

# ***The World of Predictive Modelling***

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**Zoubida El Hachemi, Ph.D**

Worldwide sales director, e-Xstream engineering



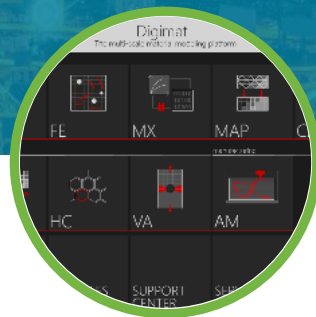
**HEXAGON**

# e-Xstream engineering, *The materials & process modeling company*



**e-Xstream**

*A Team of Passionate  
Material & Process  
eXperts !*



**Digimat**

*The material &  
process modeling  
platform*



**MaterialCenter**

*Material Lifecycle  
Management  
Platform*



**MSC Software**

*Software for Virtual  
Validation &  
Optimization of  
Engineering Designs*



**Hexagon**

*Digital Solutions  
Smartly Connecting  
the Physical & Digital  
Worlds*

# Hexagon at a Glance – *Shaping Smart Change*



## Technology Solutions Provider

- Leader in **software and sensors** technologies
- Focused on **vertical productivity solutions**



## Global Reach

- Broad range of vital industries served
- More than **18,000** employees in **50** countries



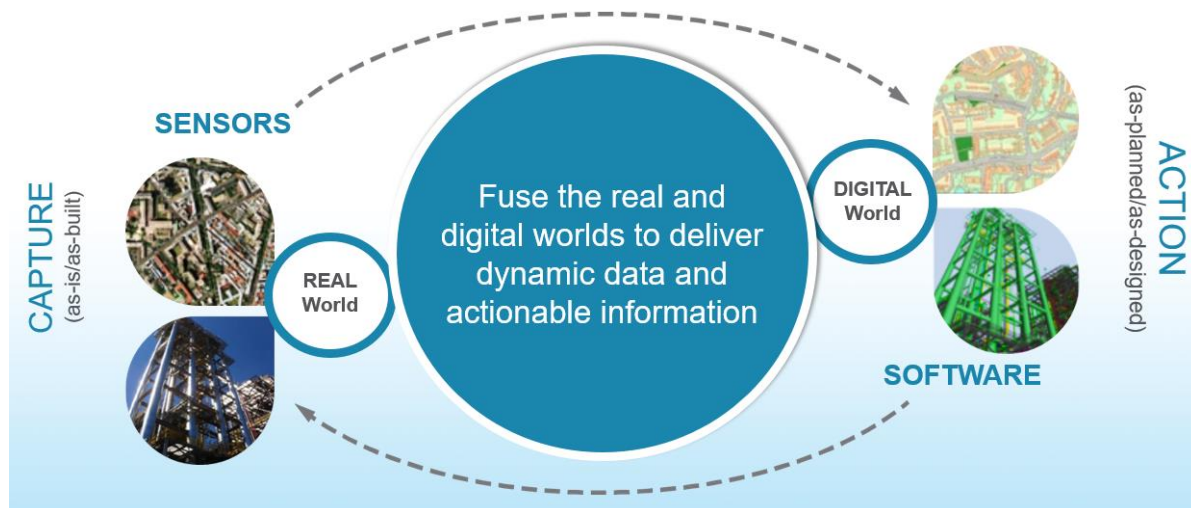
## R&D Focused

- **12%** of sales invested in R&D, **3,200+** active patents
- **3,400+** employees in R&D

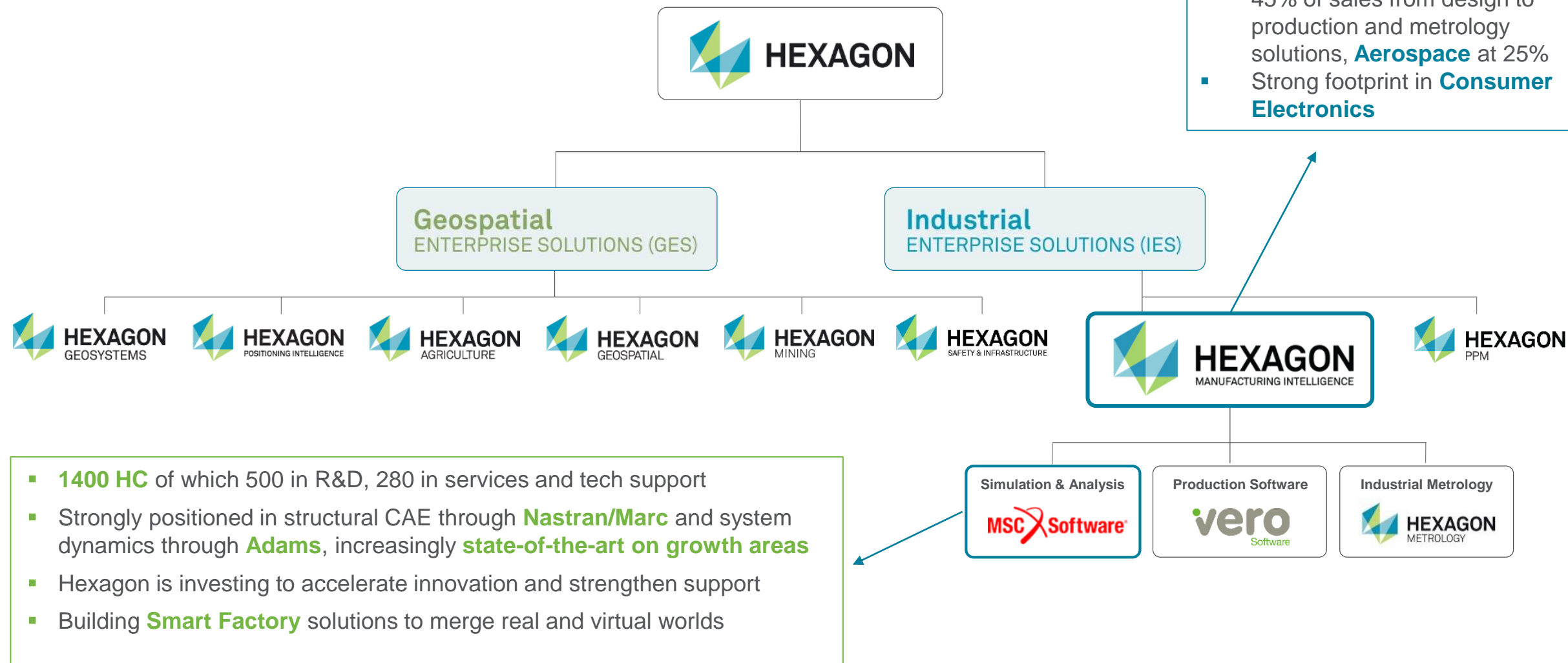


## Strong Financials

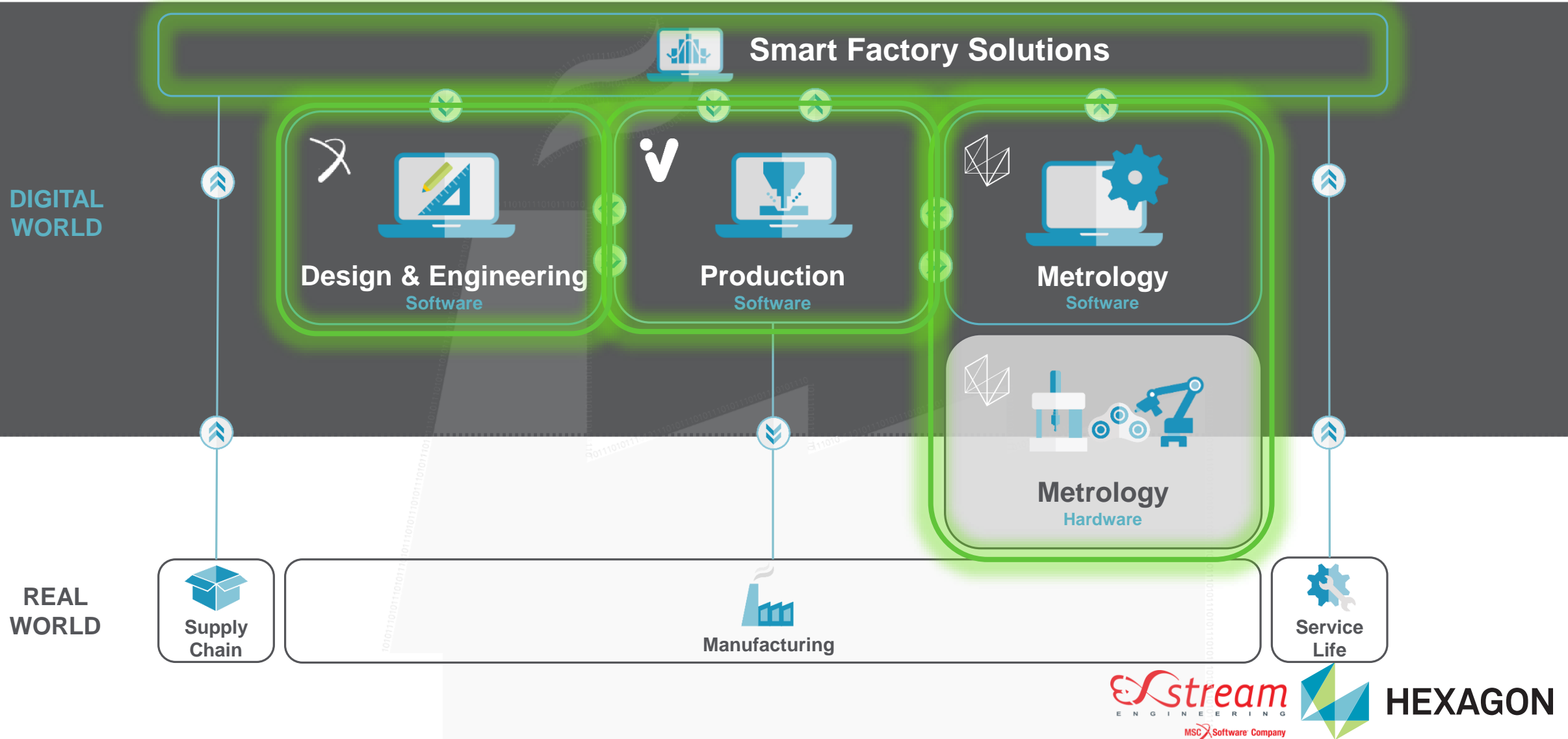
- **3.5 bn EUR** in net sales
- **24.1% operating** margin



