Powering Innovation That Drives Human Advancement

Ansys ConceptEV

Client Presentation

Agenda

“Optimize your powertrains and your teams!”

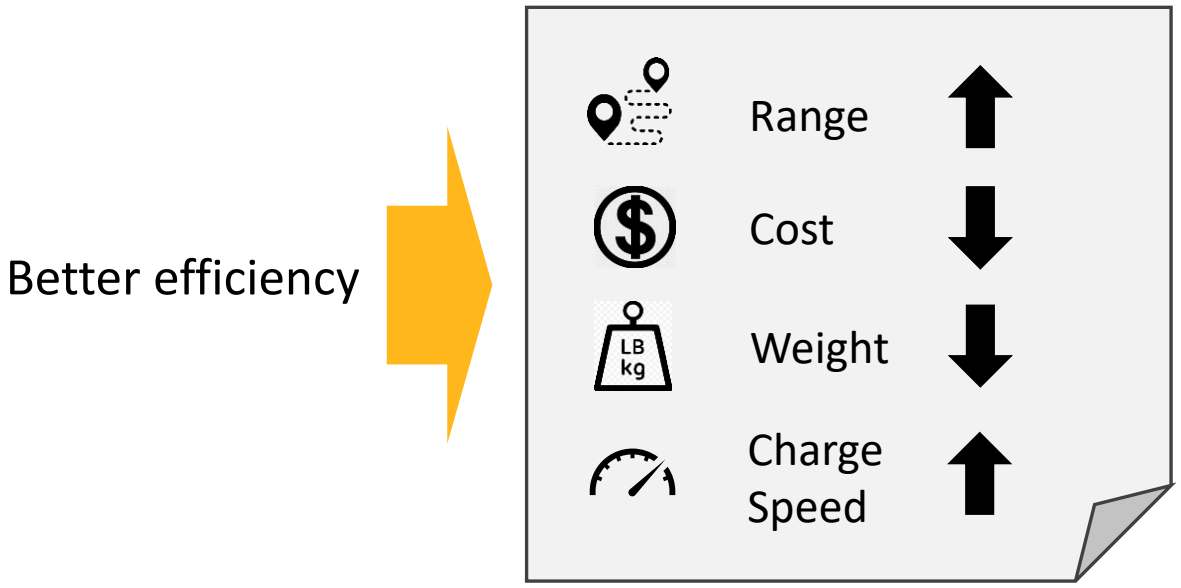
01 – CHALLENGES

02 – SOLUTION

03 – CASE STUDY

Challenges

- Intense global competition in the automotive industry to develop the best EV powertrain & gain market share
- Efficiency is one of the key design goals



Challenges

- To create the highest performance powertrain, the components must be optimized together – as an interconnected system

Individually Optimized Components
[motors + inverters + batteries + transmissions]

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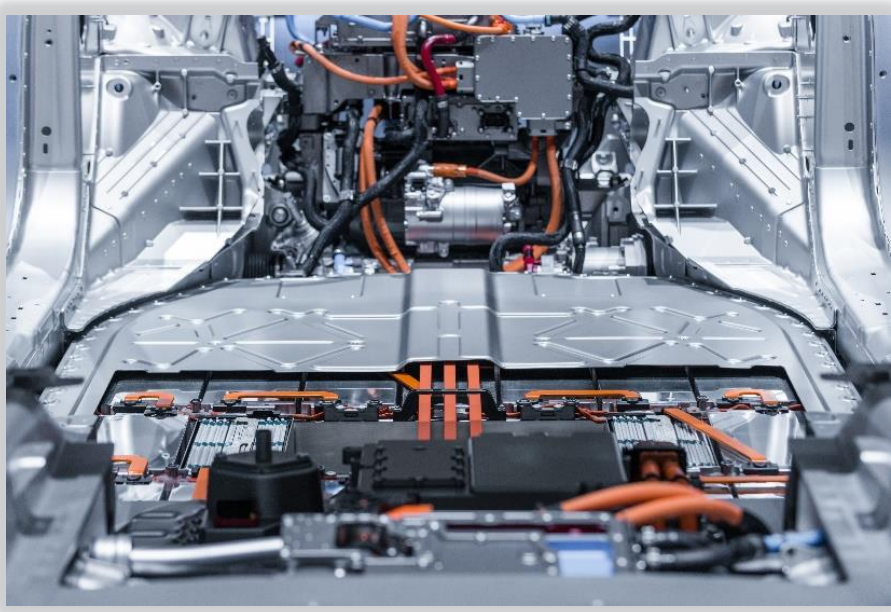
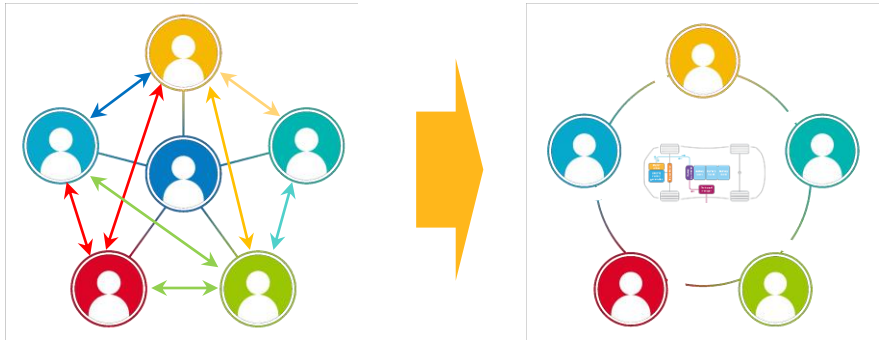
Optimized System



