NEXT LEVEL ENGINEERING
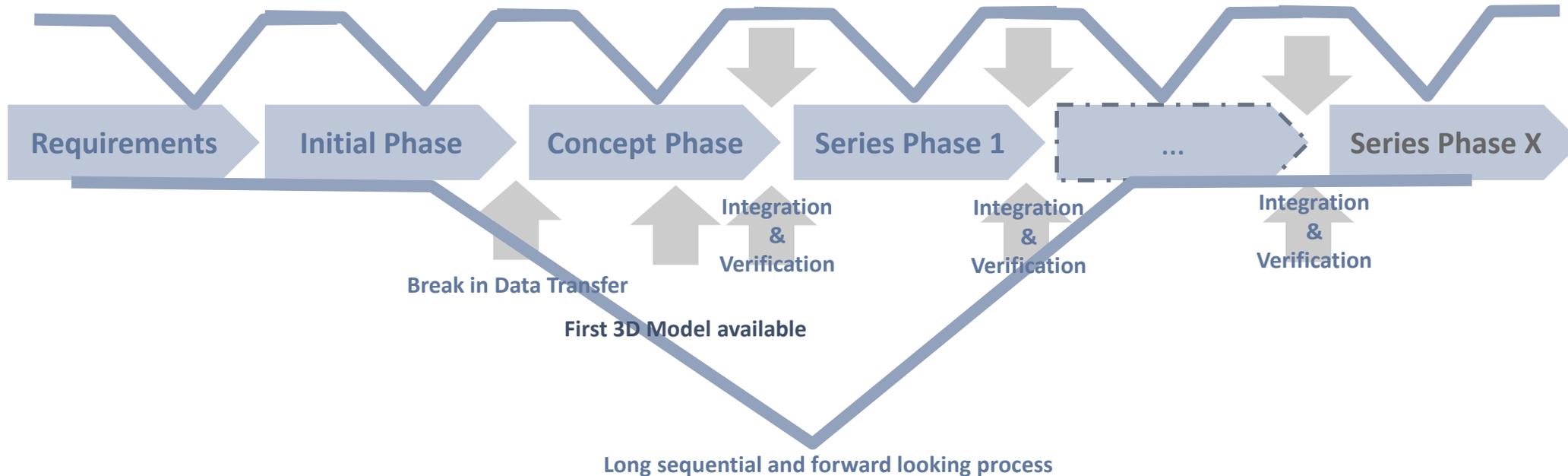## EXPLORING THE DIGITALIZATION OF CAR DEVELOPMENT KNOW-HOW

22.05.2019
Gagan Saket
Hans-Peter Daunert

MOTIVATION – WHERE WE COME FROM?
PRODUCT DEVELOPMENT TODAY.

Requirements	Initial Phase	Concept Phase	Series Phase 1	...	Series Phase X

Integration & Verification

Integration & Verification

Integration & Verification

Break in Data Transfer

First 3D Model available
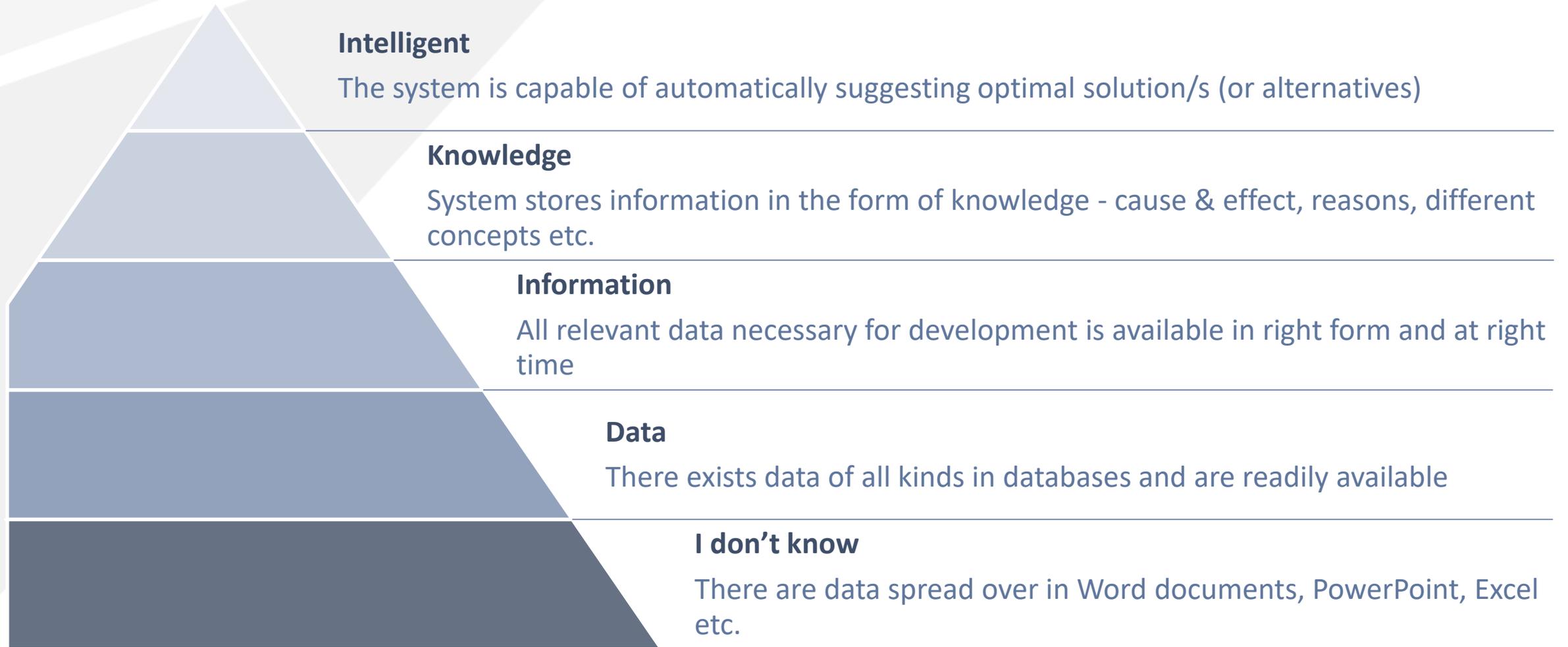
Long sequential and forward looking process

