

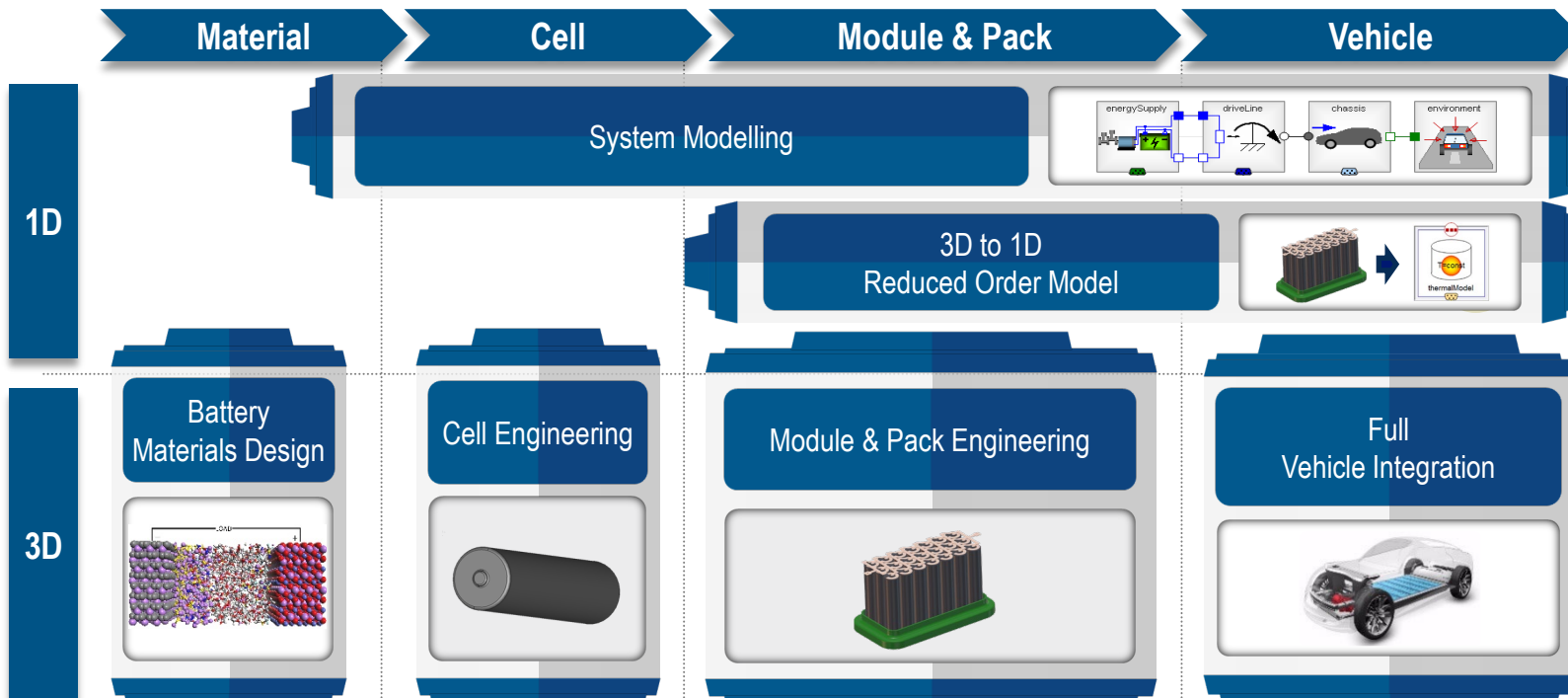


Battery Module Optimization

