Strategic partnership for new innovations and research on a new level
Active Research Environment for the Next generation of Automobiles

- Developments for Industrial 4.0 and Digitalization
- 3 starting technical research projects + 1 overlapping research area

**DigitPro**
Digital Prototype
- Process Simulation
- Virtual Testing
- Closed Process Chain

**ForschFab**
Research Factory
- Interchangeable production of future applications

**LeiFu**
Material and Construction
- Light-weight materials
- Functional integrity

Khoch3
Creativity – Cooperation – Competence Carrier

Overview on the starting projects
### Active Research Environment for the Next generation of Automobiles

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<tr>
<th>Scientific partners</th>
<th>Industrial partners</th>
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<tr>
<td>Universität Stuttgart</td>
<td>DAIMLER</td>
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<td>BASF</td>
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<td>Fraunhofer</td>
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**Founders**

**In discussion**

19 industrial and scientific partners

ARENA2036 Research Campus @ Vaihingen
**DigitPro – Digital Prototype**

- closed simulation process chain
- from preliminary design to the final component
- micro, meso and macro modeling
- different simulation software tools
- HDF5 Format
- digital fingerprint

- braided components
- **Open-Reed-Weaving** components

- 50% development time mind.
- 10% weight

Defined targets for the starting phase
ENVYO® is a multi-purpose mapping tool for LS-DYNA, introduced to public at the 14th German LS-DYNA User's Meeting.

Four different mapping schemes have been realized:
- Closest Point
- Search Radius
- Ondulation consideration
- RVE Mapping

properly transform results from process simulations onto structural meshes
**DigitPro – Digital Prototyp**

- **Closest Point**
  - All fibers defined by the user are considered
  - Equivalent thickness distribution based on a given user input

- **Search Radius**
  - A search radius will be considered
  - If a specific fiber ID cannot be found within a certain vicinity of an element, a resin material ID will be assigned instead
  - Equivalent thickness distribution based on a given user input

- **Ondulation consideration**
  - Ordering of the fiber assignment in target mesh not based on user input but on distance to the target element
  - Thickness is considered based on the offset of found elements

- **RVE Mapping**
  - RVEs are detected within a search radius
  - Material cards from a database will be assigned

---

Explanation of the different routines

properly transform results from process simulations onto structural meshes
Averaging of fiber directions possible:

```
FiberBundle#2:
Lay=2,IP=1,Fib=1
Lay=5,IP=1,Fib=1
Lay=8,IP=1,Fib=1
Lay=11,IP=1,Fib=1
...
MapStress=NO
MapStrain=NO
```

```
FiberBundle#1:
Lay=3,IP=1,Fib=1
Lay=6,IP=1,Fib=1
Lay=9,IP=1,Fib=1
Lay=12,IP=1,Fib=1
```

Explanation of the different routines
Link to an HDF5 data storage container has been realized

- Binary storage format
- Solver independent
- Well be extended within the VMAP project
Workflow

One user has to define an initial data structure:

```plaintext
#!/usr/bin/env bash

# Main mapping definition
ENVY0=HDF5-DEFINITION

# In- and output meshes

# HDF5-Structure-SimStages.txt
HDF5-File_Target=MyHDF5-File.h5

# END-OF-FILE
```

HDF5 exchange workflow as realized in ARENA2036

- 020_OPTIMIZATION
- 030_PROCESS_SIMULATION
  - 001_BRAIDING
  - 002_INFILTRATION
- 040_MAPPING
  - 001_Map2Structural
  - 002_Map2RTM
- 050_STRUCTURAL
- 080_MATERIAL_DATABASE
- 090_CAD
**Workflow**

- One user has to define an initial data structure

- Further data can be assigned to the respective sub-folders

```plaintext
#-----------------------------
# Main mapping definition
#-----------------------------
ENVYQ=RV5=POSTPROCESSING
#-----------------------------
In- and output meshes
#-----------------------------
PushToHDF5DataBase=YES
HDF5-File_Target=MyHDF5-File.h5
WriteOriginalFiles=YES
WriteResultFiles=YES
RV5_INFO=braid_data.txt
#-----------------------------
# ARENA2036 - File Status
#-----------------------------
DevelopmentStage=080 MATERIAL DATABASE
#-----------------------------
# END-OF-FILE
#-----------------------------
```

HDF5 exchange workflow as realized in ARENA2036
Workflow

- One user has to define an initial data structure
- Further data can be assigned to the respective sub-folders
- The next user can read the assigned data

HDF5 exchange workflow as realized in ARENA2036
Within the ARENA2036 research campus, a multi-scale, integrative simulation environment is being established, allowing to consider multiple manufacturing processes.

The developed mapping, homogenization and data exchange platform is solver independent.

Optimization and CAM interfaces are under investigation.


The Digital Prototype as Part of ENVYO® - Development History and Applications within the ARENA2036 Environment.
Digital Fingerprint - Overview

Statistics:
- Personal efforts: 448 PM
- Budget tot: 3,96 Mio €
- Budget Funding: 2,42 Mio €
- Tot. funding: 61,02 %
- Industrial funding: 40,00 %
- relation Industry/Research: 2,27

What's next?
ARENA2036 & the Digital Prototype: Introduction and Overview

DigitPro – 

**Digital Fingerprint - Tasks**

- Connection of all steps along the process chain of industrial 4.0
- Generation of a common data platform for all data arising along the components life-time
- Automated data flow between the processes
- Intelligent component and coupling to interpretation tools (e.g. FE analysis)
- Connection to processing tools (CAM) and highly flexible, automated processes
- Component specific data storage
- Component evolution using stored and generated data