



## Groundbreaking Simulation Solutions

*physics on screen*

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# **Modular Model and Run Management for the efficient handling of complex models in a collaborative simulation environment**

March 2023

# Challenges in CAE

## Present

Increasing complexity of product portfolio

Need for collaboration

- Access to models and results for all
- Clearly annotated data

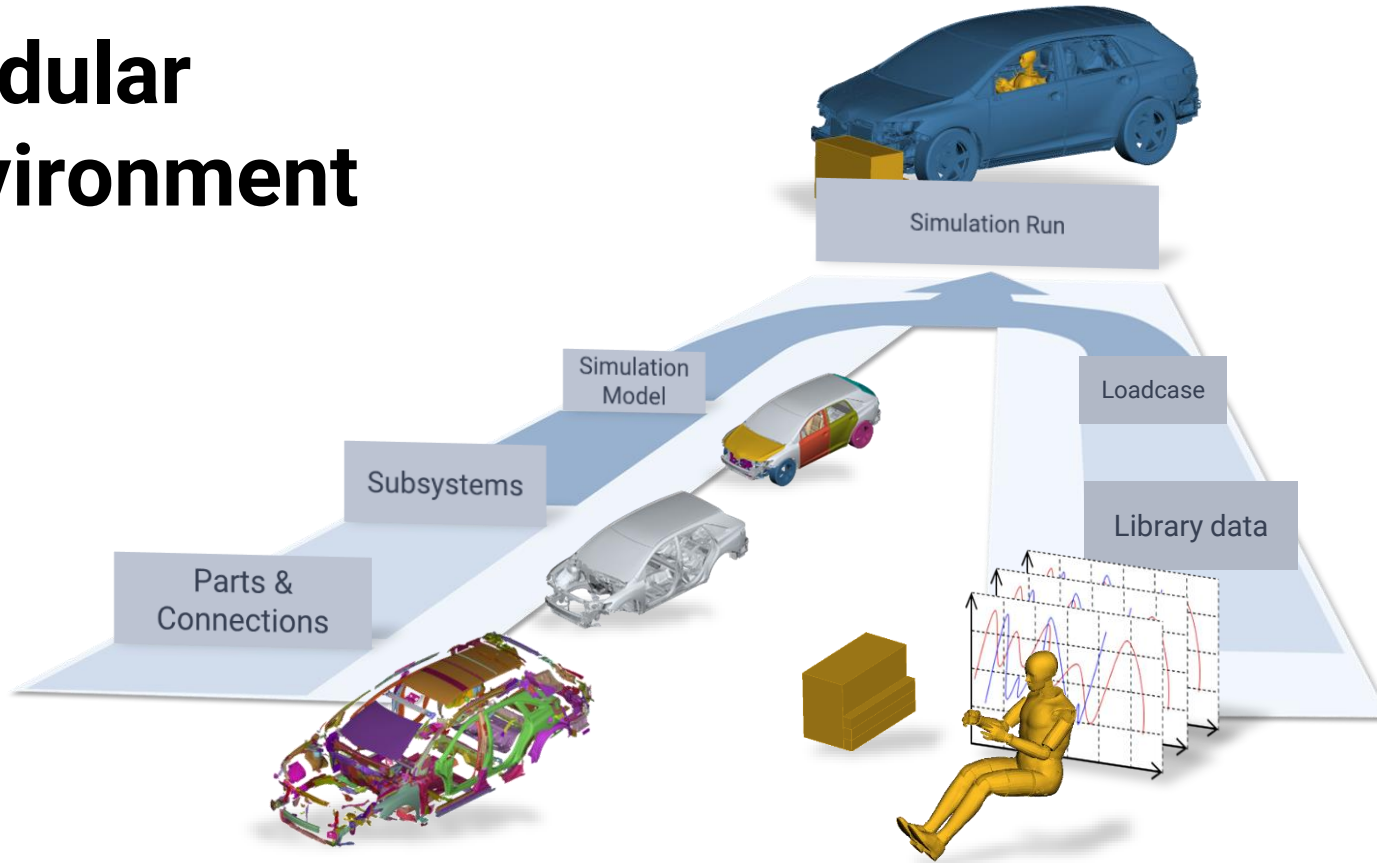
## Upcoming

Increasing complexity of simulation models

Utilization of virtual methods for product validation and homologation

- Requirement to document model origin, loadcase parameters, etc.

# Modular Environment



# Contents

## Core concepts

Main principles of the Modular Environment

## Model Anatomy

The structure of a Modular Model

## Methodology







Solutions for model composition

## Data Management









Key-enabler for data traceability

## Core concepts

**Includes List**

-  Header file
-  BCs and ICs
-  Subassembly A
-  Subassembly B
-  Connections
-  Materials

**Simulation Run**

-  Simulation Model
  -  Subassembly A
  -  Subassembly B
  -  Connections
-  Loadcase
  -  Header file
  -  BCs and ICs
  -  Materials

## Simulation Run



### Simulation Model



Subassembly A



Subassembly B



Connections



### Loadcase



Header file



BCs and ICs



Materials

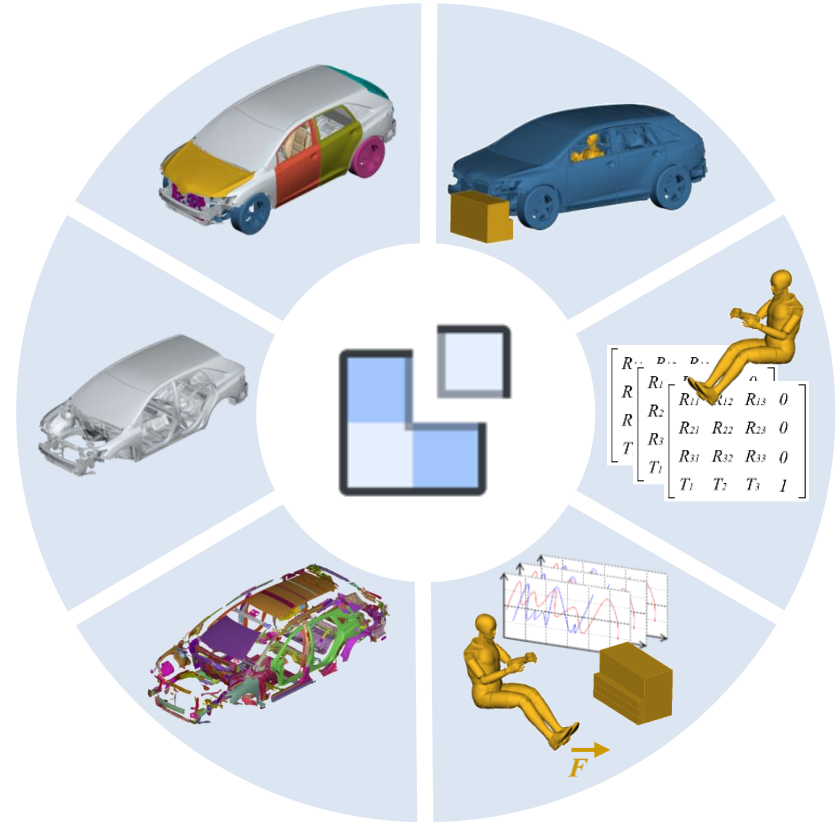
## Separation of Model from Loadcase data