➢ Current product development typically follows a **V-Model** of development
➢ Current product development process is long, sequential and only forward looking
  ➢ No way to jump through the phases – **no agility** in product development
  ➢ No simulation support in early phases of development
➢ Process driven and not Data Driven
➢ Not a **self learning** process – **no intelligence and feedback**

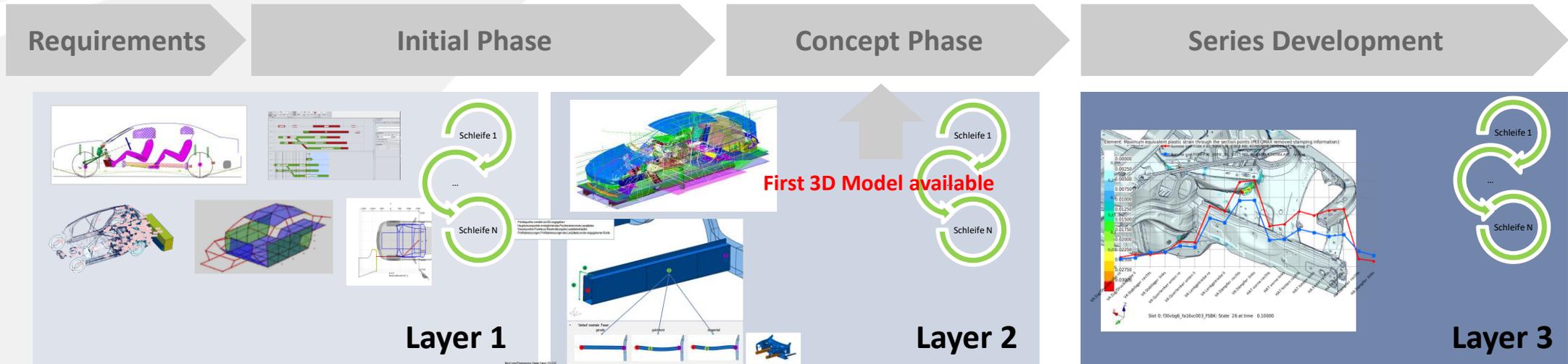# MOTIVATION – WHERE WE ARE?
PRODUCT DEVELOPMENT OF FUTURE.

➢ It should be cyclic, short & agile
➢ It should be able to combine and link data, tools & methods in all phases of development
➢ It should allow for full simulation support also in early phases of development
➢ It should be data driven and not process driven
➢ It should be intelligent & provide reusable results – strive for self-optimization

We are aiming for intelligent & self learning processes through
digitalization of know-how

MOTIVATION.
LEVEL OF DIGITALIZATION.

Intelligent

The system is capable of automatically suggesting optimal solution/s (or alternatives)

Knowledge

System stores information in the form of knowledge - cause & effect, reasons, different concepts etc.

Information

All relevant data necessary for development is available in right form and at right time

Data

There exists data of all kinds in databases and are readily available

I don't know

There are data spread over in Word documents, PowerPoint, Excel etc.

MOTIVATION – WHERE WE ARE?
PRODUCT DEVELOPMENT TODAY – DATA VIEW.

