

Ansys Composite Solutions Simulation Tools

Layered Composites Introduction

Ansys Composite Simulation Tool Summary

- Ansys has many simulation tools available for composites.
- While this course is designed to be foundational in nature and simulation tool agnostic, knowing about the extensive portfolio of Ansys composite simulation tools can help you when you take this foundational knowledge and apply it using simulation.
- Many Ansys products can support the simulation of composites, and this short presentation is intended to highlight some of those tools and a small fraction of the capabilities.
- More comprehensive product information, training and help can be found on the Ansys.com Website, Ansys Help, Ansys Innovation Space, and Ansys Learning Hub.

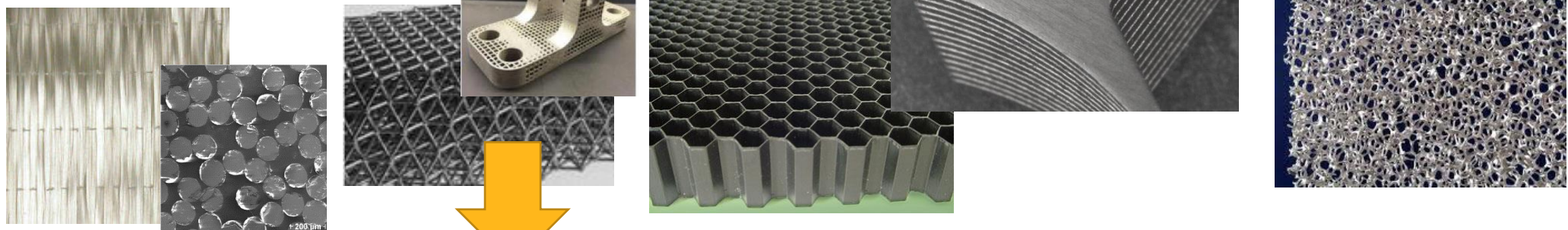
Ansys Composite Simulation Tool Summary

- The following products will be briefly touched upon.
 - Ansys Material Designer
 - Ansys Composite PrepPost (ACP)
 - Ansys Composite Cure Simulation (ACCS)
 - Ansys Short Fiber Composite Workflow
 - LS-DYNA for Composite Simulations

Material Designer

Material Designer

Parts with a
Complicated
Microstructure

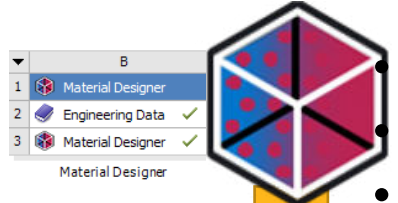
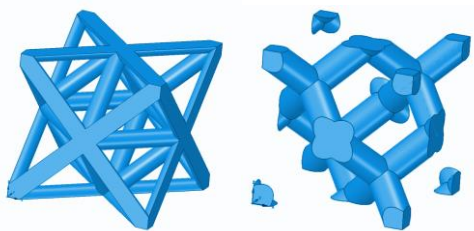
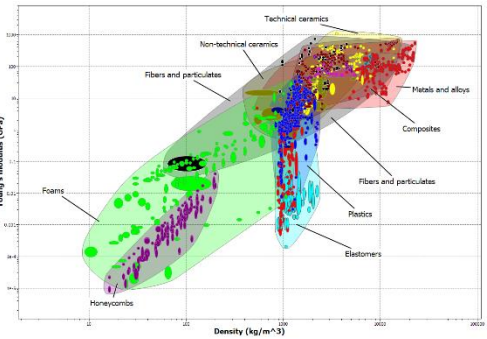


GRANTA

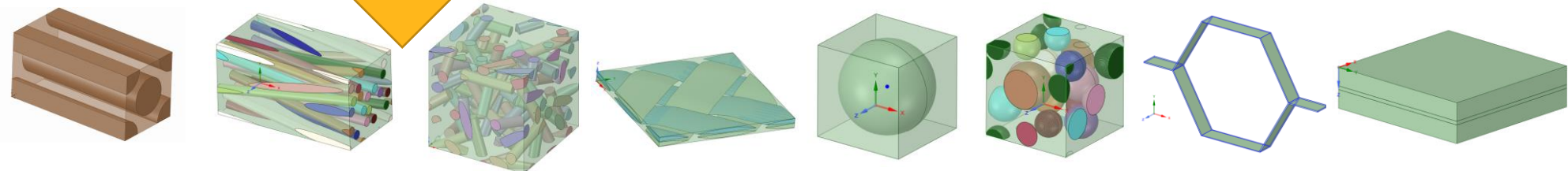
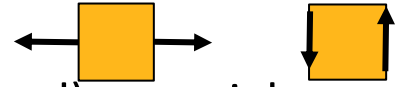
MATERIAL DESIGNER