# Hexagon – Manufacturing Intelligence



# HMI – Delivering Productivity focused SMART FACTORY solutions





# MSC Software – *Key Investment Areas*

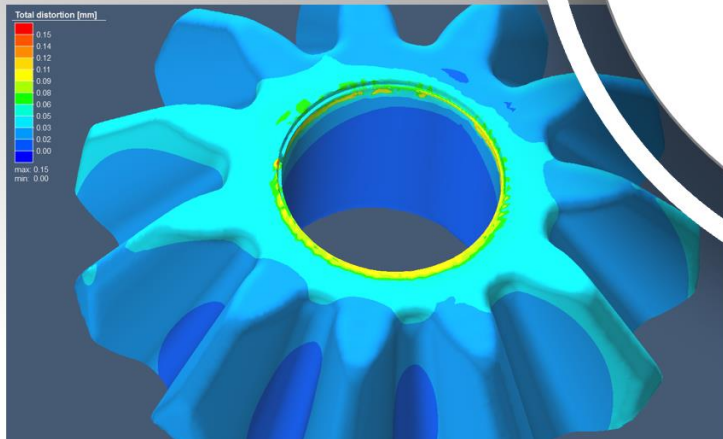
**Structures, Acoustics & Fluids**



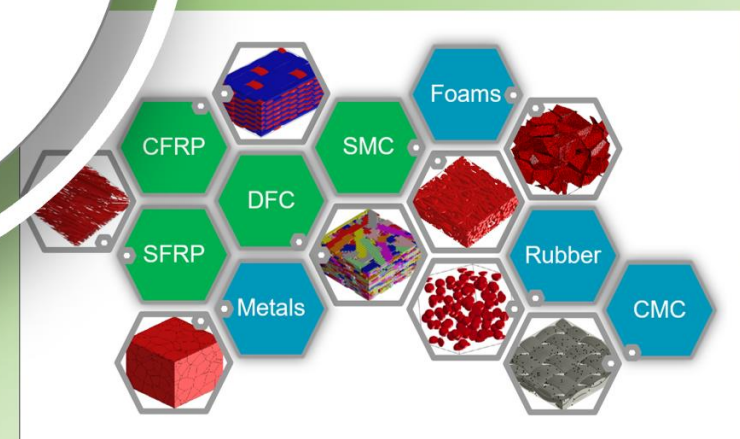
**Systems Modeling & Validation**



**Manufacturing**



**Materials**



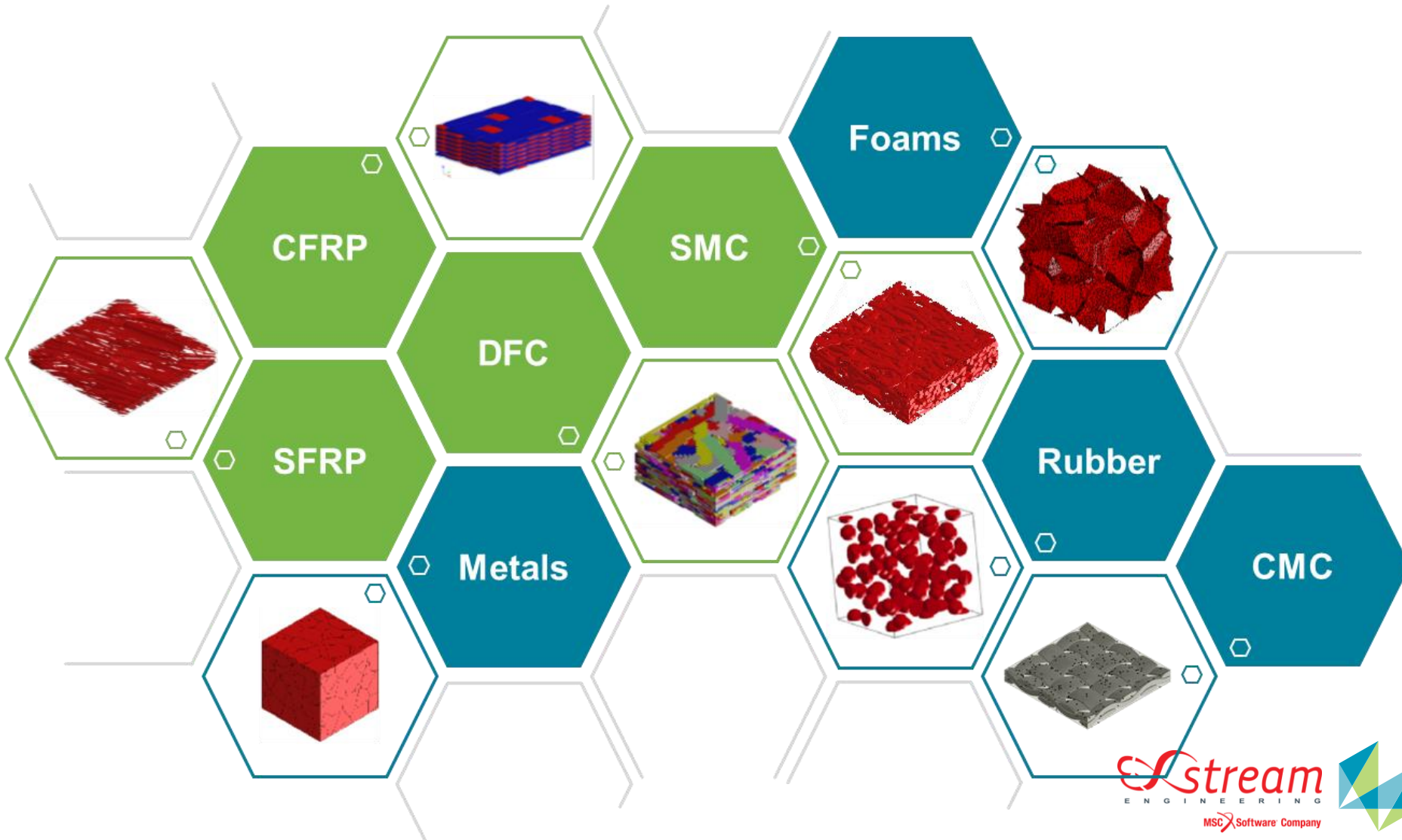
**Openness and  
Productivity**



- Process Automation
- Inter-Operability
- Machine Learning
- Co-Simulation
- Digital Thread

# Accurate, Robust, Fast & Easy Modeling of Fiber Reinforced Plastics and Composites

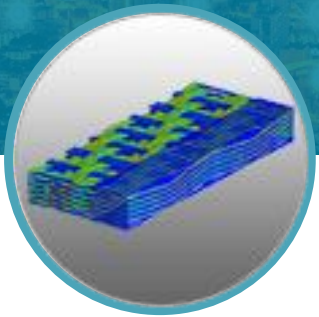
*Accelerated investments in addition material systems...*



# Our Material eXpertise empowered by Digimat & Material Center

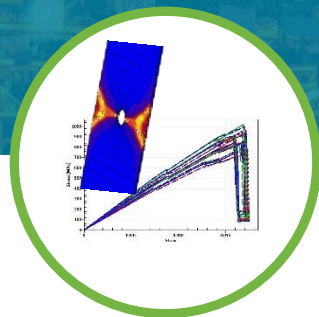
*Our objective is to solve your materials challenges!*

