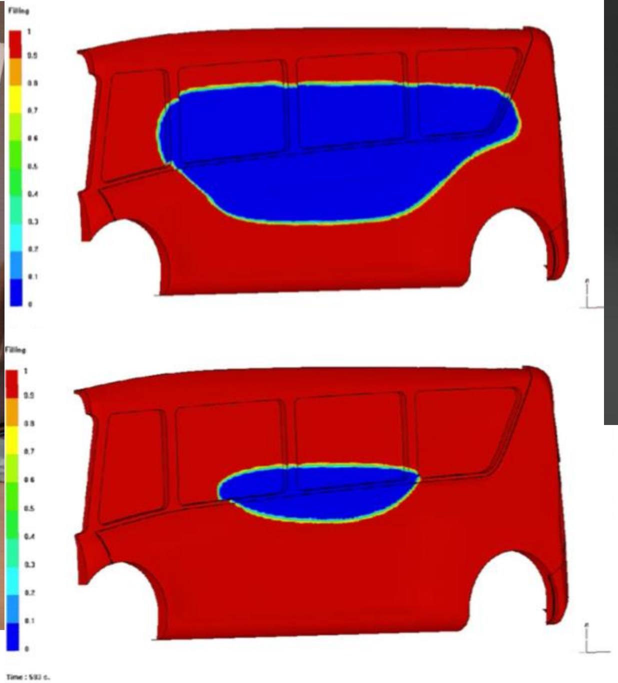
Open up Unlimited Design Options for Unthinkable Vehicle Concepts

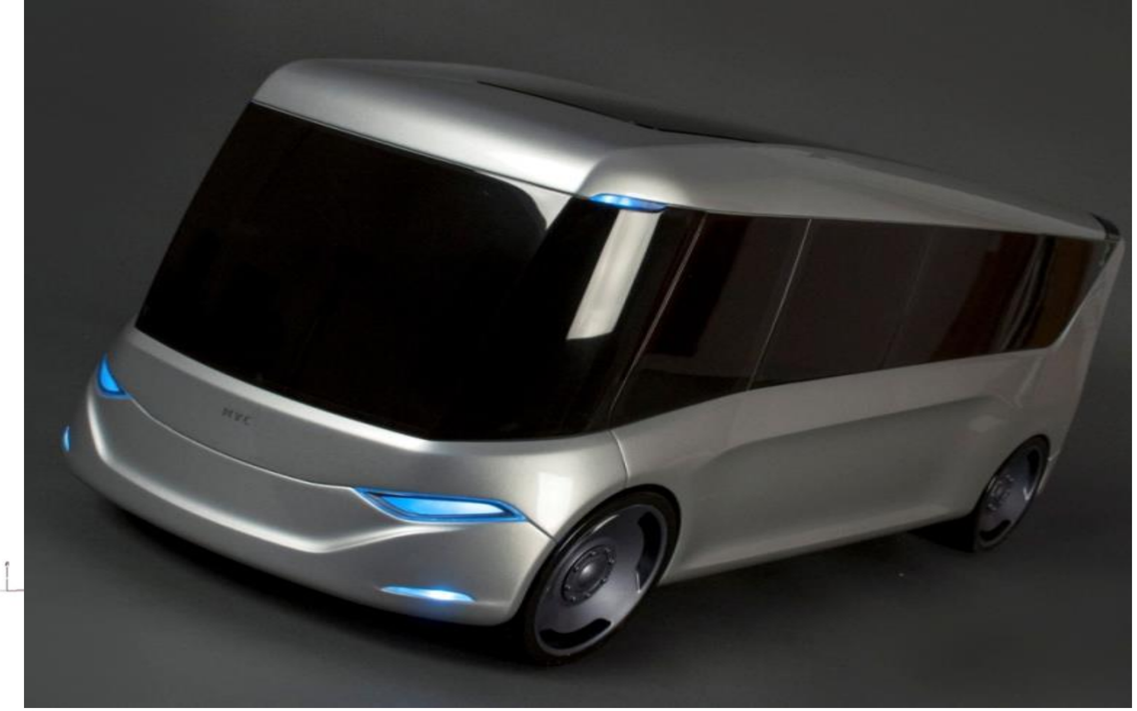
Test new vehicle concepts regarding their feasibility and compare different system layouts with regards to energy efficiency, performance and comfort by using ESI’s Virtual Prototyping solutions.