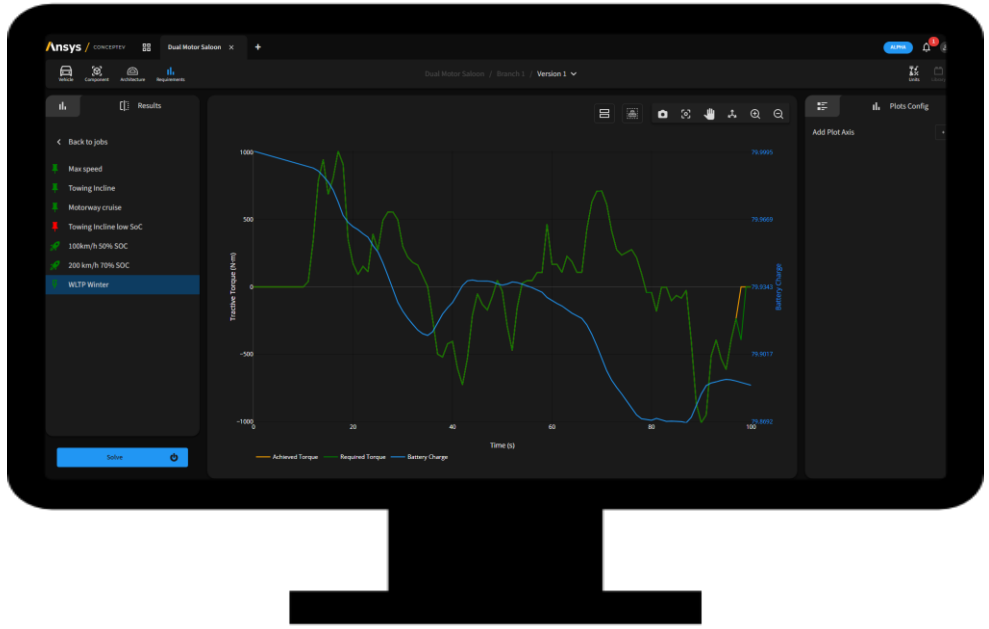
How?

- System level analysis & metrics in the component design loop
- Democratized & shared system level model (collaborative)
- System analysis in the early design phase



Solution

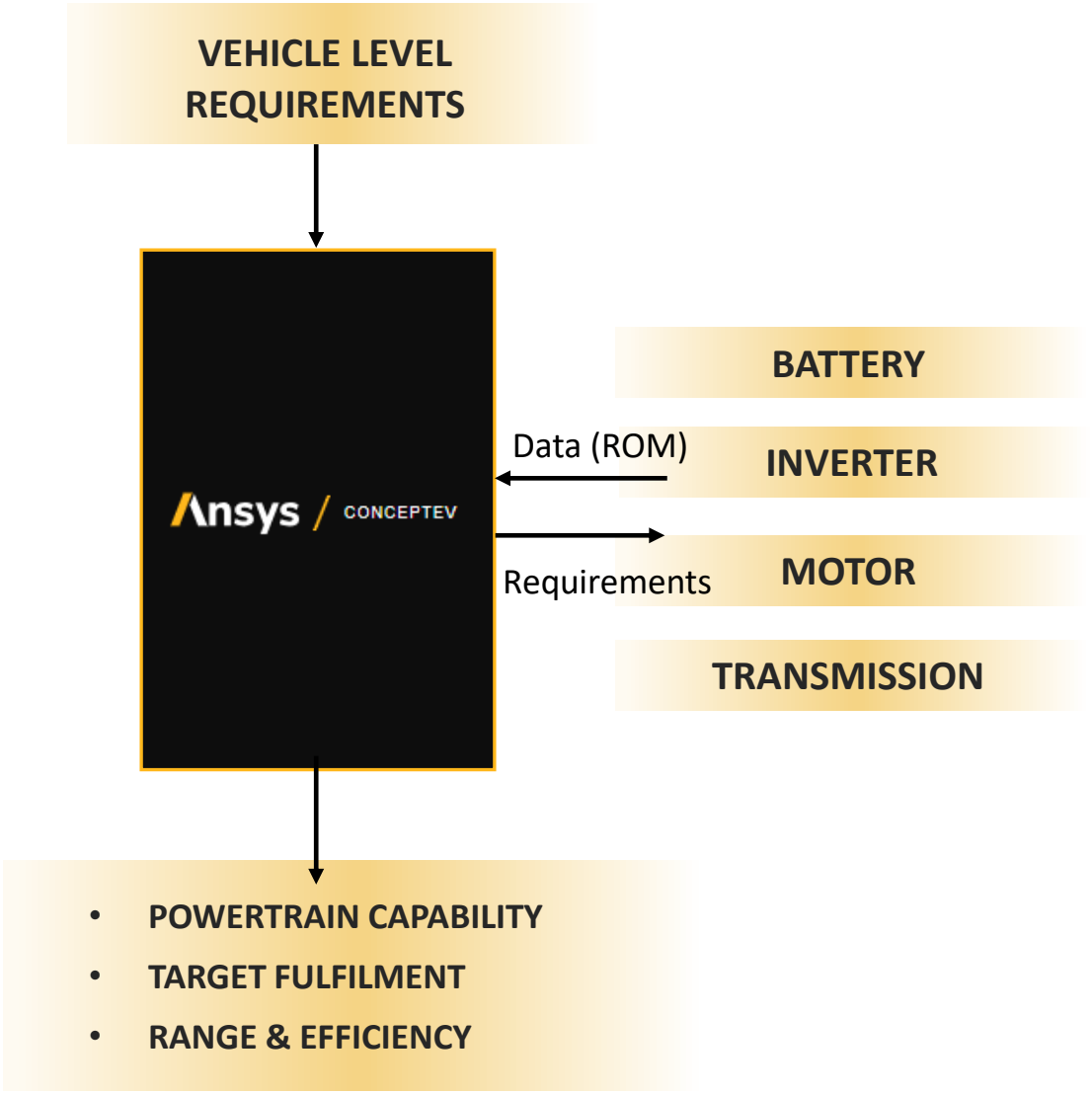
Ansys CONCEPTEV



- Ansys ConceptEV is a cloud-based design & simulation platform for the concept design of EV powertrain
- System & Component Design engineering teams can collaborate on a shared system simulation connected to requirements from the start of the design process

Solution

- Create model & add collaborators
- Import component models
- Connect components in powertrain architectures
- Add system level requirements
- Simulate the system with embedded control strategies
- Evaluate performance against requirements
- Assess metrics over drive cycles (e.g. range, efficiency)