Material lifecycle software to manage material models, data & processes with Full traceability



## Virtual Material Engineering

*Virtually develop new materials and understand how they behave*



## Virtual Material Testing

*Save time & costs by virtually testing coupons*



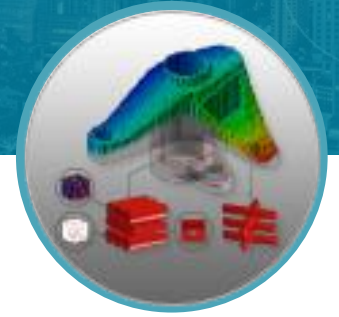
## Multiscale FEA

*Combine advanced material models and the local microstructure*



## Effect of Manufacturing

*Investigate effect of manufacturing like curing, defects, ...*



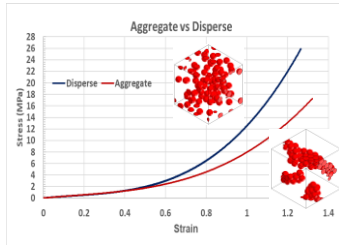
## Additive Manufacturing

*Virtually predict & optimize residual stress & warpage*

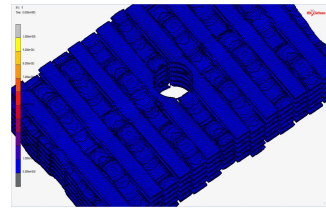


# 10x MATERIALS SOLUTION

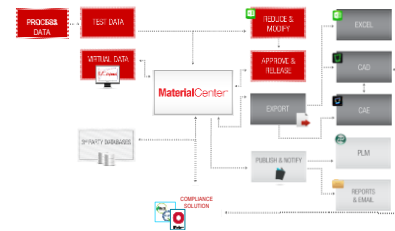
## 1 Virtual Material Development



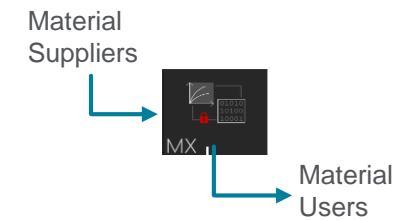
## 2 Virtual Material Testing



## 3 Materials Lifecycle Management



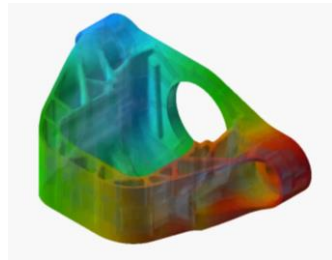
## 4 Material eXchange



## 5 Compliance & Sustainability

Material	PREPREG 40% 120 Qualification Data
Material	PREPREG 40% 120 Qualification Data
Material	40%
Compliance	
Central Compliance Status	Valid
Provisional IS	Checked OK
REACH Annex XIV	Checked OK
REACH Annex XVII	Checked OK
RoHS (2011/65/EU)	Checked OK
RoHS Annex II	Checked OK
RoHS complete part	Checked OK
RoHS sub part	Checked OK
US Conflict Minerals	Checked OK
Compliance Details	View this material's part details
Compliance	
RoHS & REACH (1%)	0.0
DEHP (%)	0.0
Phthalates (%)	0.0

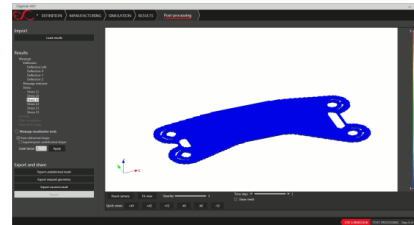
## 6 Effect of Processing



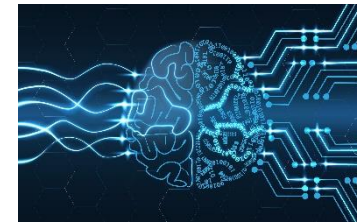
## 7 Accurate Material Modelling



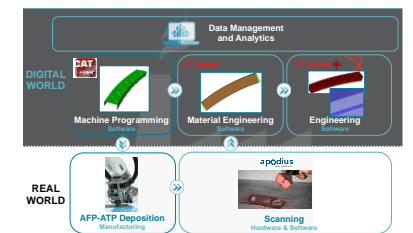
## 8 (Additive) Manufacturing



## 9 Material Intelligence(AI)

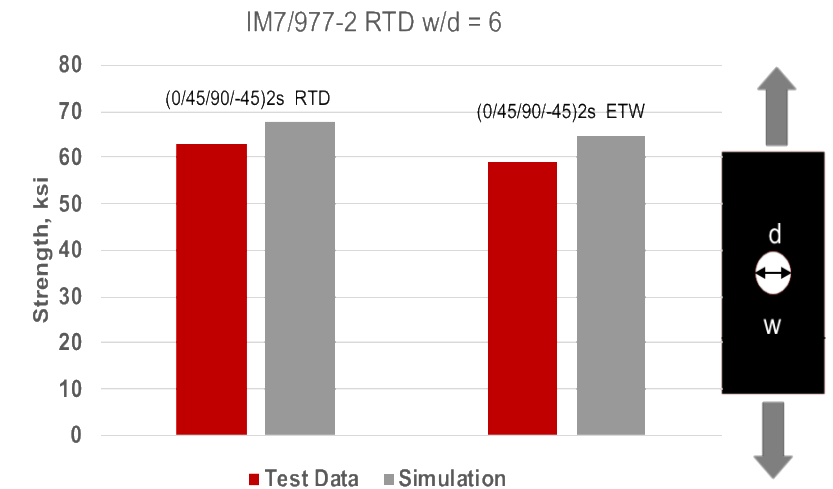
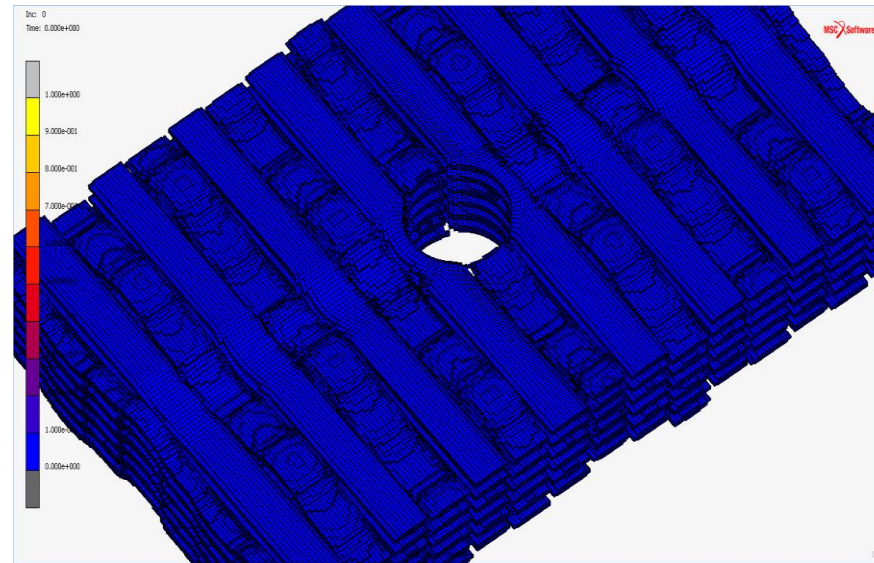
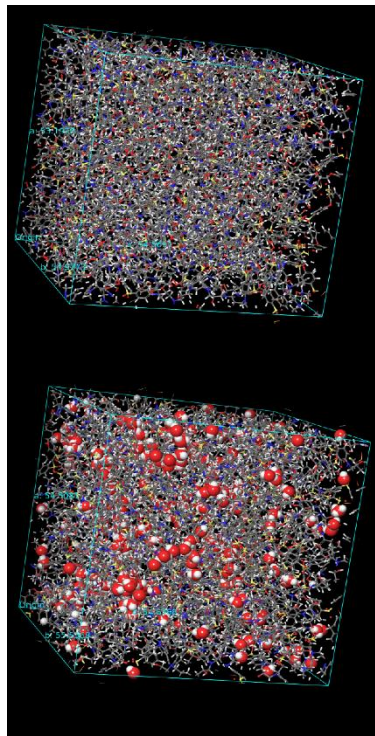


## 10 Digital Continuity & (Material)Twin



# 1. Virtual Material Development

*Bridging the gap between disciplines & scales for faster/cheaper material development*