ESI PAM-COMPOSITES

Light RTM application: Bus body side





- 13*6.5 feet
- fiberglass Chopped Strand Mat (CSM)
- integrated flow media
- Polyester resin

Optimum resin flow pattern computed with PAM-RTM

"In this project, the RTM simulation helped us to secure and to optimize the process. Today, we are using ESI's PAM- RTM not only to assess process parameters, including injection time and pressure in mold, but also to fine-tune mold design."

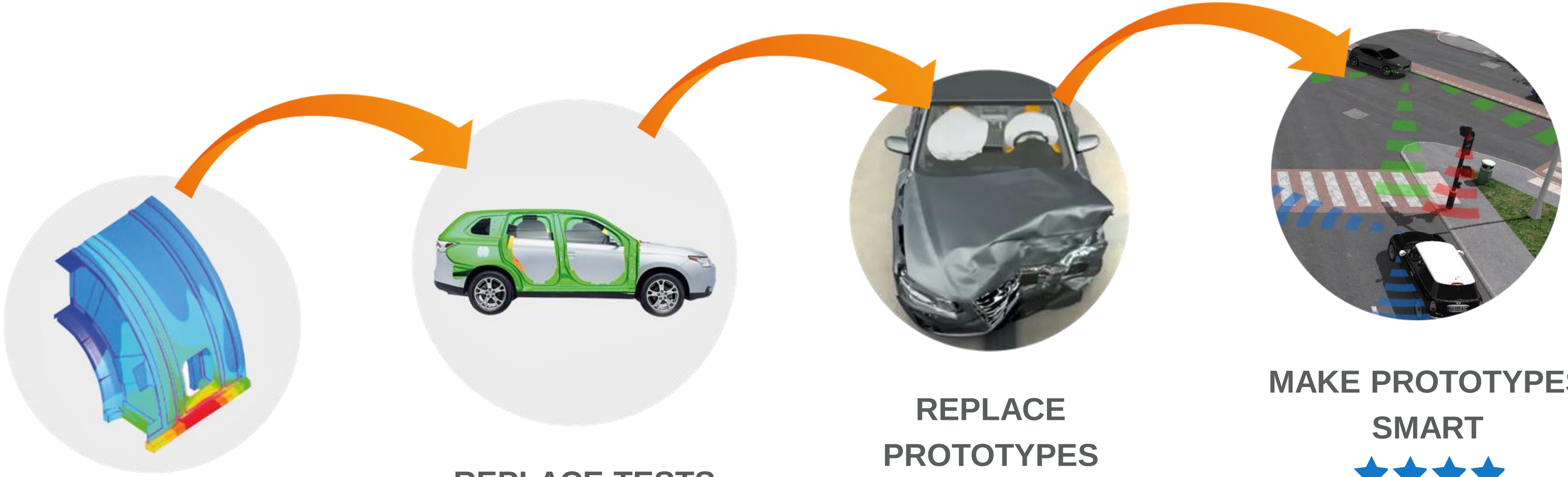
Jérôme RAYNAL
Sales and Export Director
Pôle de Plasturgie de l'Est