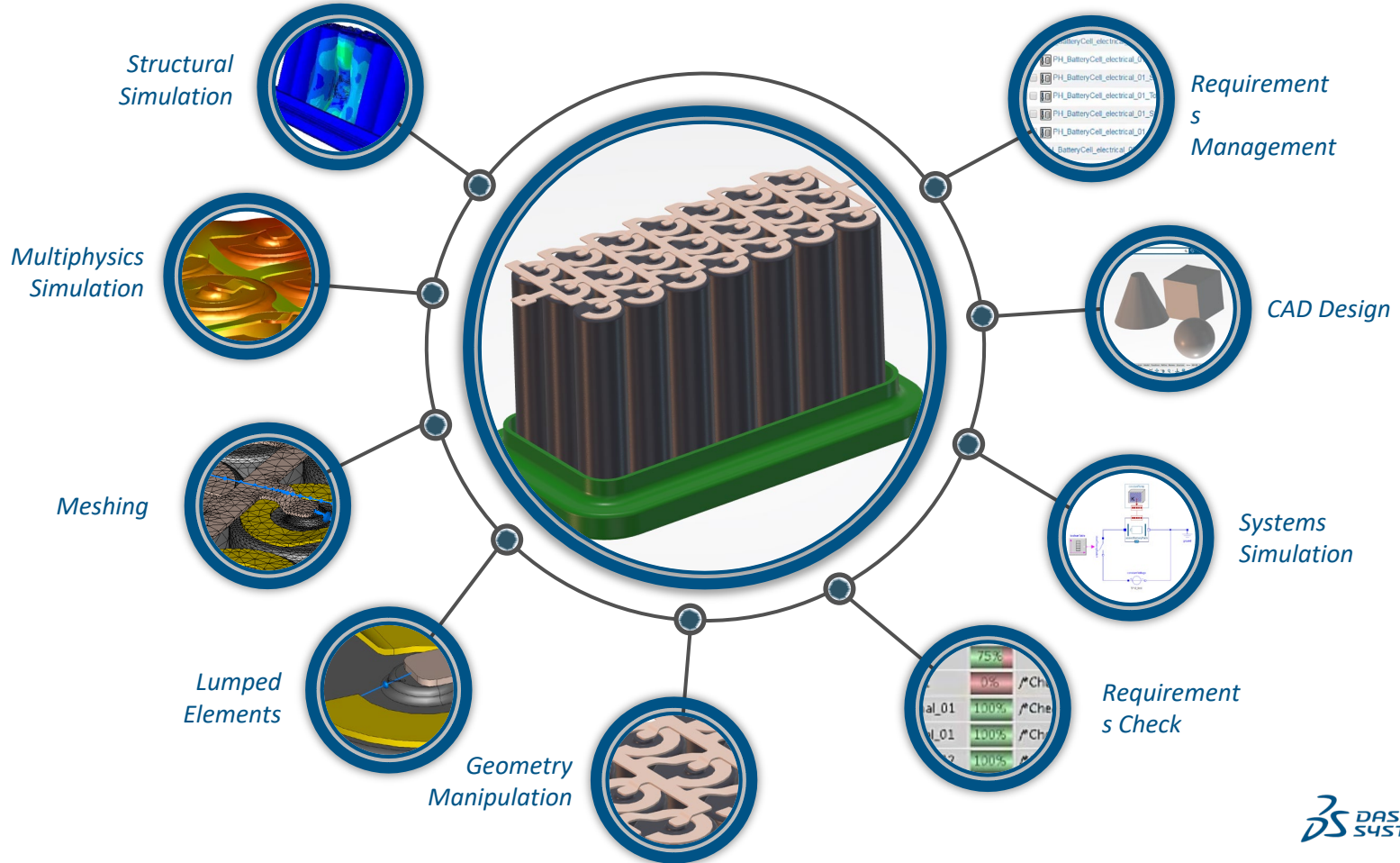
Chris JONES

3DEXPERIENCE[®]

