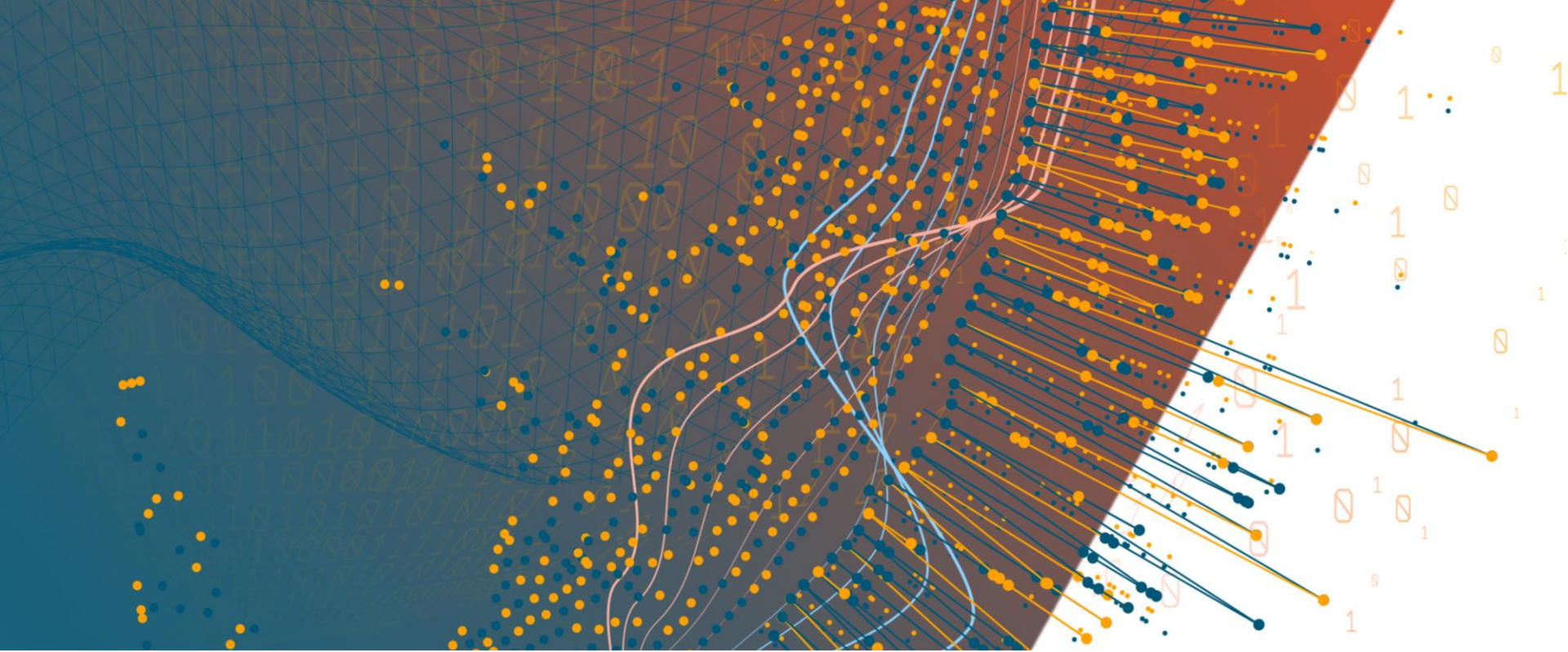

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# CAR WEBINAR ON E-MOBILITY

13/05/2020

# CAR Webinar

## Altair Agenda

- Altair Automotive Overview
  *Lars Fredriksson*
- Designing more efficient e-Motors
  *Lars Fredriksson*
- Extending Vehicle Range / Lightweighting
  *Lars Fredriksson*
- Crash and Safety
  *Jean Michel Terrier*

**Lars Fredriksson**
VP – Simulation-Driven Innovation

**Jean Michel Terrier**
VP – Business Development RADIOSS

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# ALTAIR AUTOMOTIVE OVERVIEW

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# Altair

Founded **1985**
Headquartered in Troy, MI US


**81offices**
in 25 countries


**$396M**
2018 Revenue

**100+**
Software products under our unique, patented licensing model

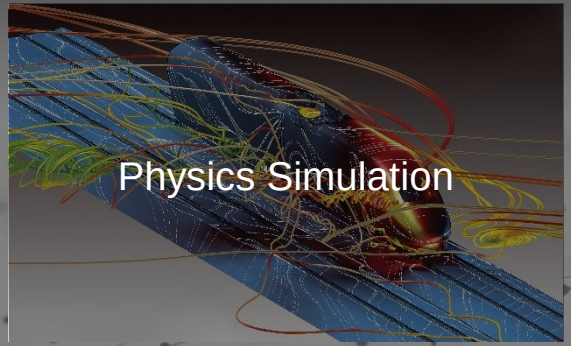
**2,500+**
Engineers, scientists and creative thinkers

**5,000+**
Customer installations globally

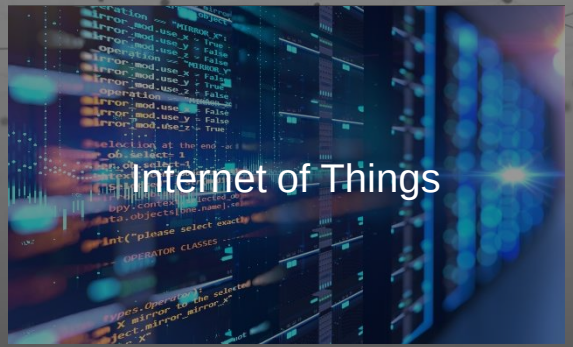
**60,000+**
Users

ALTAIR

# Broad Portfolio of Comprehensive Solutions





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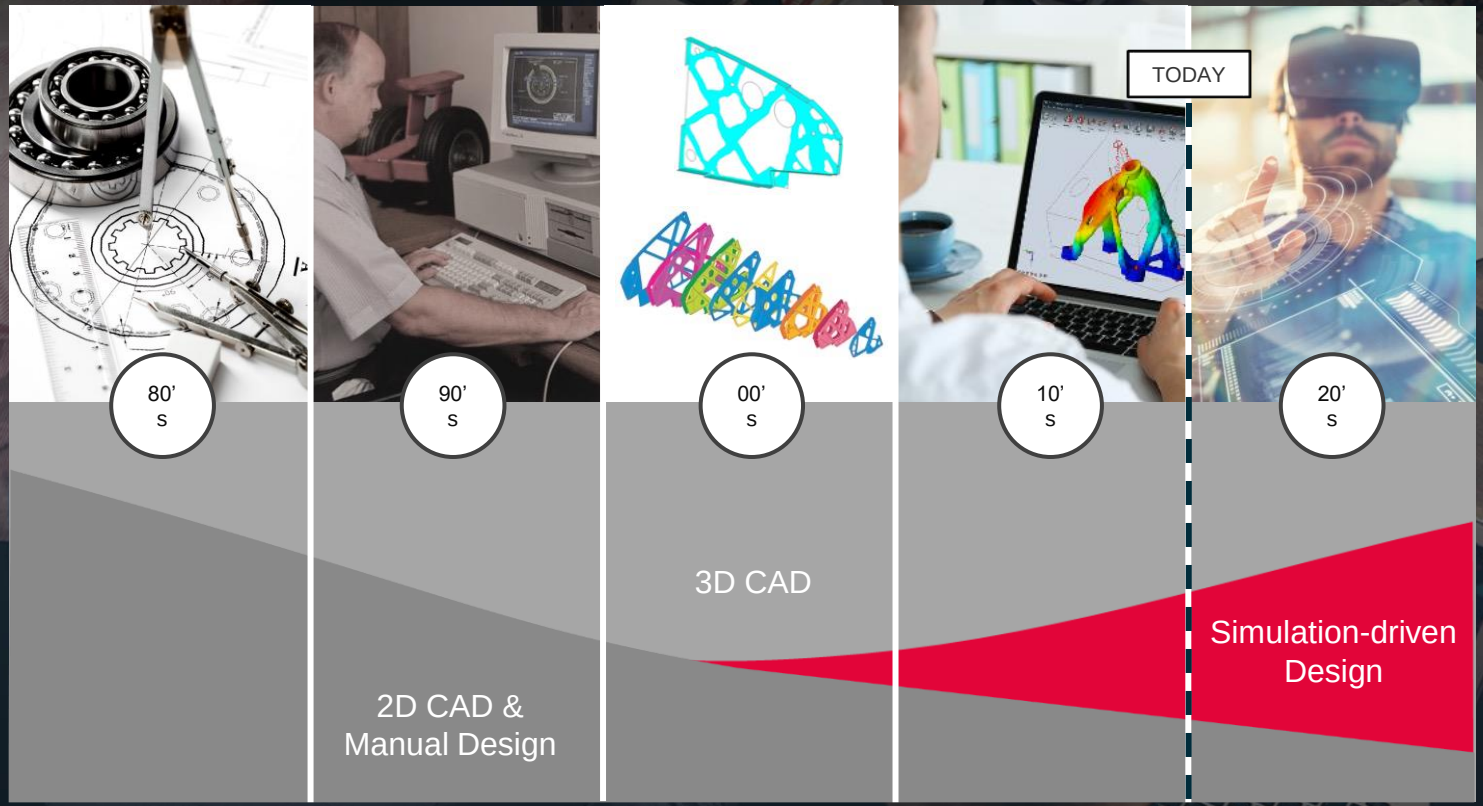
# Simulation-Driven Design

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# Altair Solver Technology for Automotive

