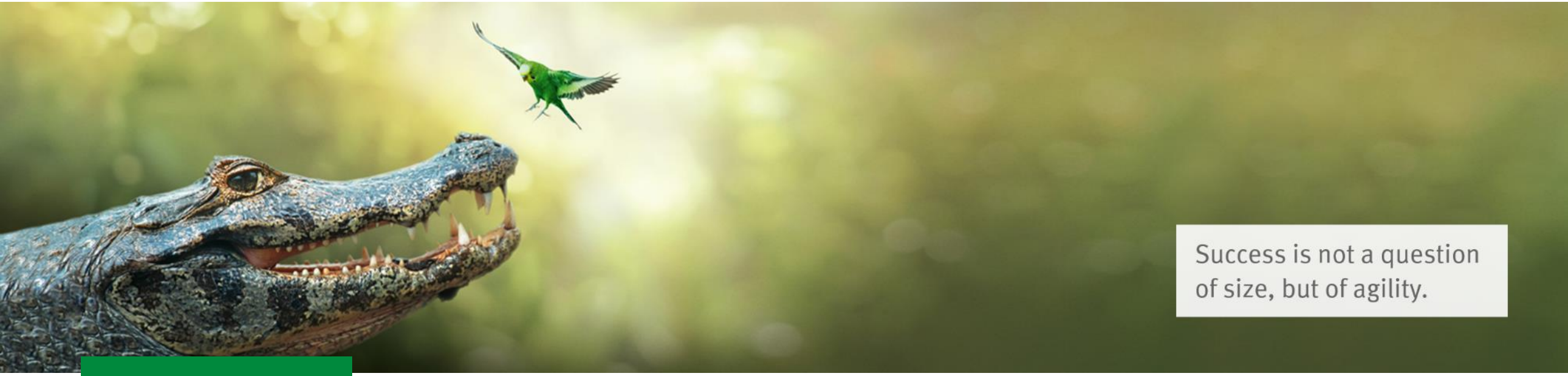
SCHAEFFLER



Systems Engineering in Automotive Development

Technical Computing Camp 2024, Brno

Milan Kertész| CKY-R&D
Innovation Engineer
5.-6. of September 2024

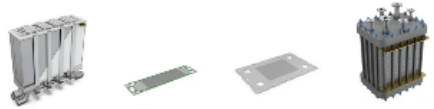
We pioneer motion

SCHAEFFLER

Introduction – Menti Survey

SCHAEFFLER

Our Product & Service Offering – Motion as the connecting element

	PRODUCT FAMILIES	PRODUCT & SERVICE OFFERING
Sustain motion	PF 6 | Repair & Monitoring Services	
Energize motion	PF 5 | Hydrogen Stacks & Plates	
Drive motion	PF 4 | E-Motors & E-Drives	
Generate motion	PF 3 | Actuators	
Transmit motion	PF 2 | Transmission & Engine Components	
Guide motion	PF 1 | Bearings & Linear Guides	

Key Aspects

- Schaeffler product & service portfolio categorized into 6 Product families
- All product families associated with their respective notion of motion, from guide motion to sustain motion
- Product families address customer requirements along all 4 market and 10 sector clusters
- Use all the Schaeffler know-how in our core technologies to create maximum customer value and a unique selling proposition