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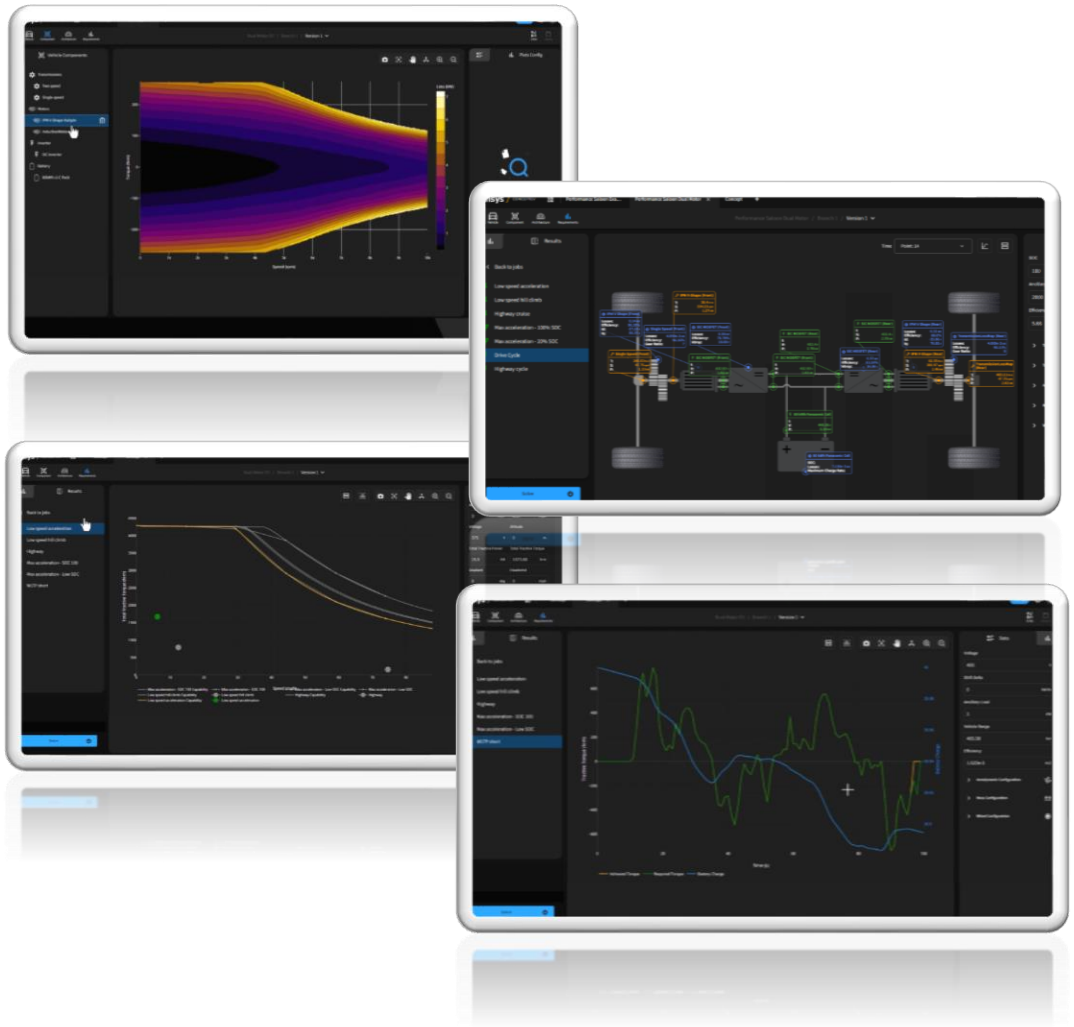
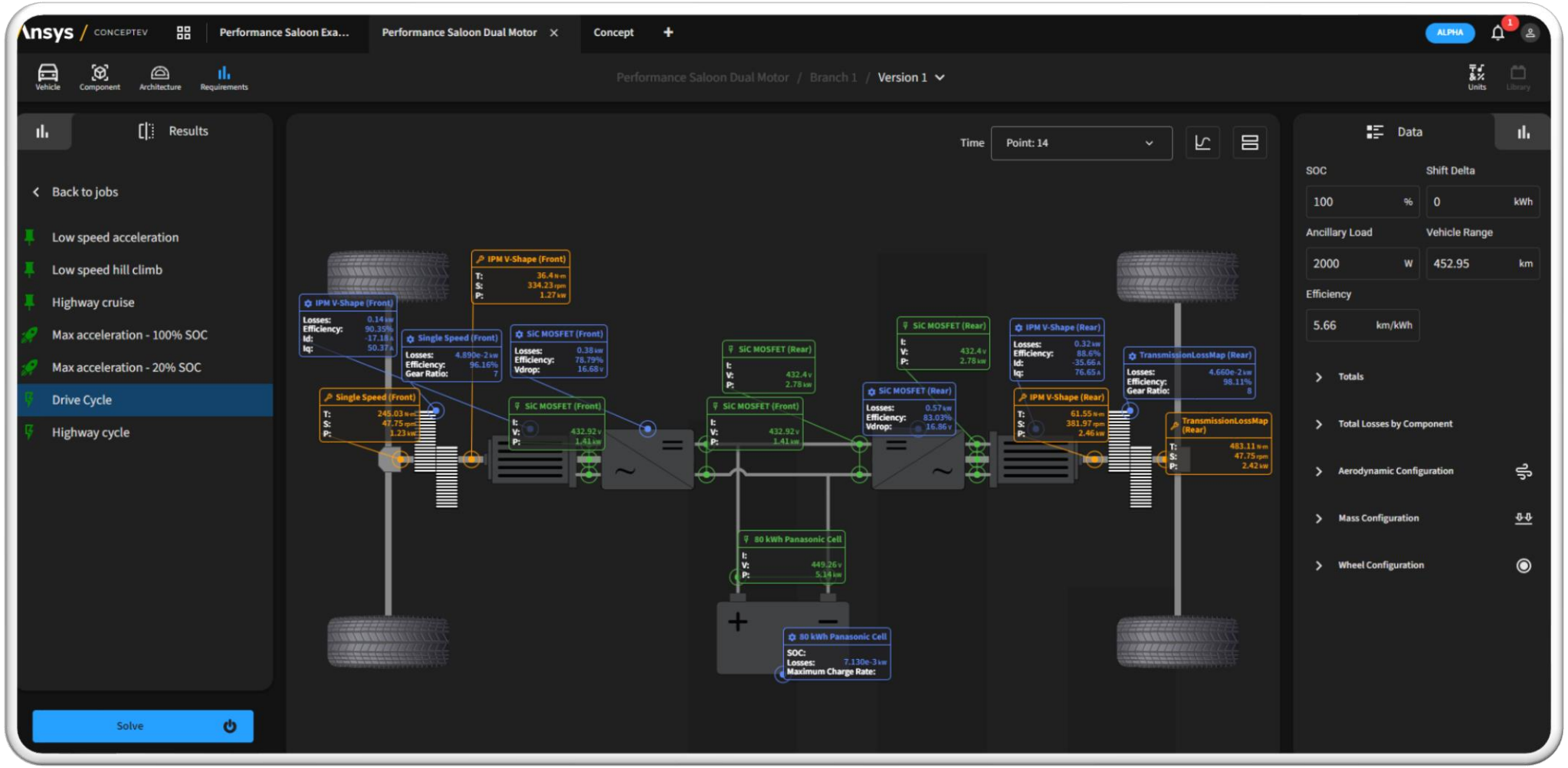