- ✓ Different lifecycle
- ✓ Separate storage
- ✓ Access control

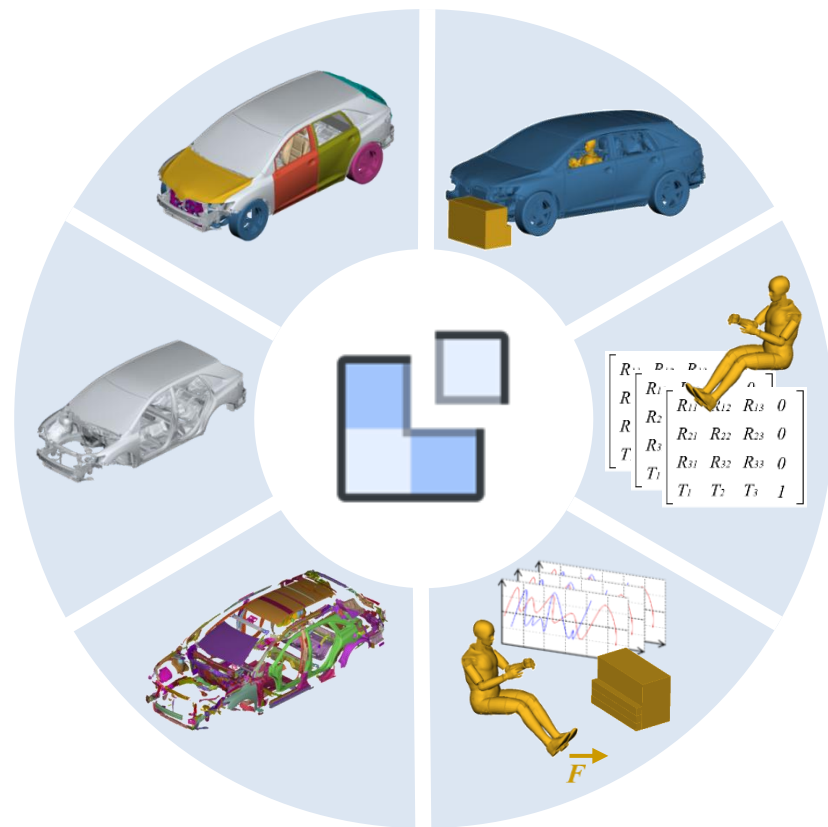


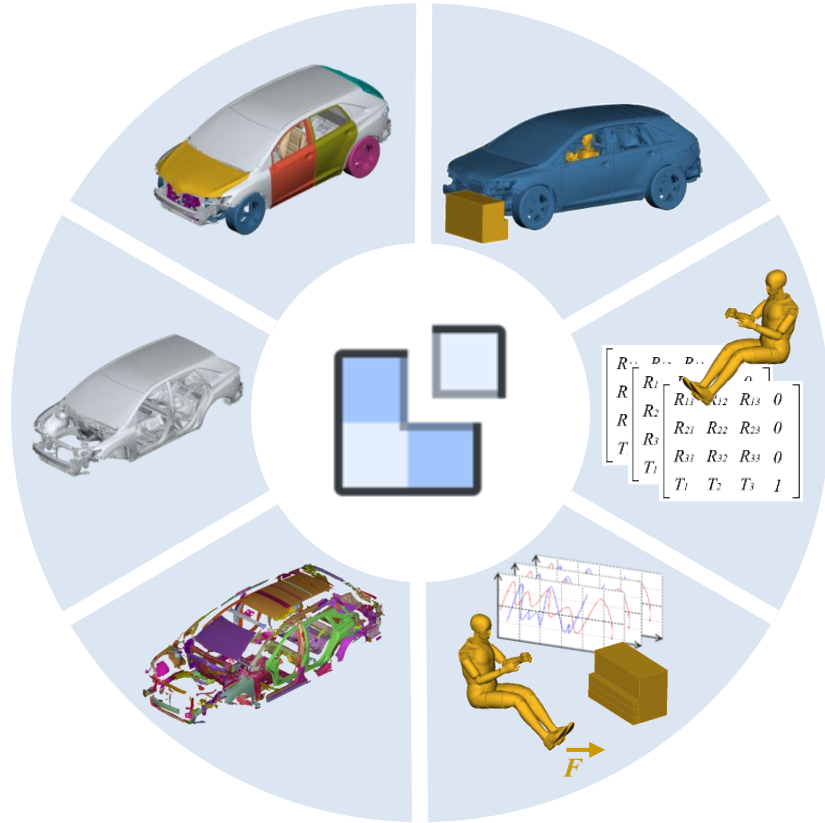
## Simulation Run

- Simulation Model
  - Subassembly A
  - Subassembly B
  - Connections
- Loadcase
  - Header file
  - BCs and ICs
  - Materials



- front\_offset\_venza\_a00\_lhd\_001\_01\_01
    - Model Setup Entities
      - front\_offset\_crash\_01
        - Common\_contact.k
        - Materials.k
        - Mass\_master.k
        - Mass\_cargo\_measuring\_device.k
        - Mass\_occupants.k
        - Time\_history.k
        - Cross\_section.k
        - Sensors\_history\_for\_FMVSS208.k
        - 150\_seat\_driver\_venza\_a00\_crash\_fe.k
        - Barrier.k
        - Gravity.k
        - Initial\_velocity.k
      - crash\_assembly\_venza\_a00\_lhd\_crash\_001
        - 101\_biw\_venza\_a00\_lhd\_crashe\_fe.k
        - 102\_door\_fl\_venza\_a00\_crash\_fe.k
        - 103\_door\_rl\_venza\_a00\_crash\_fe.k
        - 104\_door\_fr\_venza\_a00\_crash\_fe.k
        - 105\_door\_rr\_venza\_a00\_crash\_fe.k
        - 108\_hood\_venza\_a00\_crash\_fe.k
        - 109\_tailgate\_venza\_a00\_crash\_fe.k
        - 115\_engine\_venza\_a00\_crash\_fe.k
        - 116\_exhaust\_line\_venza\_a00\_crash\_fe.k
        - 128\_fr\_suspension\_venza\_a00\_lhd\_crash\_fe.k
        - 130\_rr\_suspension\_venza\_a00\_crash\_fe.k
        - 133\_fuel\_tank\_venza\_a00\_crash\_fe.k
        - 154\_radiator\_venza\_a00\_crash\_fe.k
        - Patches.k





**Contents**

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**Methodology**

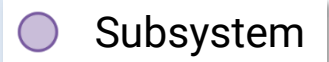
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**Hierarchy**

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**Identity**

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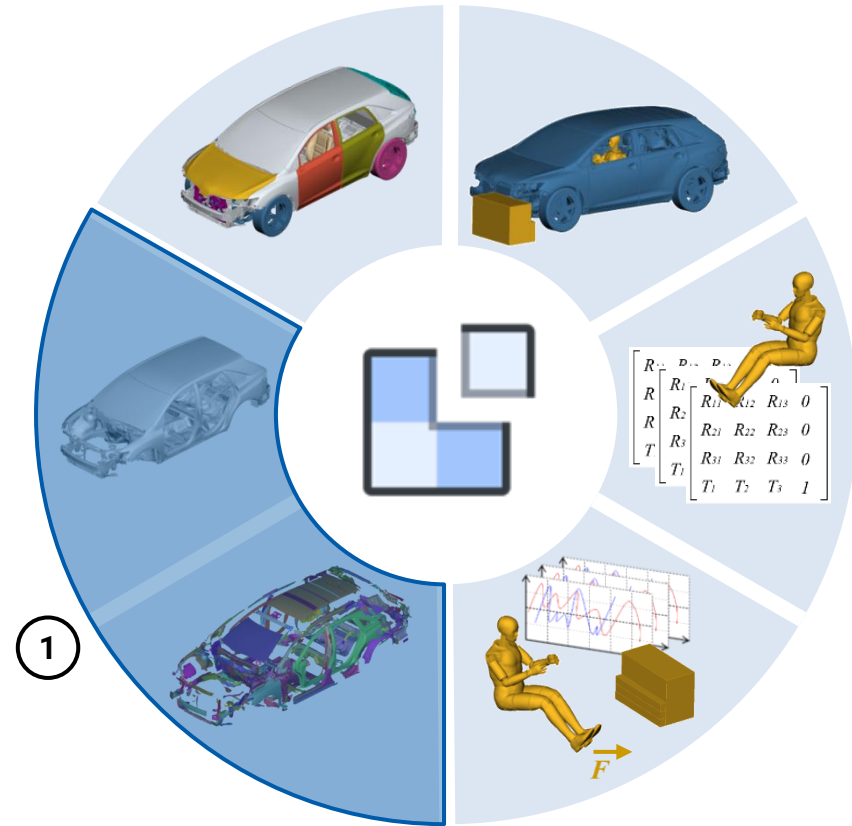


- Geometry
- Connections
- Interfaces
- Model Setup Entities

...

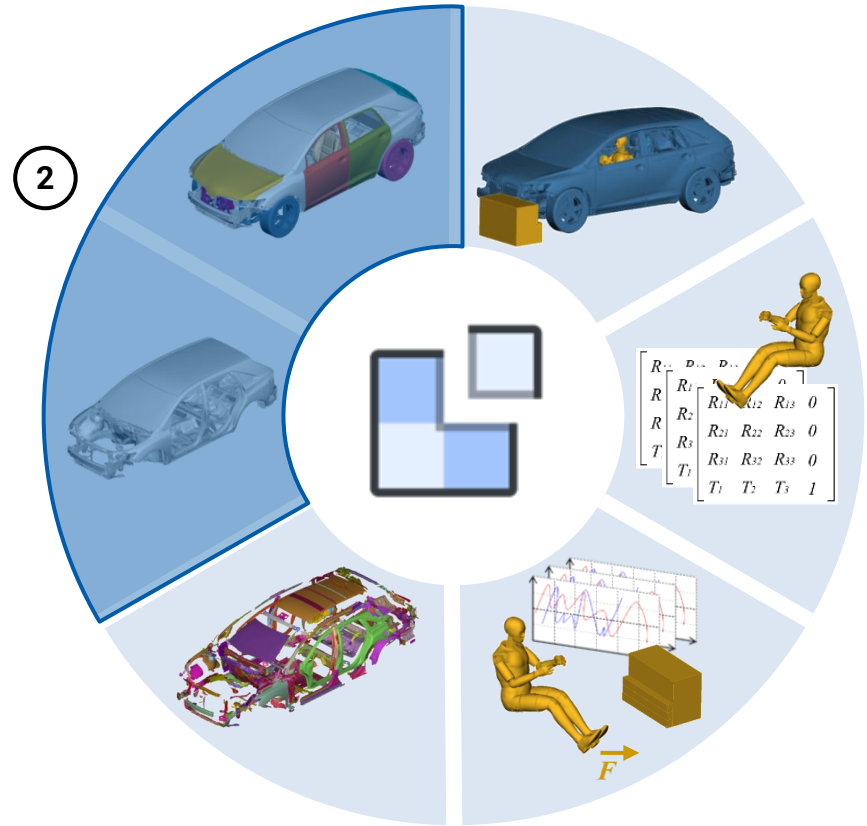
| Module Id | Iteration      |
|-----------|----------------|
| Variant   | Representation |
| Project   | File Type      |
| Release   | ...            |