Critical Distortional Invariant  
(RTD)=0.08  
(ETW)=0.011

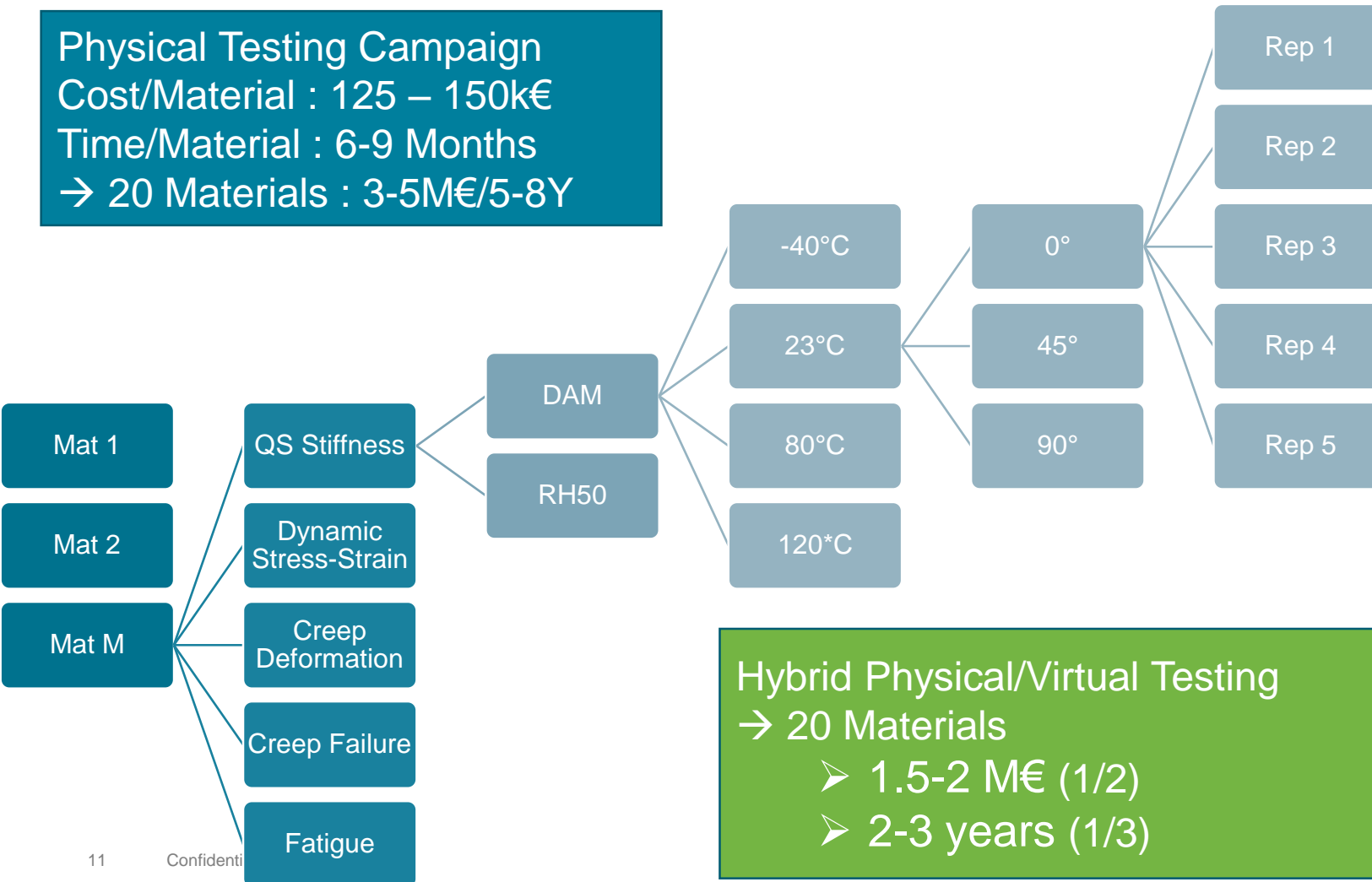
Detailed Damage & Failure  
Analysis

Strength Prediction

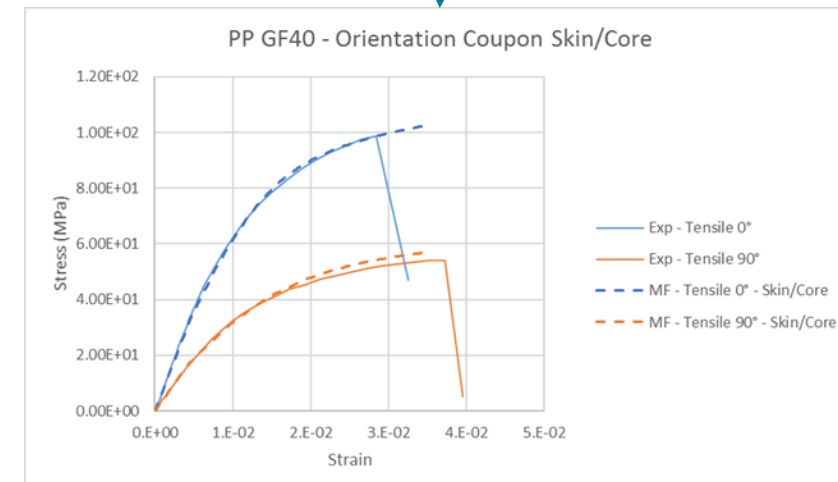
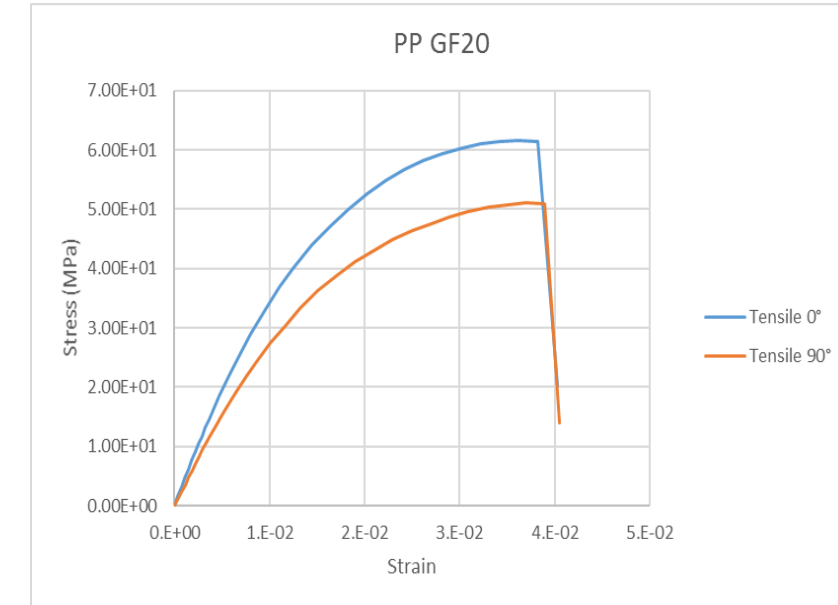
## 2. Virtual Material Testing

Hybrid physical/virtual testing to support Material Suppliers and Users

Physical Testing Campaign  
Cost/Material : 125 – 150k€  
Time/Material : 6-9 Months  
→ 20 Materials : 3-5M€/5-8Y