> ➢ Product development happens in 3 different levels of detail
> ➢ No way to combine tool and methods across different layers
> ➢ Inefficient & insufficient information transfer between processes and phases
> ➢ Concept development is conceptually different from series development

MOTIVATION – WHERE DO WE WANT TO GO?
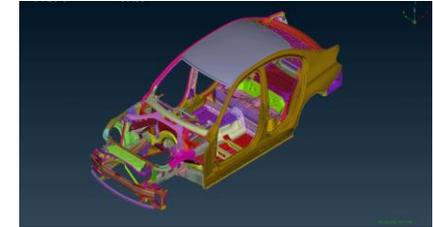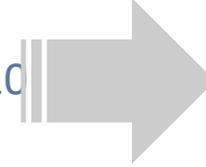# THE PRODUCT DEVELOPMENT TOMORROW – DATA VIEW.
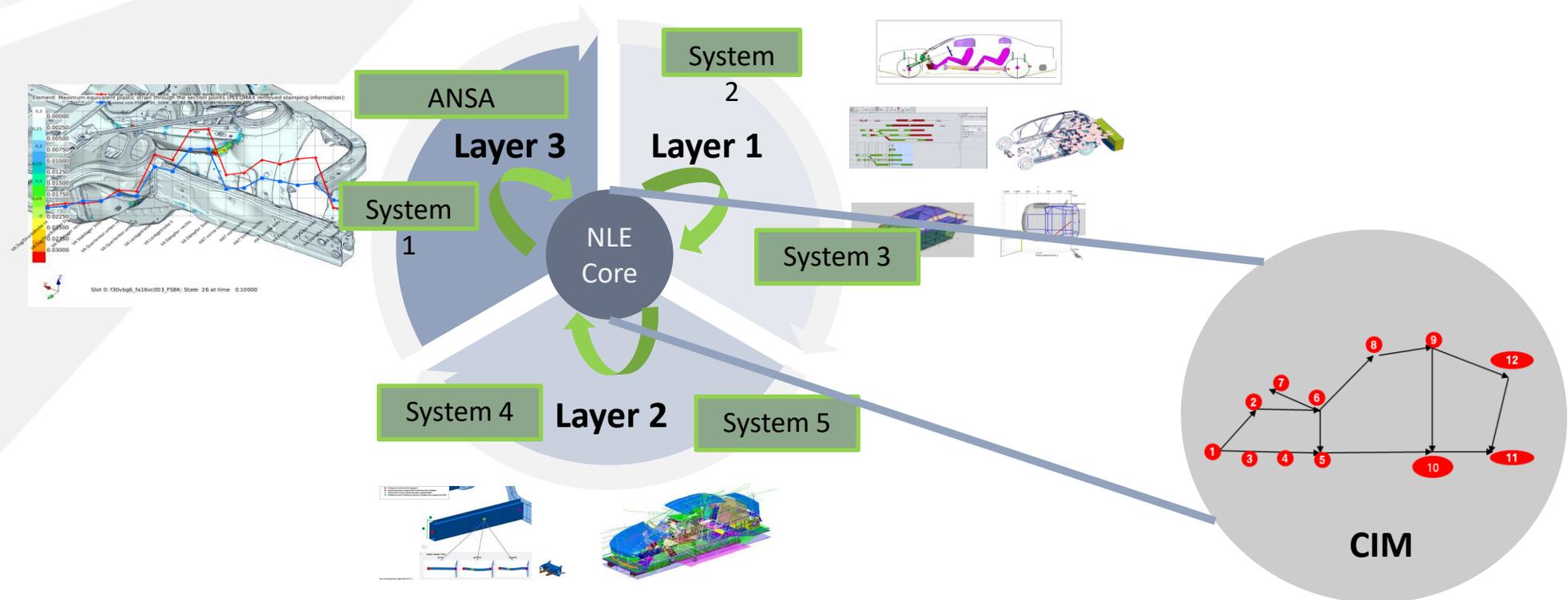
- A Core is formed with a **Car Information Model (CIM),** which
  - Builds a "machine readable abstracted layer" of a complete product
  - Provides additional information as linked data – **Requirement, Function and Geometry**
  - Forms the springboard for attaching knowledge