# ① Part - Subsystem

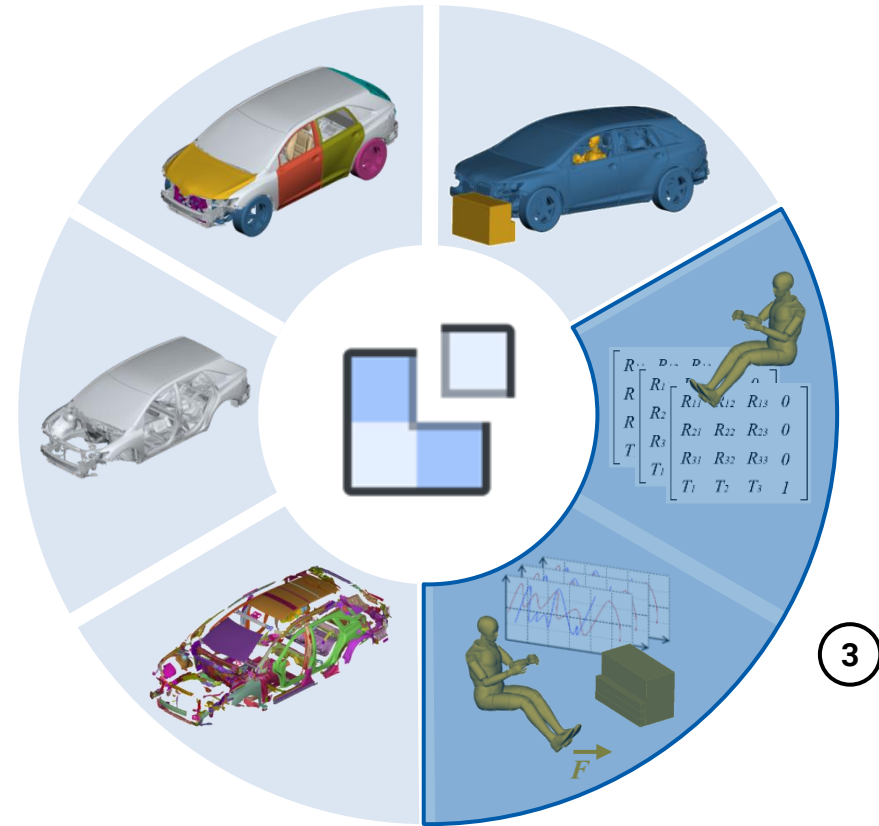


① Part - Subsystem

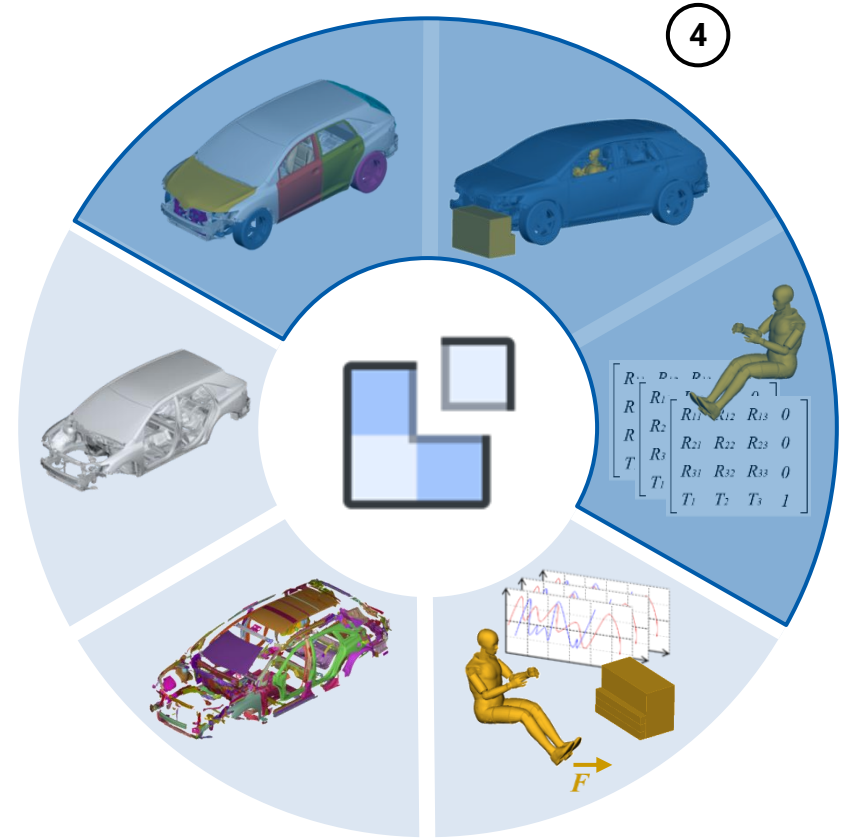
② Subsystem - Sim. Model



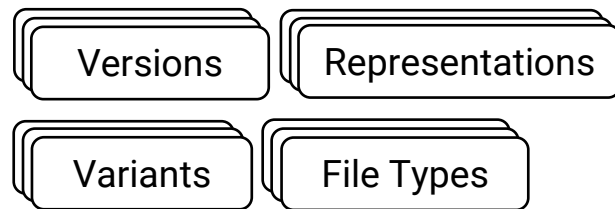
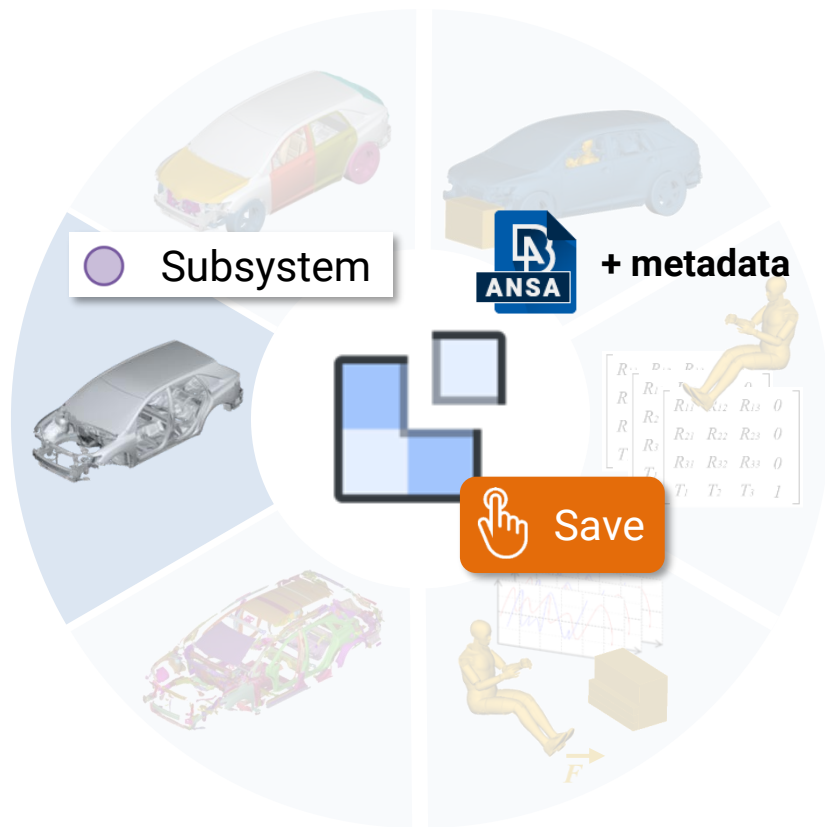
- ① Part - Subsystem
- ② Subsystem - Sim. Model
- ③ Library files - Loadcase

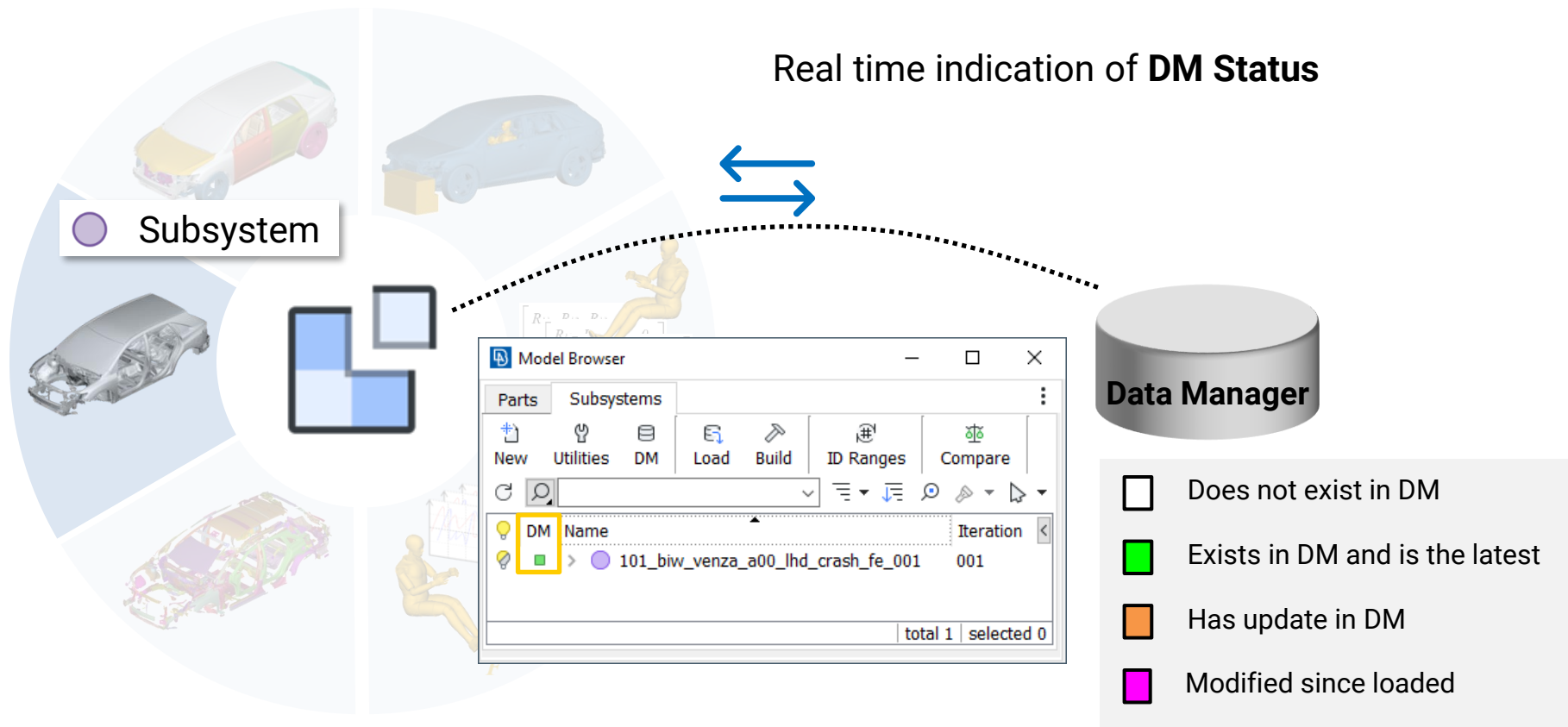


- ① Part - Subsystem
- ② Subsystem - Sim. Model
- ③ Library files - Loadcase
- ④ Sim.Model - Loadcase - Run