Motion as the connecting element

SCHAEFFLER

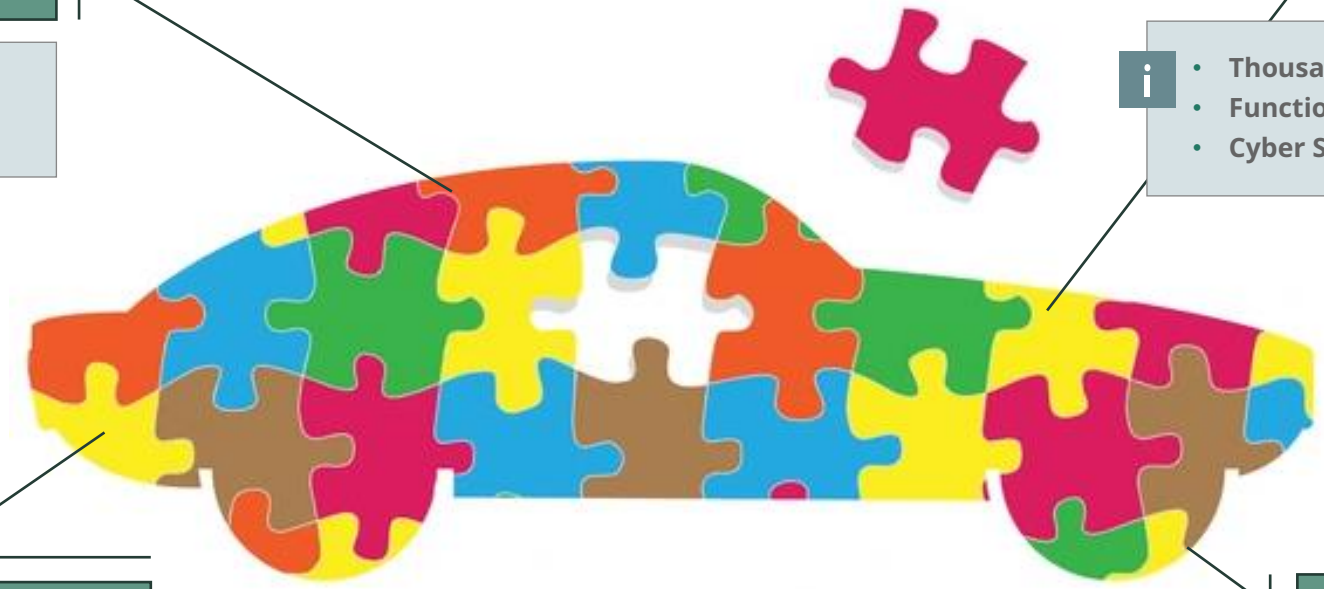
Modern Car – A Complex System

Many Subsystems

- Big number (tens)
- Mechatronic nature

Advanced Functionality

- Thousands of requirements
- Functional safety
- Cyber Security



Frequent Changes

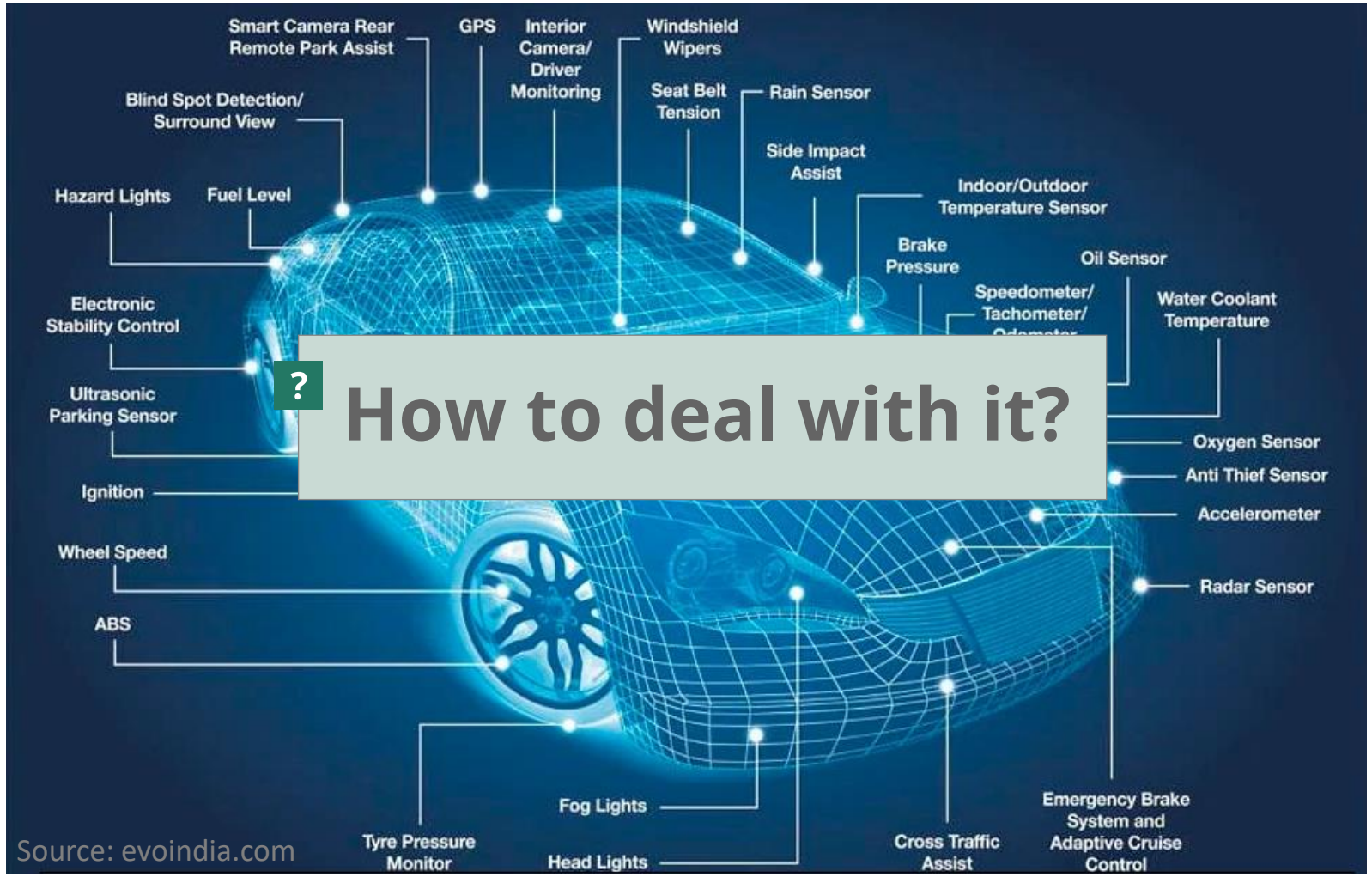
- High uncertainty
- A lot of interactions