HOW WILL IT WORK? – A SIMPLE CASE.
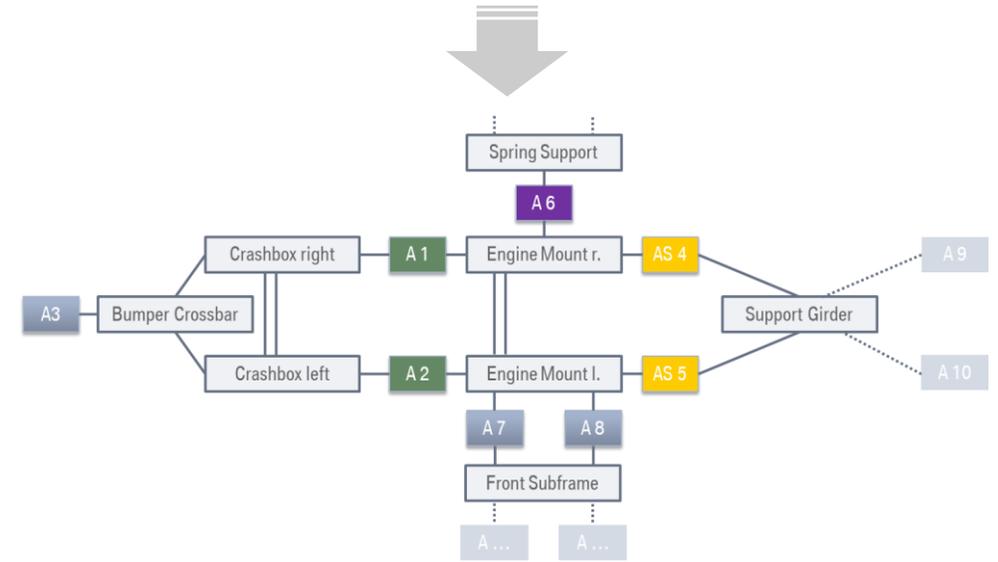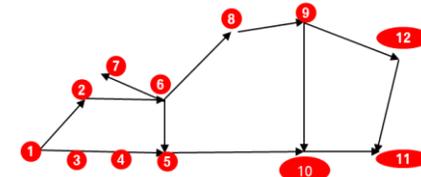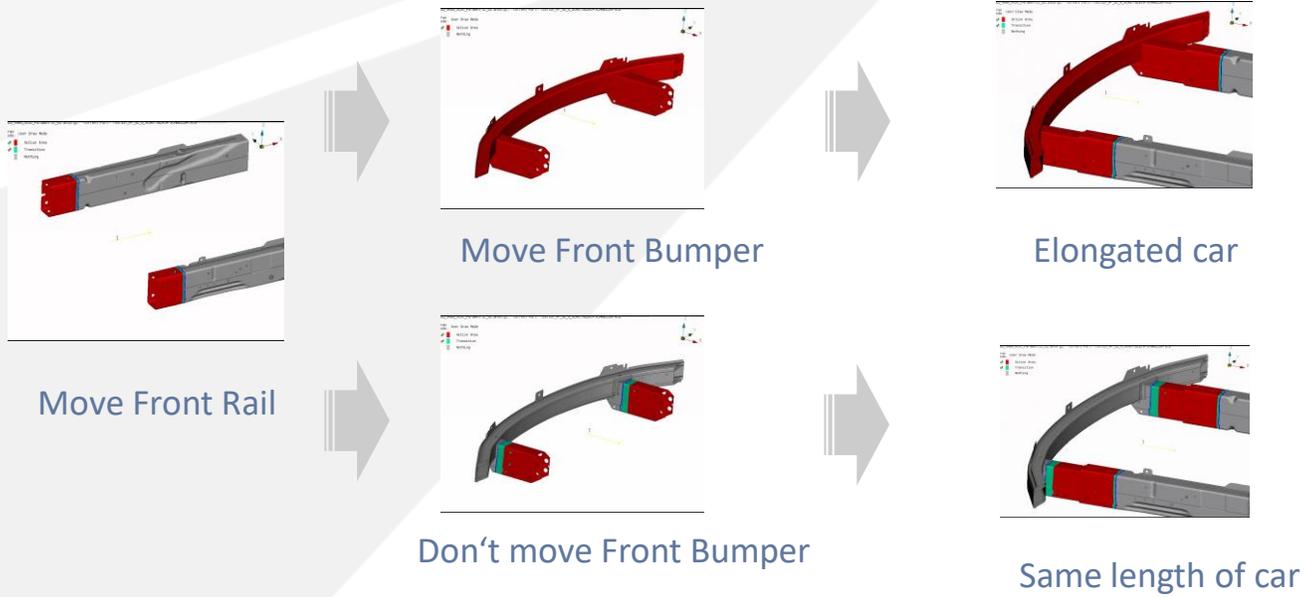
Move B-Pillar
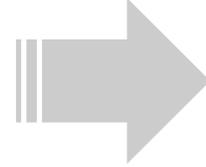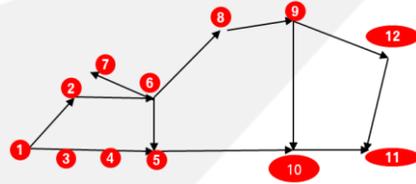
Move Point 9 & 10