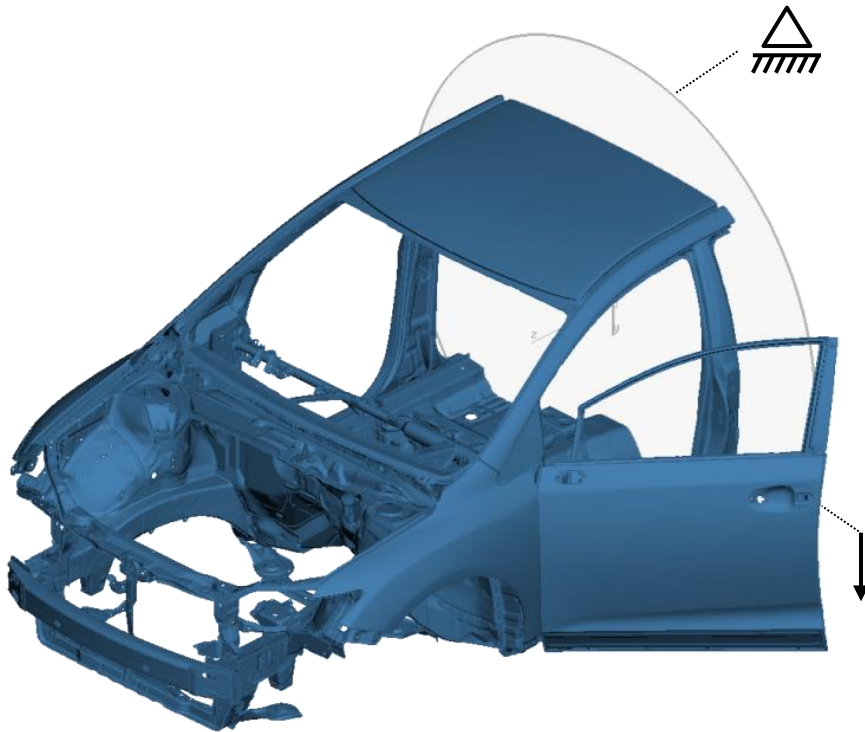




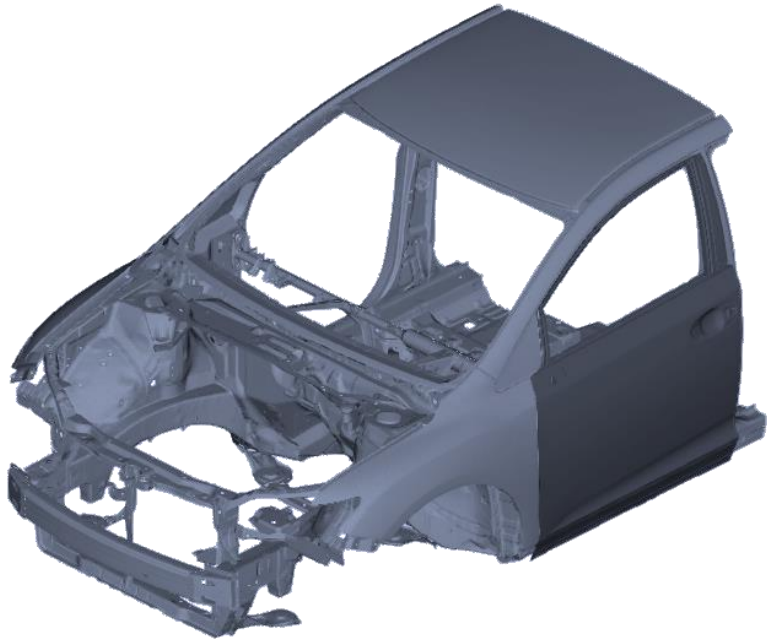




# Model Anatomy



- ▶ Simulation Run
- Simulation Model
- Loadcase
- ⊞ Header file
- Materials



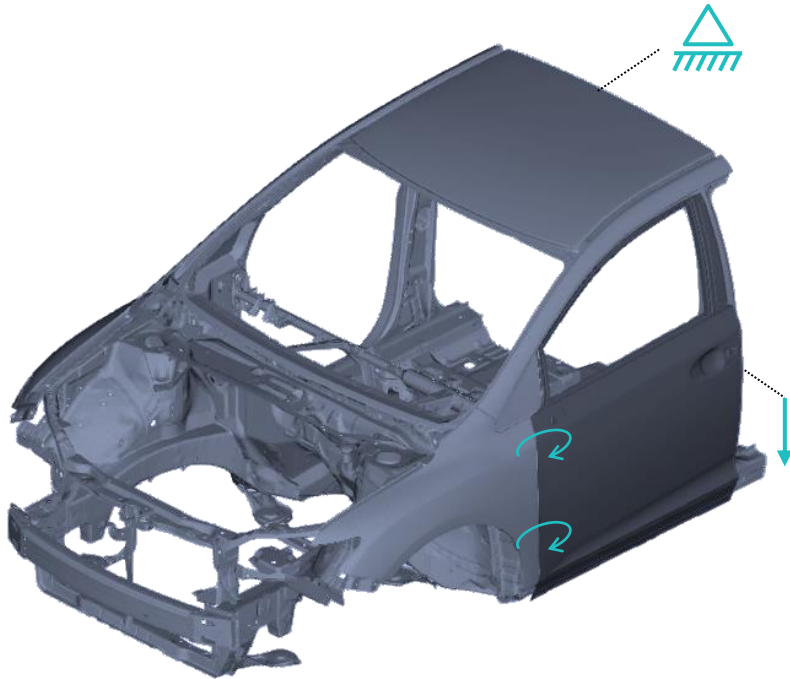
## Simulation Run

### Simulation Model

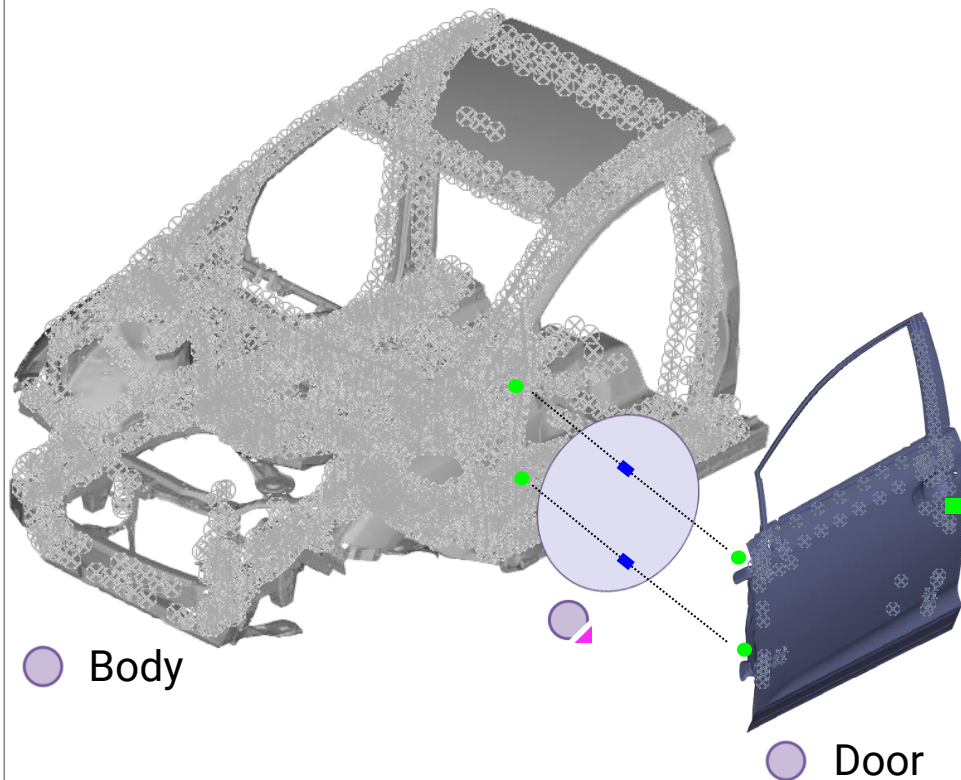
#### Loadcase

Header file

Materials



- ▶ Simulation Run
  - ▣ Simulation Model
  - ▣ Loadcase
  - ⊞ Header file
  - Materials



## Subsystems

- Intra-modular connections
- Interfaces
  - Points
  - Sets

## Connecting Subsystems

- Inter-modular connections
  - Connectors / Connections
  - Assembly Sets

**Assembly Point [A\_POINT]**

Name:  Id:

Position:    Node Id:

Connectivity:

Type:

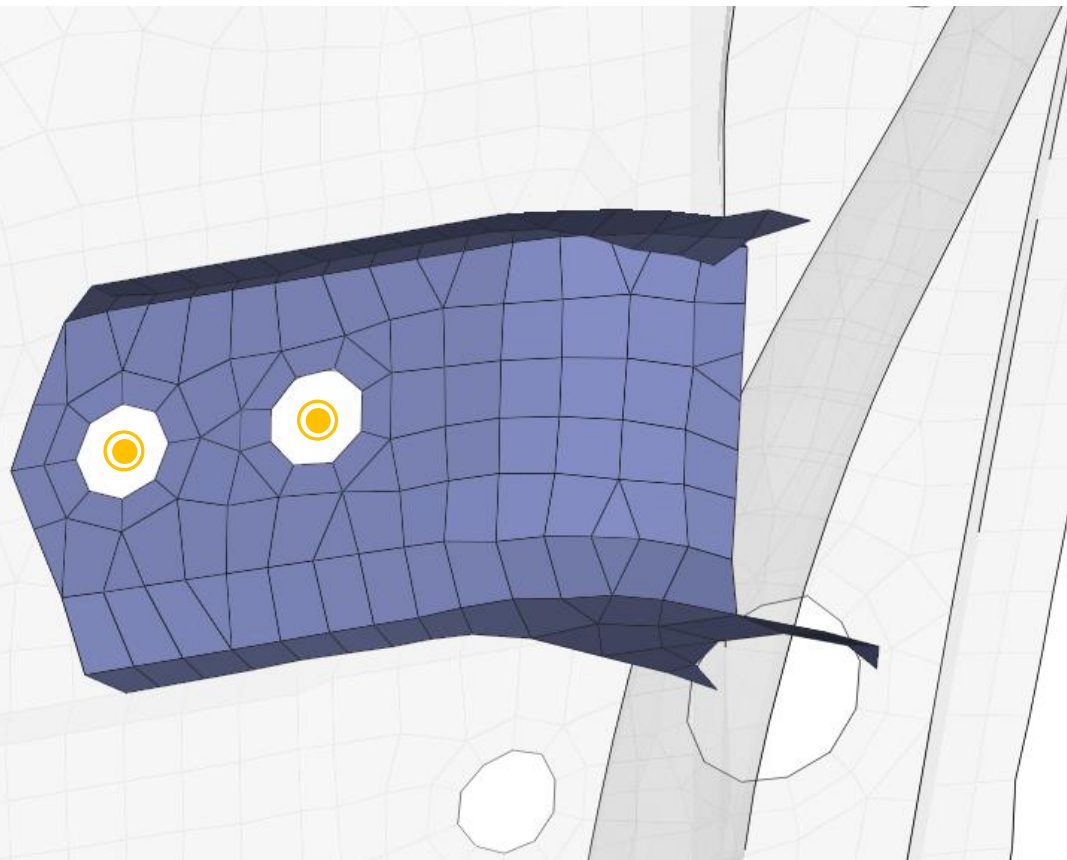
| Search      |                                     |
|-------------|-------------------------------------|
| Search For  | User-defined Area                   |
| Area        | <input checked="" type="checkbox"/> |
| Search Dist | 1.                                  |

| Interface             |                                     |
|-----------------------|-------------------------------------|
| Interface Type        | Rbe2                                |
| DOFs                  | 123456                              |
| Output with subsystem | <input checked="" type="checkbox"/> |


| Other       |                          |
|-------------|--------------------------|
| Local CS    | 0                        |
| Update CS   | <input type="checkbox"/> |
| Active DOFs | 123                      |


Comment:


☒ Interface Node:







**Assembly Point [A\_POINT]**
✕

Name   Id


Position    Node Id  

Connectivity  

Type

**Search**

Search For

Area ☒ 

Search Dist

**Interface**

Interface Type

DOFs


Output with subsystem ☒

**Other**

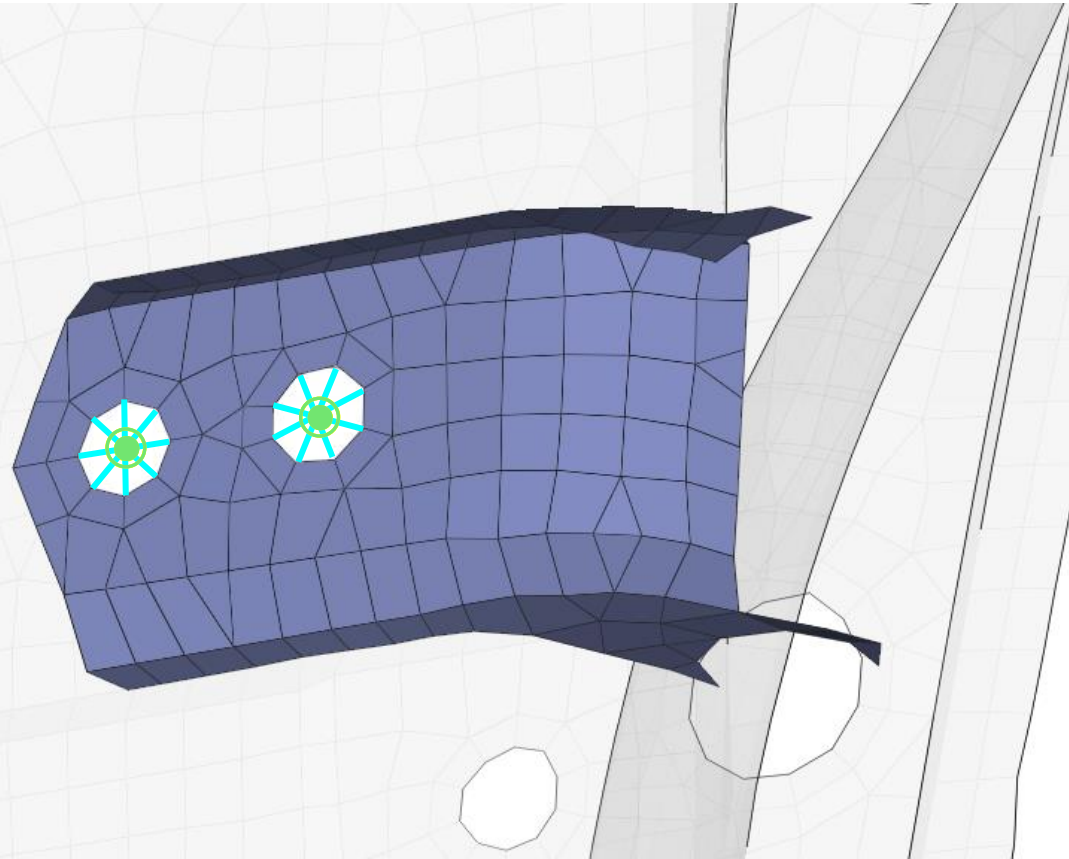
Local CS

Update CS ☐

Active DOFs

Comment:  

☒ ok
Interface Node



CONNECTOR\_ENTITY [CONNECTOR\_ENTITY]

Name

External Connector: 101\_BODY - 102\_DOOR\_FL

Position

982.93

-858.14

722.4797

Direction

.21634373

.89327079

-.3940339

Interface 1

Connectivity 1

#SUB:101\_BODY

Search

Search For

A\_POINT

Reference point

1000001

Text to match

101\_BODY

.

\*

Search space

By Search Dist

Search Dist

2.742593

Interface 2

Connectivity 2

#SUB:102\_DOOR\_FL

Search

Search For

A\_POINT

Reference point

2000000

Text to match

102\_DOOR\_FL

.

\*

Search space

By Search Dist

Search Dist

2.742593

Representation

Body

Representation

Rigid

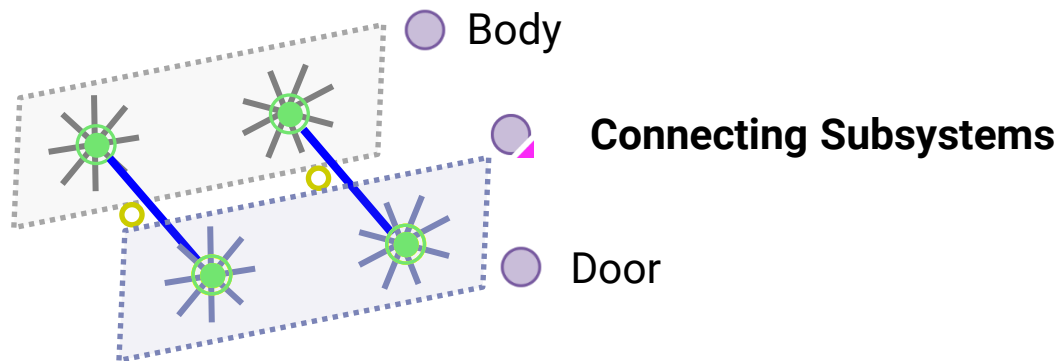
Comment:

ok

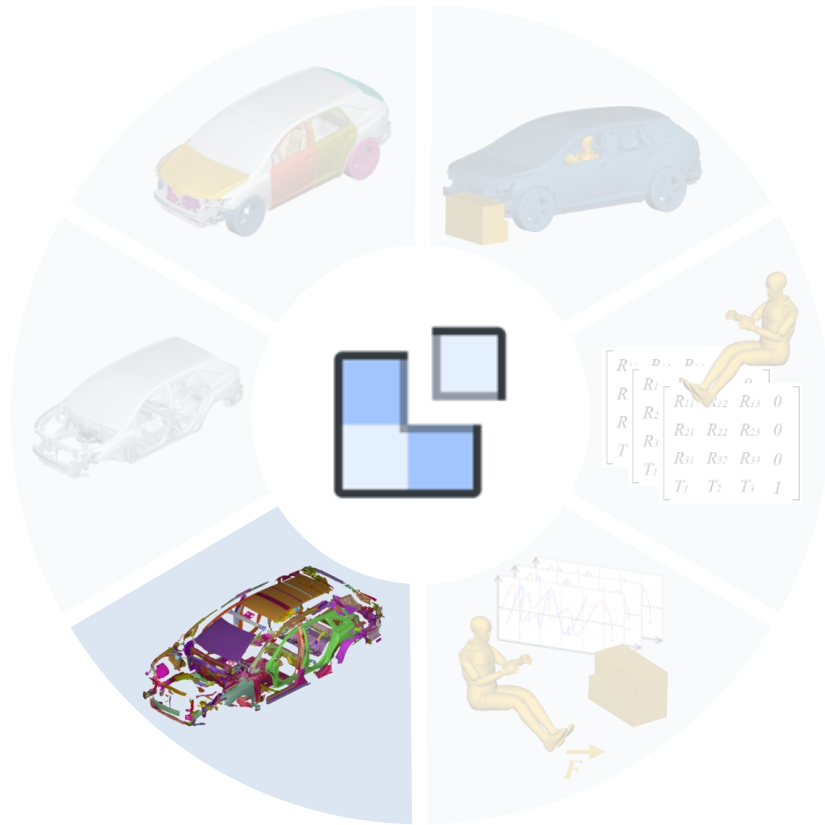
OK

Apply

Cancel



# Methodology



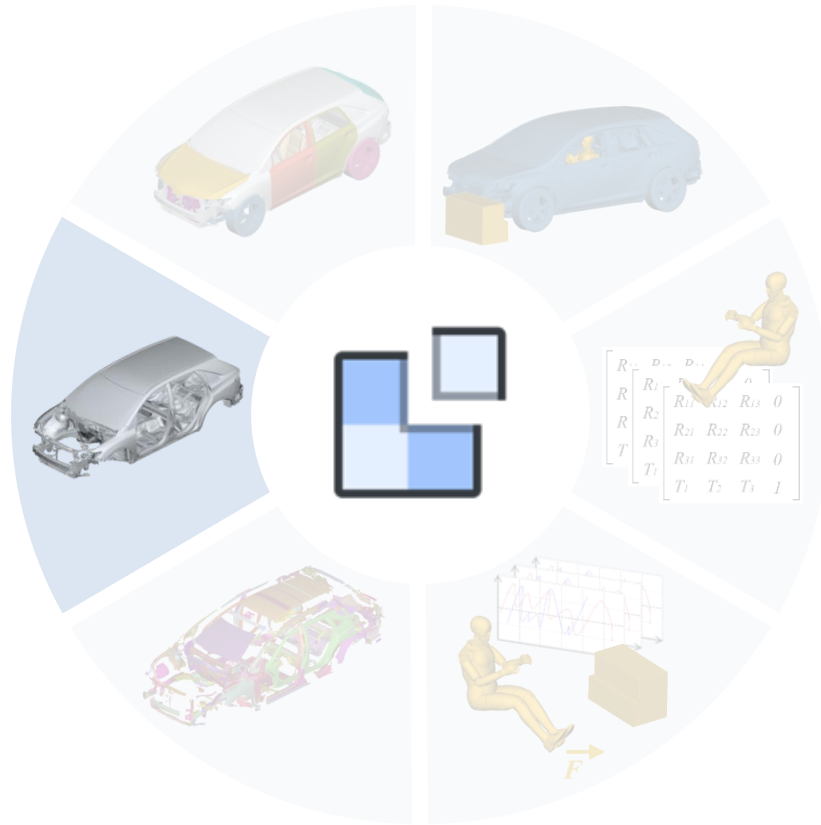
## Parts

Pre-mesh treatment

Property/Material set-up

Meshing

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} & 0 \\ R_{21} & R_{22} & R_{23} & 0 \\ R_{31} & R_{32} & R_{33} & 0 \\ T_1 & T_2 & T_3 & 1 \end{bmatrix}$$