Iterative Development

- Milions lines of code
- Incremental implementation

SCHAEFFLER

Modern Car – A Complex System

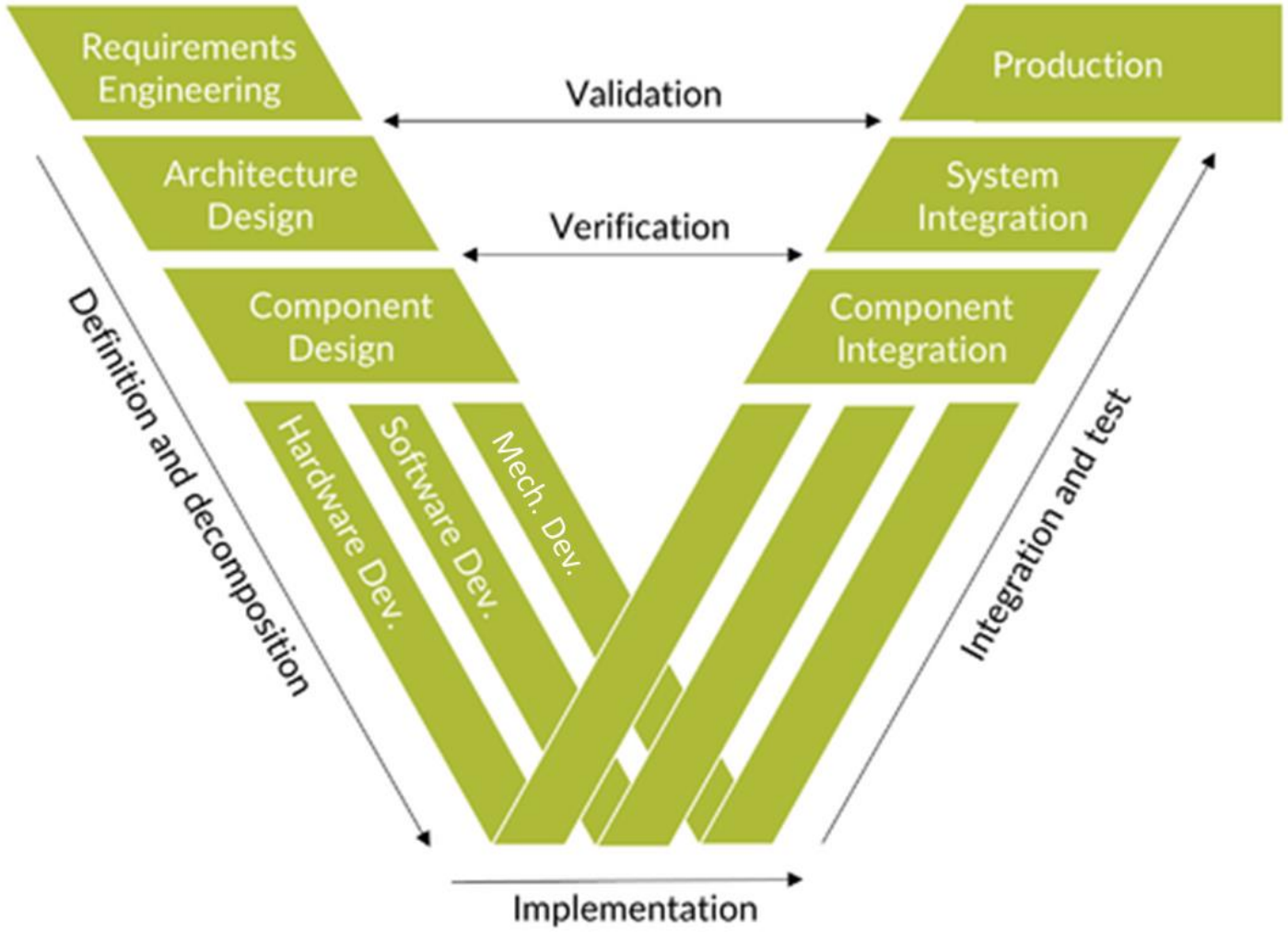


Source: evoindia.com

- **SYSTEMS ENGINEERING (SE)**
- DOCUMENT BASED (DBSE)
- REQUIREMENTS BASED (RBSE)
- MODEL BASED (MBSE)