**SimSolid**
Meshless Structural Analysis

Crash
Safety
Blast
Gravity
Springback

**RADIOSS**
Structural Explicit

**OptiStruct**
Structural Implicit

Durability
Vibrations
Acoustics
Buckling
Heat Transfer

Forming
Extrusion
Additive
Casting
Molding

**Inspire**
Manufacturing

**ACTIVATE**
Systems

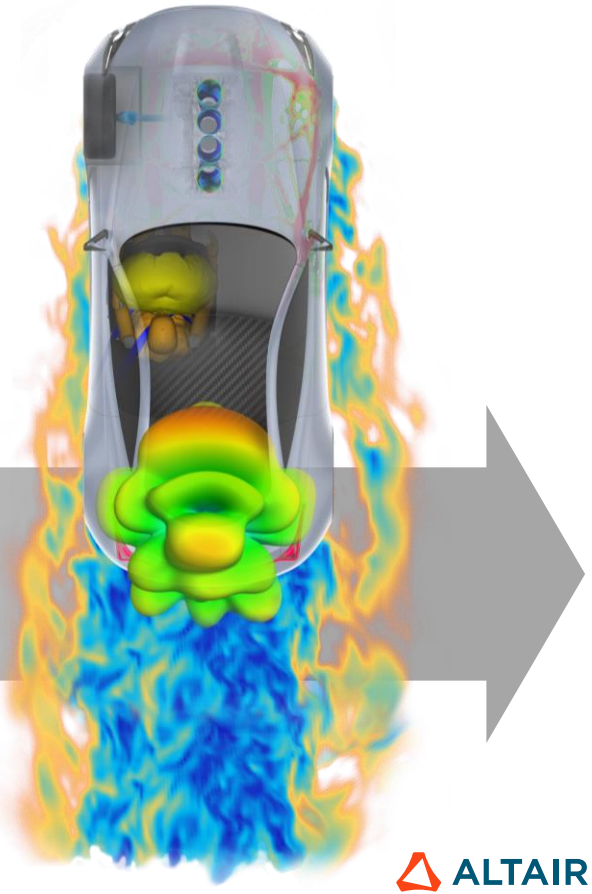
**AcuSolve**
**nanoFluidX**
**ultraFluidX**
**ElectroFlo**
CFD and Thermal

**FEKO**
**FLUX**
Electromagnetics

**MotionSolve**
Multi-body Dynamics

HPC
Cloud

Design Optimization
Machine Learning



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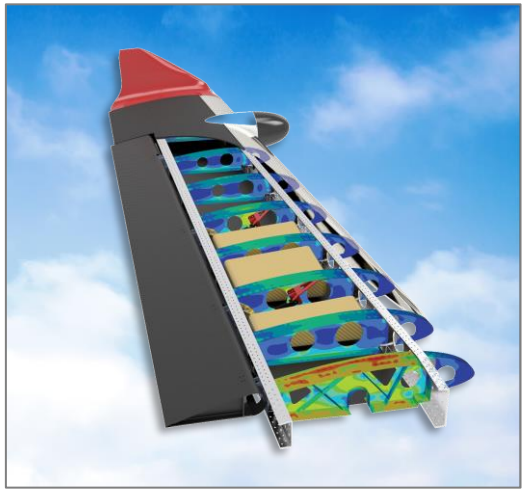
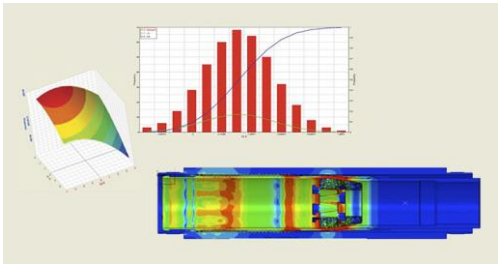
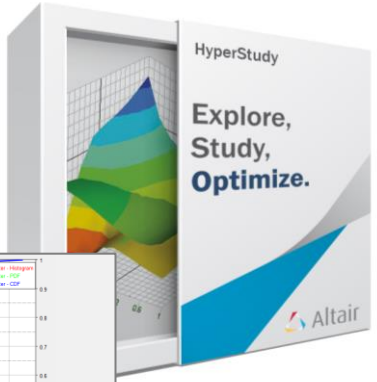
# Altair Optimization Technology

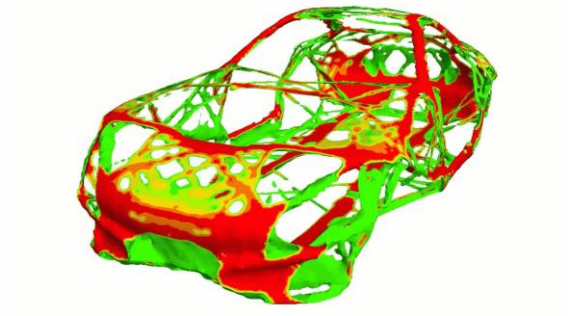


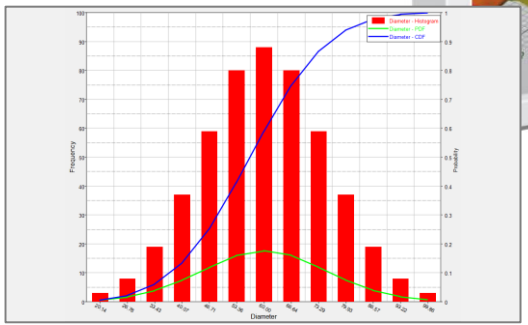


**OptiStruct**
Linear Optimization

**HyperStudy**
DOE / Nonlinear Optimization / MDO





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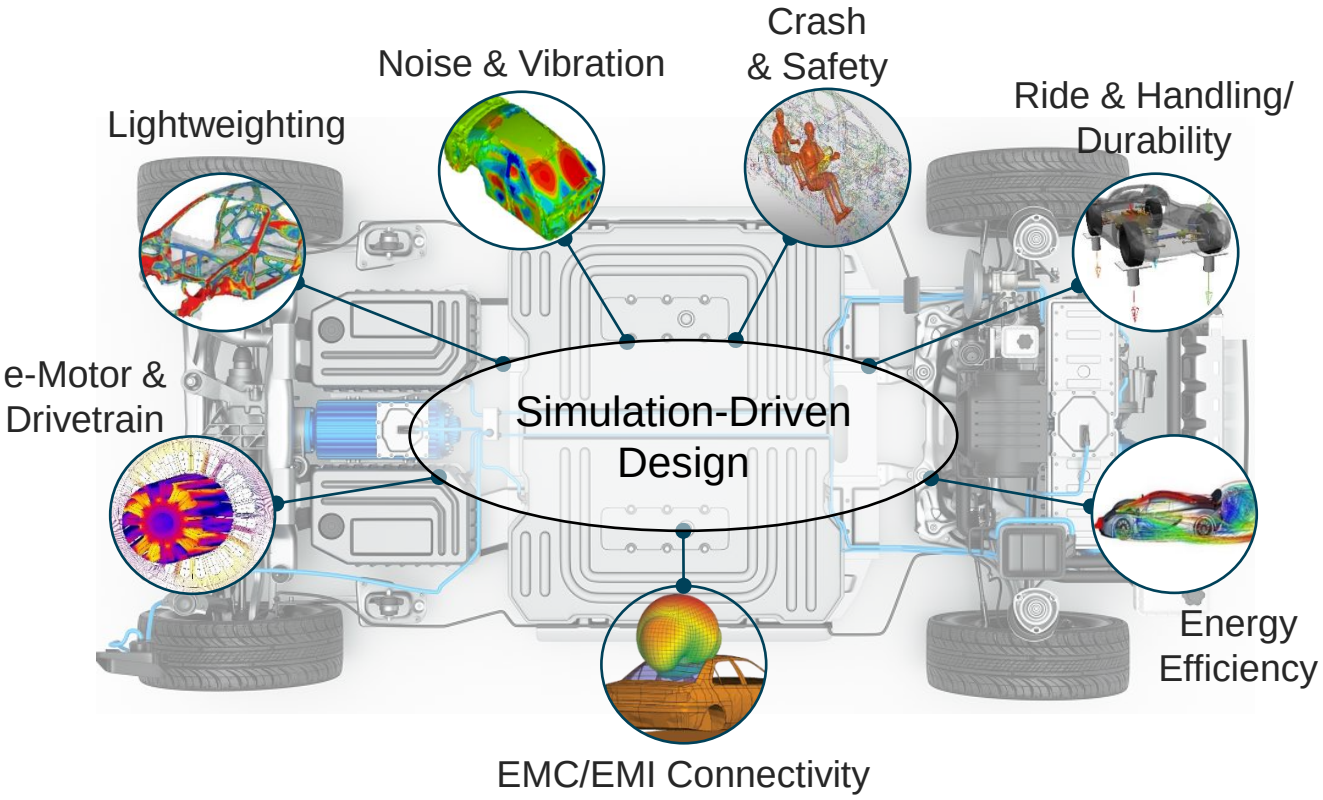
# Altair Products and Solutions for e-Mobility




## New Key Systems:

- Traction Motor
- Battery
- Power Electronics - Inverter
- System Modeling and Control

## Challenges:

- Packaging and Weight Distribution
- New Requirements & Physics
- Complex System