## Parts

Pre-mesh treatment

Property/Material set-up

Meshing

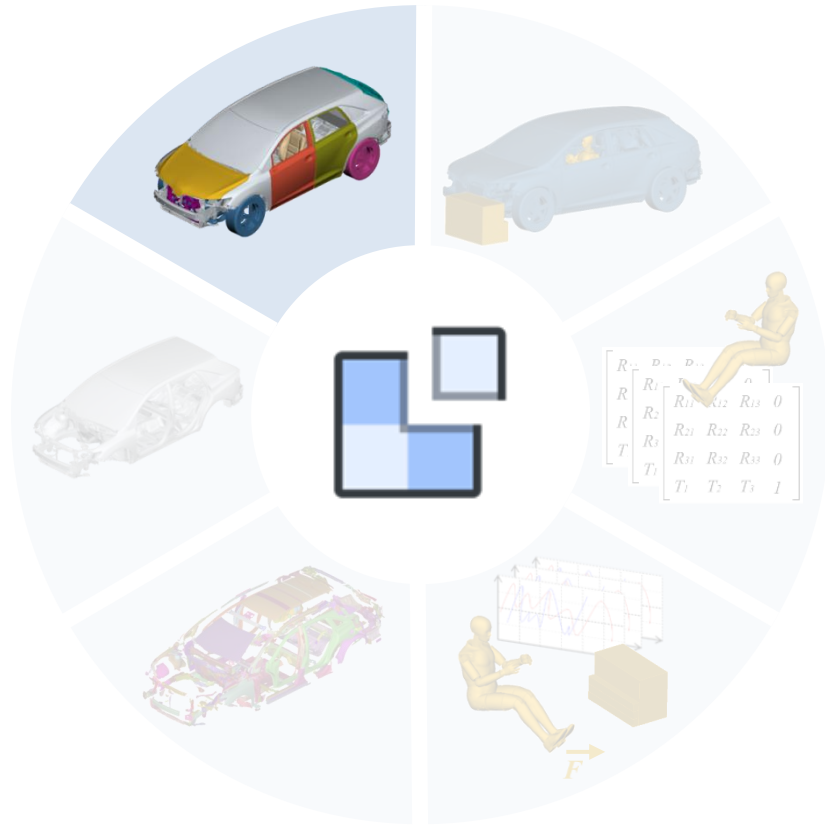
## Subsystems

Depenetration

Parts assembly

Mark interfaces

Renummer



### Parts

Pre-mesh treatment

Property/Material set-up

Meshing

### Subsystems

Depenetration

Parts assembly

Mark interfaces

Renumber

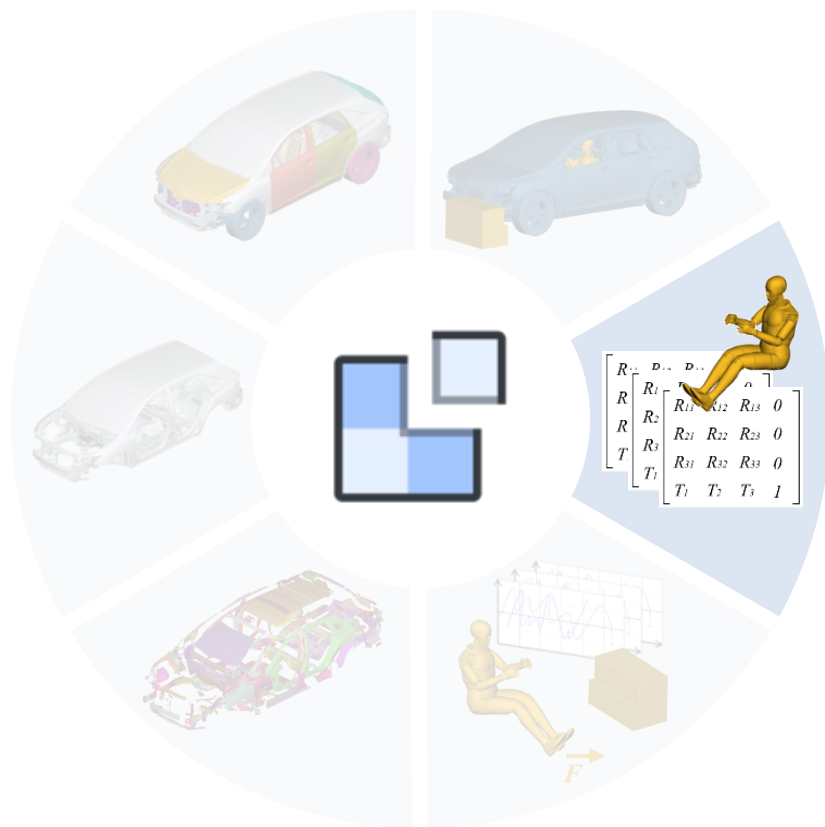
### Sim Models

Subsystem positioning

Check for ID conflicts

Define contacts

Subsystem assembly



## Parts

Pre-mesh treatment

Property/Material set-up

Meshing

## Sim Models

Subsystem positioning

Check for ID conflicts

Define contacts

Subsystem assembly

## Subsystems

Depenetration

Parts assembly

Mark interfaces

Renumber

## Loadcases

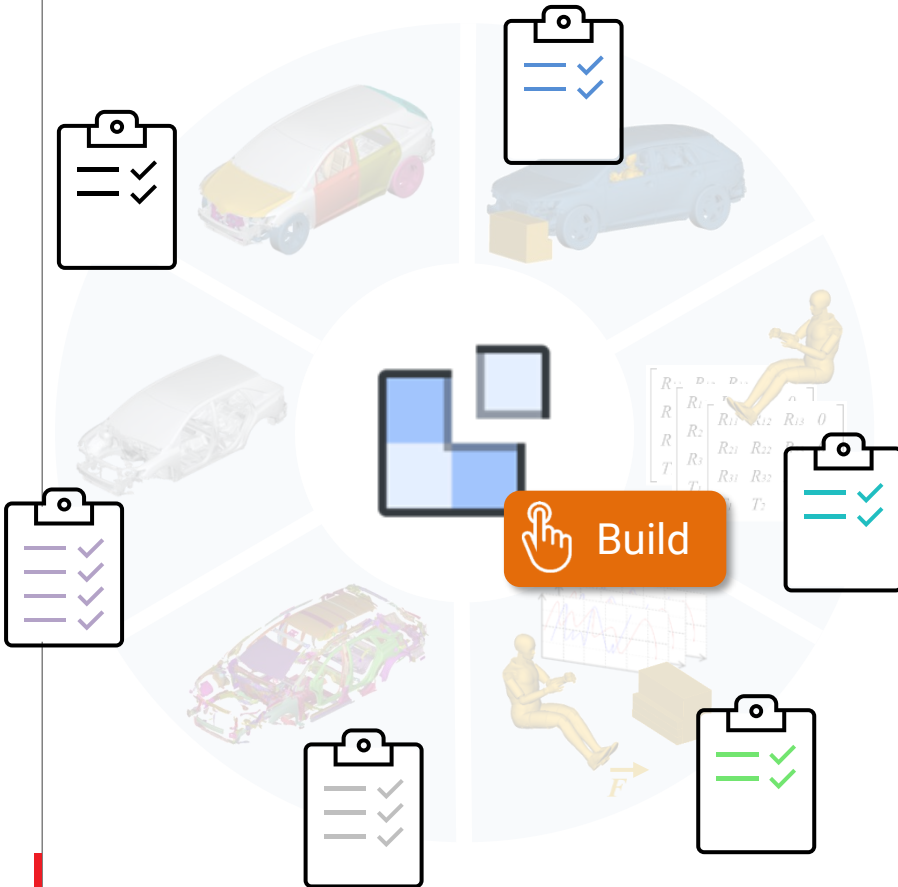
Boundary conditions

Initial conditions

Dummy positioning

Parameters definition

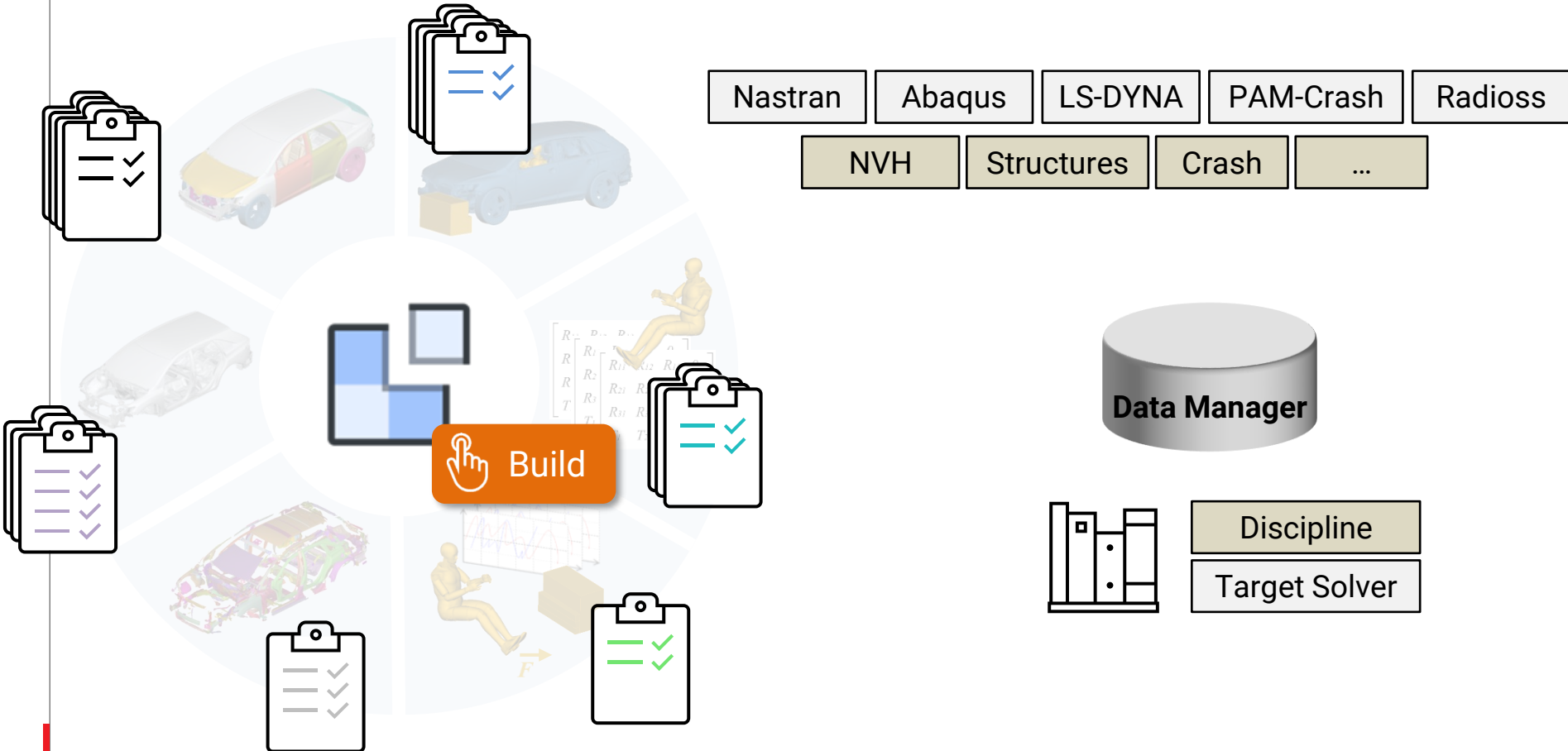
Confirms that a module is **ready to Save**











The screenshot displays the Model Browser application window. The top navigation bar includes tabs for Parts, Subsystems, Library Items, Simulation Models, LoadCases, and Simulation Runs. The Simulation Models tab is active, showing a list of models with columns for Name, Iteration, and Build Status. A hand cursor points to the 'Build' icon in the toolbar. Below the list, the 'Build Process: Simulation Models (Default)' section is visible. It contains a table of build steps, with the 'Check Assembly Status' step selected. A hand cursor points to the 'Build' button at the bottom. The 'Output' tab is active, showing the status of the build process.

Model Browser

Parts Subsystems Library Items Simulation Models LoadCases Simulation Runs

New Utilities DM Load Load Build ID Ranges Compare

Name Iteration Build Status

> body\_P1\_R1\_durability\_001 001

> Unassigned

total 2 | selected 1

Details Contents Connectivity DM Features Build

Build Process: **Simulation Models (Default)**

| Index | Active                              | Type     | Name                         | Build Status |
|-------|-------------------------------------|----------|------------------------------|--------------|
| 1     | <input checked="" type="checkbox"/> | Built-in | Load Base Modules            |              |
| 2     | <input checked="" type="checkbox"/> | Built-in | Realize Internal Connections |              |
| 3     | <input checked="" type="checkbox"/> | Built-in | Realize Internal Connectors  |              |
| 4     | <input checked="" type="checkbox"/> | Built-in | Realize Internal GEBs        |              |
| 5     | <input checked="" type="checkbox"/> | Built-in | Numbering Rules              |              |
| 6     | <input checked="" type="checkbox"/> | Built-in | Check Assembly Status        |              |
| 7     | <input checked="" type="checkbox"/> | Built-in | Check Parameters             |              |

Info Output

running...

Smart assembly report

Assembly status: Failed

Remaining undefined interfaces (error): 0

Interfaces with non-OK status (error): 0

Connectors with non-OK status (error): 1

Interfaces that do not belong to any subsystem (info):

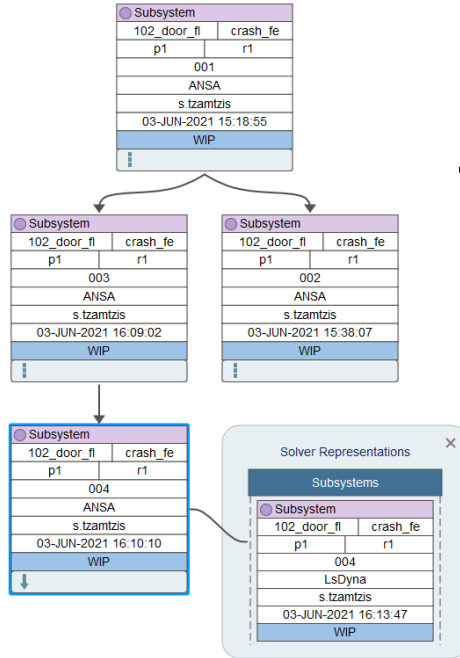
The Build function 'Check Assembly Status' has identified finished.