SCHAEFFLER

V-Model – Automotive System Development Standard



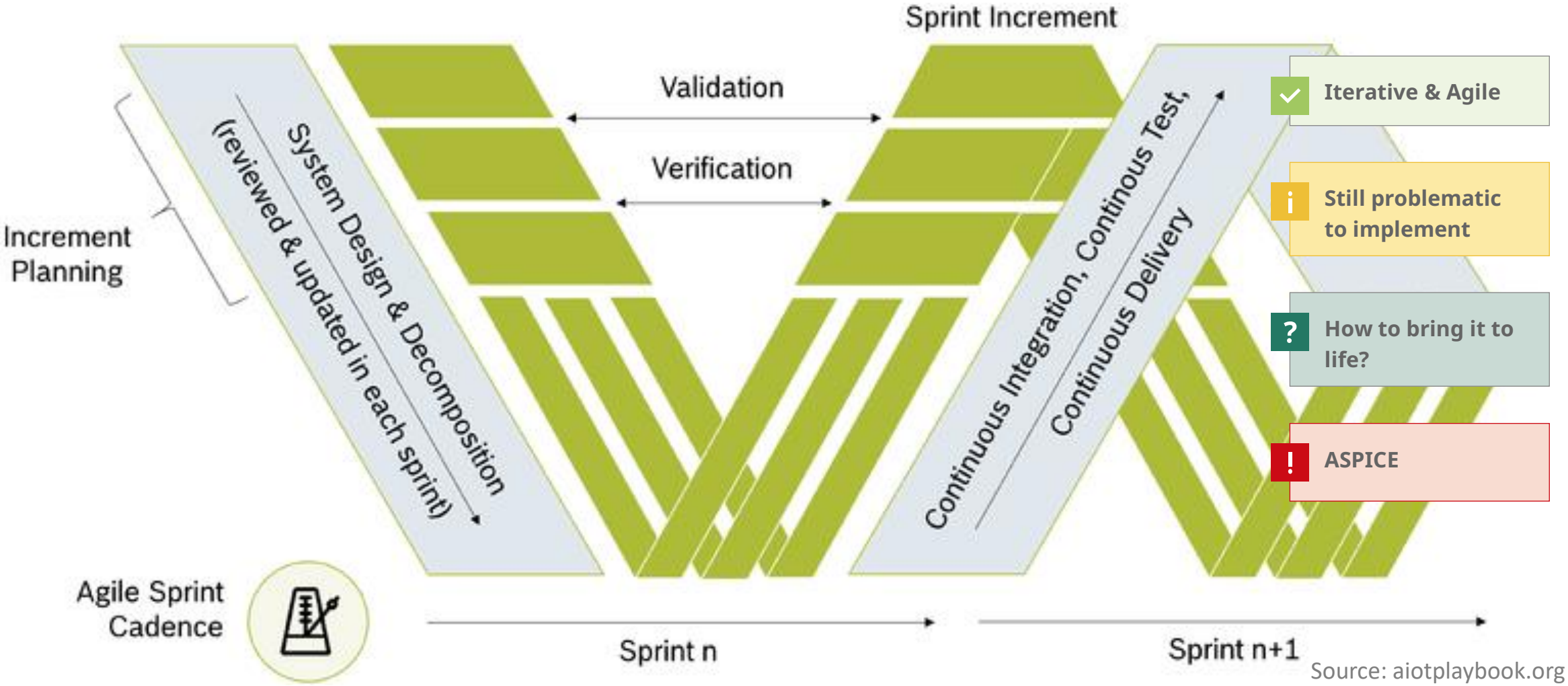
! **Shows relations, not time**

! **Not Agile, nor iterative!**

Source: aiotplaybook.org

SCHAEFFLER

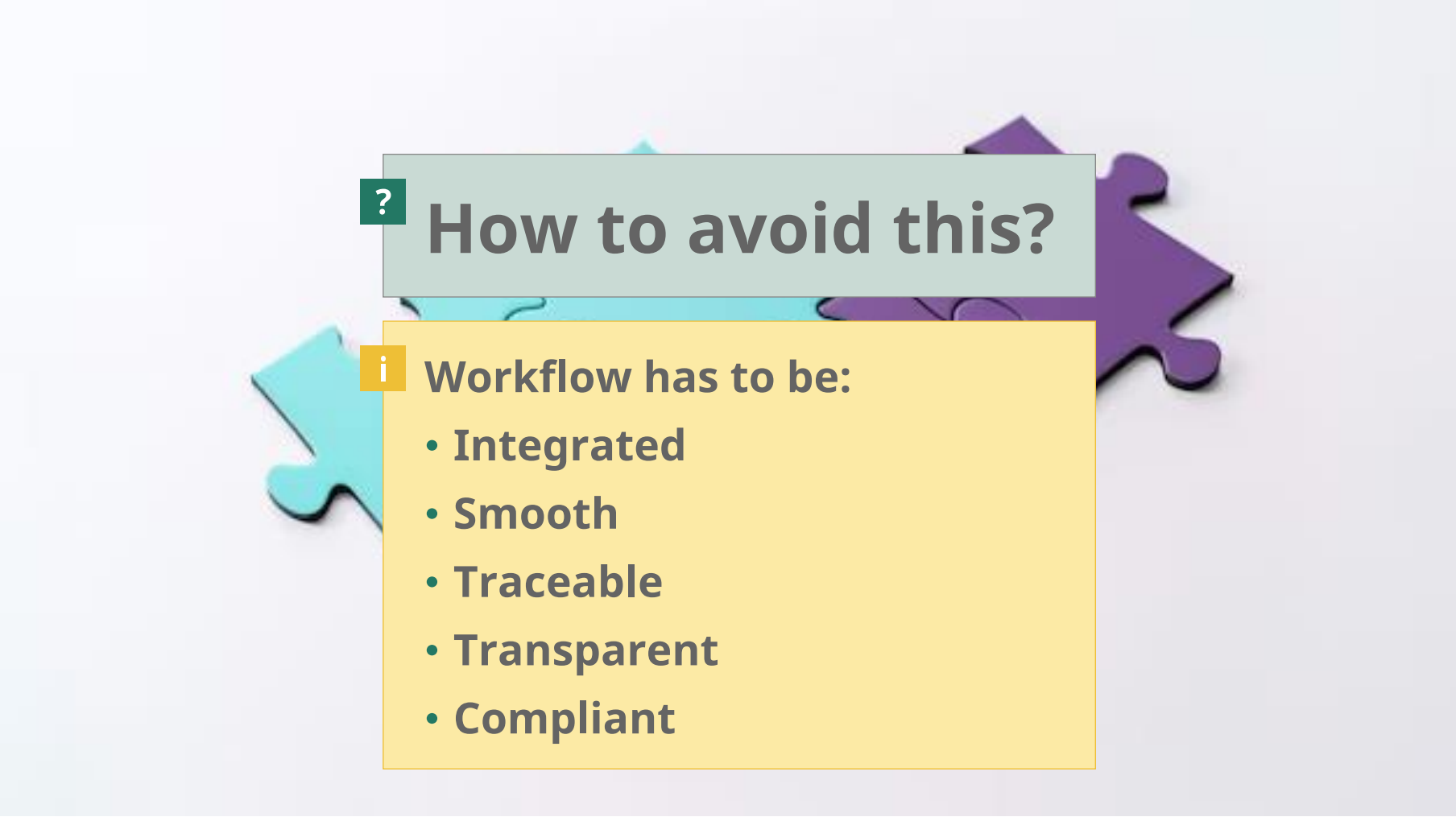
V-Model – Automotive System Development Standard