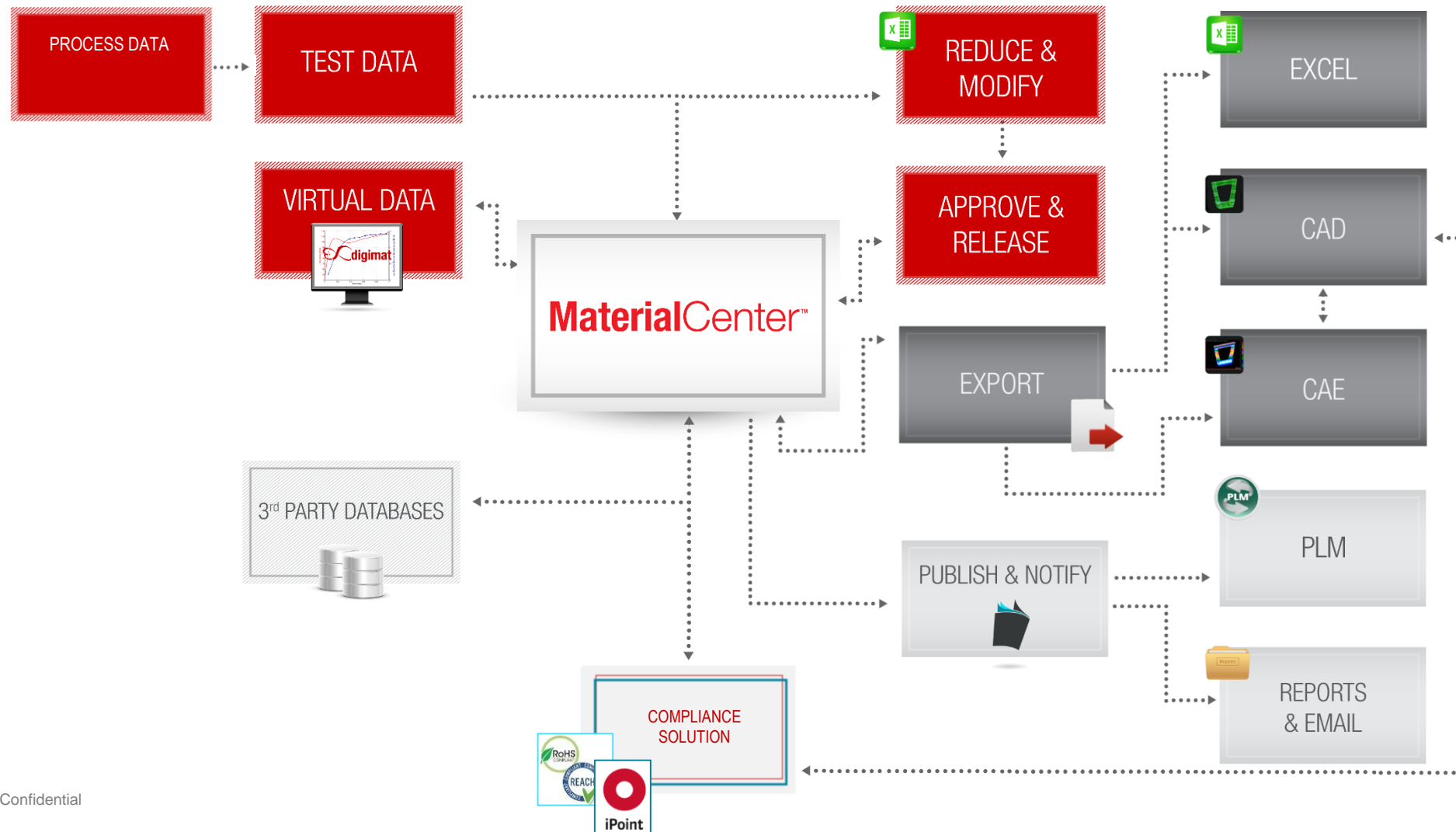


Hybrid Physical/Virtual Testing  
→ 20 Materials  
➤ 1.5-2 M€ (1/2)  
➤ 2-3 years (1/3)



### 3. Material Lifecycle Management

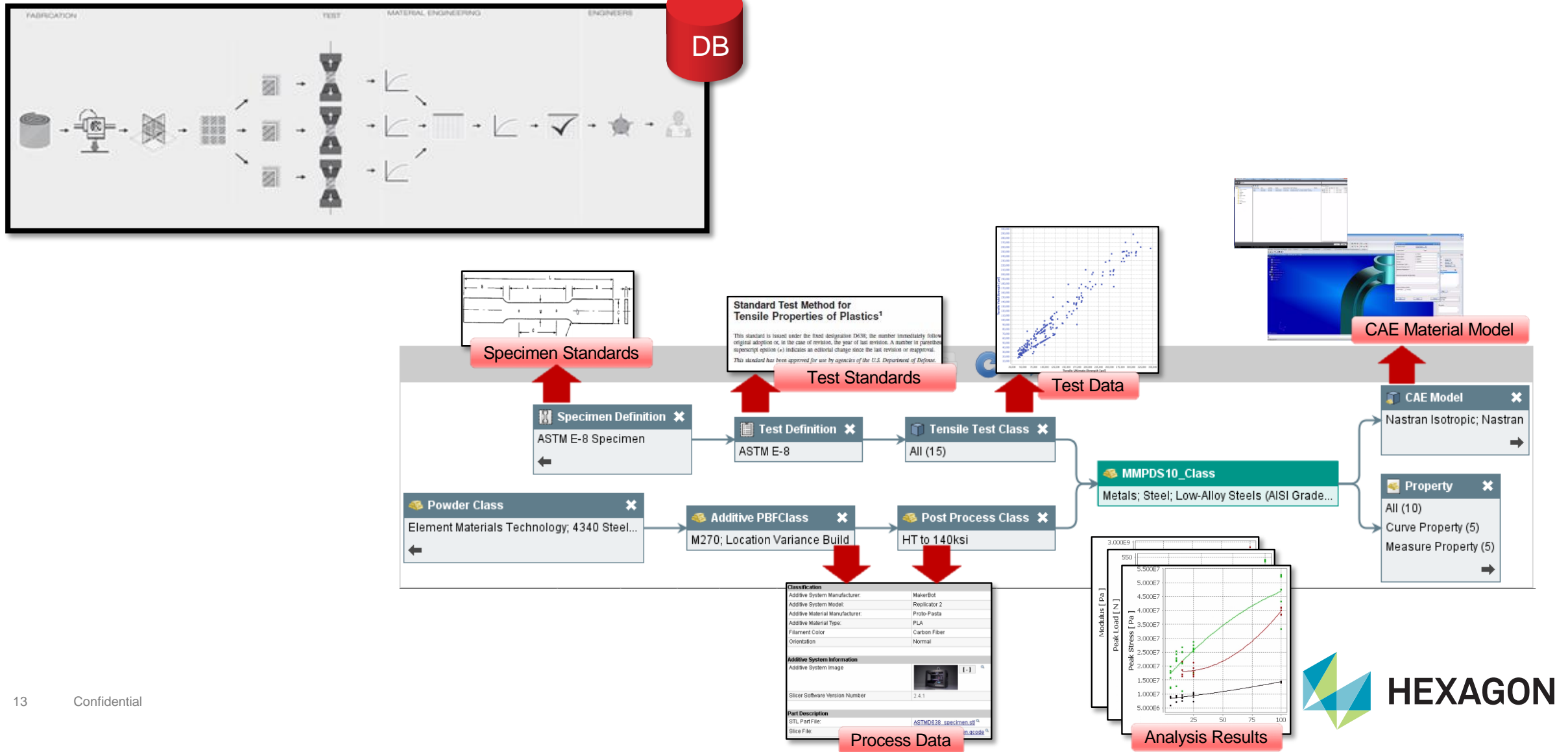
*Enterprise software with proven security & scalability to manage Materials IP*