MECHANICAL, ACP

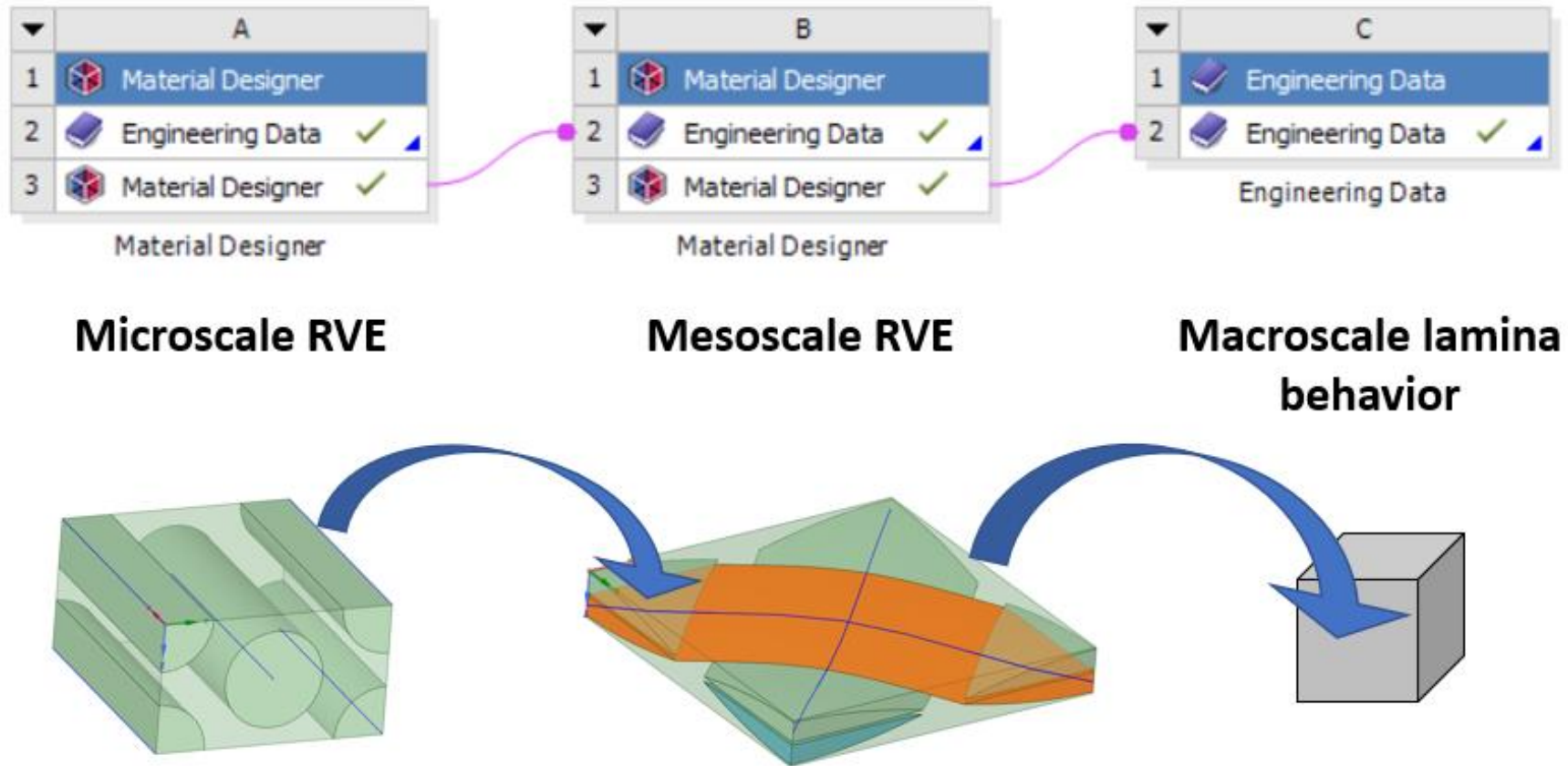
MECHANICAL



- Model the micro-structure (RVE)
- Expose it to a set of unitary load cases
- Extract the (force) results
- Obtain homogenized (averaged) material properties



The homogenized properties defined by Material Designer can be used in Mechanical or Ansys Workbench



Material Designer can be completely parameterized: optimize RVE architecture and material properties in an optimization workflow

Ansys Composite PrepPost (ACP)