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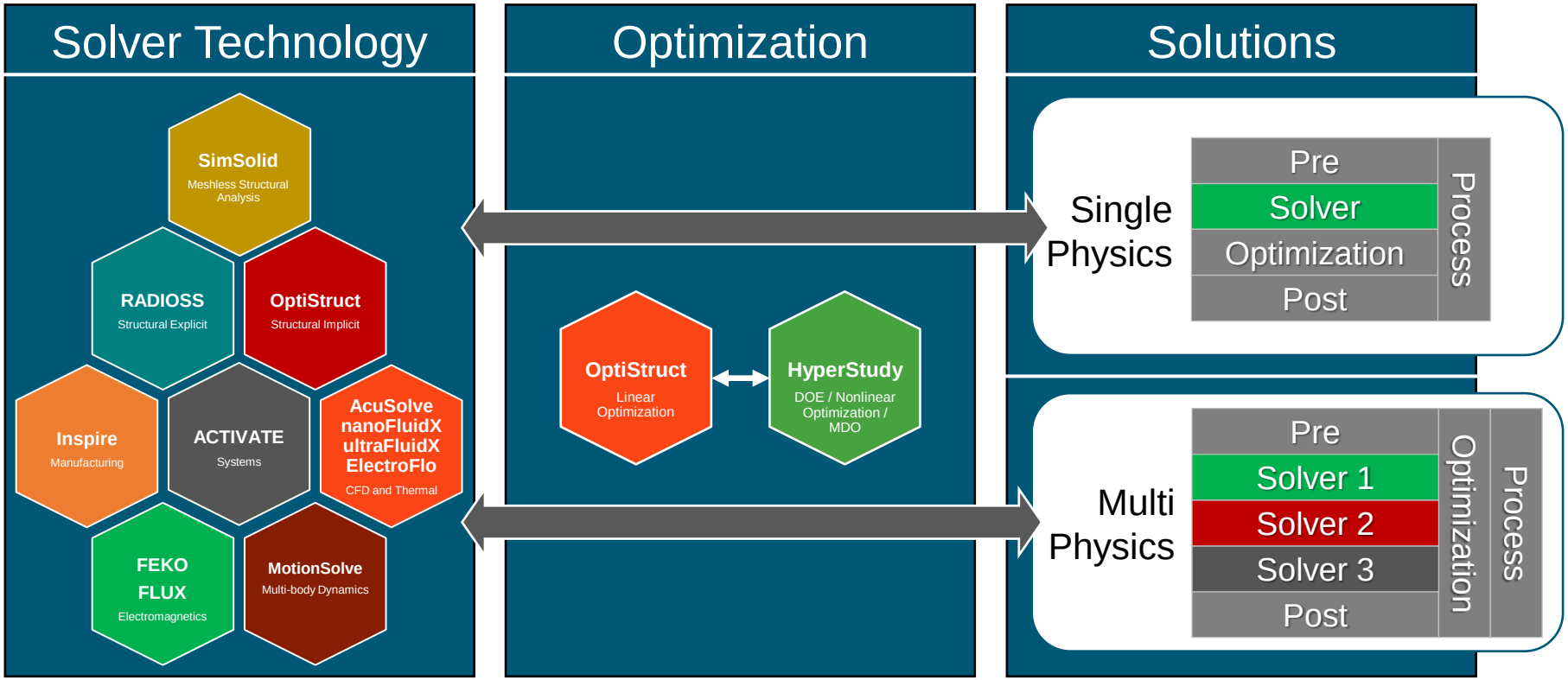
# Products and Solutions for Simulation-Driven Design

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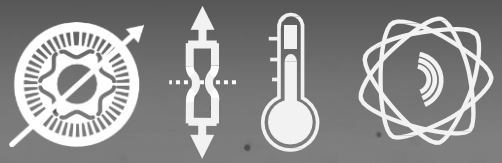
# Common Theme for many Altair E-mobility Solutions?



Multi-Physics

Consistent and holistic Setup of Multiphysics Problems

Optimization/Exploration

Design Exploration & Optimization of e-Powertrains

Process/Automation

Efficient Solutions and highly automatic Processes for e-Powertrain Design

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# EFFICIENT E-MOTOR DESIGN

# LIGHT WEIGHTING

# ALTAIR BATTERY DESIGNER



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# DESIGNING MORE EFFICIENT E-MOTORS

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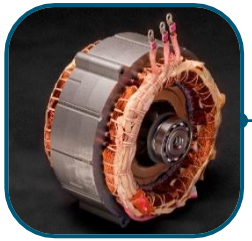
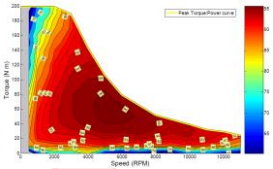
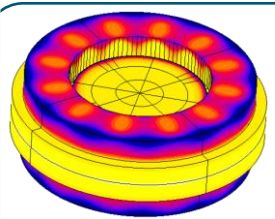
# E-MOTOR Multiphysics at Altair





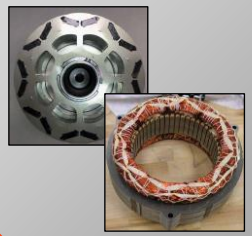
**Efficiency**

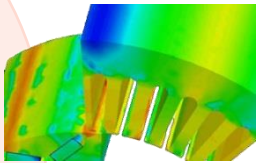
Light Weighting of
- Permanent Magnets
- Rotor Structure
- Housing
- Covers



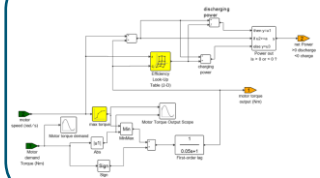
**Thermal**

**Weight**



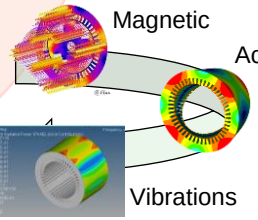


**Stiffness / Strength / Durability**



**System / Control**

Multiphysics



Magnetic

Acoustic

**Acoustics**

Vibrations

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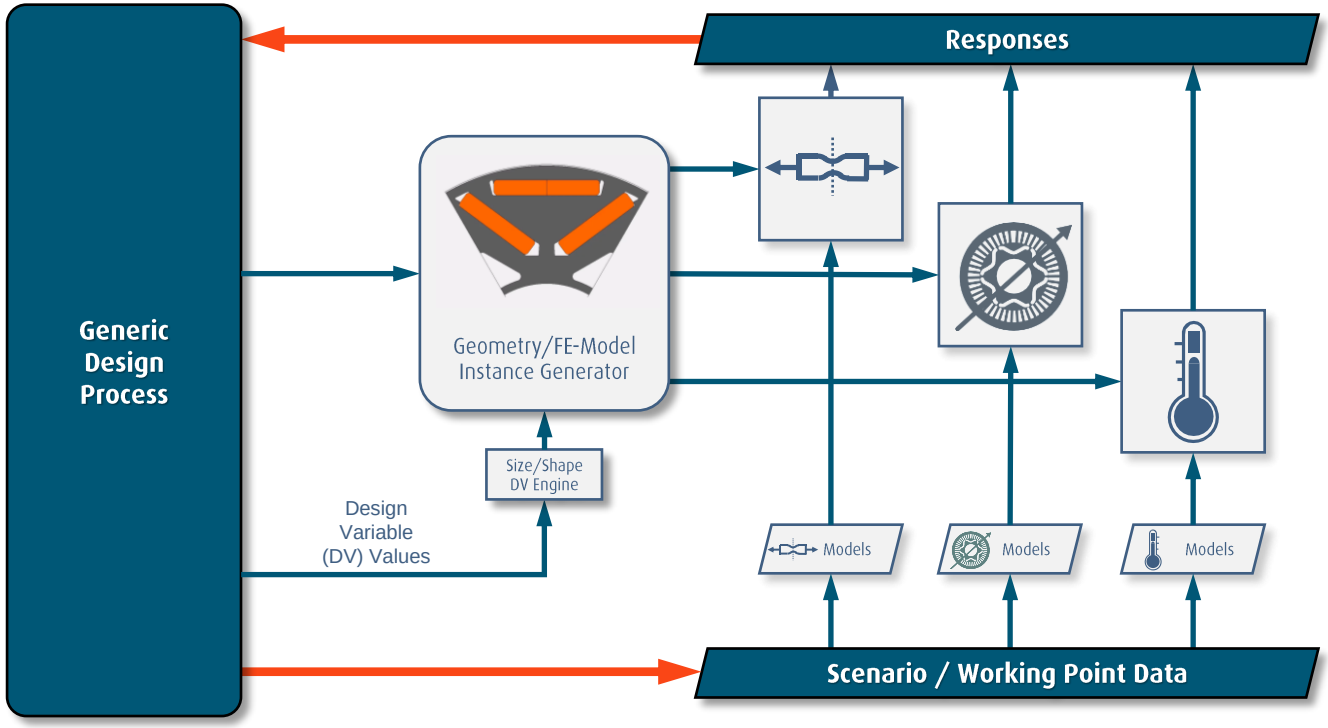
# The generic Multiphysics Design Process

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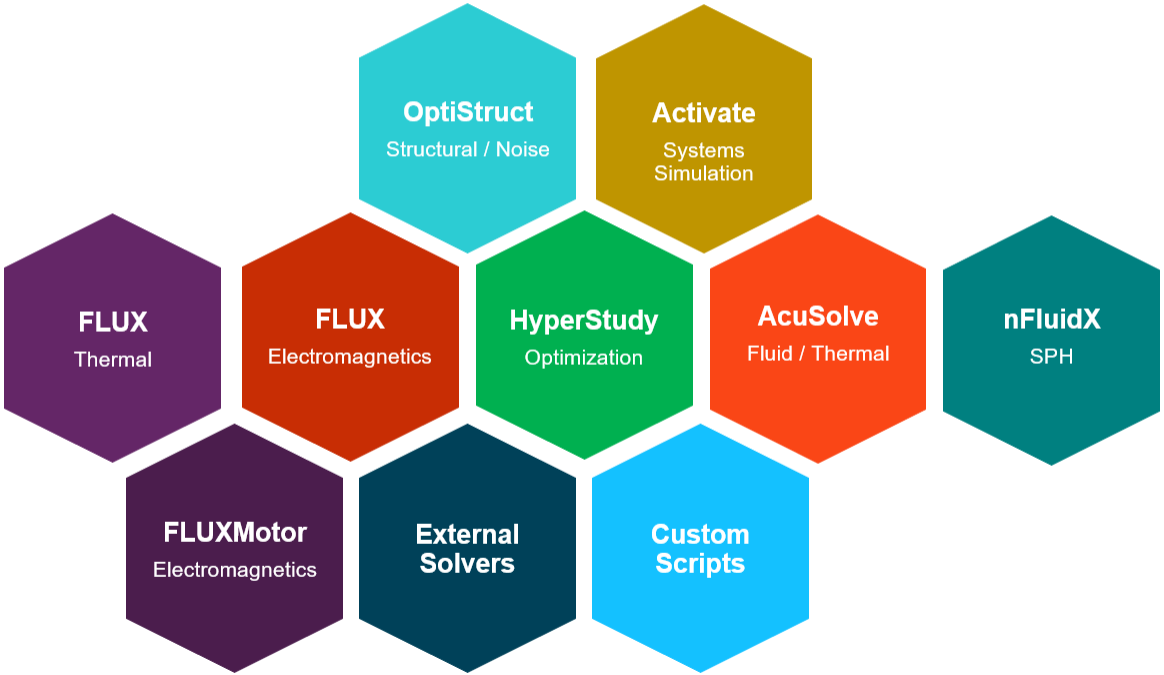
# E-Motor Multiphysics Solution – Optimization-Centered