### 3. Material Lifecycle Management.

*Manage the entire material lifecycle from left to right of test*



## 4. Material Exchange Platform

*The marketplace where material data & models can be exchanged*

### Material Suppliers



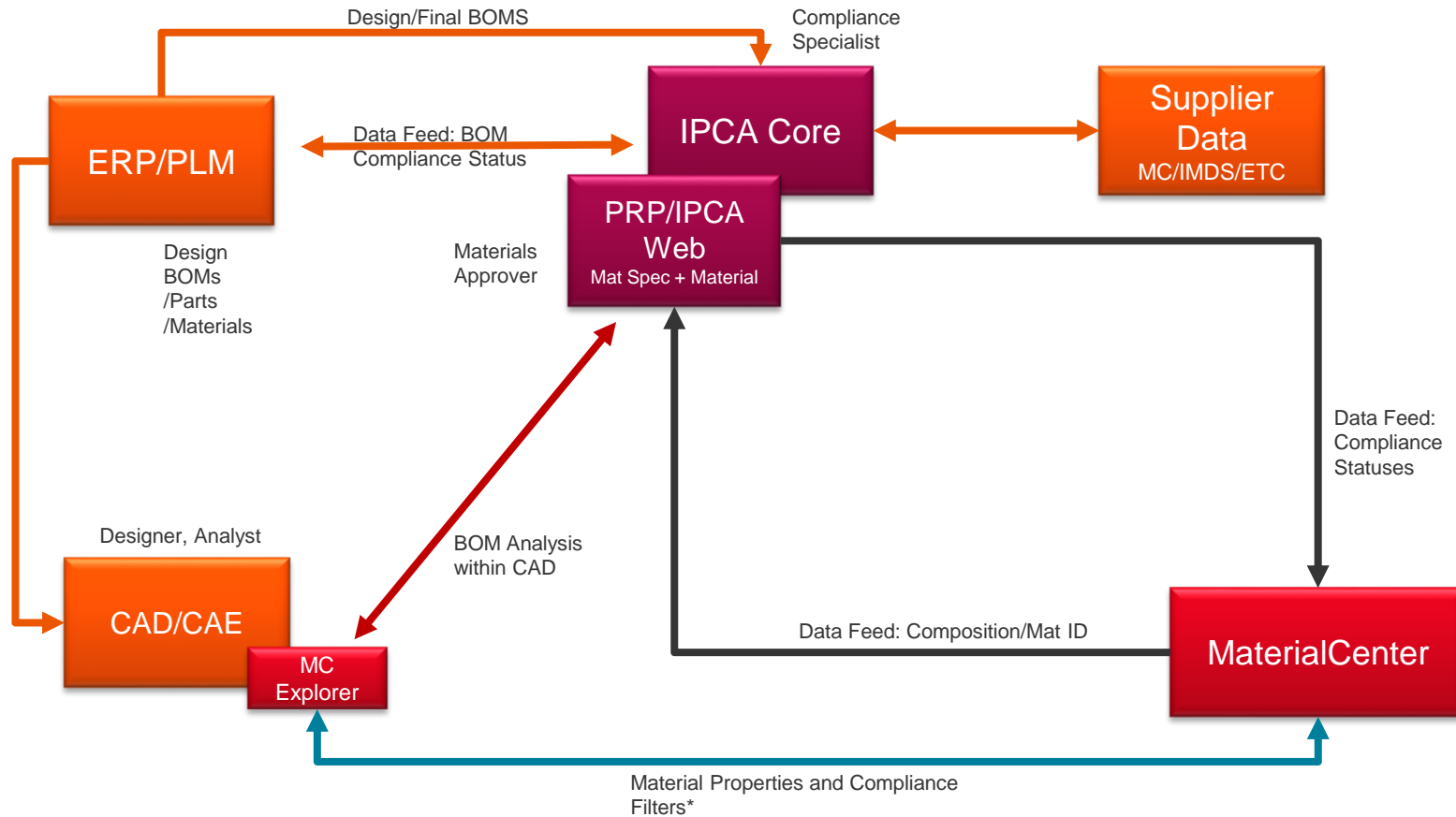
### Material Users



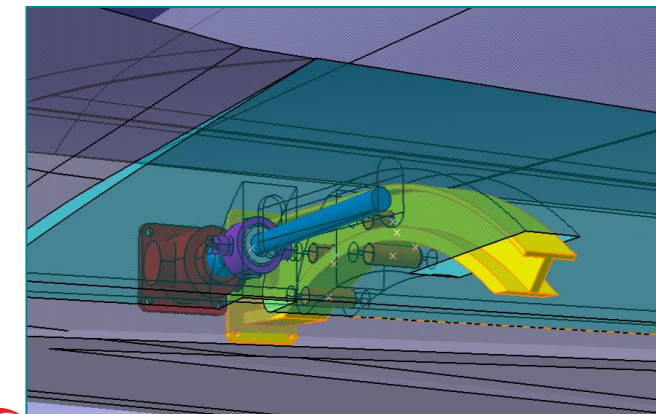
Note: A small, non-exhaustive list of representative customers

# 5. Compliance & Sustainability

*Compliance Info @ the fingertips of M&P Engineer at Material, Part & Assembly*

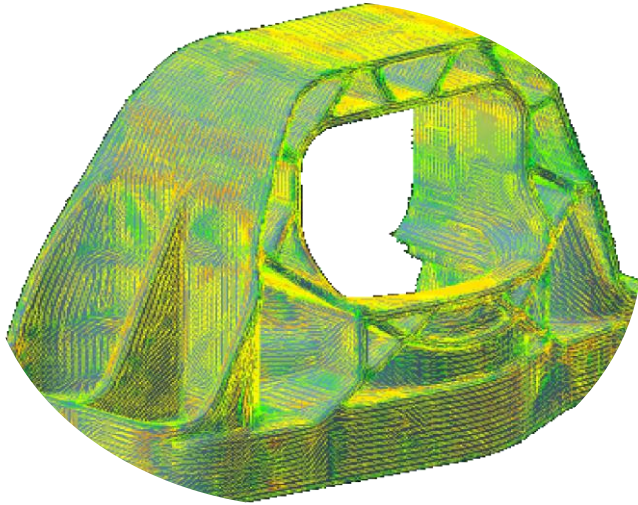


PREPREG1/ 40%/ 120 Qualification Data; 40% [ Composite Design Data ]		Actions
Pedigree Viewer	Add To Clipboard	Export To Excel
Find Similar	Create Material	Edit Material
Details	Revisions	Test Data
Process Viewer	Comments	
Display	Select	Actions Select
Classification		
Material	PREPREG1/ 40%/ 120 Qualification Data	
Resin Content	40%	
Compliance		
Overall Compliance Status	Yellow	
Proposition 65	Checked ERROR	
REACH Annex XIV	Checked OK	
REACH Annex XVII	Checked ERROR	
RoHS (2011/65/EU)	Checked OK	
RoHS Annex III	Checked OK	
SVHC complete part	Checked OK	
SVHC each level	Checked OK	
US Conflict Minerals	Checked OK	
Compliance Details	<a href="http://oc-lm-app.rt.ipnt.de/ipca/">http://oc-lm-app.rt.ipnt.de/ipca/</a>	
Composition		
Bisphenol A diglycidyl ether ( % )	40	
DEHP ( % )	0.2	
Polyacrylonitrile ( % )	50	

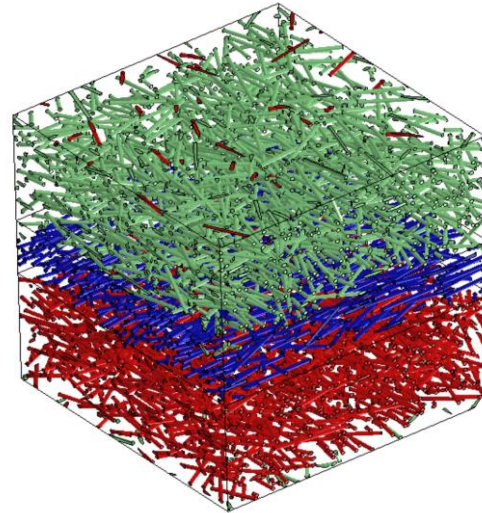


## 6. Effect of Processing (Molding, AM, Curing, Draping, ...)

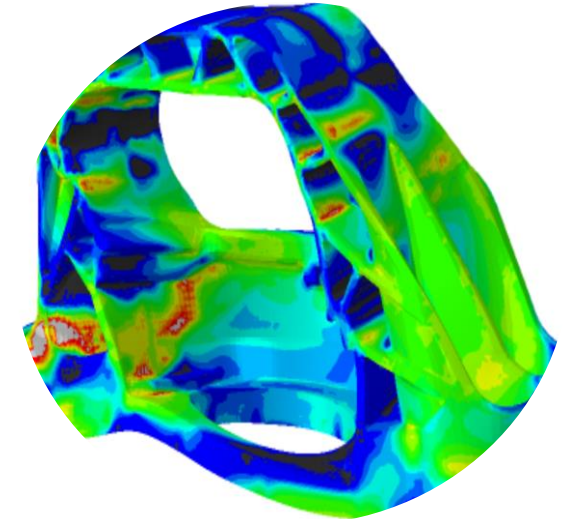
*Material microstructure bridges the gap between manufacturing & part quality*



Manufacturing  
Process



Material  
Behavior



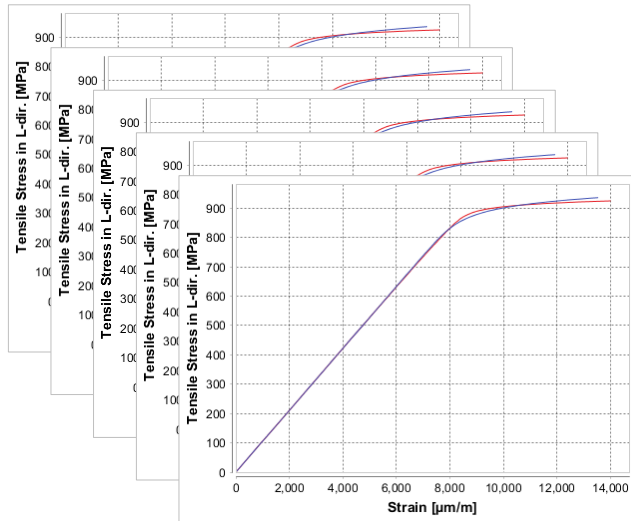
Part  
Performance





# 7. Accurate Material Models

*Identify the right model for the right material and application*



## Test Data Reduction

- Material Model Calibration
- Reverse Engineering
- Variability (A/B Basis)
- in-house processes



JAHM Software



## Material Models

- Linear & Nonlinear
- Isotropic & Anisotropic
- Temperature-dependent
- Failure,...
- Native or User-defined
- Support of MSC and all other major FEA codes
- Phenomenological or Multi-Scale



HEXAGON

## 8. Additive Manufacturing Solution

*An end-to-end solution built on pointwise, industry leading technologies*



**MSC Software®**

**Stream**  
ENGINEERING  
MSC Software Company

**simufact**  
Simulating Manufacturing

**ICON**  
3D Systems

**ROMER**

**Leica**

**HEXAGON**  
MANUFACTURING INTELLIGENCE

And more...