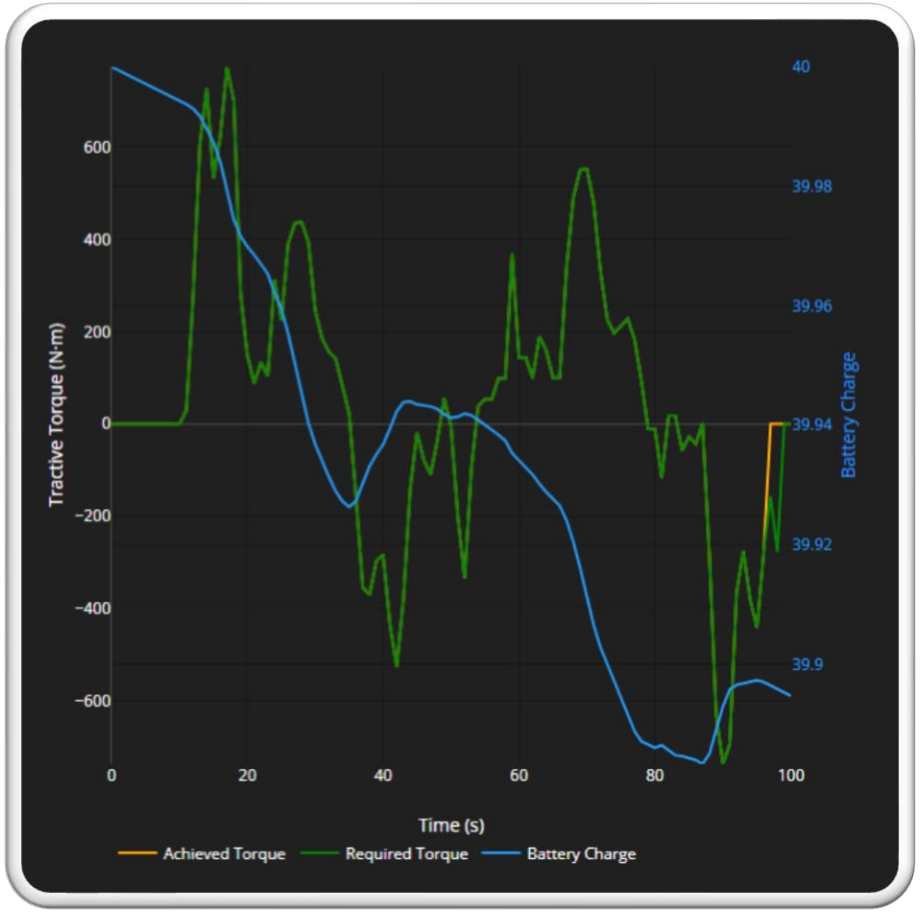
- Model-based approach to optimizing the powertrain system & components.
- Rapid evaluation of different powertrain configuration & component design choices
- Data-driven decisions are made early in the design process.
- Shared system model empowering teams to share their knowledge & insights
- Simple set-up with minimum data required
- Scalable for increasing demand, complexity & number of users

Ansys ConceptEV – Demo



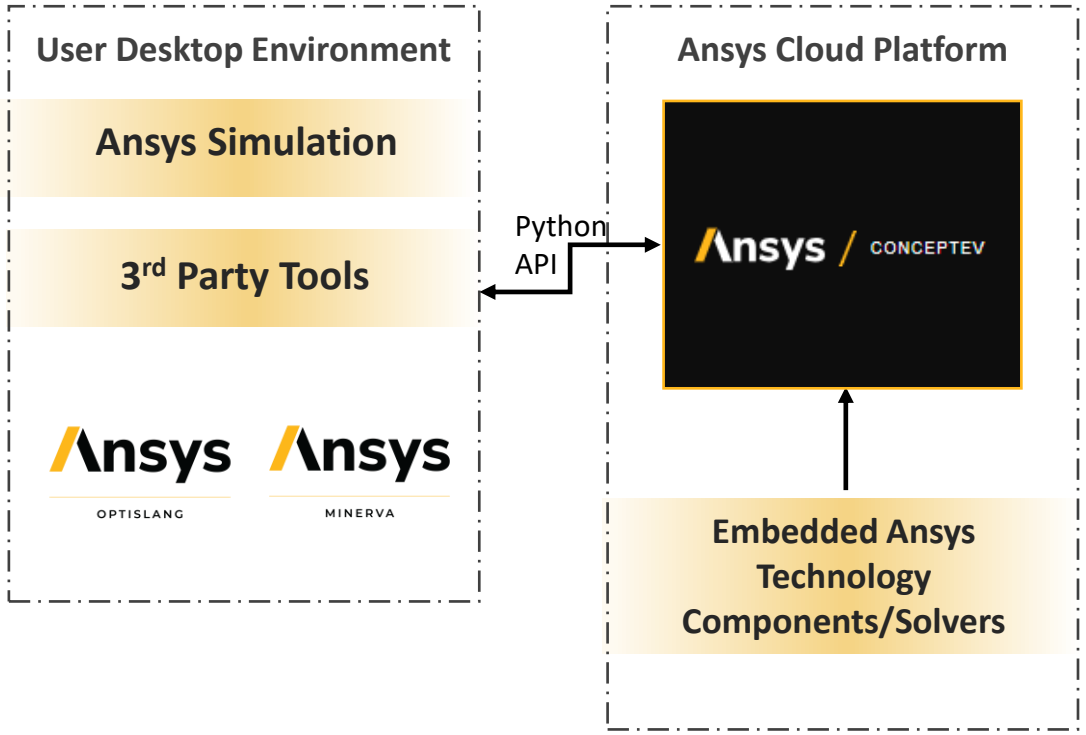
Ansys ConceptEV – Simulation Methodology

- Iterative electrical system solve based off equivalent circuit parameters
  - Voltage at motor terminal function of battery + harness + inverter losses & voltage drops
  - System voltage function of battery SoC (varies across cycle)
- Multi-state analysis & optimization at each time step:
  - Motor(s) control Id/Iq
  - Power split between EDUs
  - Gear selection (function of state in previous time step)
- Evaluation of operating states for requirement evaluation:
  - Max capability from component limits
  - Max regen from battery limits
  - Max efficiency mode



How is Ansys ConceptEV Connected and Automated?