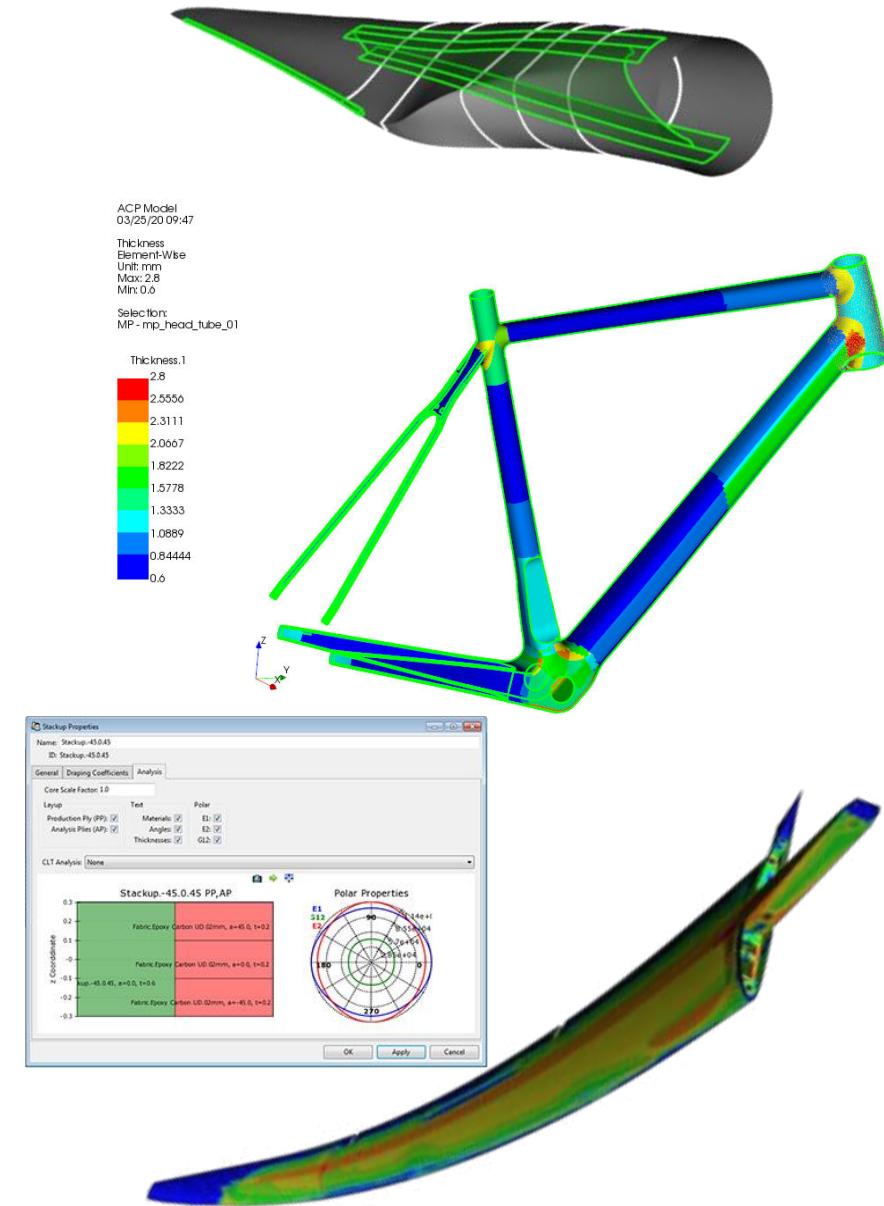


Ansys Composite PrepPost

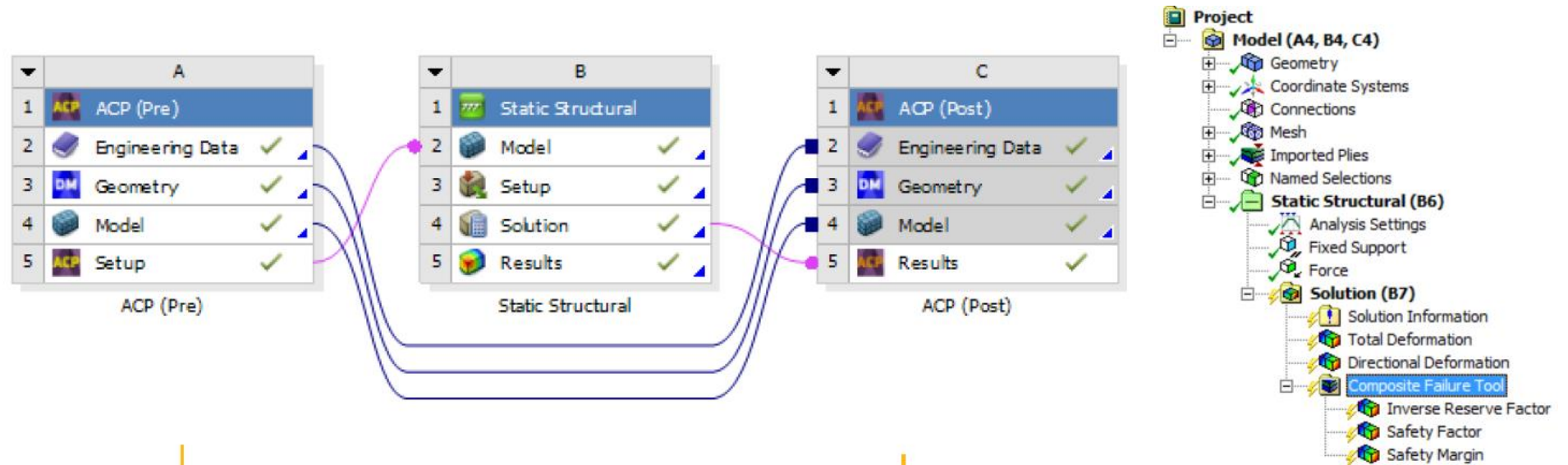
The light, strong and versatile properties of composite materials make them attractive for many types of manufacturing. Ansys offers a complete suite of tools to help users with their simulation.