Battery Cooling and Aging Solution



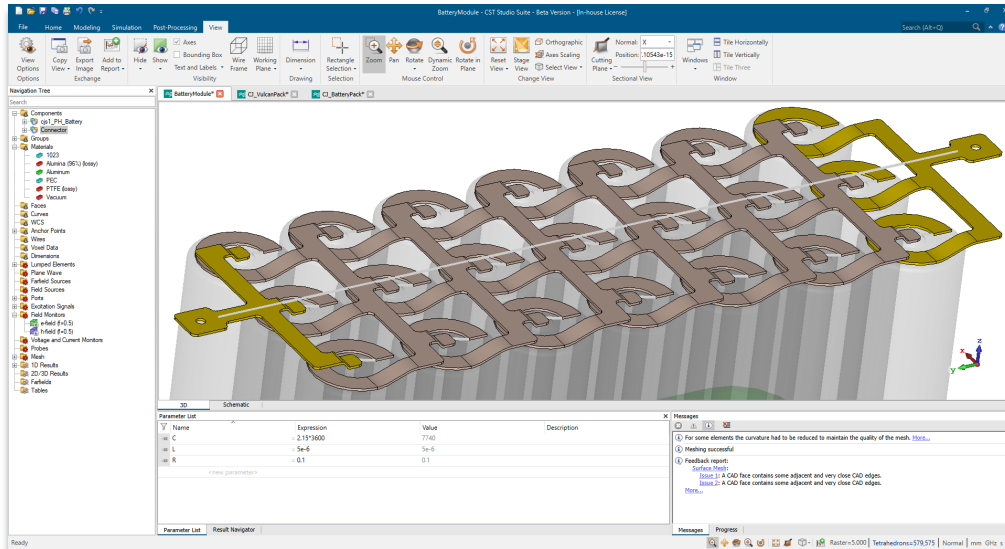
Engineering Process





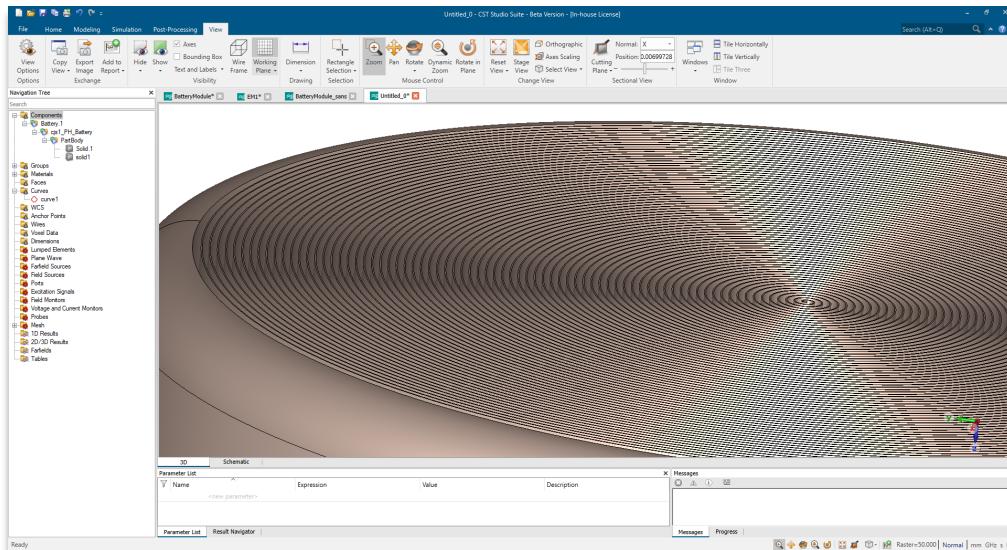


Wiring Plane Model Preparation



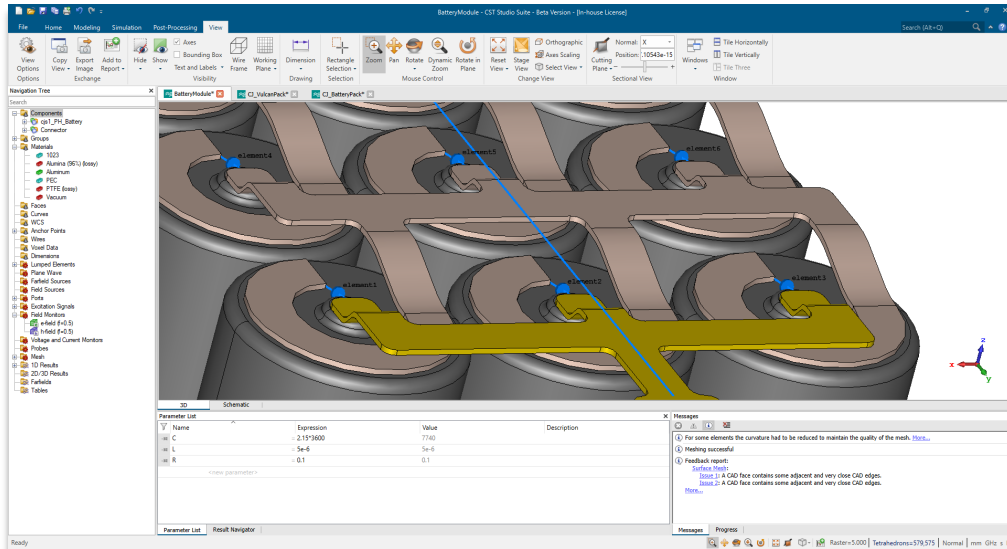
- ▶ Imported Geometry Manipulation
- ▶ De-featuring