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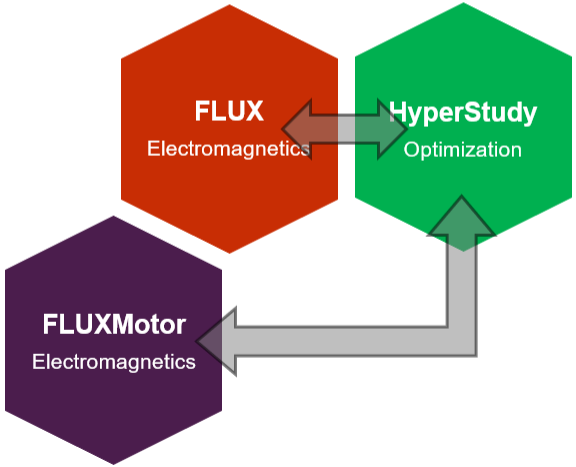
# E-Motor Multiphysics Solution – Optimization-Centered

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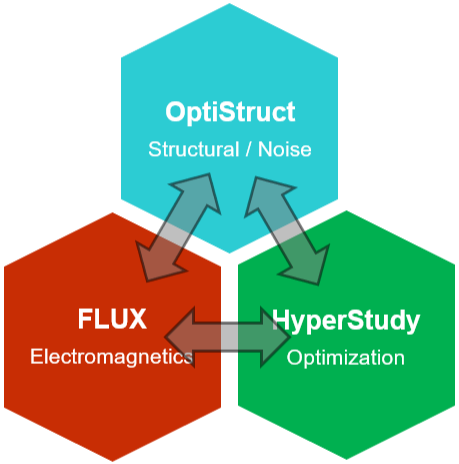
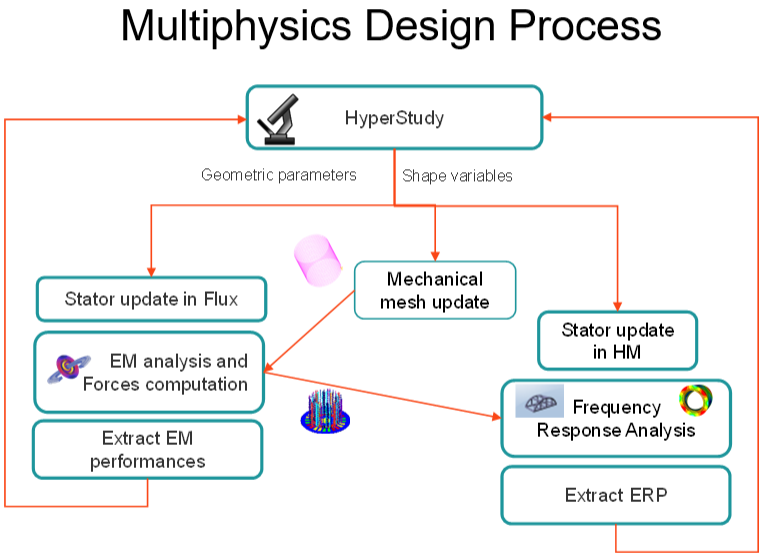
# E-Motor Multiphysics Solution – Optimization-Centered

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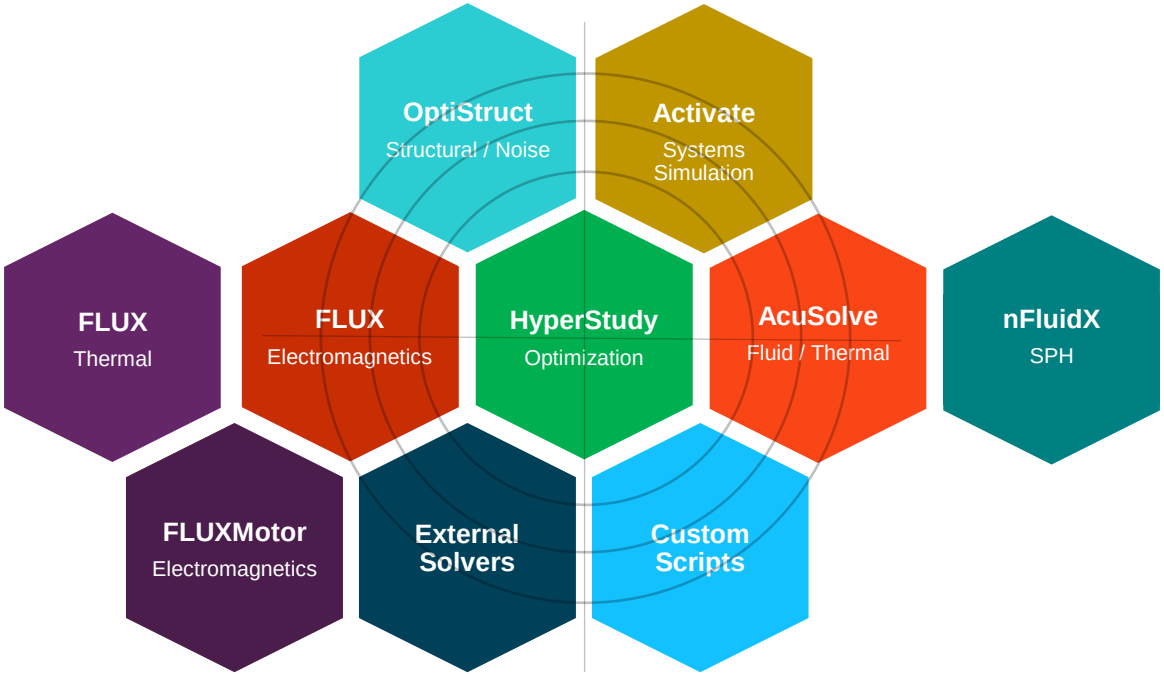
# E-Motor Multiphysics Solution – Optimization-Centered

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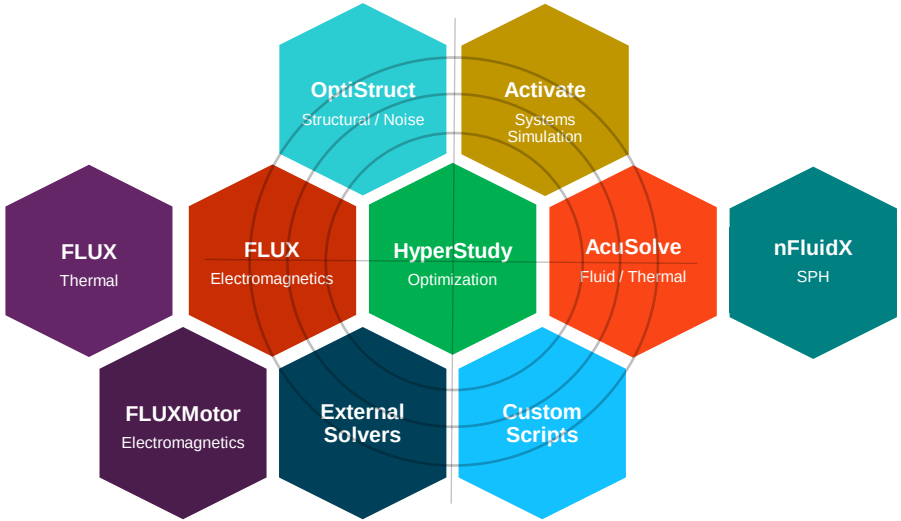
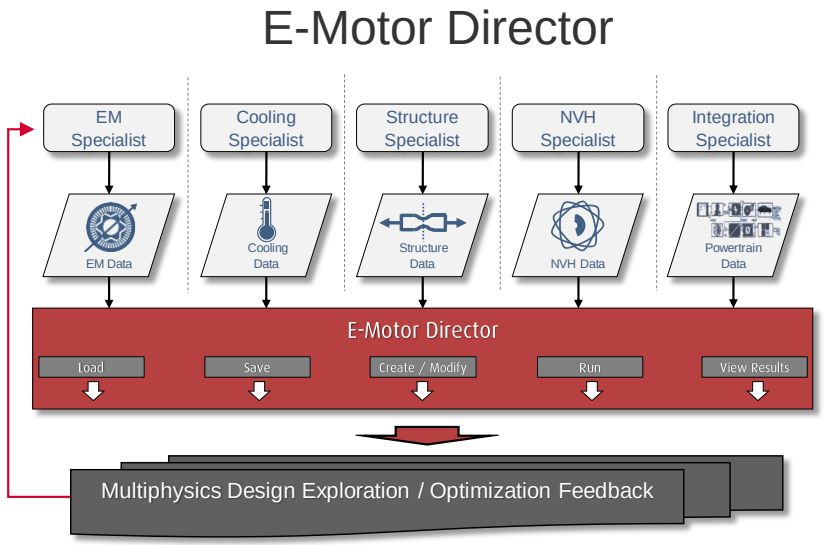
# E-Motor Multiphysics Solution – Optimization-Centered