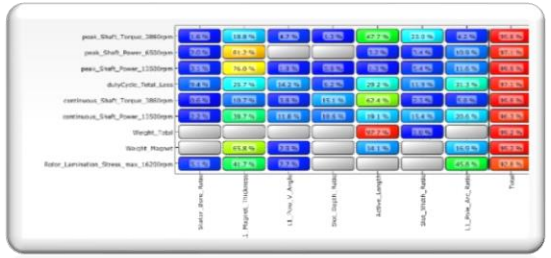
- Open interfaces for connection with Ansys or 3rd party tools
- Python API for automated workflows
- Can use optiSLang to drive design space exploration studies



Example of Component Optimization at System Level

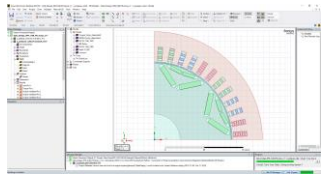
System level optimization solution for electric machines

Design parameters



Ansys / OPTISLANG

Ansys MOTOR-CAD / Ansys MAXWELL



Ansys CONCEPTEV

Automated ROM

Vehicle level requirements ✓ ✗

Range

Efficiency

Differentiators of Ansys ConceptEV

- Bespoke design & simulation platform for EV powertrains with in-built control

- Quickly & simply perform design space exploration against requirements on a shareable platform

- Open & accessible to cross-functional teams enabling enhanced communication & model exchange

Case Study: Example of an Automotive OEM

CURRENT SCENARIO	CONCEPTEV SCENARIO
Internal solution with mixture of commercial system simulation tools & in-house development	*Fully supported simulation evaluation tool integrated with existing component design workflows*
Vehicle attributes broken down into specification of sub-system – requirements cascade	*More comprehensive data driven design space exploration in early phase*
Overspecification of sub-systems	*Optimized powertrain design trade-offs*
Siloed organization	*Shareable within & across the organization*
Specialist system tools owned by few people – closed access	*All stakeholders work around the same data/tool*

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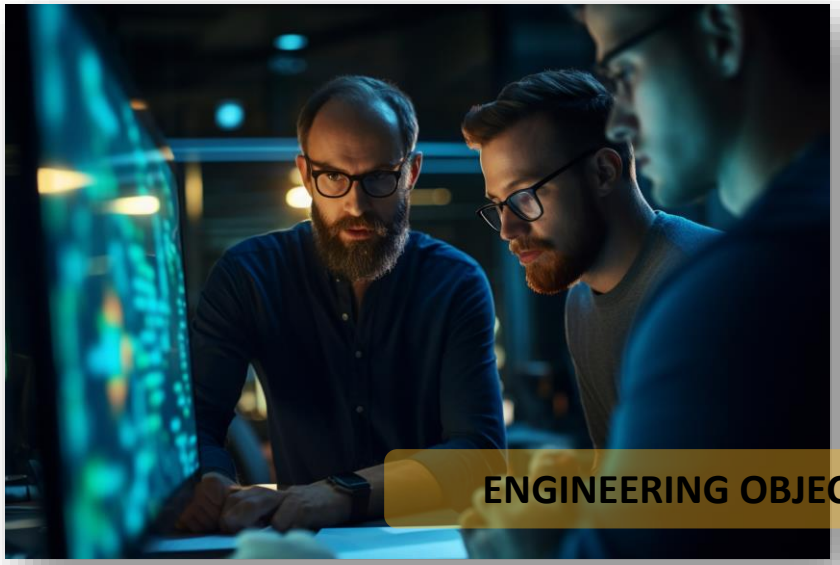


ENGINEERING OBJECTIVES

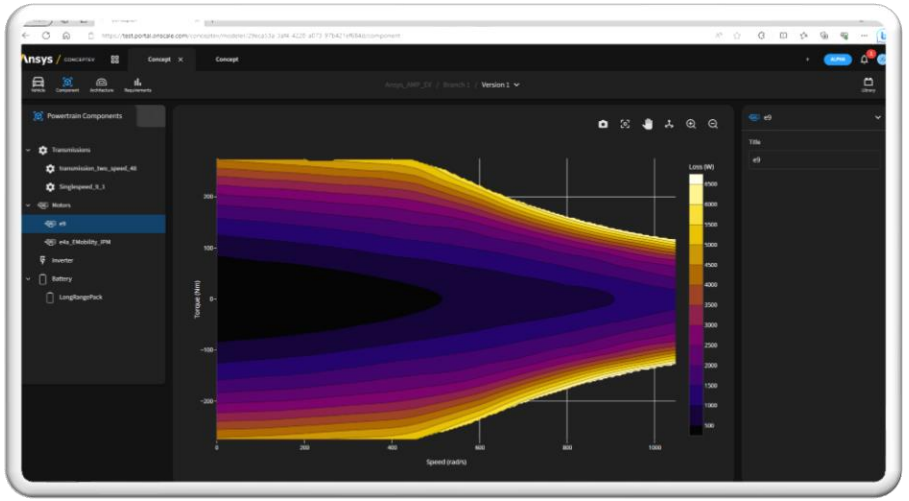
- ✓ Better system design decisions
- ✓ Better management decisions due to visibility
- ✓ Lowered technical & commercial risks
- ✓ Increased human understanding of design space
- ✓ Reduced # of design iterations
- ✓ Higher quality concept design – traceable & open
- ✓ Fully engaged stakeholders
- ✓ Cross-functional teams working from the same data sets

BUSINESS OBJECTIVES

- ❑ Accelerate time to market (more NPIs)
- ❑ Produce more competitive powertrain design
- ❑ Achieve cost target
- ❑ Save time & boost innovation

Summary

- ConceptEV is an innovative new cloud native tool developed by Ansys for the design & optimization of electrified powertrains.
- It enables early-stage evaluation and optimization of powertrain configurations.
- Through the cloud interface, teams can collaborate & exchange data to ensure system trade-offs are integrated into component design decisions.