- ▶ Material properties

Full Fidelity Cell model



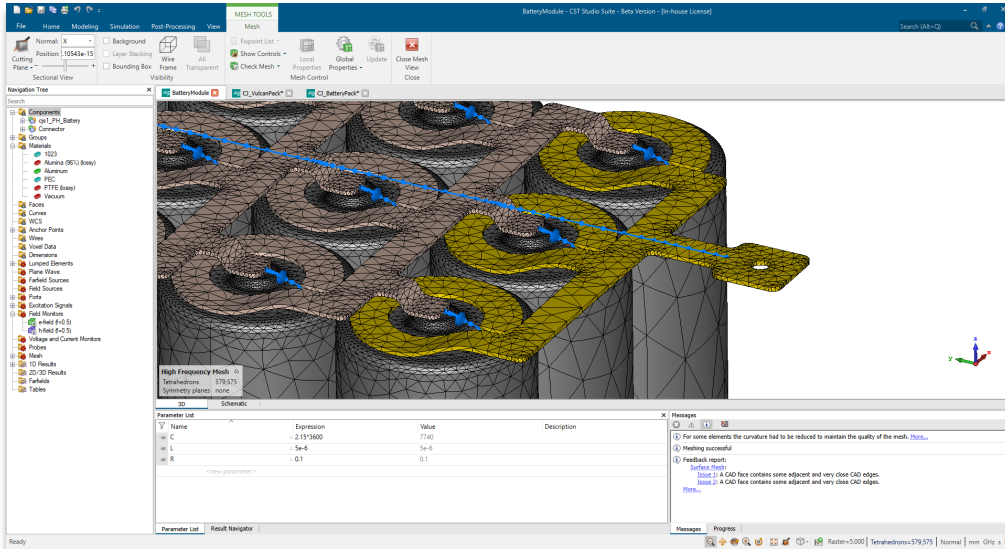
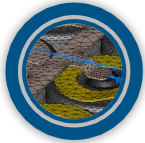
- ▶ High fidelity geometry
- ▶ Detailed material properties
- ▶ Calculate broadband equivalent circuit values
- ▶ Electrostatic Simulation