- The Optimization Tool is the center of the Process
- Process built as a Session File to HyperStudy
- Automation of process potentially realized through „E-Motor Director“
- Complete flexibility of Design Study Content

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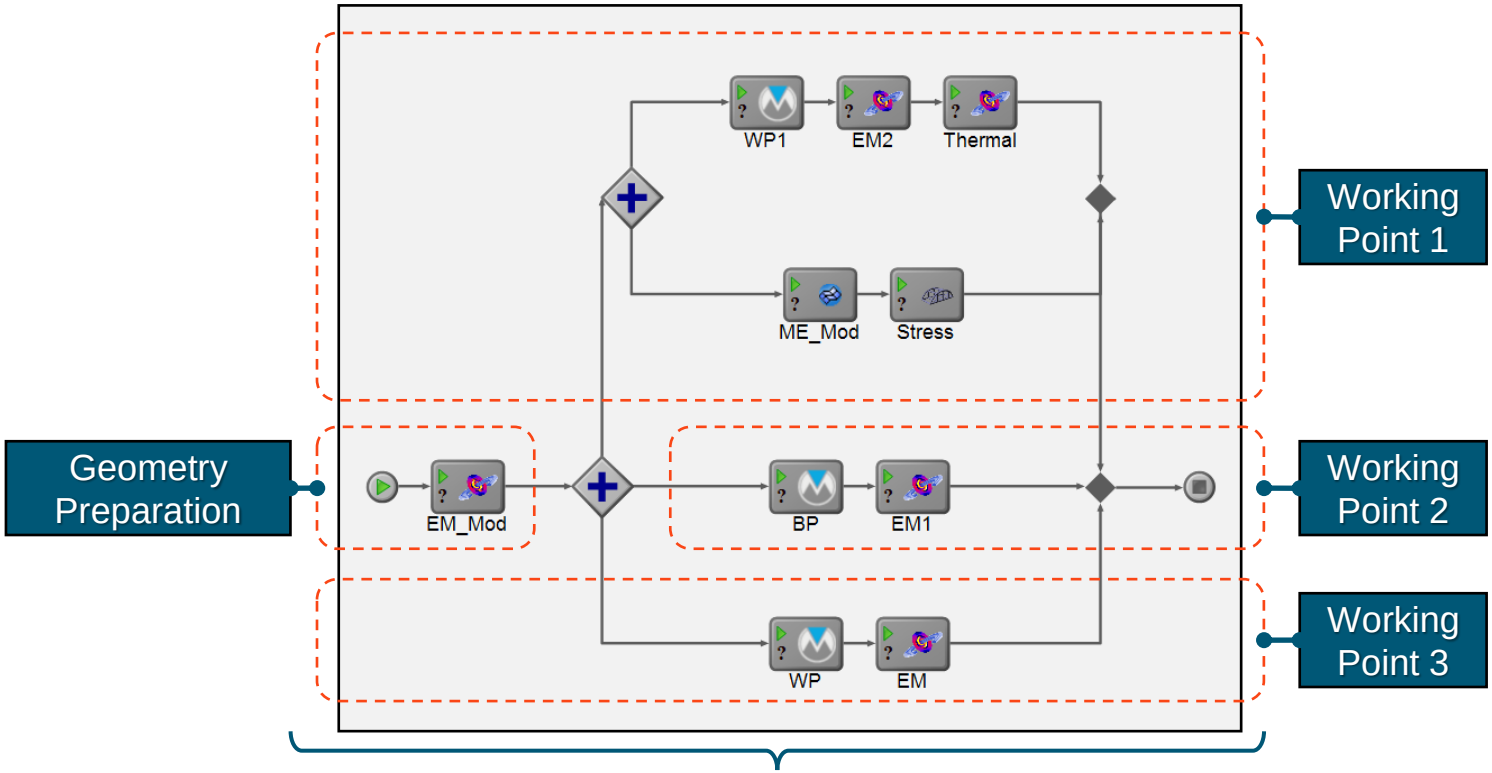
# GENERAL DEFINITION OF STUDY CONTENT




=> Export to Batch Script

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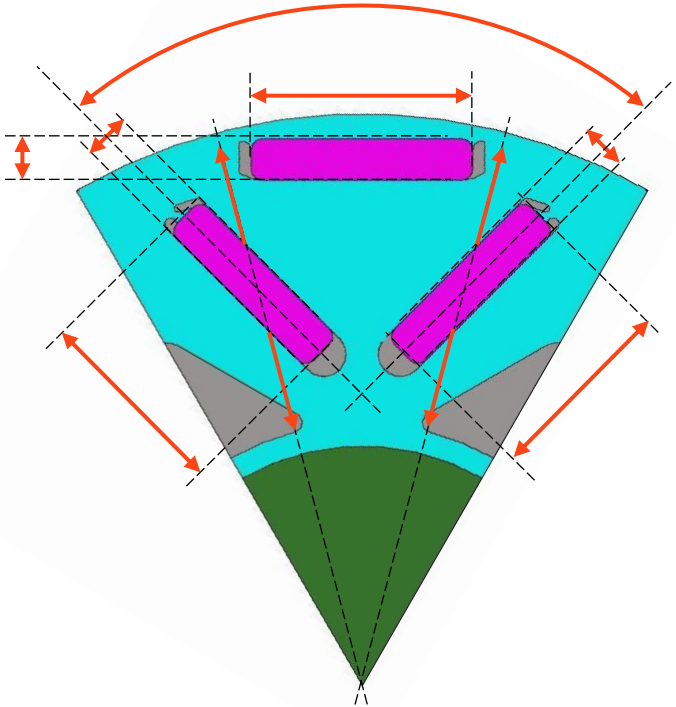
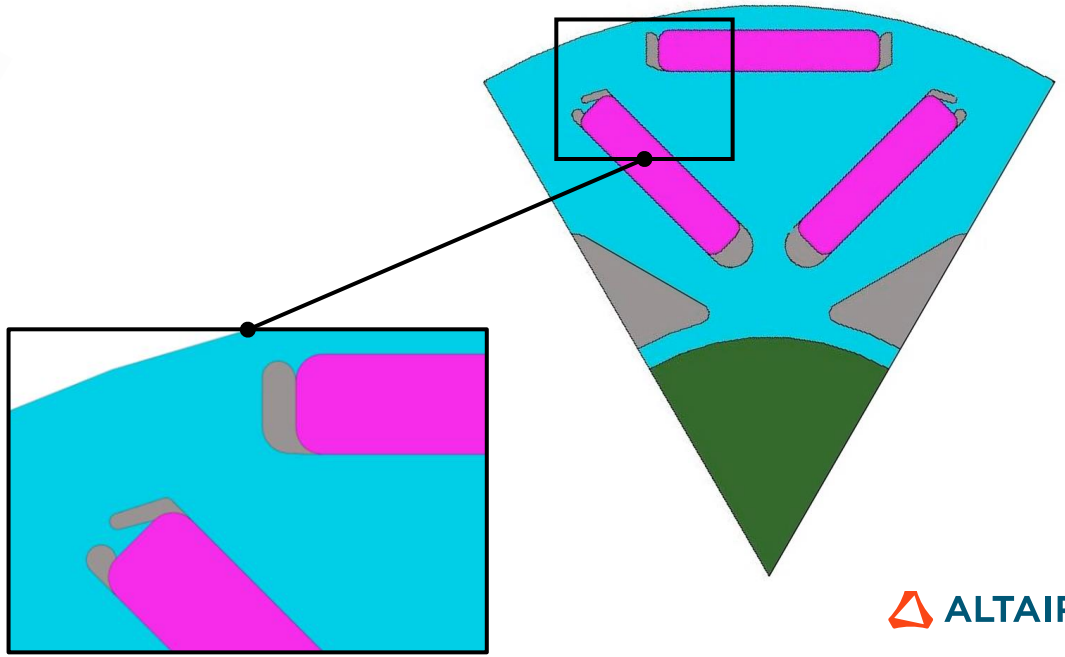
# COMMON GEOMETRY & DESIGN VARIABLE DEFINITION