Source: aiotplaybook.org

SCHAEFFLER

Back to Puzzle Problem

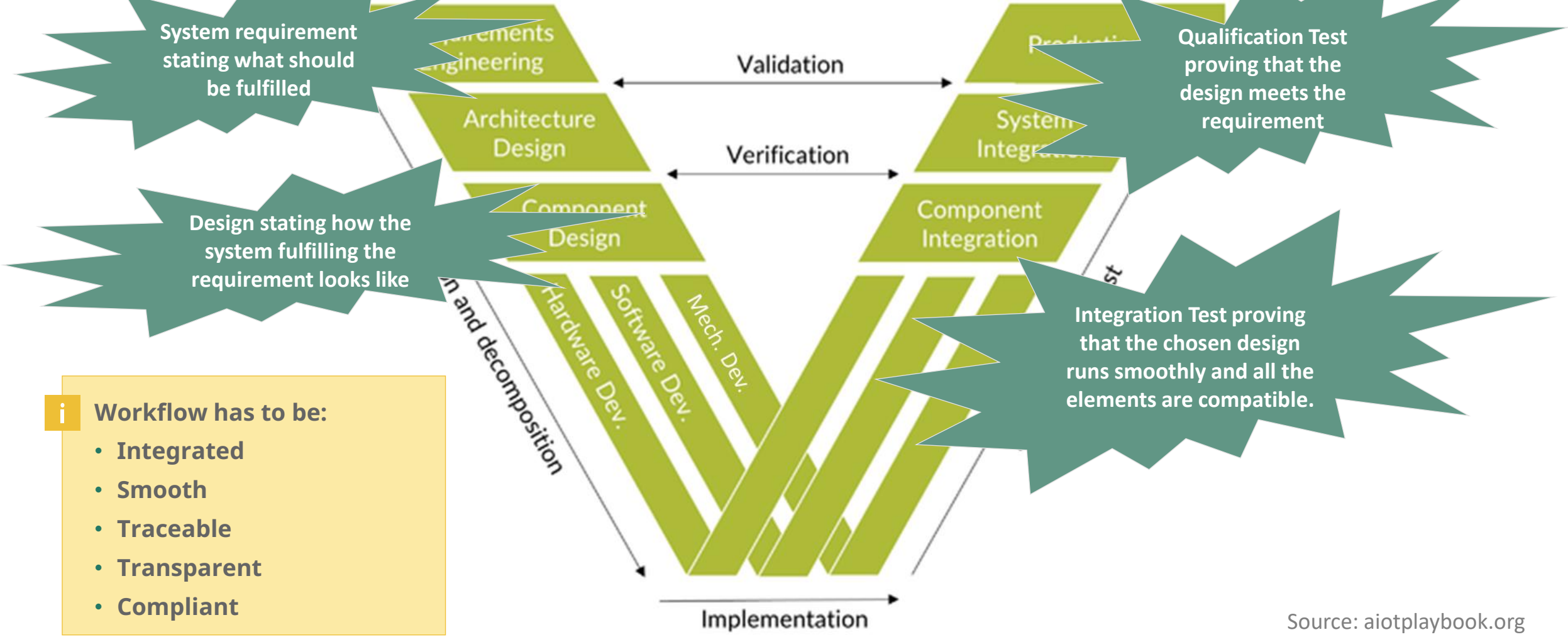


SCHAEFFLER

Holistic Take on Systems Engineering

System requirement stating what should be fulfilled

Design stating how the system fulfilling the requirement looks like



Qualification Test proving that the design meets the requirement

Integration Test proving that the chosen design runs smoothly and all the elements are compatible.

Workflow has to be:

- Integrated
- Smooth
- Traceable
- Transparent
- Compliant

Source: aiotplaybook.org

SCHAEFFLER

Holistic Take on Systems Engineering – Deep Dive

Requirement

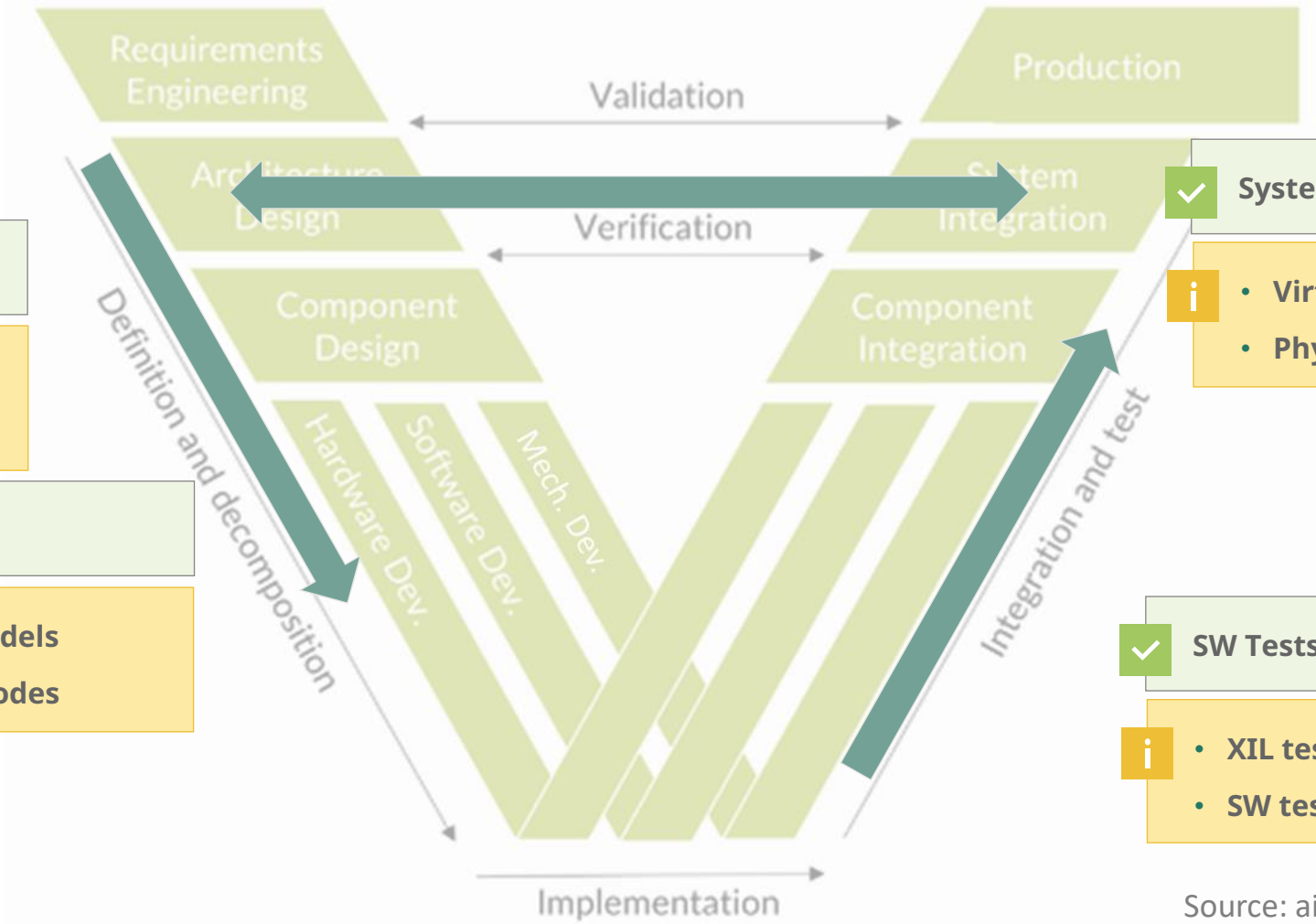
- Standardized ReqIF format

System Design

- Architecture models
- Simulation models

SW Design

- Software models
- Generated codes



System Tests

- Virtual test mgmt
- Physical test mgmt

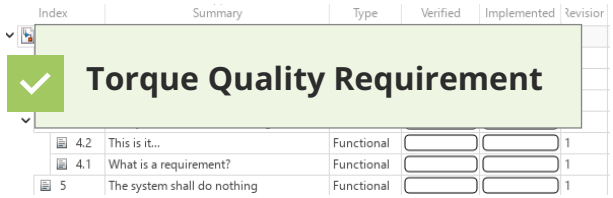
SW Tests

- XIL testing
- SW test management

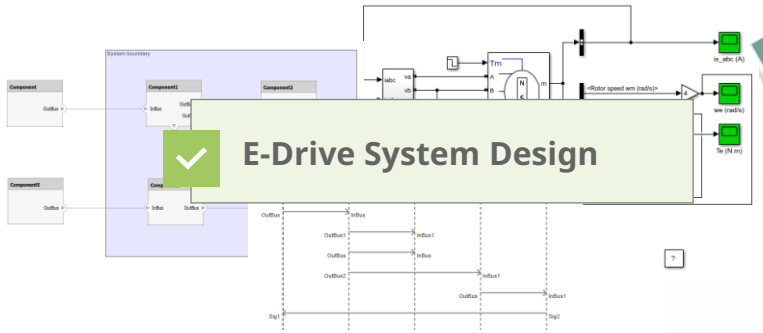
Source: aiotplaybook.org

SCHAEFFLER

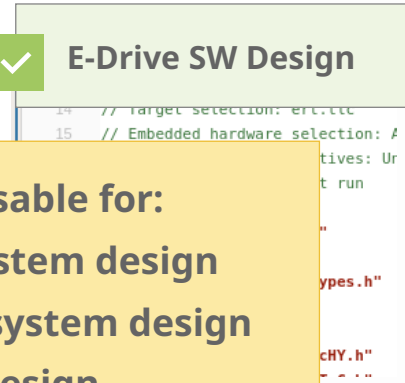
Holistic Take on Systems Engineering – E-Drive Example