Lumped Elements



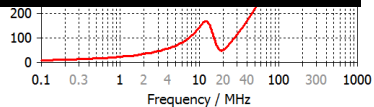
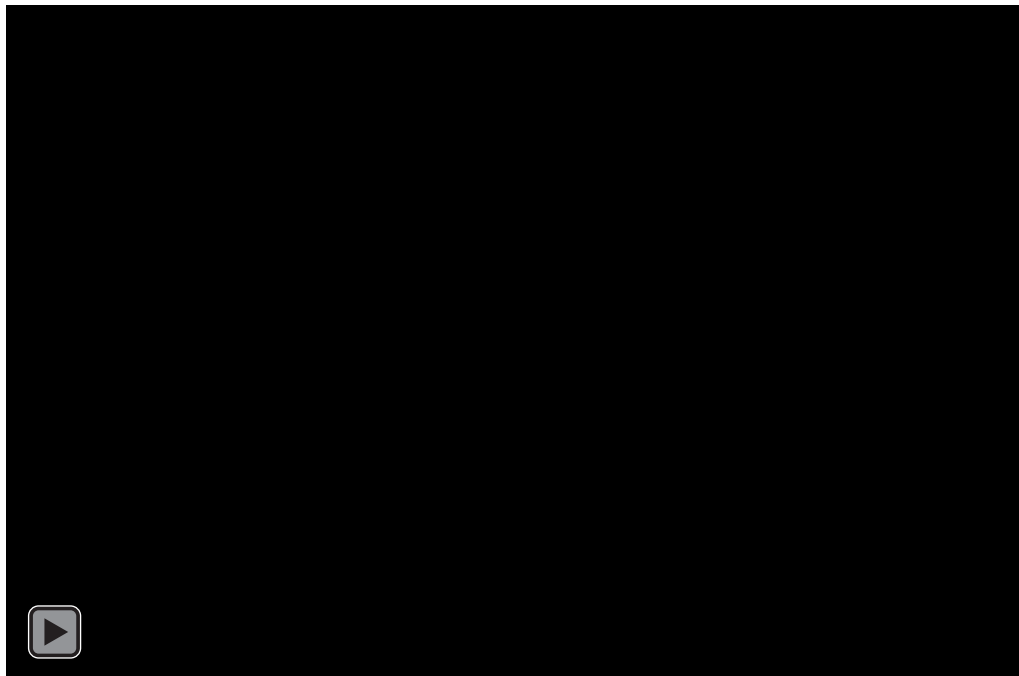
- ▶ Battery cell described by lumped elements
- ▶ Simulation set-up
- ▶ Boundary conditions
- ▶ Field monitors

Meshing



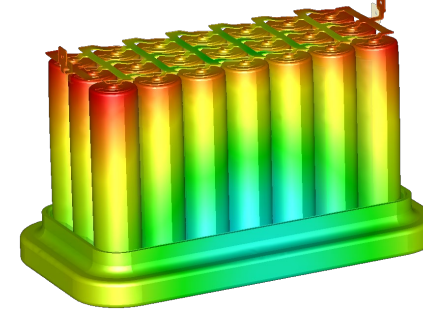
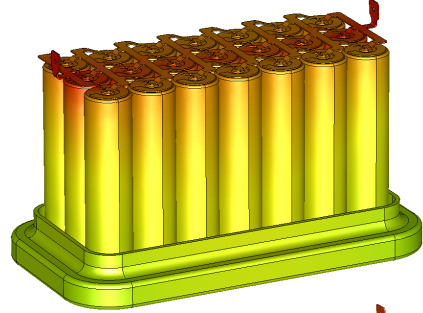
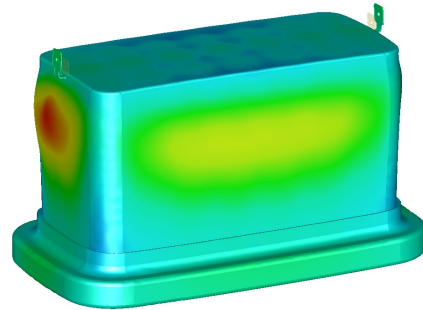
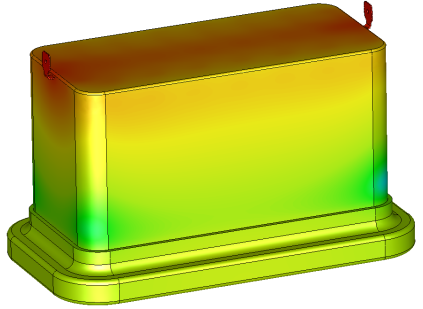
- ▶ Solver selection
- ▶ Adaptive mesh refinement
- ▶ Time domain and frequency domain solvers