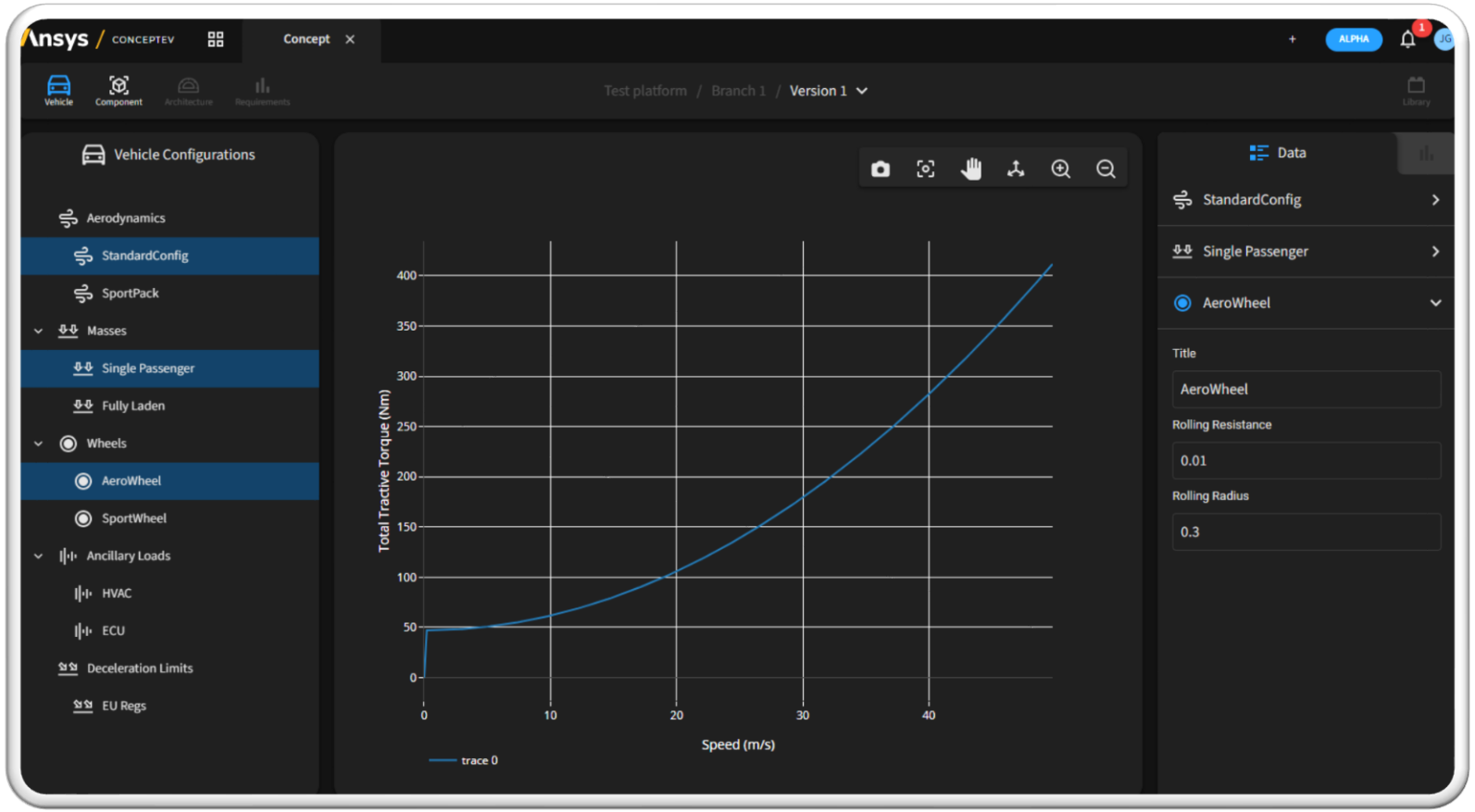

Ansys

Additional Slides

More About the Interface - Demo

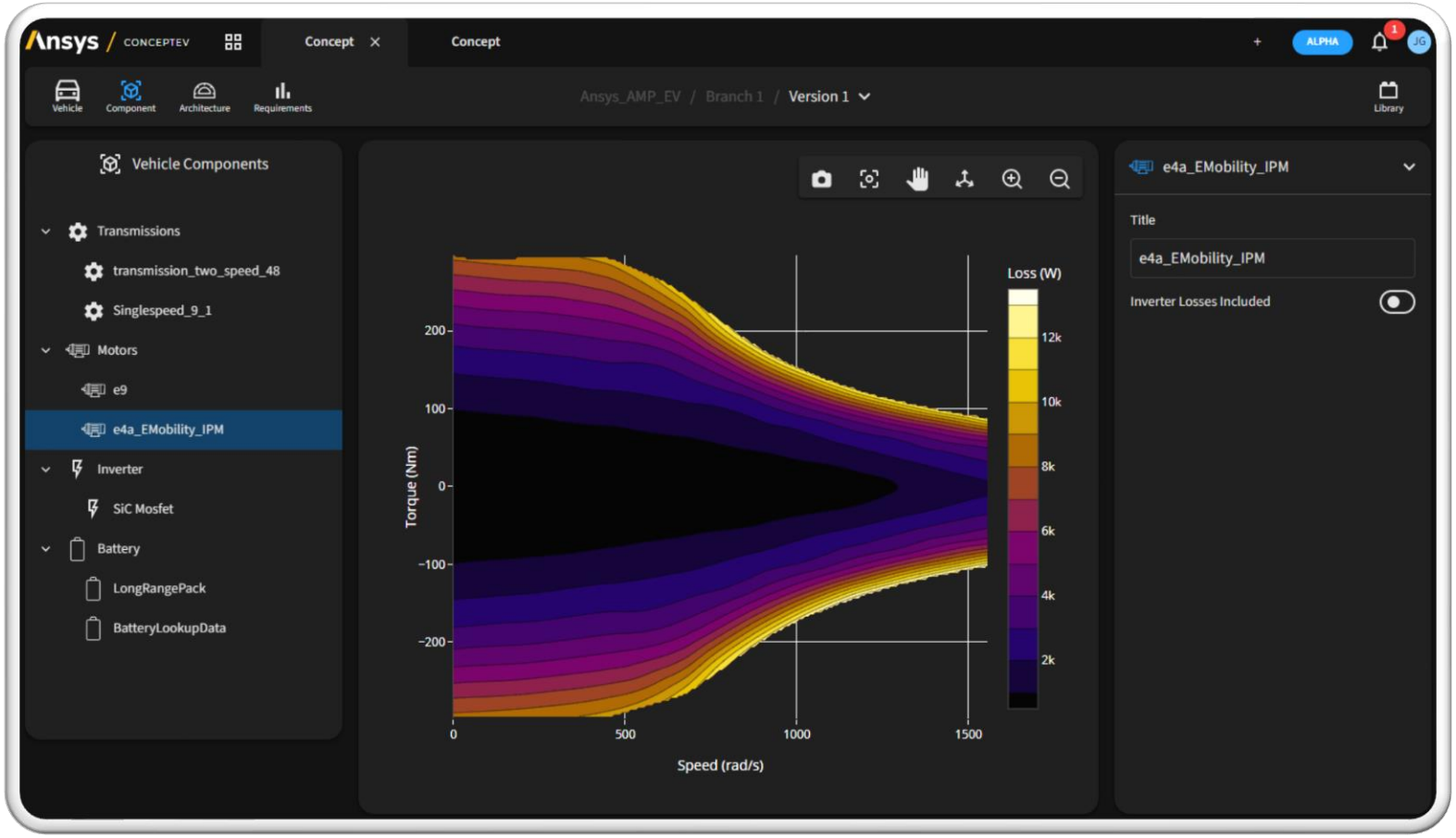
Ansys ConceptEV Preview – Vehicle Model

- Vehicle mode: multiple aero, mass, wheel, and stability configurations defined



Ansys ConceptEV Preview – Component Model Connections

- Electric machine, Inverter, transmission, battery models/data connected
- Range of different model fidelity options for each component
- Automated interfaces are built from component tools (e.g. Ansys Motor-CAD)
- Many components can be defined