Geometry & Design Variables



Design Range



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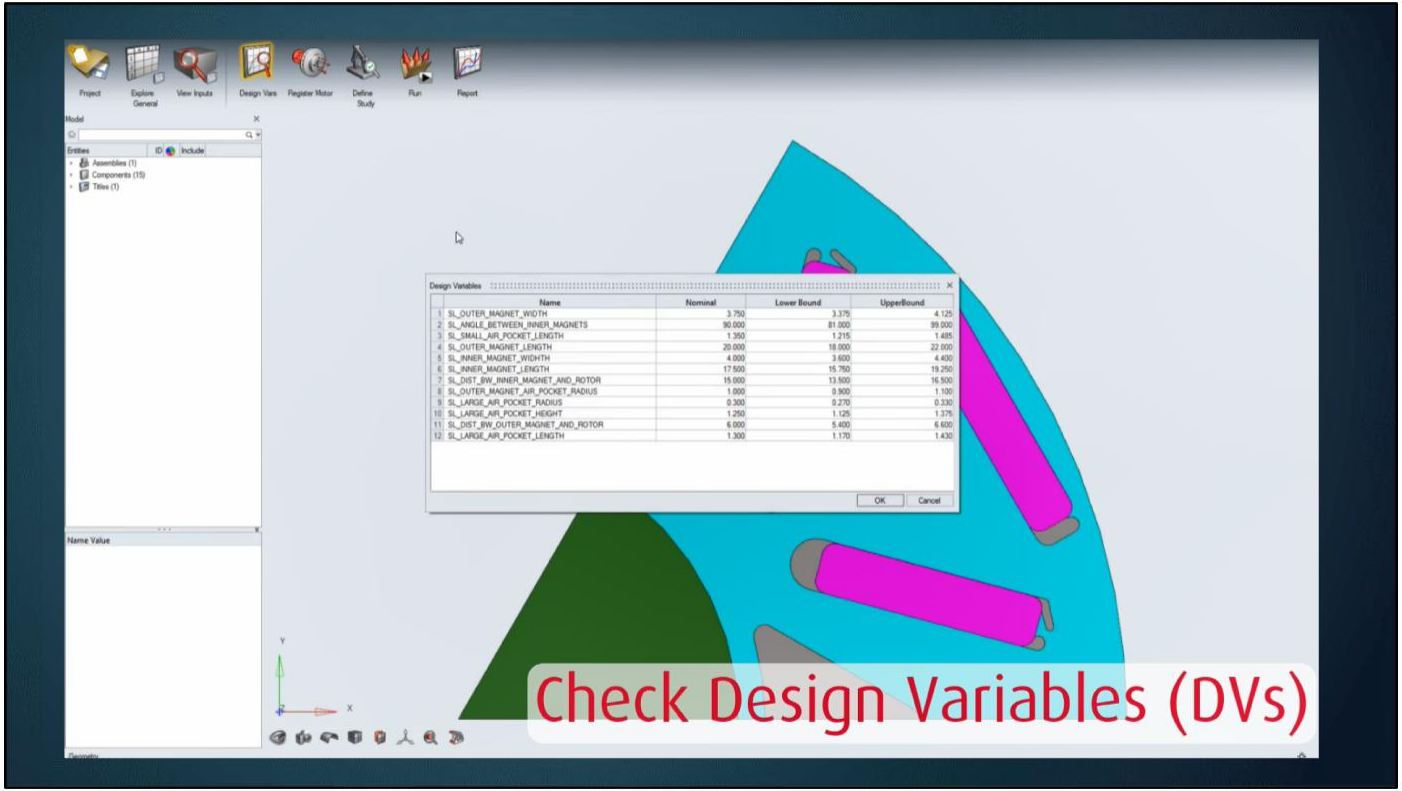
# EXAMPLE RUN THROUGH OF SETUP PROCESS

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# EXTENDING VEHICLE RANGE / LIGHT WEIGHTING

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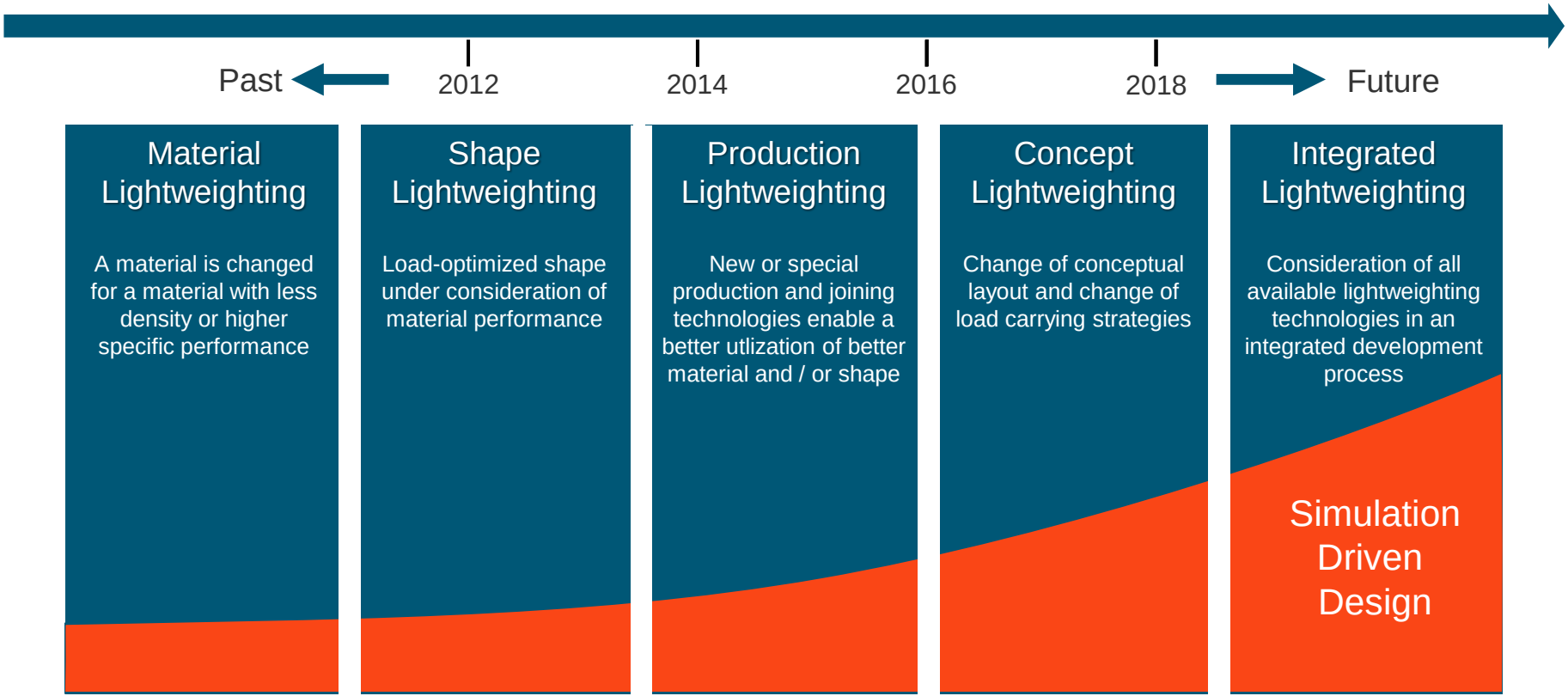
# AUTOMOTIVE LIGHTWEIGHTING STRATEGIES



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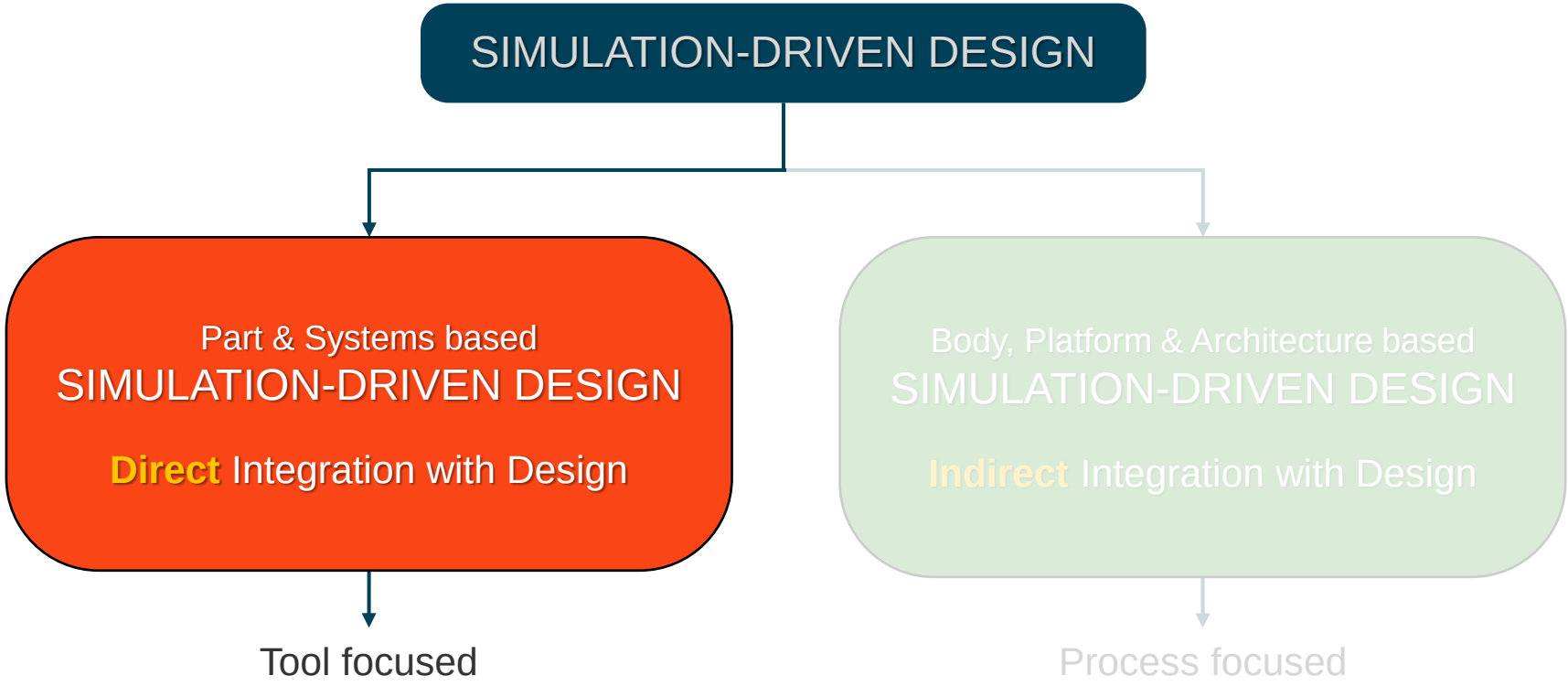
# Tool & PROCESS FOCUSED SIMULATION-DRIVEN DESIGN