MVC SOLUÇÕES EM PLÁSTICOS

PPE

Virtual Prototyping Delivers Exponential Benefits

Moving from inert to intelligent and autonomous



CONDUCT DESIGN CHECKS ★

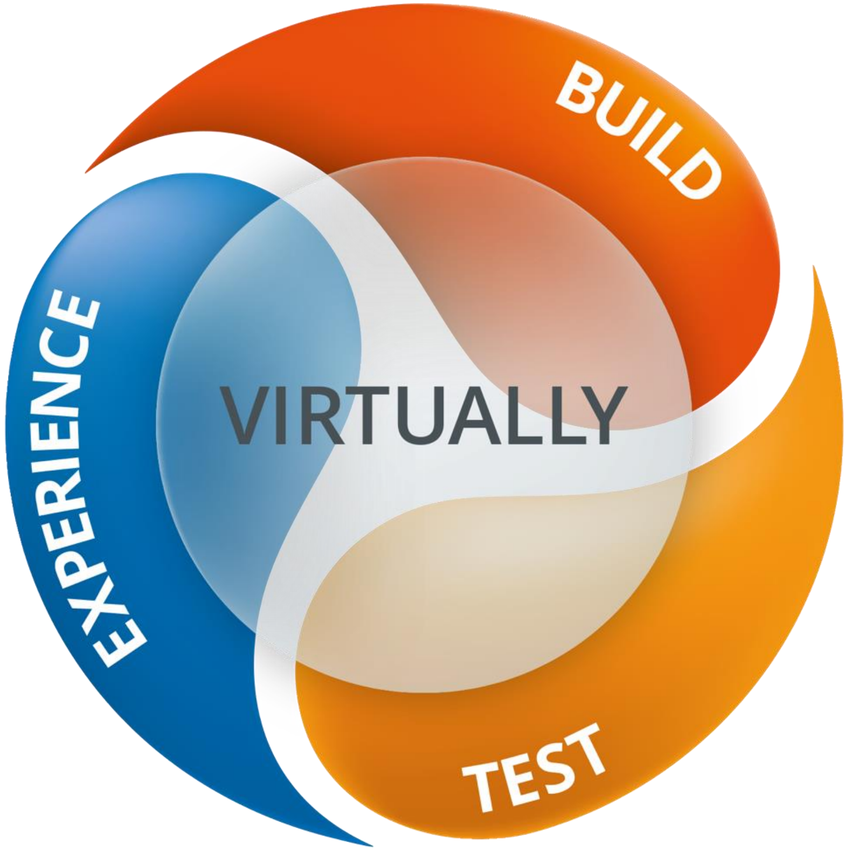
REPLACE TESTS ★★

REPLACE PROTOTYPES ★★★

MAKE PROTOTYPES SMART ★★★★

Images courtesy of Mitsubishi Motors and Audi AG.