**Stream**  
ENGINEERING  
MSC Software Company

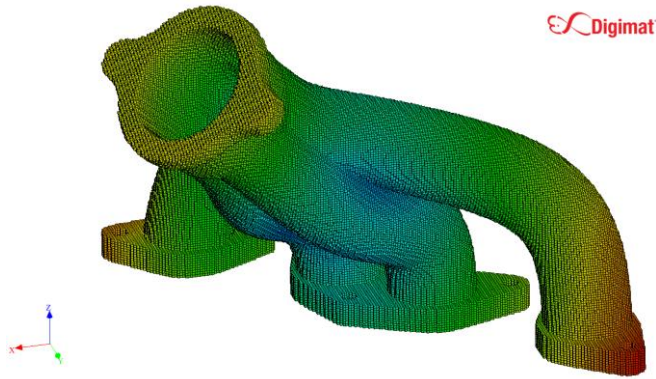


**HEXAGON**

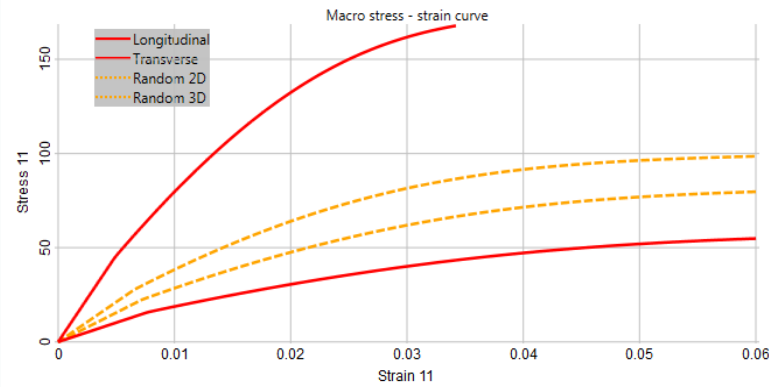
## 8. Additive Manufacturing Solution

*A holistic solution covering Materials, Processes & Part Performance*

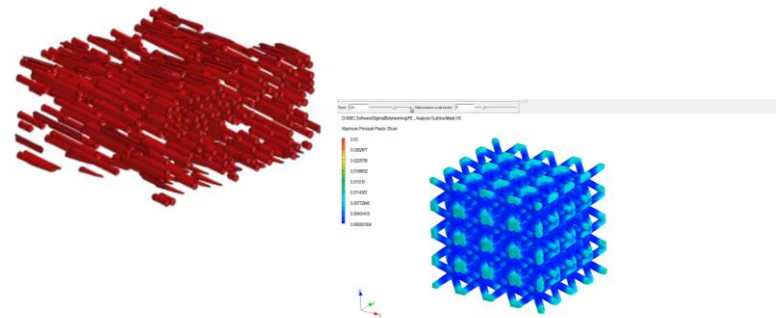
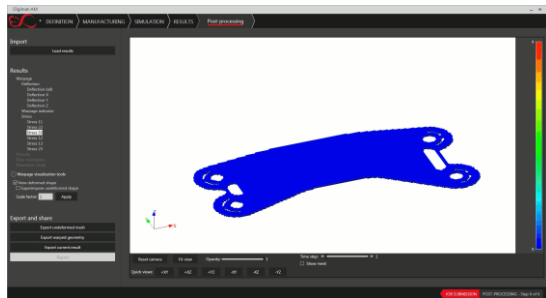
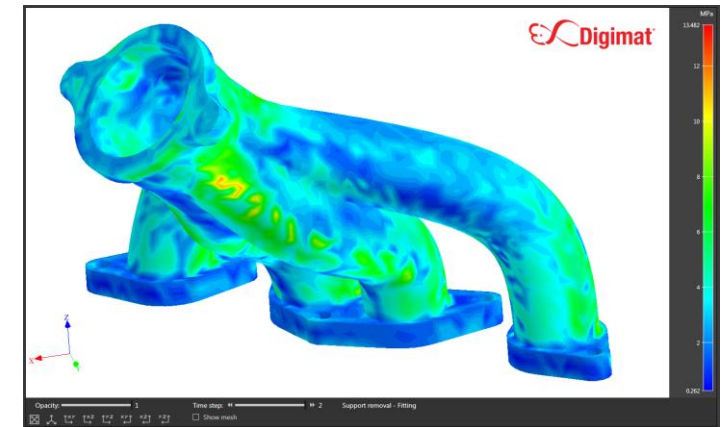
### Process



### Material



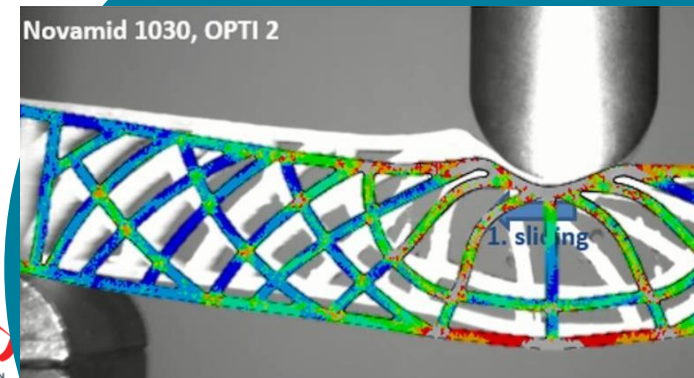
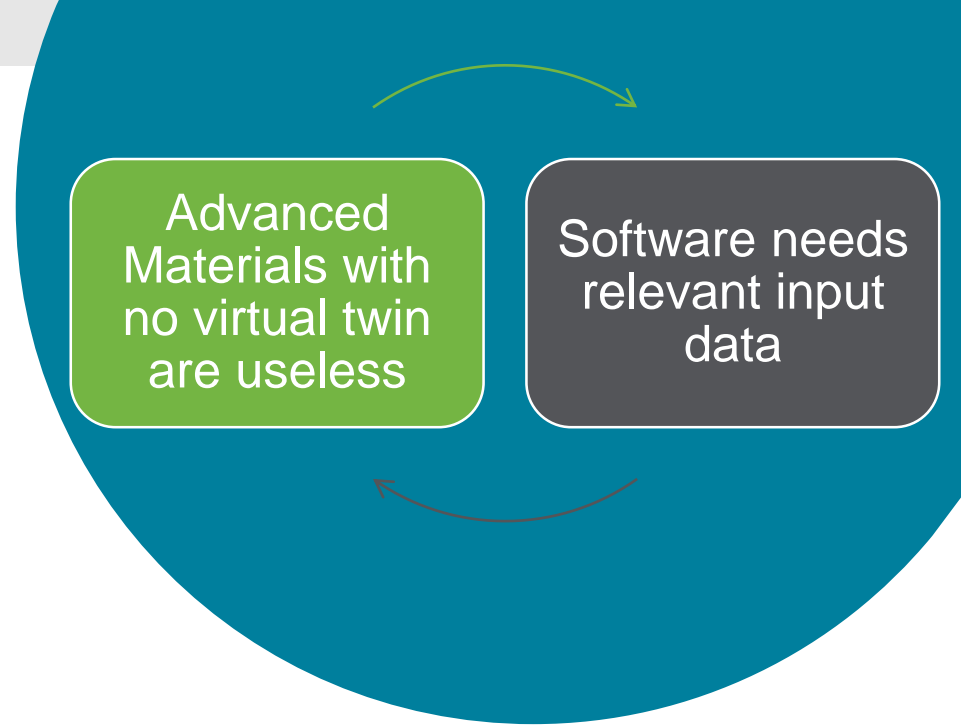
### Performance