Ansys Composite PrepPost (ACP) is an advanced and dedicated tool for layup modeling and failure analysis of thin and thick-walled composite structures

- Arbitrary layered composite models for static and transient simulations (implicit and explicit)
- Efficient and detailed model and result review
- Allows to combine composite and non-composite parts in one simulation model
- Best-in-class shell and solid element modeling capabilities
- Efficient ply- or zone-based layup modeling
- Built-in tools for defining ply sequences, material orientation, ply extents, variable material data etc.
- Import layup definitions from 3rd party manufacturing simulation software through open Composite CAE H5 interface



Project Schematic with Ansys Composite PrePost (ACP)



Pre-processing

- Material
- Geometry
- Mesh
- Composite Lay-up

Composite Lay-Up Modeling

Simulation

- Loads
- Boundary Conditions
- Solution
- Mechanical Postprocessing

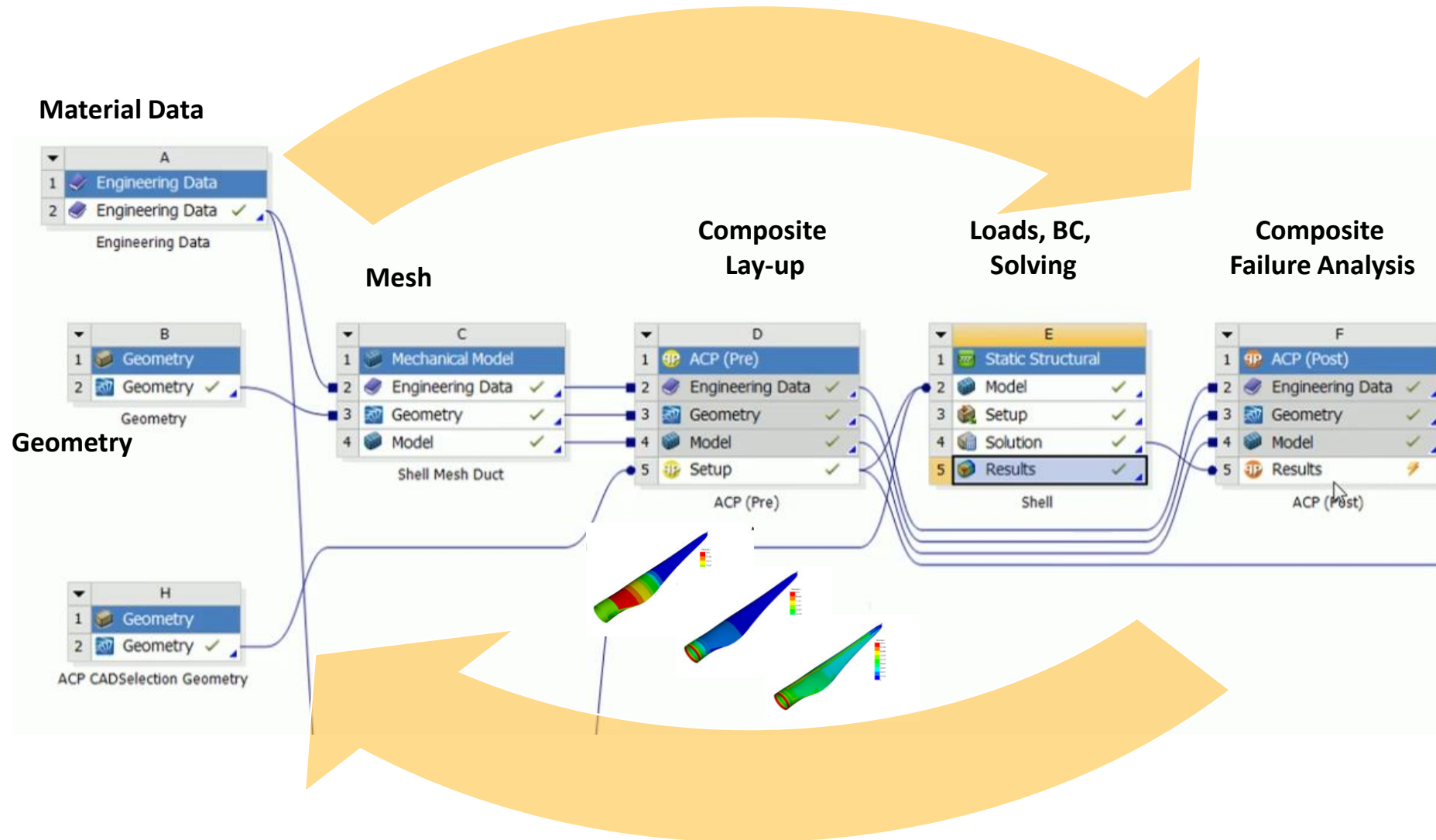
Structural and thermal solving capabilities