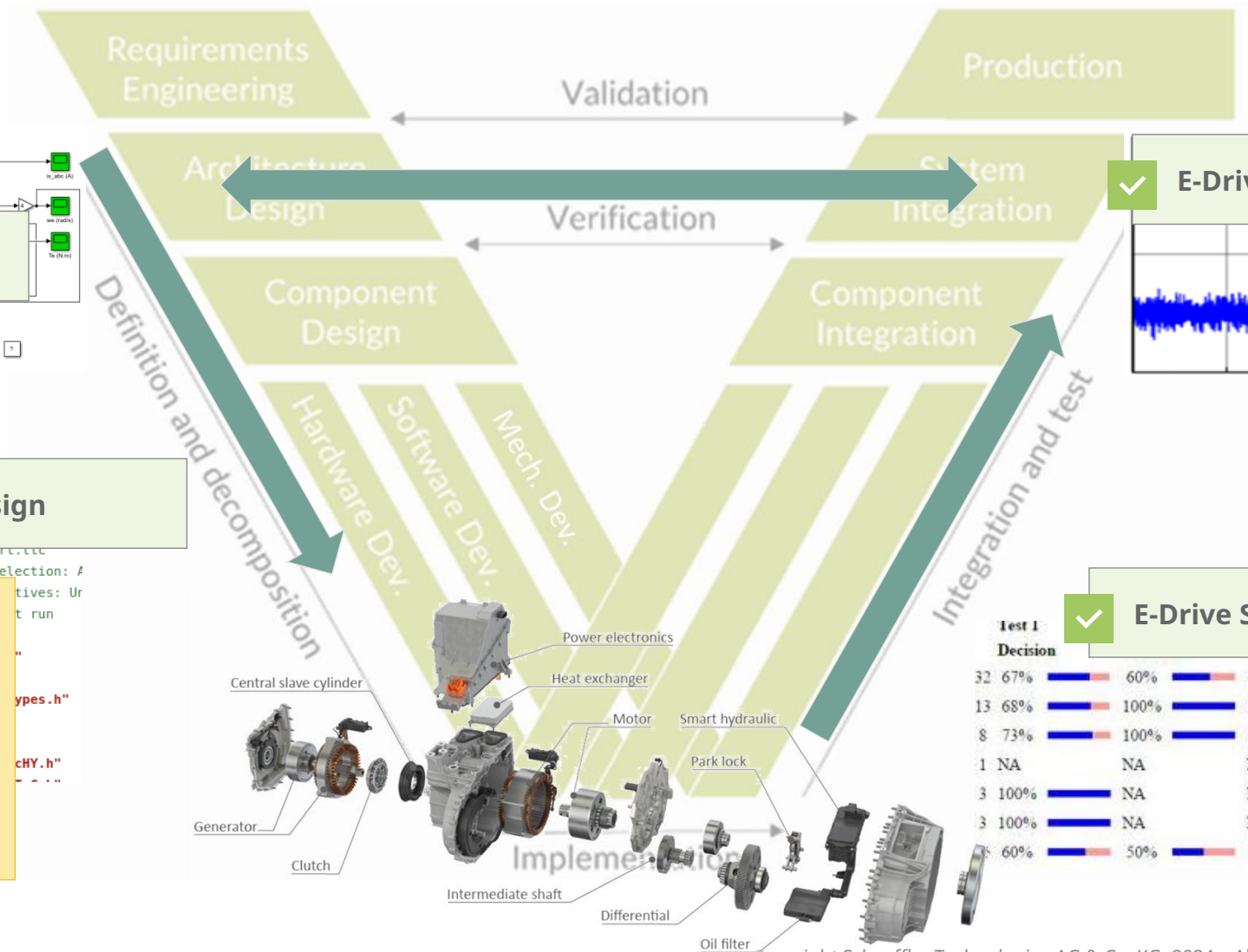
Torque Quality Requirement



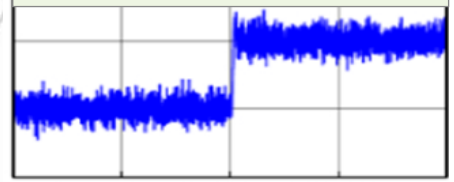
E-Drive System Design



E-Drive SW Design



E-Drive System Tests



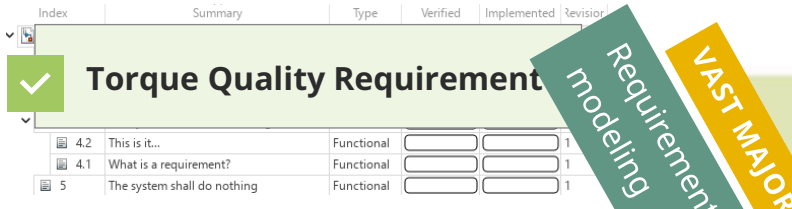
E-Drive SW Tests

Same process usable for:

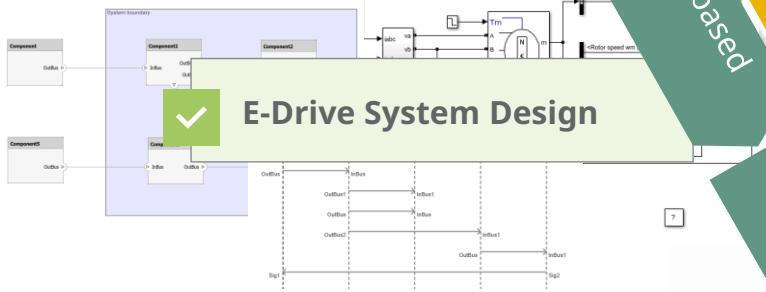
- Hydraulic system design
- Mechancial system design
- Electronics design
- Etc.