Mission & Vision



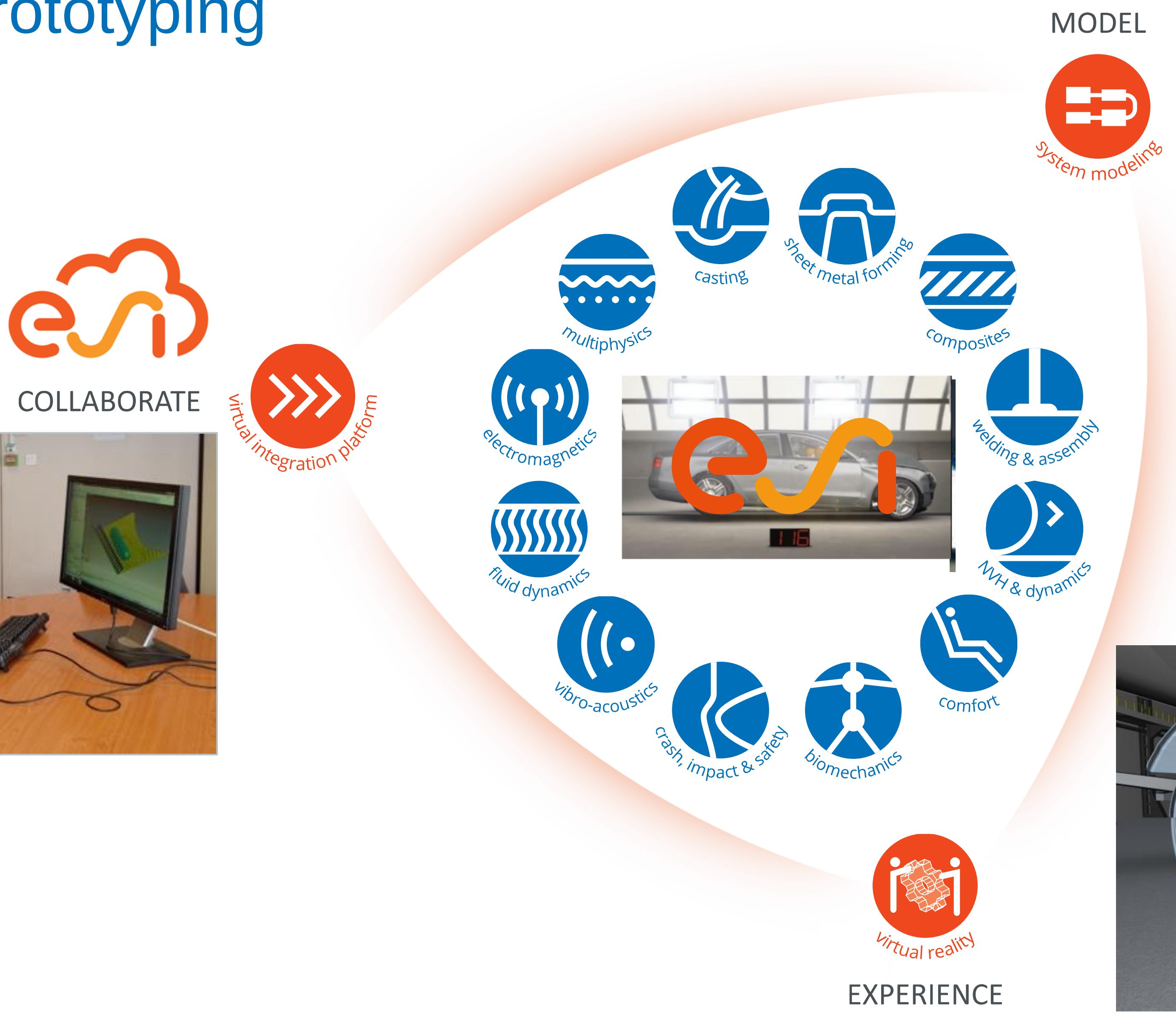
ESI’s Mission

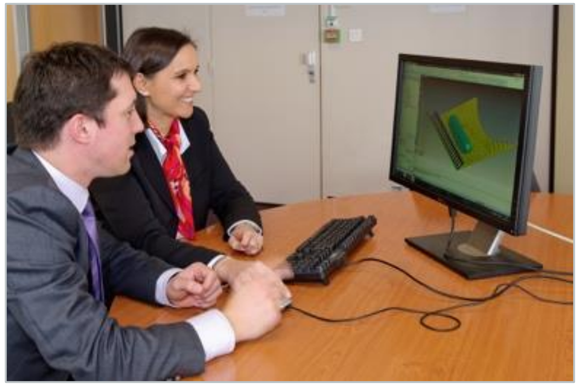
Deliver Virtual Prototyping solutions that improve industrial product development

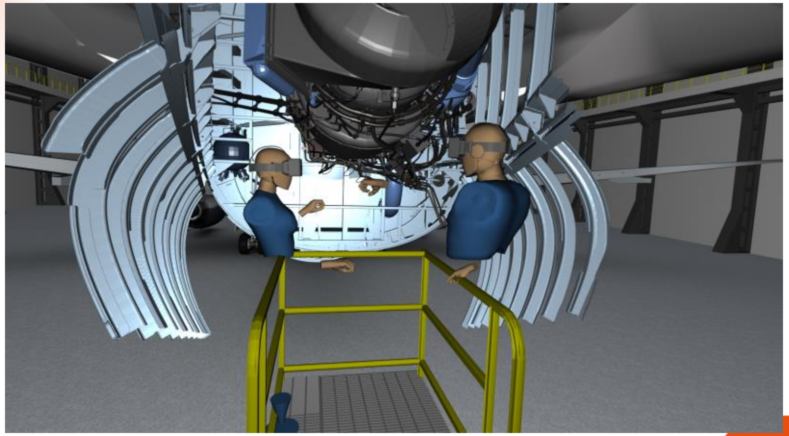
ESI’s Vision

Be the leader in Virtual Prototyping thanks to a unique knowledge in material physics

Virtual Prototyping







Images courtesy of Alupress AG, Mitsubishi Motors, PSA Peugeot Citroën, Renault and Audi AG.