Electromagnetic Simulation Results



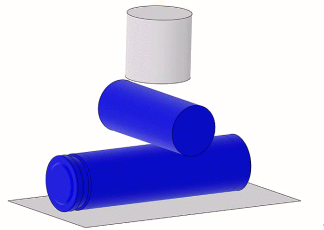
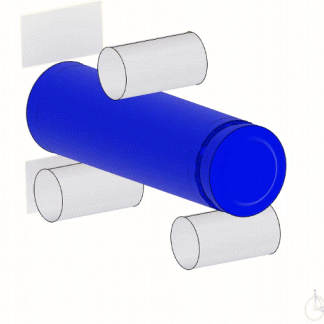
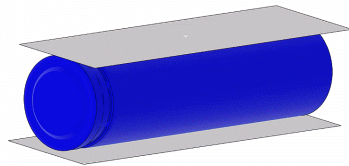
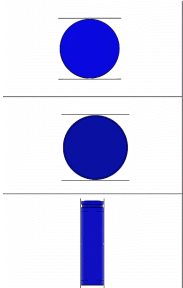
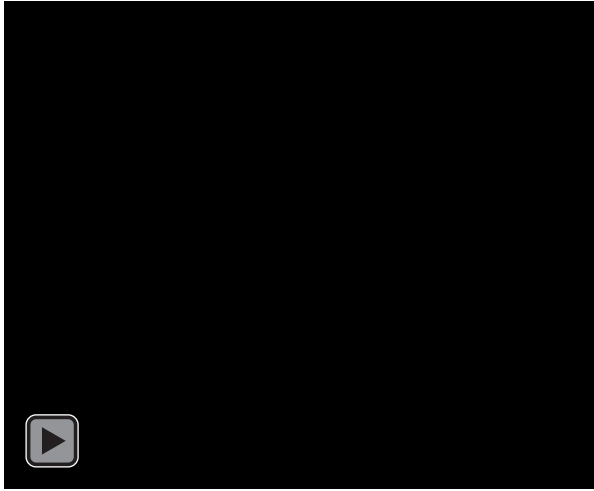
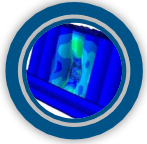
- ▶ Radiated emissions
- ▶ Total impedance
- ▶ Surface currents

Multiphysics Simulation



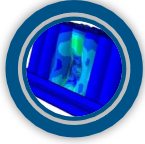
- ▶ Multiphysics simulation chain
 - ▷ Electromagnetic
 - ▷ Thermal
 - ▷ Mechanical

Structural Mechanics Simulation

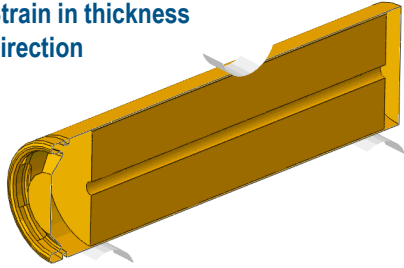


- ▶ Mechanical stress simulation
 - ▷ Compression
 - ▷ Bending
 - ▷ Drop & impact test
- ▶ Cell and pack level
- ▶ Explicit/implicit simulation using ABAQUS