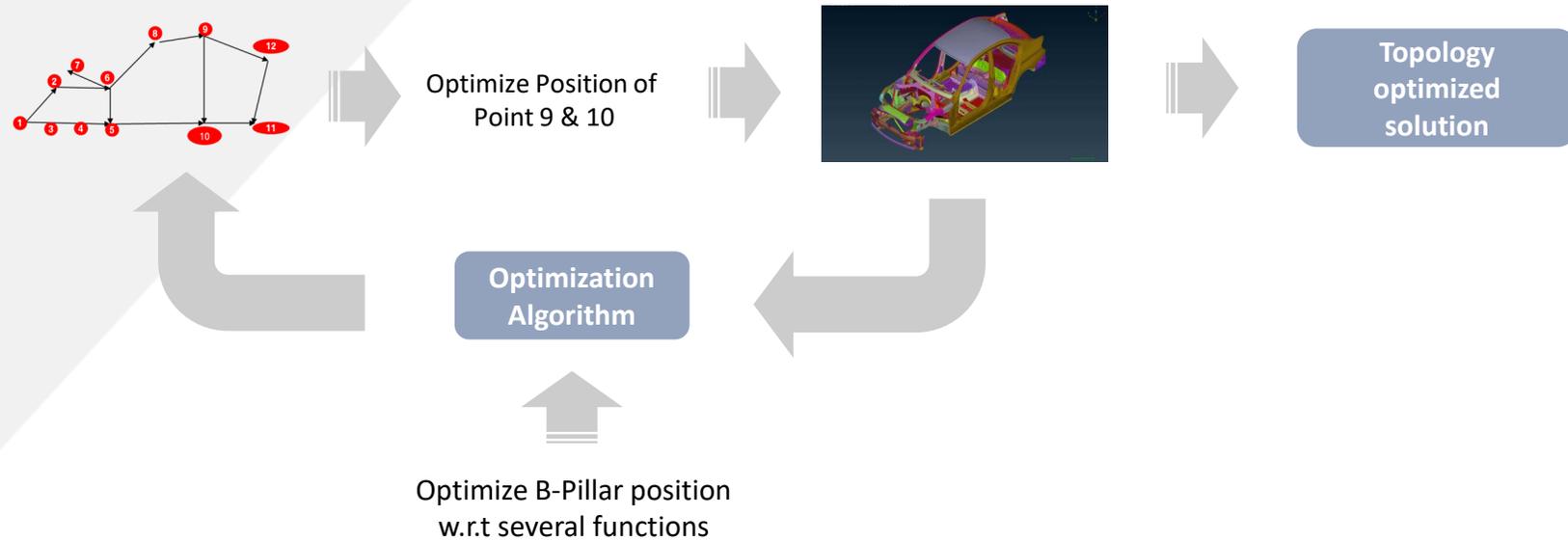Human Description   Layer 1 Interpretation   Machine Interpretation   Layer 3 Interpretation

A complex geometry change
"move B-Pillar"
has been translated
into a simple machine understandable language
"move points 9 & 10"

HOW WILL IT WORK? – A MORE COMPLEX CASE.

Move Front Rail

Move Front Bumper

Elongated car

Don't move Front Bumper

Same length of car

Even complex changes could be modeled through **Scenarios**

WHAT MORE?
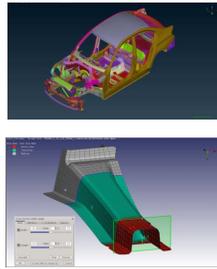# TOPOLOGY OPTIMIZATION – NOT JUST THICKNESS & MATERIAL.

Optimize Position of
Point 9 & 10

Topology
optimized
solution

Optimization
Algorithm

Optimize B-Pillar position
w.r.t several functions

Reframing the task:

Optimization of B-Pillar position with respect to several functions

WHAT MORE?
DIGITALIZATION OF KNOW-HOW.
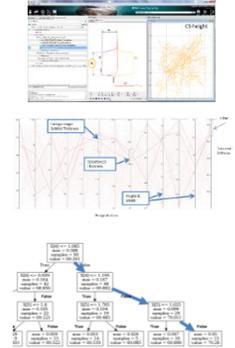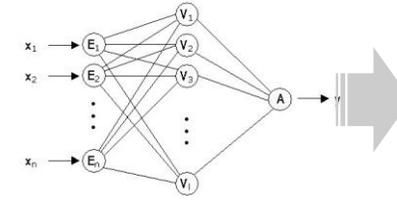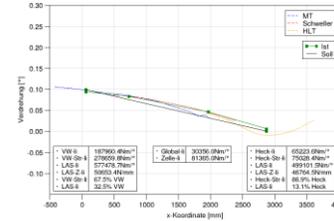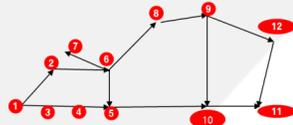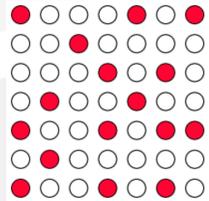
Generate many random variants combination

- Different Position of 9 &10
- Different combination of Thickness & Material
- Different Cross-Section

- CIM models exactly what is changed and how it is changed.
- It also provides this information in generic form for other tools for processing

1000s of Variants could be generated

All variants are Simulated

A Machine learning model is trained

Machine learning Model has learned causes and effects

We don't need to know the exact causes & effects beforehand:
The machine learning model, models them for us.
This is exactly what it has learned
## More about it in following session

HOW BETA CAE HELPED US?
# PARAMETRIC CAE DESIGN (PCD) FRAMEWORK.