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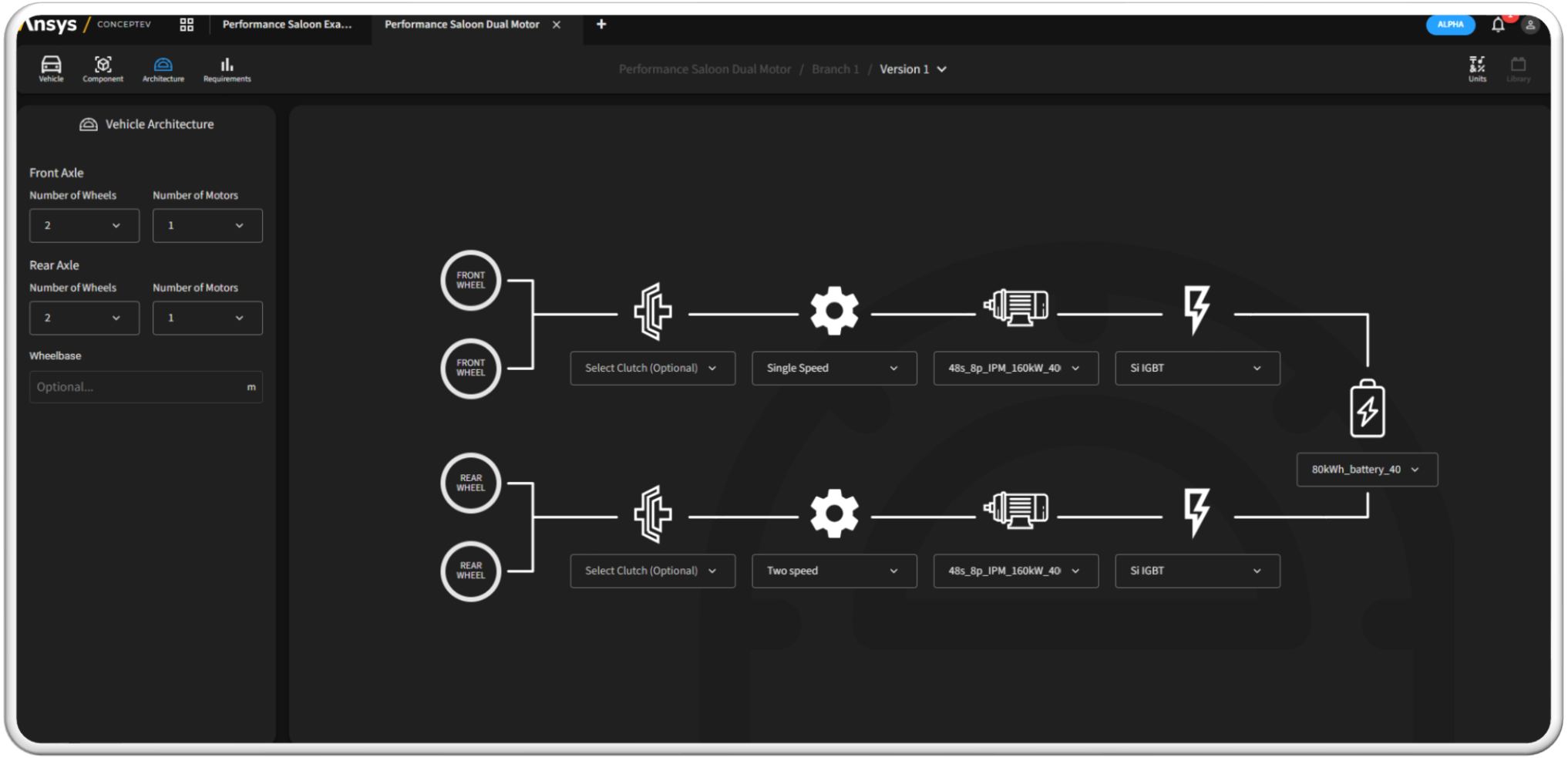
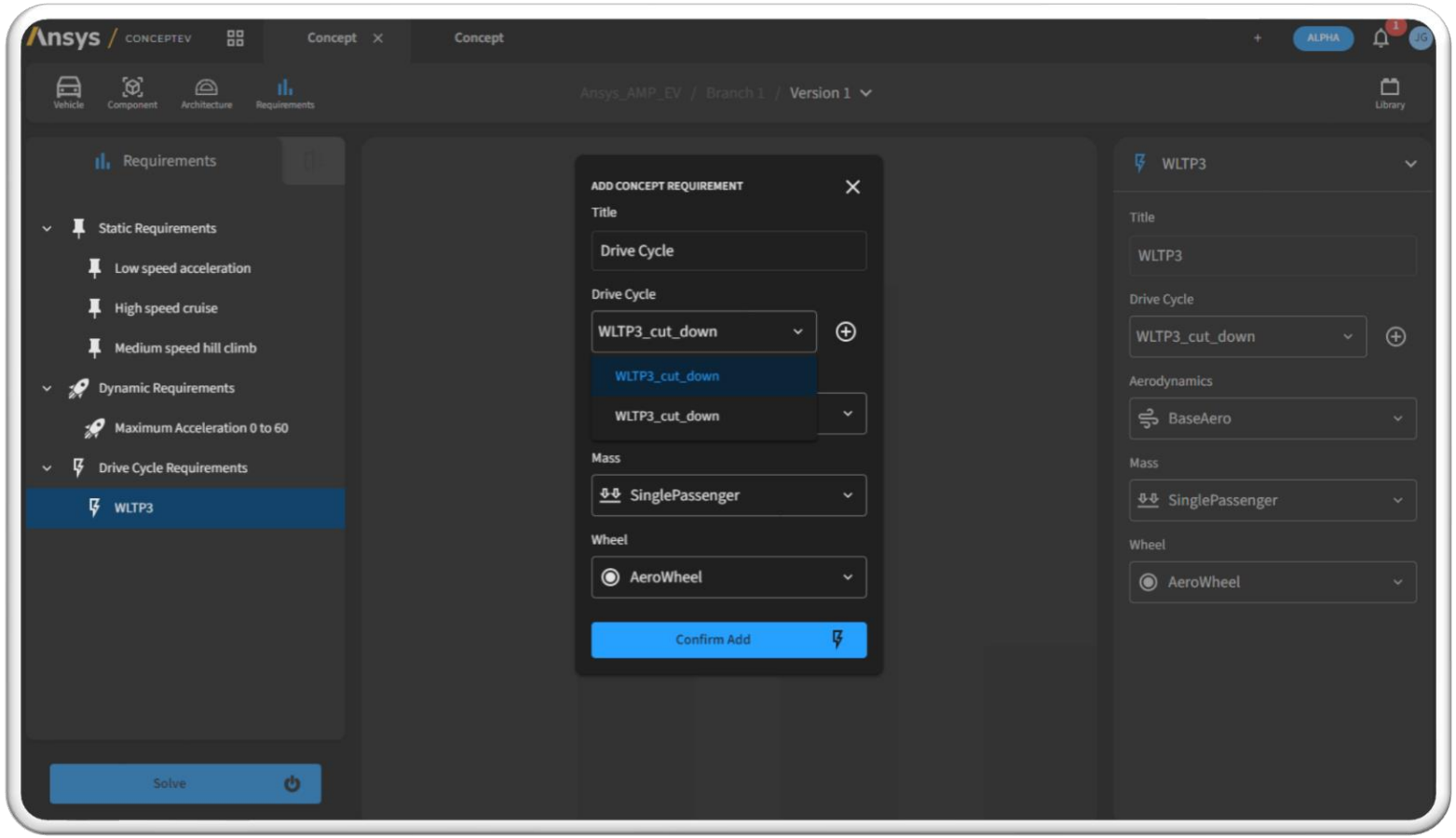