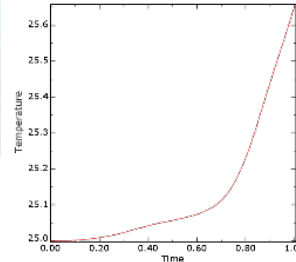
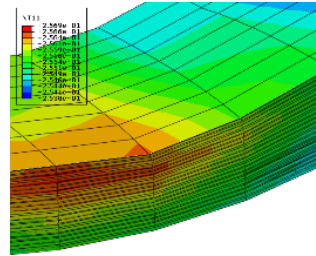
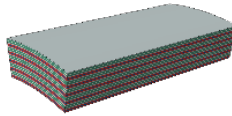
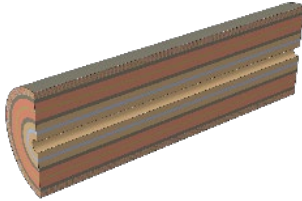
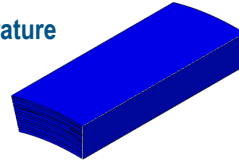
Internal Short Circuit



Strain in thickness
direction



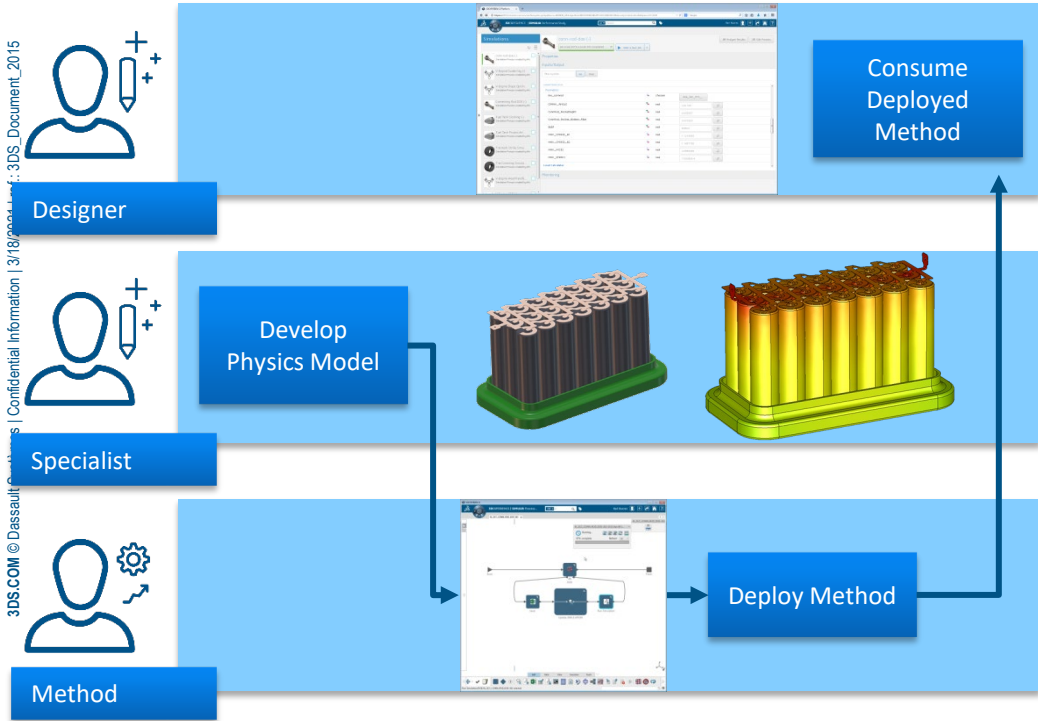
Temperature



- ▶ Detect short circuit initiation due to deformation
- ▶ Layered core representation
- ▶ Measure internal temperature and electric current in the core
- ▶ Co-simulation can treat easily this multi-physics behavior with minimal modeling effort

Process Automation

3DS.COM @ Dassault Systèmes | Confidential Information | 3118procas | 3DS_Document_2015



Common method across all simulation

Capture and enforce best practices

- ▶ Modeling
- ▶ Process

Capture all communication and knowledge

- ▶ Structured communication
- ▶ Ad hoc

Summary

- ▶ Complete workflow for batter pack development and optimization
- ▶ Closed loop from requirements through engineering and simulation to results
- ▶ Powerful Multiphysics capabilities across multiple domains
- ▶ Individual best in class solutions tied together
- ▶ Fully integrated with the **3DEXPERIENCE** Platform