Build Add Edit Copy Delete

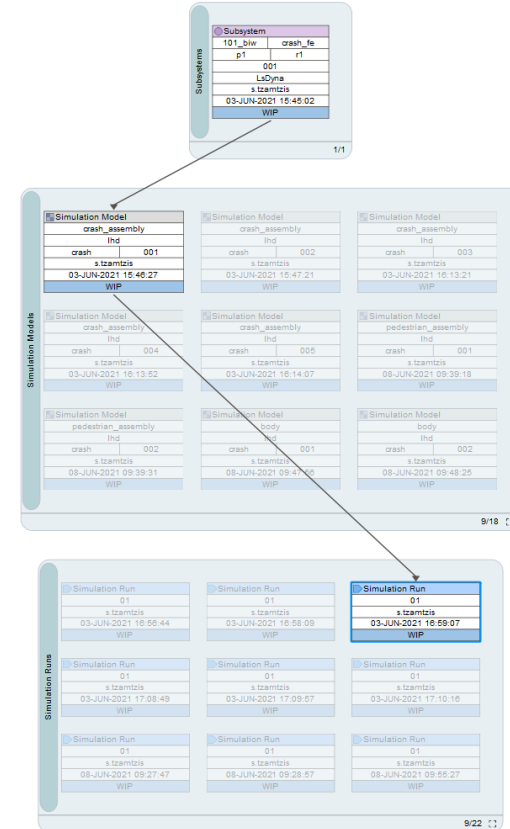
total 7 | selected 1

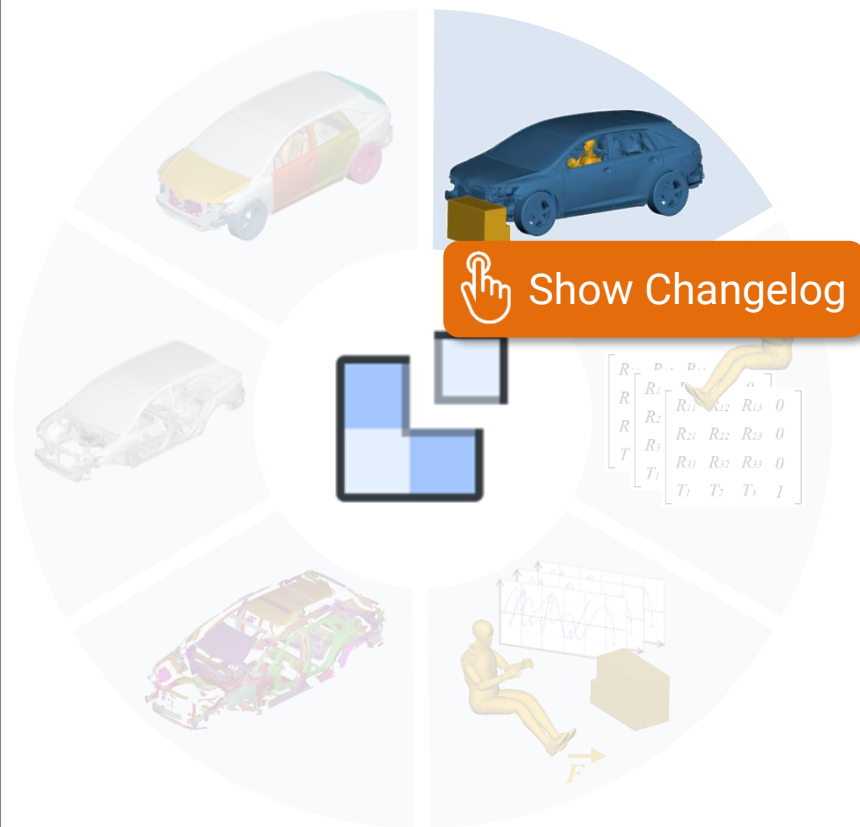
# **Data Management**

## Lifecycle graph

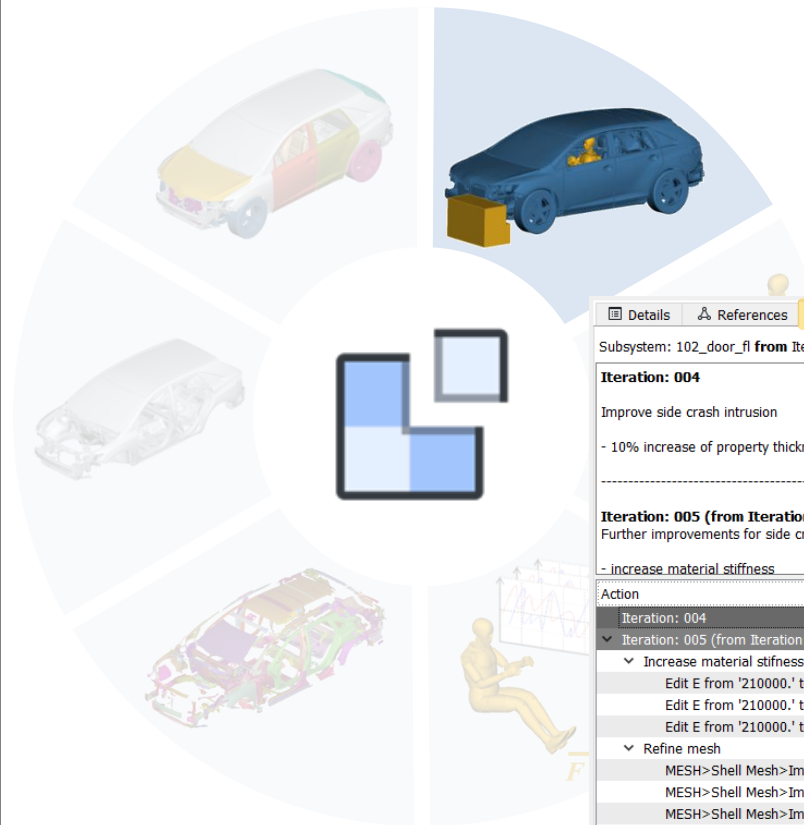


## Where Used graph





|                   | Parent                            | Selected                          |
|-------------------|-----------------------------------|-----------------------------------|
|                   | frontal_50kph_p1_r1_lhd_004_01_01 | frontal_50kph_p1_r1_lhd_005_01_01 |
| > Properties      |                                   |                                   |
| > Attributes      |                                   |                                   |
| > Contents        |                                   |                                   |
| ▼ crash           | ✓                                 | ✓                                 |
| > Properties      |                                   |                                   |
| > Attributes      |                                   |                                   |
| > Contents        |                                   |                                   |
| 101_biw           | ✓                                 | ✓                                 |
| > 102_door_fl     | ✓                                 | ✓                                 |
| 103_door_rl       | ✓                                 | ✓                                 |
| 104_door_fr       | ✓                                 | ✓                                 |
| 105_door_rr       | ✓                                 | ✓                                 |
| 108_hood          | ✓                                 | ✓                                 |
| 109_tailgate      | ✓                                 | ✓                                 |
| 115_engine        | ✓                                 | ✓                                 |
| 116_exhaust_line  | ✓                                 | ✓                                 |
| 128_fr_suspension | ✓                                 | ✓                                 |
| 130_rr_suspension | ✓                                 | ✓                                 |
| 133_fuel_tank     | ✓                                 | ✓                                 |
| 150_seat_driver   | ✓                                 | ✓                                 |
| 154_radiator      | ✓                                 | ✓                                 |
| Patches           | ✓                                 | ✓                                 |
| ▼ frontal_50kph   | ✓                                 | ✓                                 |
| > Properties      |                                   |                                   |
| > Attributes      |                                   |                                   |
| > Contents        |                                   |                                   |



|                                   | Parent | Selected |
|-----------------------------------|--------|----------|
| frontal_50kph_p1_r1_lhd_004_01_01 |        |          |
| frontal_50kph_p1_r1_lhd_005_01_01 |        |          |
| > Properties                      |        |          |
| > Attributes                      |        |          |
| > Contents                        |        |          |
| crash                             | ✓      | ✓        |
| > Properties                      |        |          |
| > Attributes                      |        |          |
| > Contents                        |        |          |
| 101_biw                           | ✓      | ✓        |
| 102_door_fl                       | ✓      | ✓        |
| 103_door_rl                       | ✓      | ✓        |

Details
References
Changeset

Subsystem: 102\_door\_fl from Iteration: 004 to Iteration: 005

**Iteration: 004**

Improve side crash intrusion

- 10% increase of property thickness for impact beam parts

---

**Iteration: 005 (from Iteration: 004)**

Further improvements for side crash intrusion

- increase material stiffness

| Action   | Entity         | Timestamp            |
|--|----------------|----------------------|
| Iteration: 004                                   |                | 03-JUN-2021 16:10:10 |
| Iteration: 005 (from Iteration: 004)             |                | 03-JUN-2021 16:12:26 |
| Increase material stiffness                      |                | 03-JUN-2021 16:11:54 |
| Edit E from '210000.' to '220000.' MAT1 MAT_E... |                | 03-JUN-2021 16:10:32 |
| Edit E from '210000.' to '220000.' MAT1 MAT_E... |                | 03-JUN-2021 16:10:32 |
| Edit E from '210000.' to '220000.' MAT1 MAT_E... |                | 03-JUN-2021 16:10:32 |
| Refine mesh                                      |                | 03-JUN-2021 16:12:09 |
| MESH>Shell Mesh>Improve                          | ANSAPART, M... | 03-JUN-2021 16:10:48 |
| MESH>Shell Mesh>Improve                          | ANSAPART, M... | 03-JUN-2021 16:10:50 |
| MESH>Shell Mesh>Improve                          | ANSAPART, M... | 03-JUN-2021 16:10:50 |

total 2 | visible 11



### Front-end



KOMVOS



ANSA



META



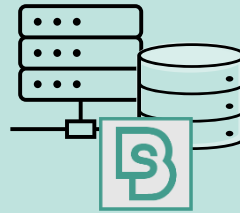
### Back-end

S  
D  
M



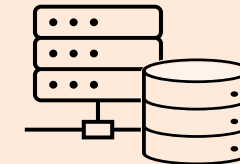
File-based DM

S  
P  
D  
M



SPDRM

T  
E  
S  
T



ASAM-ODS

- Two alternative SDM back-ends
- Integrated with all BETA Suite Apps
- Interface to test-result databases

### Front-end



KOMVOS



ANSA



META



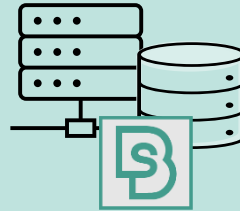
### Back-end

S  
D  
M



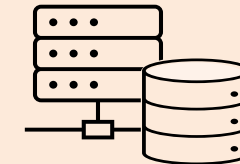
File-based DM

S  
P  
D  
M



SPDRM

T  
E  
S  
T



ASAM-ODS

- Part of the BETA Suite
- Minimum configuration
- Suitable for smaller teams or as an entry-level solution
- Highly customizable

### Front-end



KOMVOS



ANSA



META



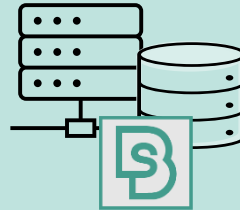
### Back-end

S  
D  
M



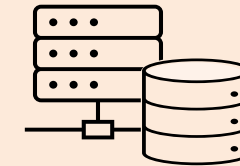
File-based DM

S  
P  
D  
M



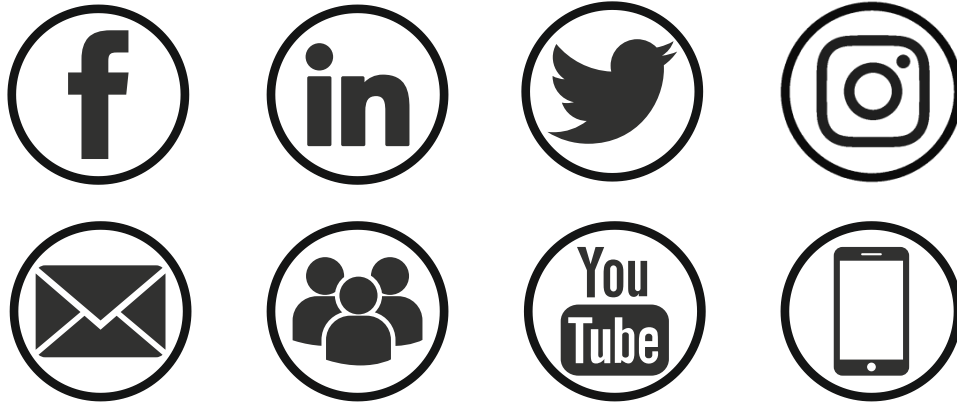
SPDRM

T  
E  
S  
T



ASAM-ODS

- Requires SPDRM
- Server-client Application
- Uses MySQL or Oracle database
- Includes Process Management module for design, execution and monitoring of Business Processes
- Role-based access control
- High concurrency & security



**Stay connected**