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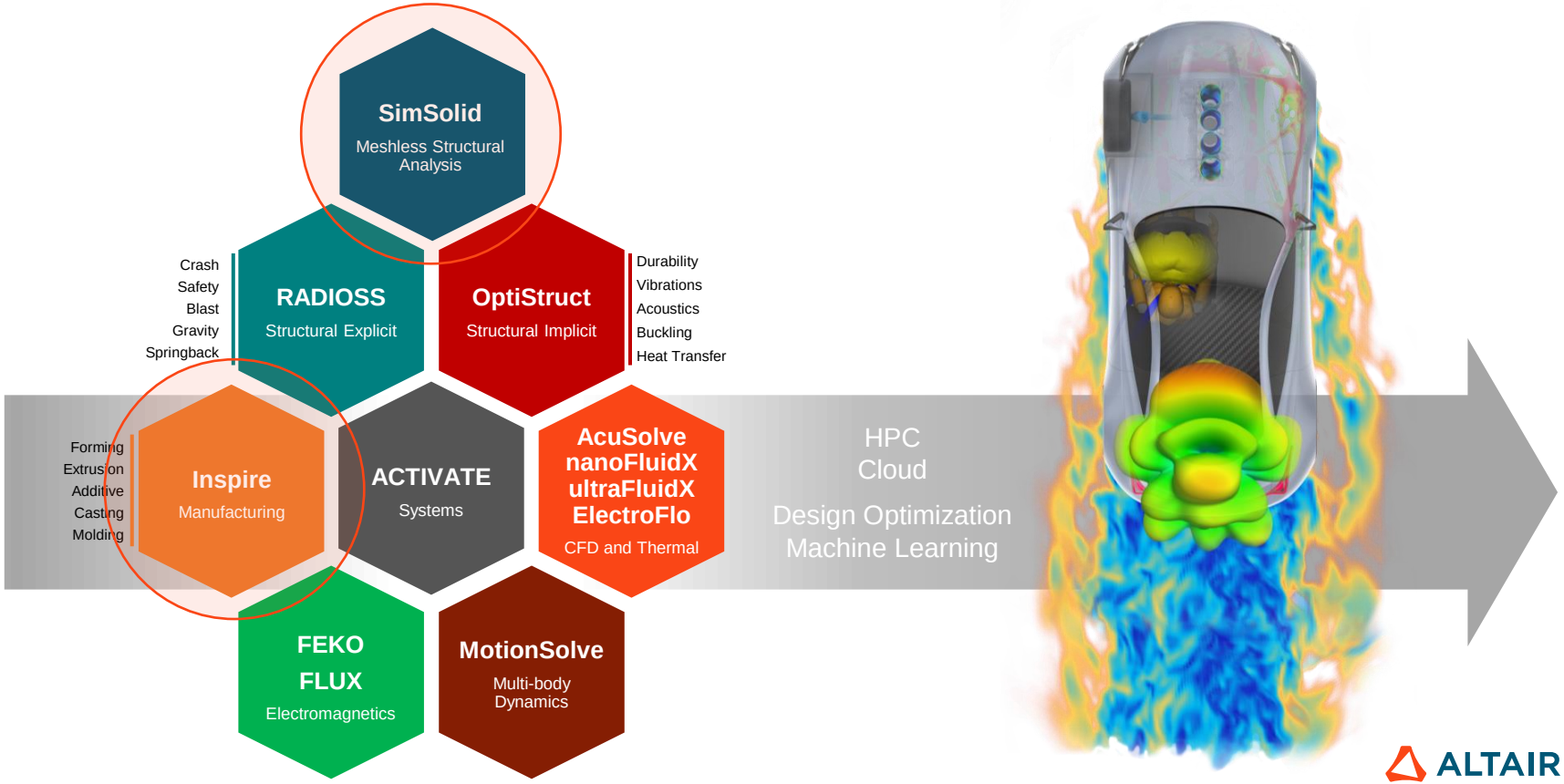
# Altair Solver Technology

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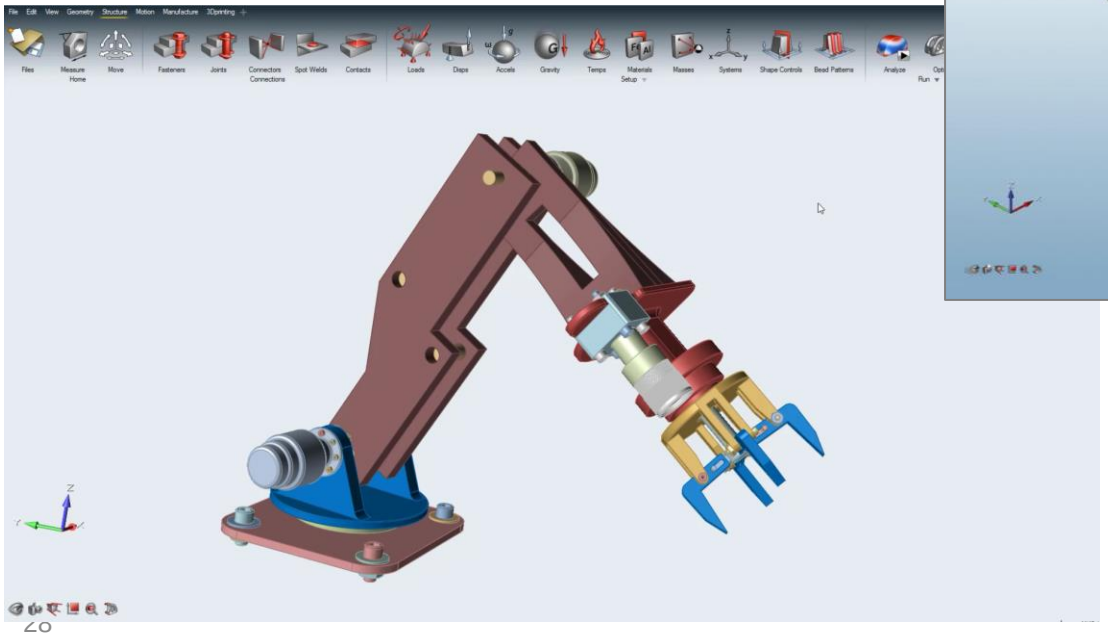
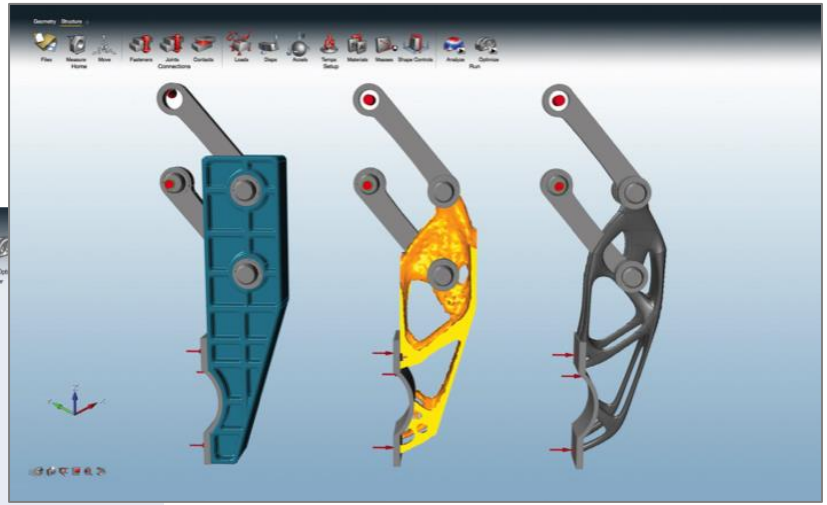
# Lightweighting of Solid Components using Inspire







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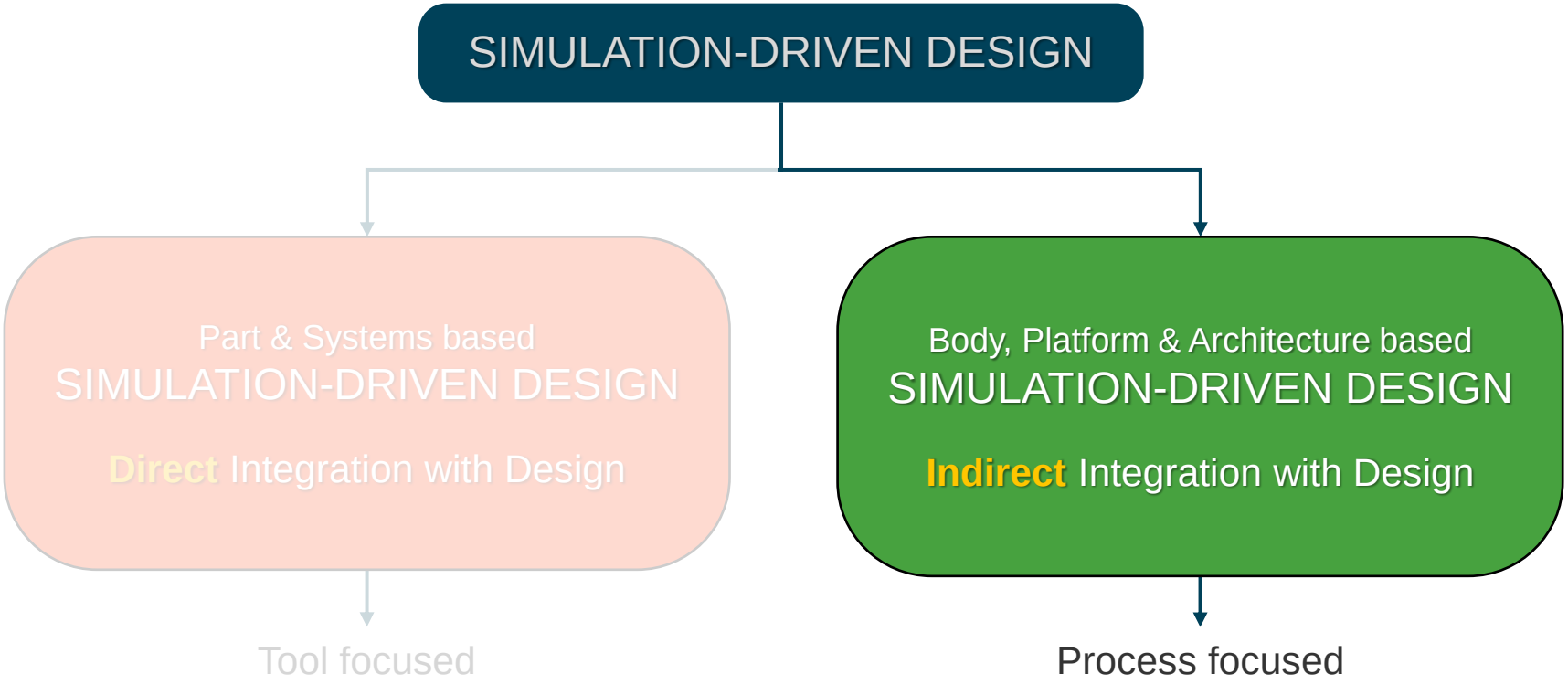
# Tool & PROCESS FOCUSED SIMULATION-DRIVEN DESIGN