Post-processing

- ACP Postprocessing
- Composite Tools in Mechanical
- DPF Composites (will be released soon)

Composite Failure Analysis

Ansys Workbench Associative Composite Workflow



Ansys Composite Cure Simulation (ACCS)

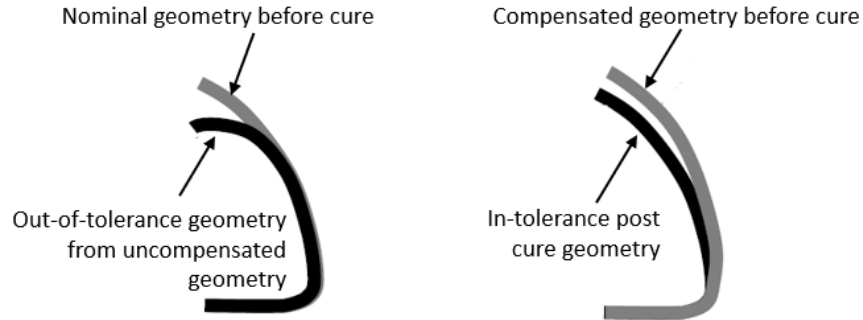


/ Curing Simulation

Ansys Composite Cure Simulation (ACCS) simulates the curing manufacturing process of a part and predicts residual stresses and process-induced distortions

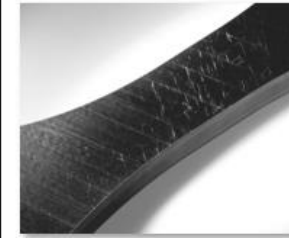
- Simulate the thermal-chemical reaction and predict the development of residual stresses and process induced distortions (PID) during composite manufacturing.
- Optimize the curing process (exothermic peak) and design the heating and cooling systems.
- Compensate the tooling geometry to meet the geometrical tolerances or to design the assembly process resulting with the minimal built-in stresses.
- Also applicable to non composite polymer materials e.g., adhesives, electronic packaging, coating