Challenges:

➤ An advanced morphing feature was always available in ANSA but followed a TOP-DOWN approach

➤ We need to start with a simulation ready model and after changes end with a simulation ready model

➤ Many technologies were identified that were missing:

- Flange detection
- Collision detection
- Connection technology
- Handling of complex scenarios
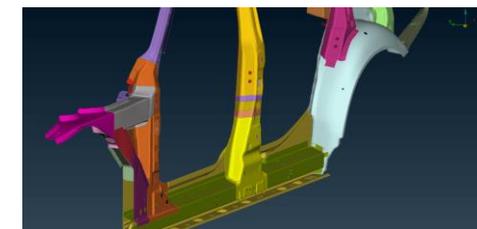- …
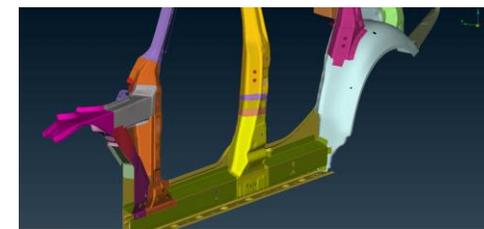
It all needs to happen semi-automatically!

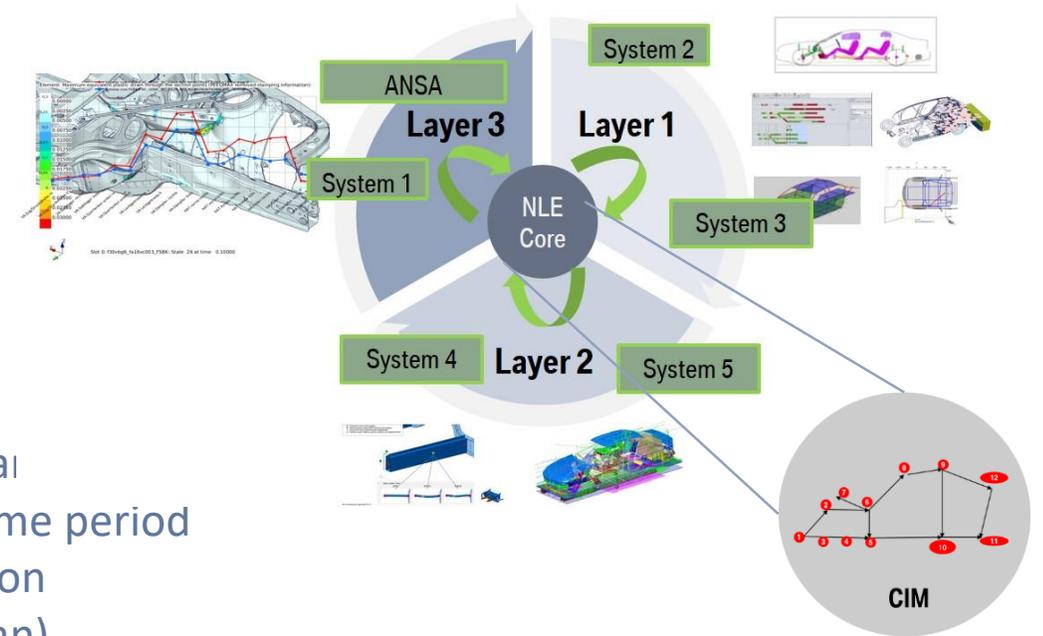We need to concentrate more in developing a functionally optimized car and not make incomplete models.
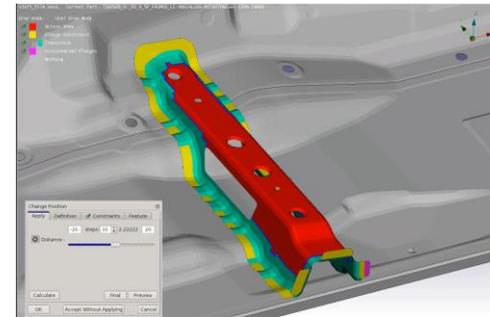
HOW BETA CAE HELPED US?
PARAMETRIC CAE DESIGN (PCD) FRAMEWORK.
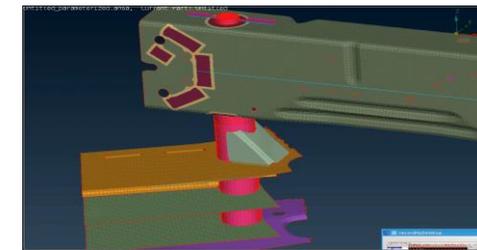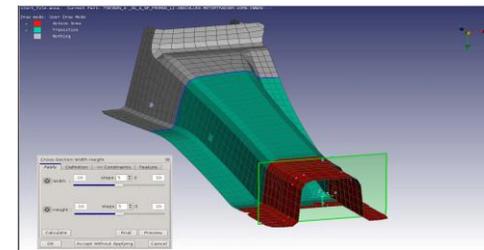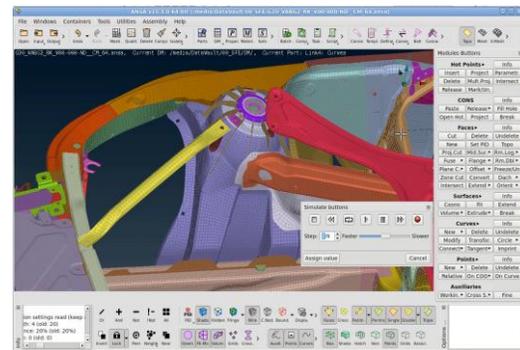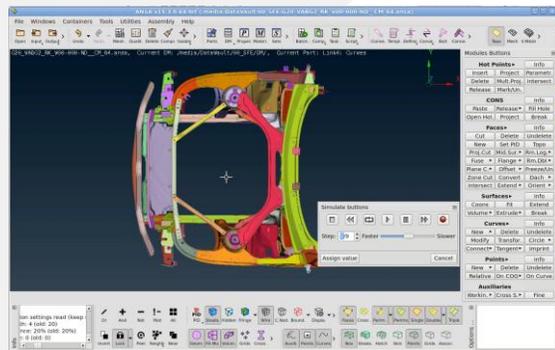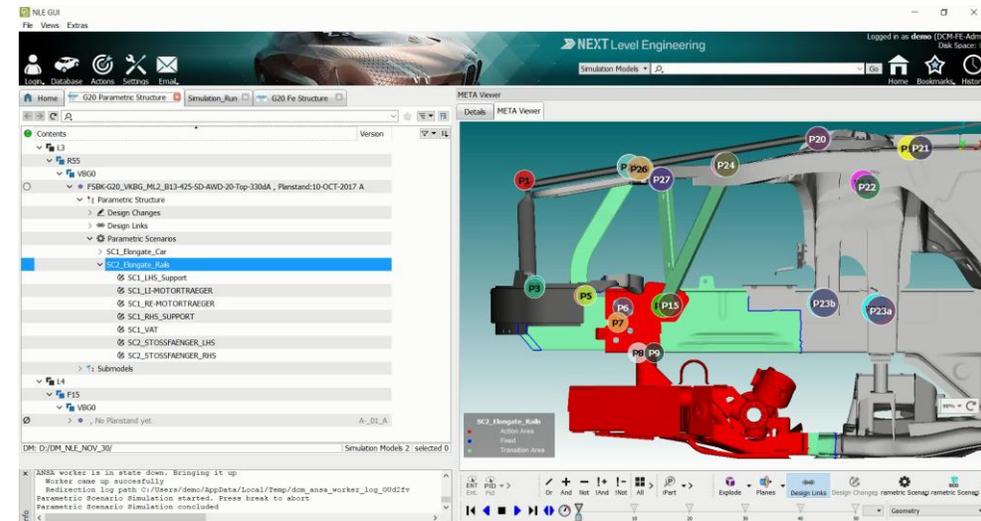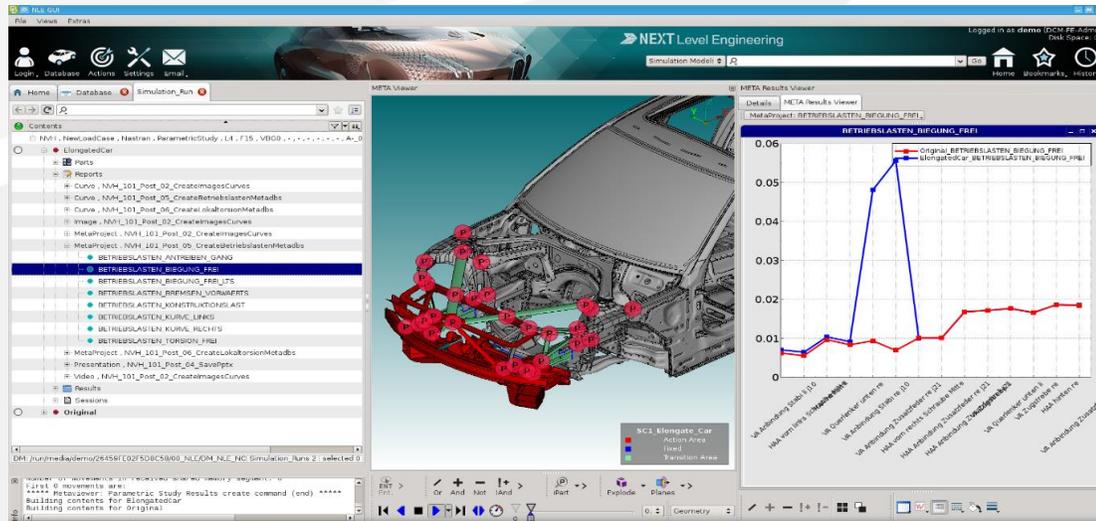
**From simulation ready model to simulation ready model**

CHALLENGES FOR IT @ BMW GROUP.
CAR INFORMATION MODEL.