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# Macro Solutions / Processes for Automotive Lightweighting

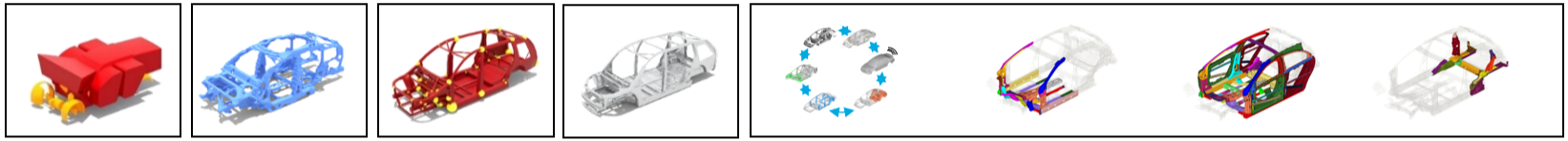
Altair Simulation Driven Proceses for Structures

Altair C123

$C^0$ $C^1$ $C^2$ $C^3$

Altair MDO

DOE/ MDO enabled Development

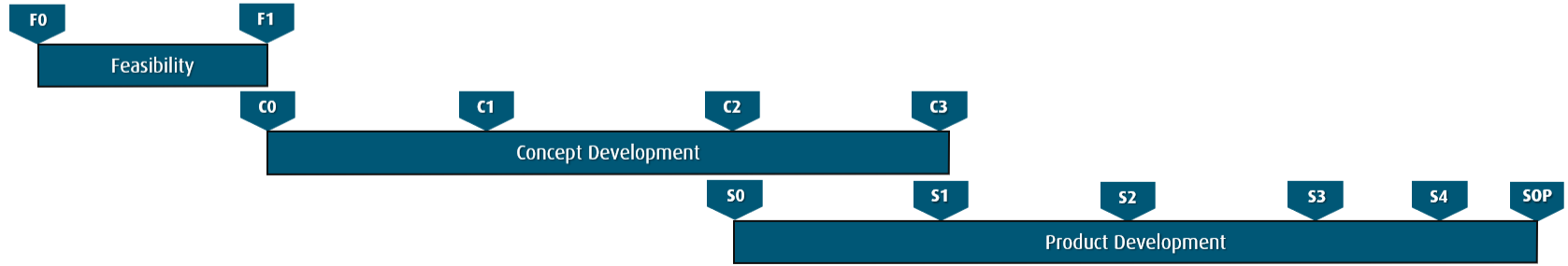


| Package, Loads, Targets.. | Load Path Identification | Load Path Dimensioning | Mature Concept Joints, BoM,… | Multi-disciplinary Optimization in Series Development |
|---|---|---|---|---|

Altair Optimization Center

Strategic and systematic Optimization integrated with Product Development

OEM Design Process

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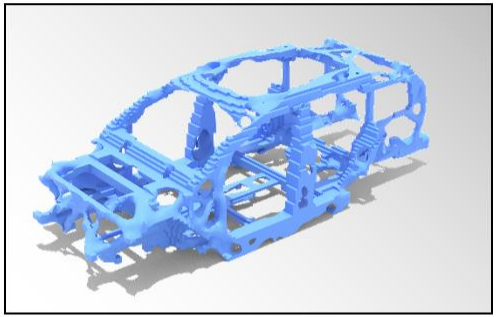
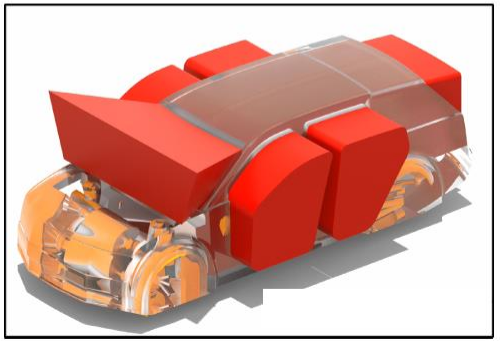
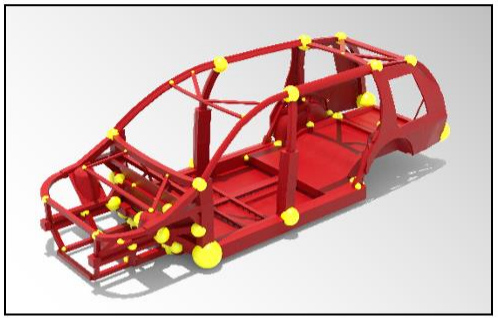
# Altair C123

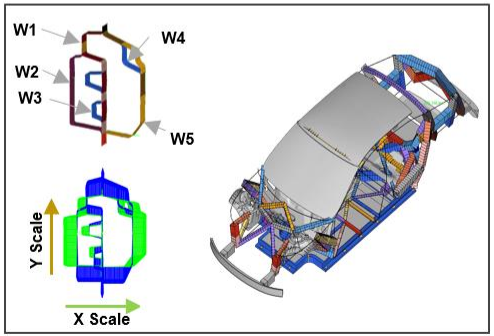


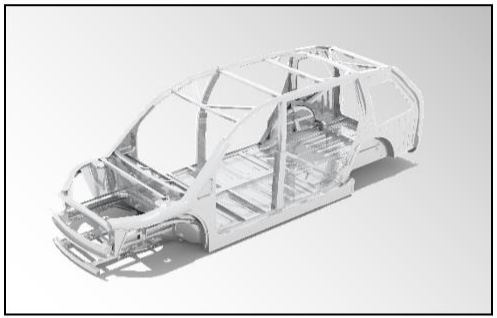
C1



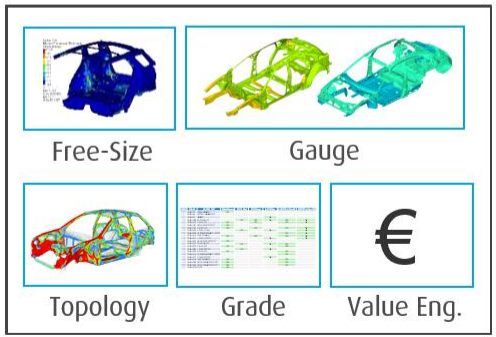


C2



C3

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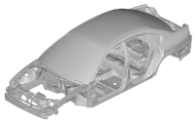
# Altair MDO

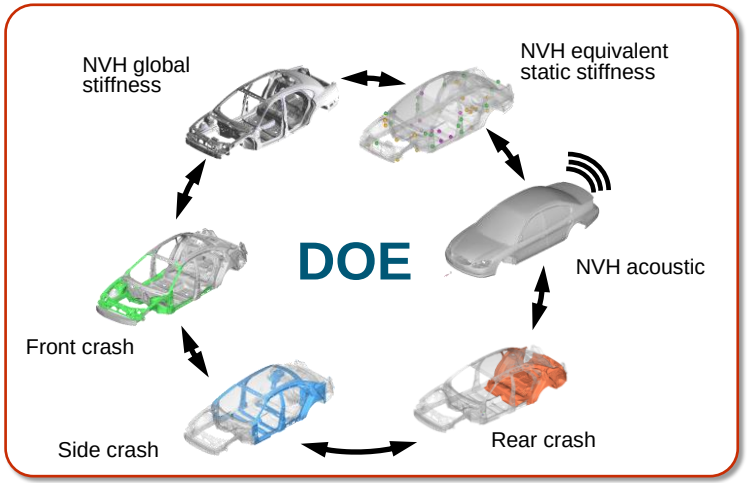
MDO Process Execution Time Line

**Baseline Body**



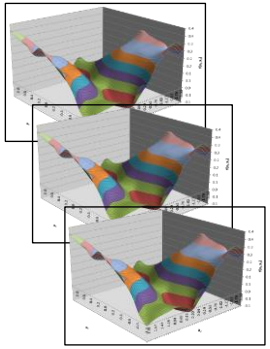
**Study Preparation**

- Import of Models
- Synchronization
- Definition of *N* DVs
- Definition of Resp.
- Setup of DOE




XN number of samples

**Meta Model Generation**

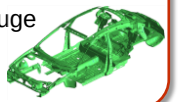


**Targets / DV Bounds**

**Optimization**

Up-Gauge

Down-Gauge



**Validation**

**Study Result:**

- **- X kg Body Mass**
- **Improved Design Balance**

Preprocessing

Execute DOE

Post-processing

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# Concept Light Weighting at Altair