Tool Compensation

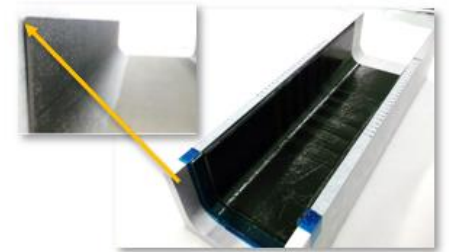


Layered Composites

Residual stress induced crack



Spring-in in a composite spar section



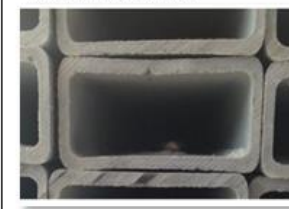
epoxy packaging

Residual stress induced cracks



Pultrusion

Distorted profile



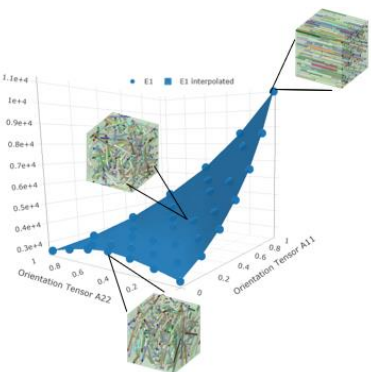
Residual stress induced crack



ANSYS

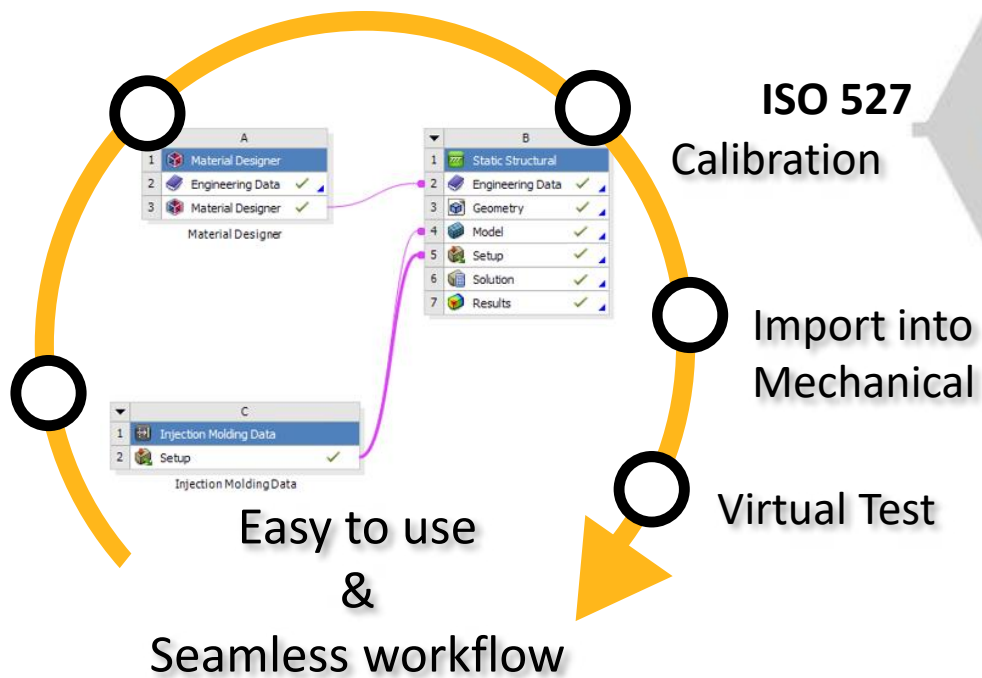
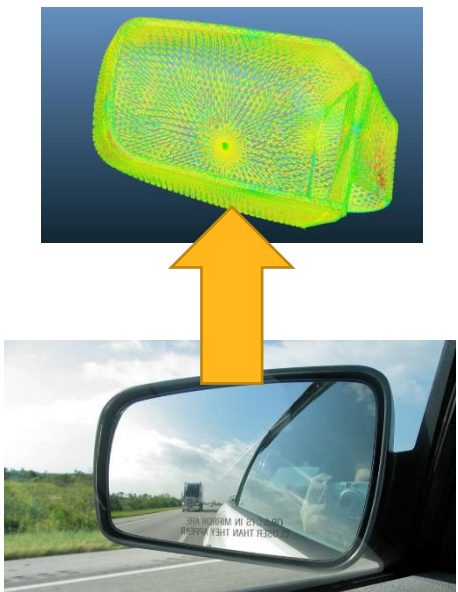
Short Fiber Composite Workflow

Short Fiber Composites



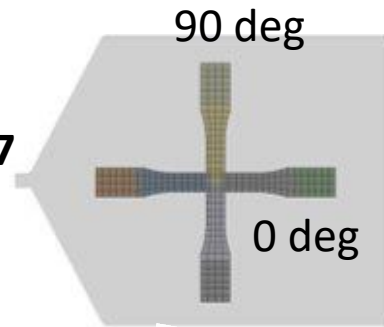
Material Response

Injection Simulation



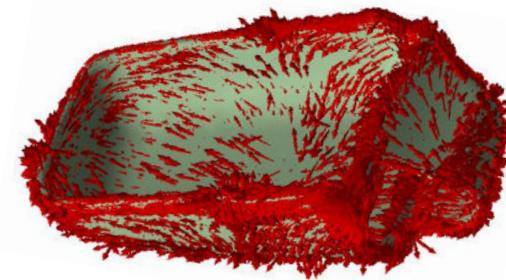
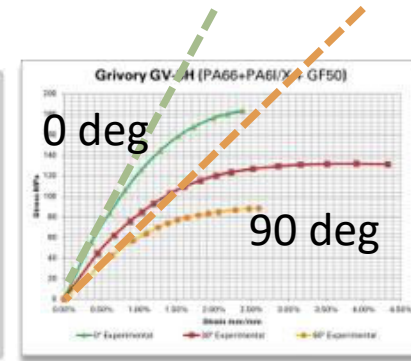
ISO 527

Calibration



Import into Mechanical

Virtual Test



[Introducing the New Short Fiber Composites Workflow with Ansys Mechanical | Ansys Webinar](#)