➤ Further requirements on data in the **Car Information Model**
  ➤ Reliable mandatory attributes for data integration, for exar
    ➤ Maturity level, quality approvals, validity area and time period
  ➤ Standardized rules for *data type* as well as action definition
    (e.g. what's a "**B-Pillar**", what does "**moving B-Pillar"** mean)
  ➤ Process definition for releasing data in NLE Core - Change Management Process for the CIM

➤ Implicit requirement on **linked data** of involved systems
  ➤ Use the NLE Core data and support the data's change process – in one "**Place of Truth**"
  ➤ Linking of data across all 3 **layers**– with a different level of detail
  ➤ Tool and vendor independent

CHALLENGES FOR IT @ BMW GROUP.
DATA & SYSTEM CONNECTIONS.
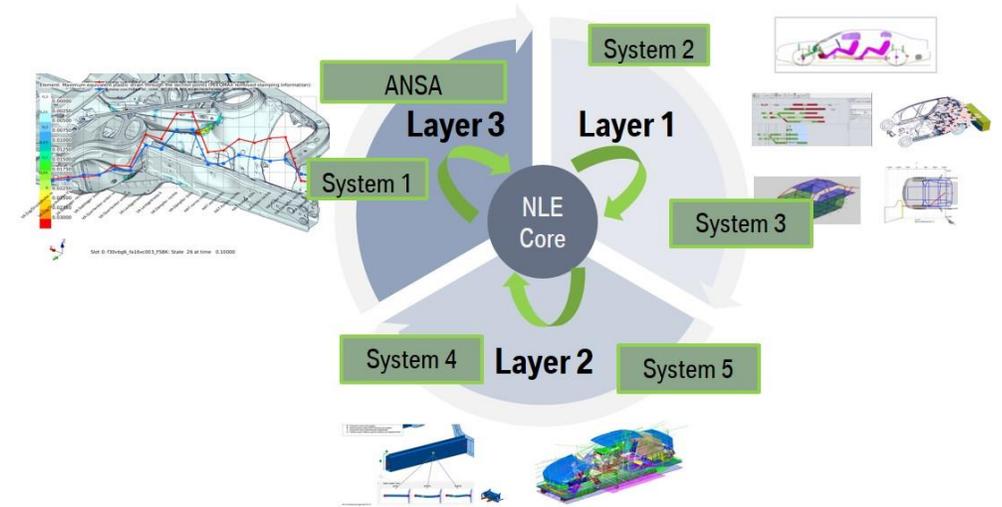
System & Data Connection & Change Process

➢ **NLE Core data** can be reused (linked and subscribed) by every involved system for multiple purposes
➢ Car development process often leads to **change requests** in **NLE Core data**
➢ NLE Core data model supports change management (will **distribute change requests** to involved systems)
➢ By the standardized data types & actions, every **system can check the impacts** of the proposed changes to their local data and work.

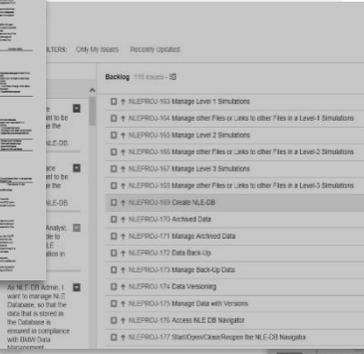**All of the above should be possible within a layer and also across the layers – no loss of information!**

CHALLENGES FOR IT @ BMW GROUP.
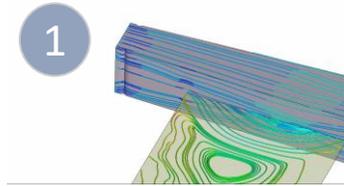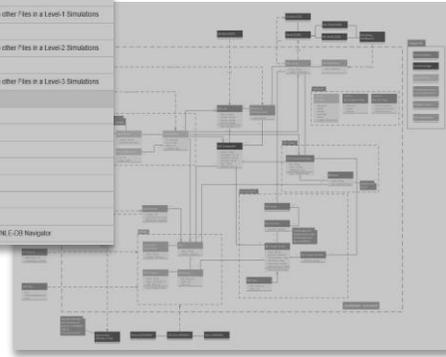# SOME RESULTS OF THE EXPLORATION PHASE.

Exploration Concept

Epics & User Stories

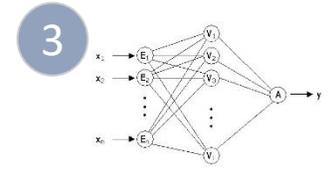**Data Model & Process**

Core System
Digital Mockups

1 Visualization of force

2 Photorealism

3 Machine Learning Use Case

4 Accessibility through multiple device

5 Conversion of Scanned Car model to FEM Model

CHALLENGES FOR IT @ BMW GROUP.
SUMMARY, NEXT STEPS.

➢ The Exploration phase of NLE was a very challenging & interesting project.

➢ It was focused on some famous engineering problems in car development.

➢ The project ran with a startup mindset and many brainstorming sessions were needed to
  - understand the necessity of a standardized data and interfaces,
  - recognize what is necessary for enabling a futuristic & highly integrated engineering process.

➢ All definitions developed are software & tool independent.

➢ The results were handed over to various BMW Group projects for further development.

Thank You