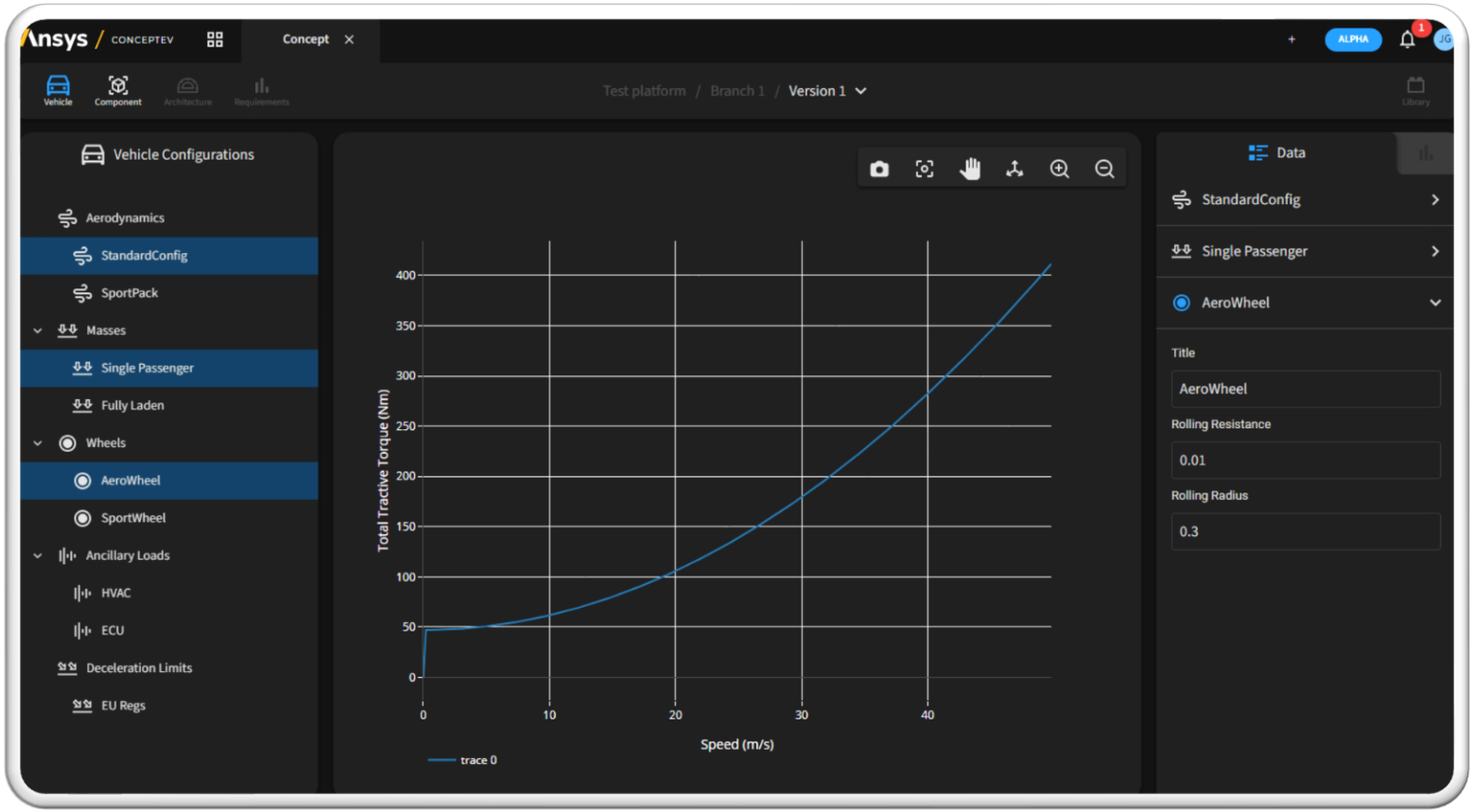
Ansys ConceptEV Preview – Requirements

- Vehicle level requirements are specified or imported
- The powertrain performance is simulated with in-built control strategies to evaluate which of these requirements can be achieved



Ansys ConceptEV Preview – Energy

- Drive cycles are performed to evaluate energy consumption & vehicle range
- Control strategies applied:
  - Power splits between drive units
  - Shifting strategies
  - Variable battery voltage with state-of-charge
  - Battery charge acceptance limits in regen
  - Vehicle stability deceleration limits using regen



EDU Requirements

What if we only receive the EDU level requirements, not those of the vehicle?

- ConceptEV will provide an EDU model where you can:
  - Define EDU level requirement list
  - Simulate EDU behavior against requirements
  - Control Id/Iq with combined inverter & motor behavior, efficiency & voltage
  - Model multi-speed transmissions
- To consider:
  - How are the EDU level requirements derived? Particularly with multiple driven axles
  - Could ConceptEV be used to change the paradigm on how component design interfaces with the system integrators? Could this lead to a competitive advantage in the development of the powertrain?