LS DYNA

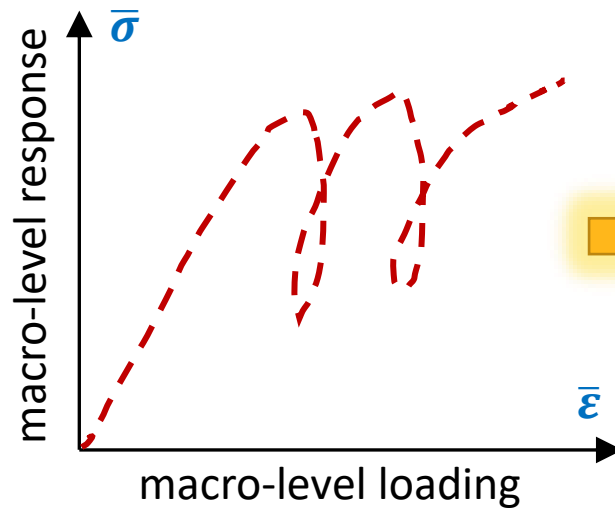


Multiscale material modeling in LS-DYNA: RVE Analysis

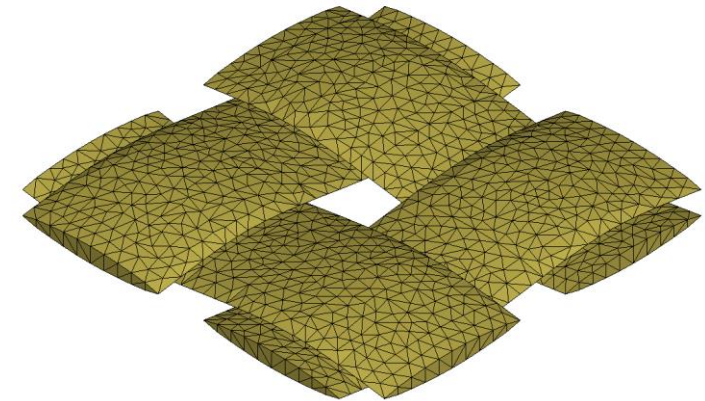
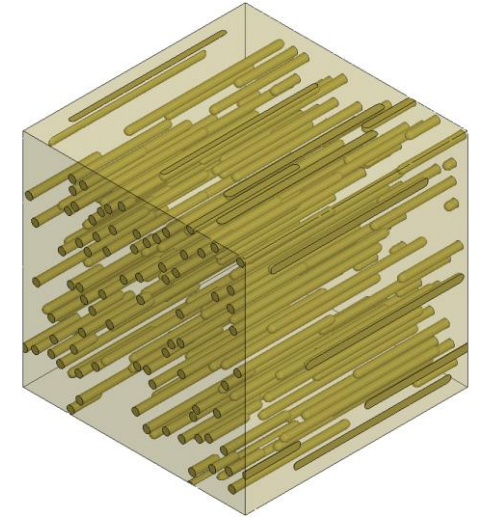
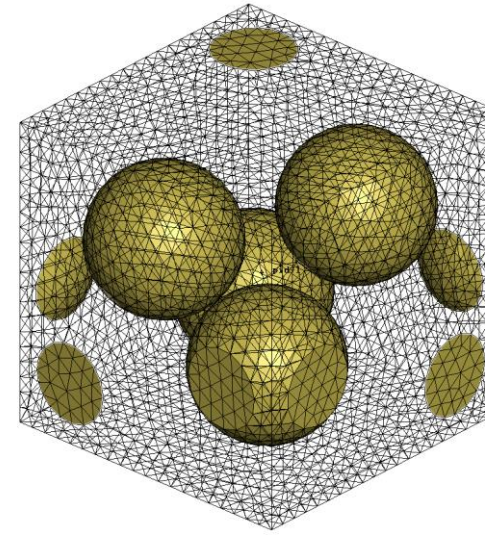
□ Computational Homogenization

❖ **Keyword **RVE_ANALYSIS_FEM* in *LS-DYNA R13***

- ✓ Virtual testing of materials
- ✓ Calibration of constitutive laws
- ✓ Accelerated design & analysis for composite materials



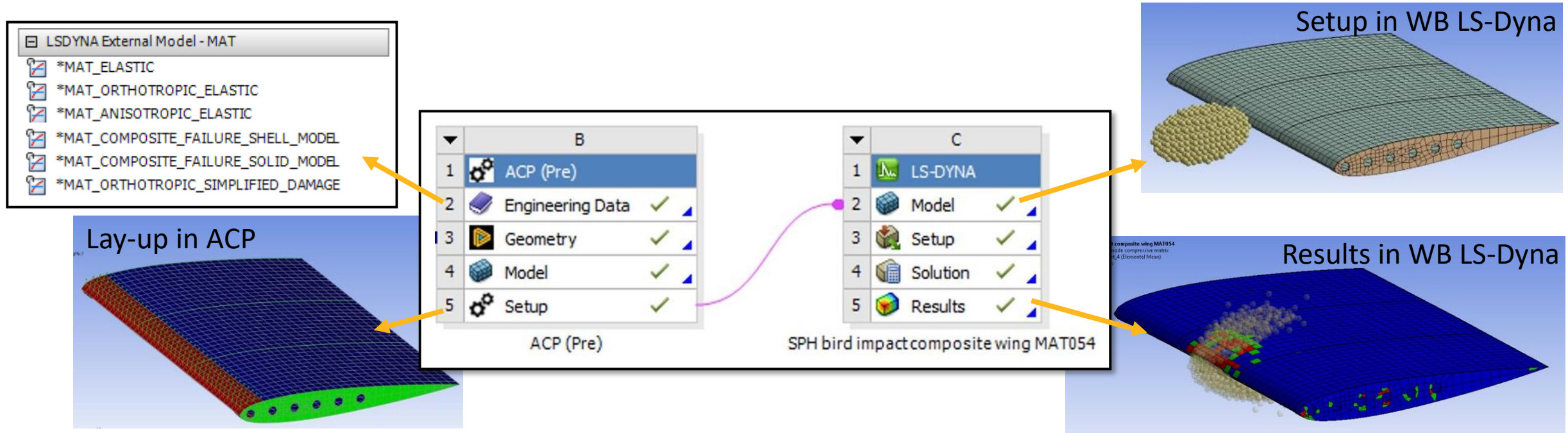
- Linear model
 $\bar{\sigma} = \bar{C} : \bar{\epsilon}$
- Non-linear model
 $\bar{\sigma} = f(\bar{\epsilon}, \beta_1, \beta_2, \beta_3, \dots)$