SCHAEFFLER

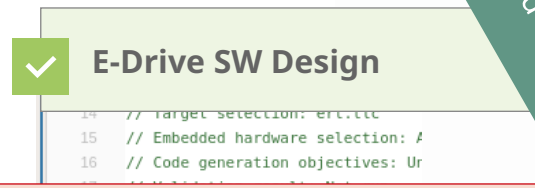
Holistic Take on Systems Engineering – Deeper Dive



Torque Quality Requirement



E-Drive System Design



E-Drive SW Design

Requirements modeling

VAST MAJORITY

Model-based design

VAST MAJORITY IN ASW

VAST MAJORITY

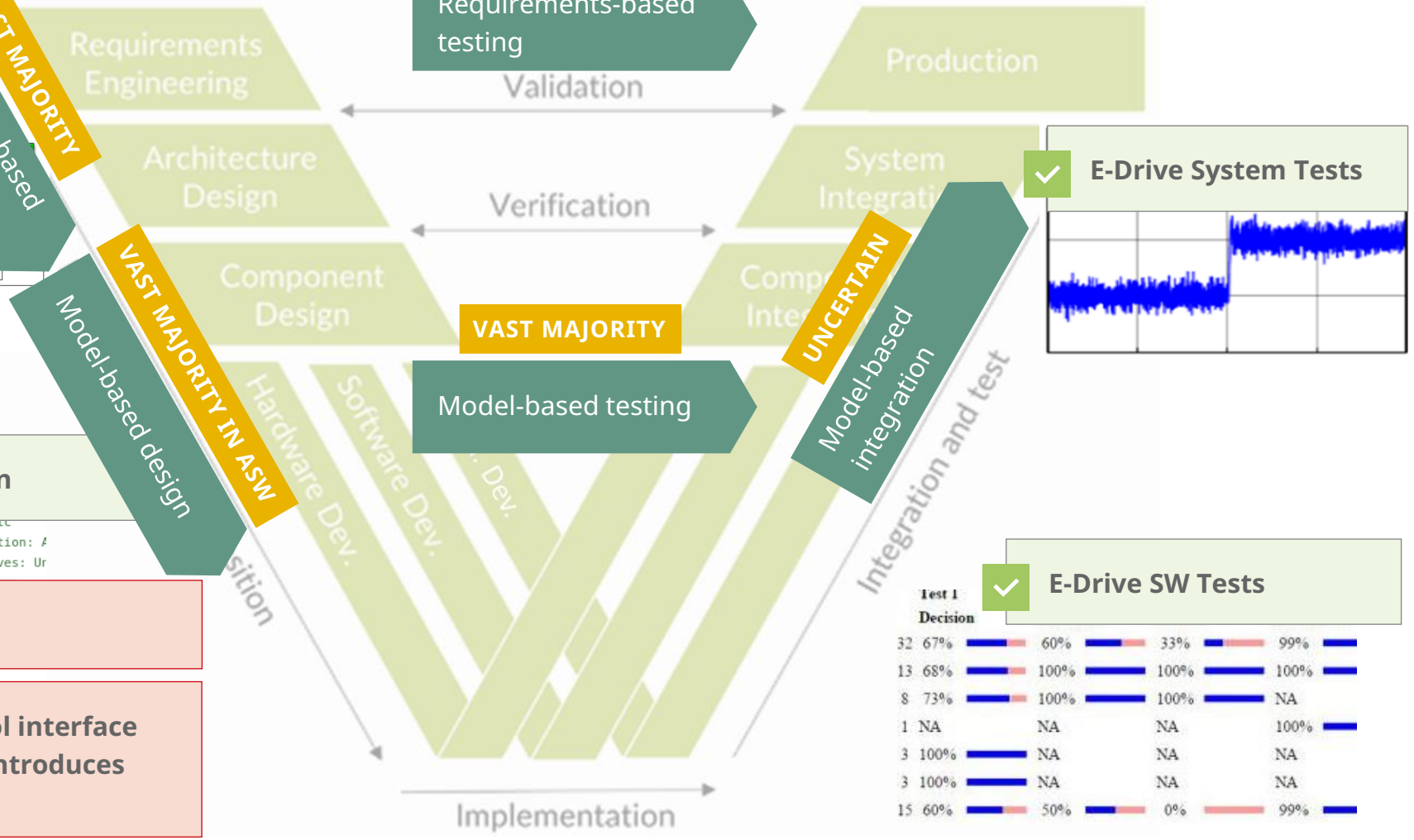
Requirements-based testing

VAST MAJORITY

Model-based testing

UNCERTAIN

Model-based integration



E-Drive System Tests

E-Drive SW Tests

! **Usually a blend of RBSE, MBSE and DBSE**

! **Use as little tools as possible – Every tool interface imposes a risk of information loss and introduces additional effort to maintain it**

SCHAEFFLER