❖ Example input files can be downloaded online: <https://www.lstc-cmmq.org/ex-rve>

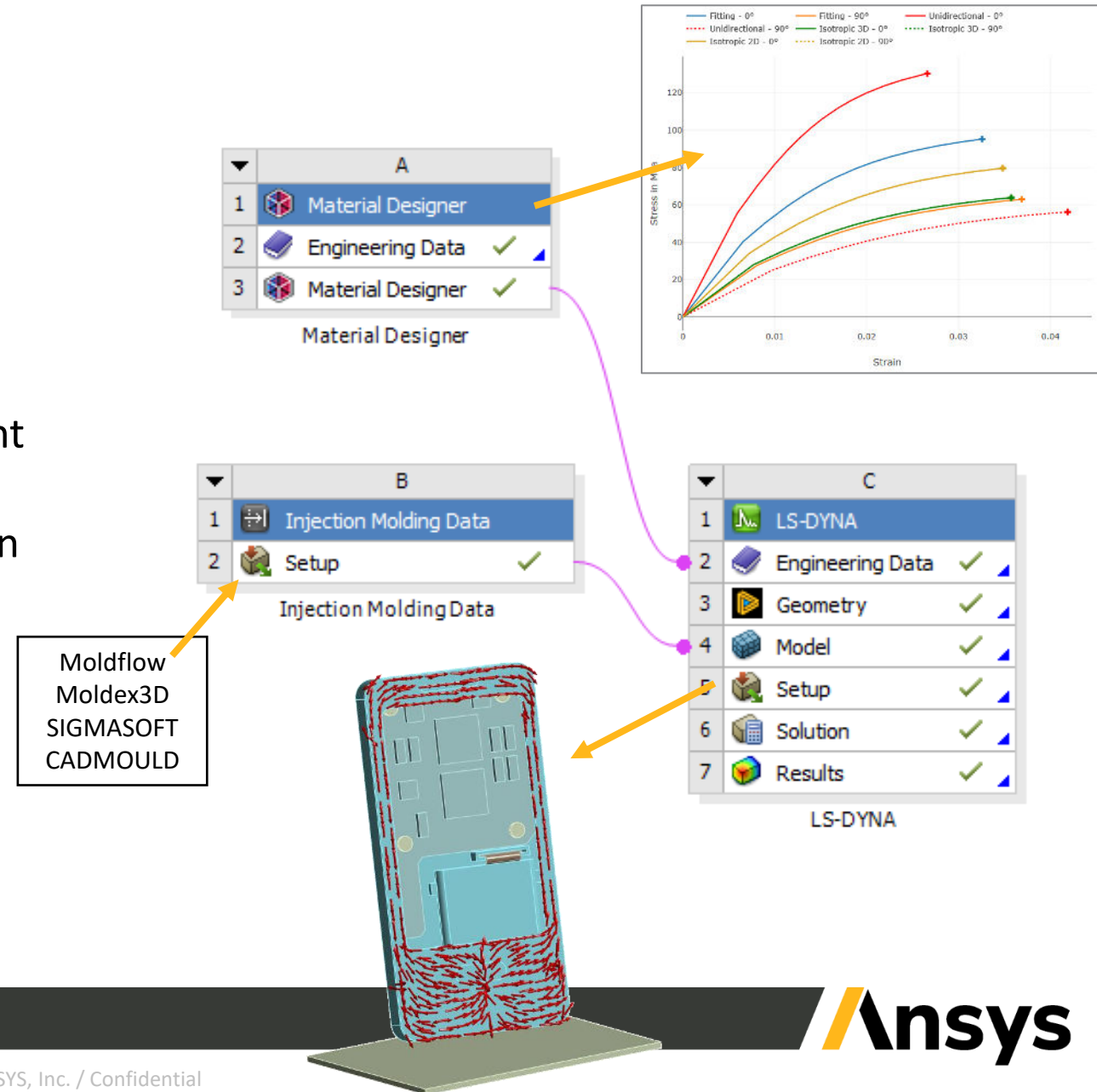
ACP to LS-DYNA Workflow in Workbench

- Analyze composite structures with respect to crash and impact: WB LS-DYNA as a preprocessor to realize LS-DYNA model of complex composites parts (further modifications and analysis in LSPP are possible after export)
- Supports shell models as *ELEMENT_SHELL, **solid models** as *ELEMENT_TSHELL and any kind of **assemblies** (new)
- Many LS-DYNA material cards are now available in **Engineering Data** allowing the definition of a material card per ply material



Short Fiber Composites in Workbench LS-DYNA

- Same workflow for implicit (MAPDL) and explicit analyses (LS-DYNA):
 - Import results from the most popular injection molding simulation tools using the **Injection Molding Data** system.
 - Calibrate the anisotropic, orientation-dependent elasto-plastic material in **Material Designer**.
 - Set up the model and post-process the results in **Mechanical**.



The Ansys logo, featuring a stylized yellow and black 'A' followed by the word 'nsys' in black.