# DSM and e-Xstream engineering Partnering for your **SUCCESS** !

**Combining DSM material portfolio & Digimat technology, we can help you to develop lighter & stiffer automotive parts**

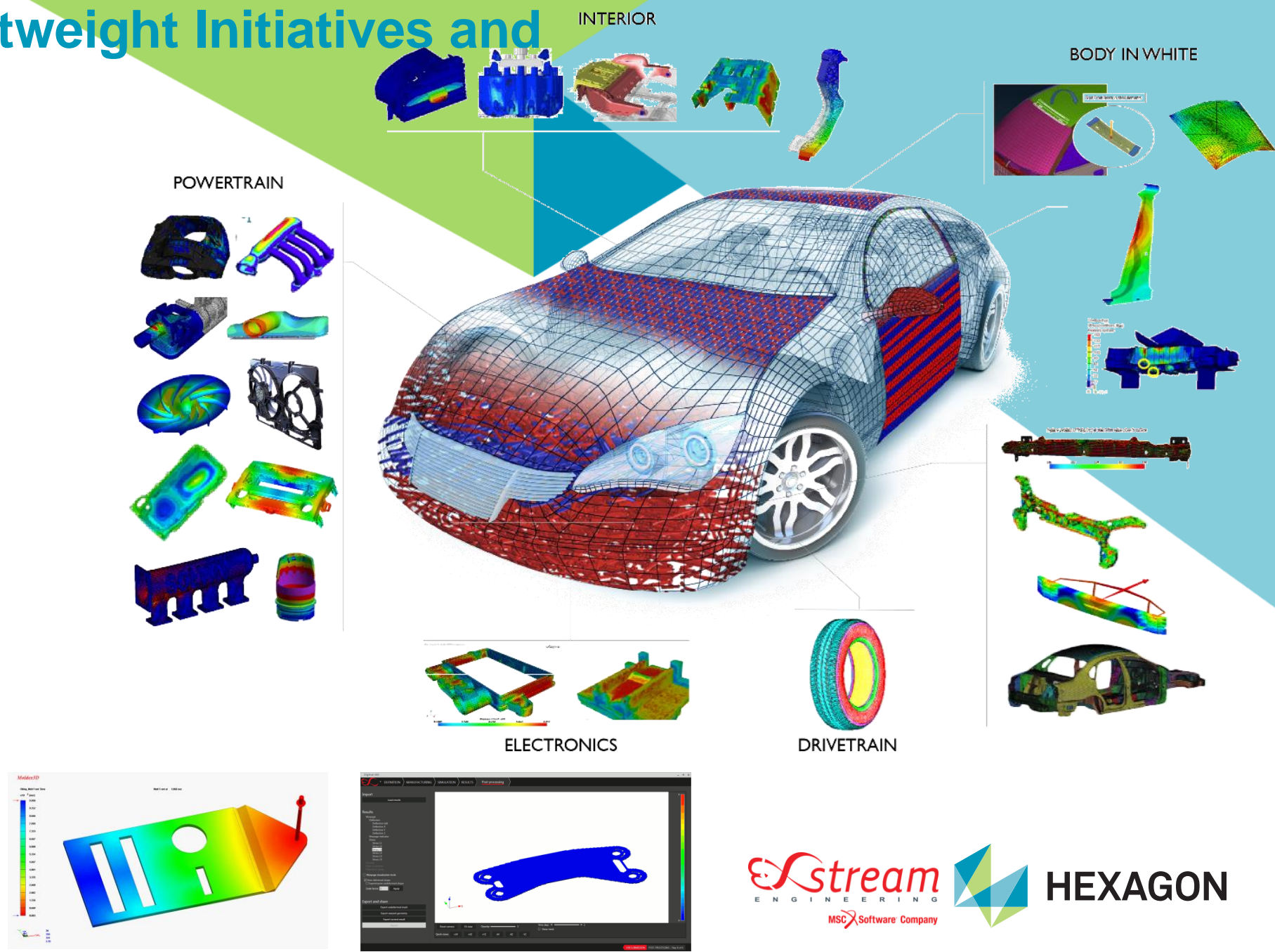
- Predict material performances
- Account for manufacturing variability
- Understand root cause of failure
- Investigate damage mechanisms
- Innovate & tune composite properties
- Optimize microstructure to maximize performances





# Supporting your lightweight Initiatives and Design Optimization

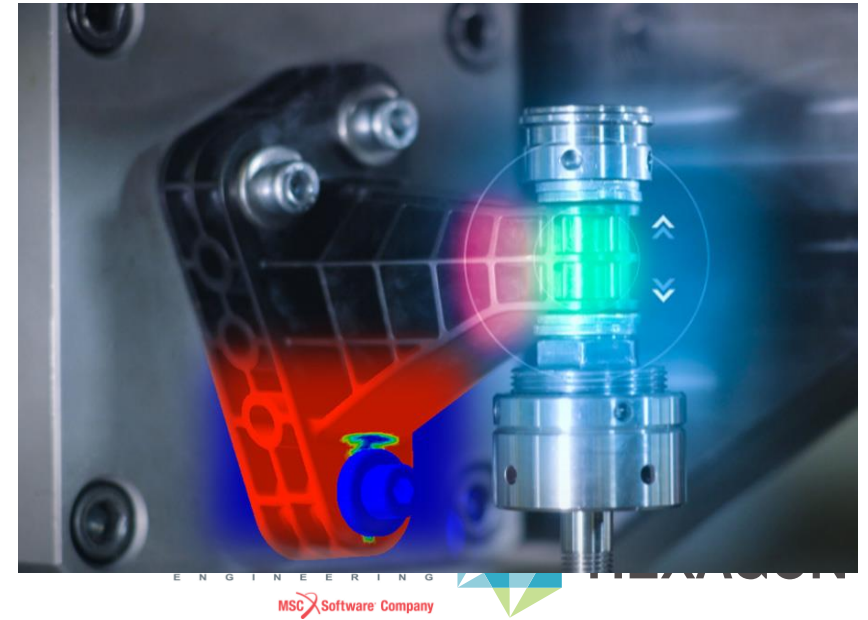
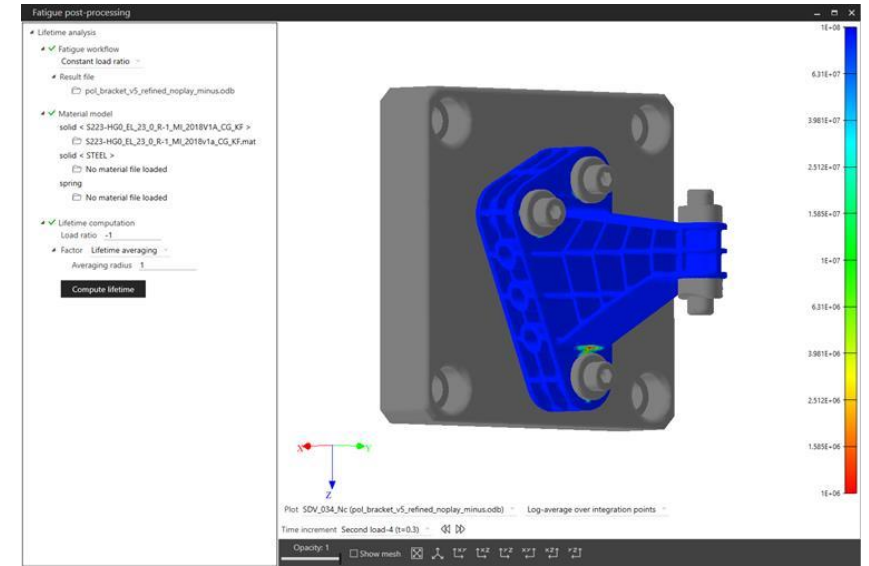
1. Any material
  - a) ForTii, Stanyl, EcoPaxx, Arnitel
  - b) Akulon, Arnite, Novamid
  - c) ...
2. Any Application
  - a) Powertrain, BIW
  - b) Interior, Exterior
  - c) ...
3. Any performance
  - a) Vibration, Stiffness, Crash
  - b) Creep, Durability
  - c) ...
4. Any manufacturing process
  - a) Injection molding
  - b) Additive manufacturing
  - c) Confidential



# Supporting Advanced Material Models

## DSM AND E-XSTREAM ENGINEERING PARTNER TO OFFER PREDICTIVE SIMULATION TOOLS FOR DURABILITY OF SFRP LIGHTWEIGHT COMPONENTS TO CUSTOMERS

- Ensure the development of reinforced plastic parts' durability prediction by setting up an easier and faster way to accurately model plastic compound materials
- Addition of 2 grades for High Cycle Fatigue
  - Akulon S223-HG0
  - ForTii Ace MX53T
- Methodology developed & validated on DSM grades
- Dedicated fatigue post-processing tool within Digimat-RP



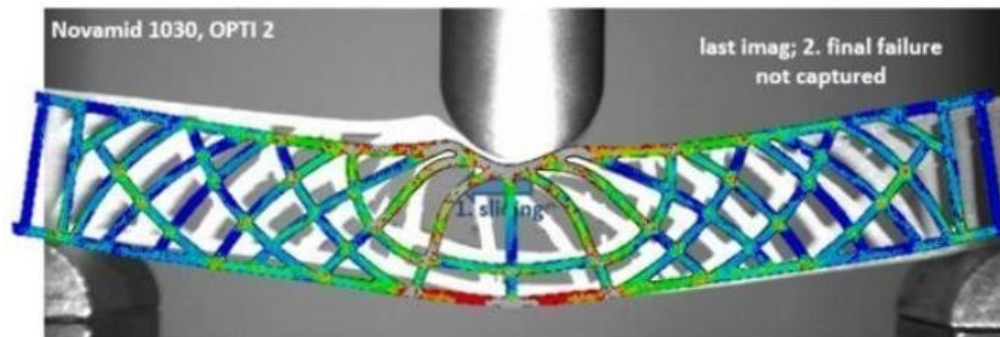
## Press Release

Geleen, 6 November 2018

### DSM adds 3D-printing grades to Digimat to accelerate adoption of polymer additive manufacturing

DSM added four 3D printing grades into Digimat-AM database:

- Novamid® ID 1030, a high-quality polyamide 6/polyamide 66, whose unique properties enable parts with a good balance between stiffness, modulus and impact properties. Novamid® ID1030 is easy to print and parts exhibit excellent interlayer strength and high surface quality.
- Novamid® ID 1030 -CF10, a 10% Carbon fiber reinforced PA6/66 filament designed for printing functional prototyping and industrial parts. Its excellent mechanical properties and smooth surface appearance make it ideal for a very broad range of applications that require robust mechanical performance at elevated temperatures (HDT up to 180° C) or light weight applications in various markets
- Novamid® ID 1070, a premium PA6 with very good mechanical performance due to unique co-polymer technology. This technology offers high stiffness due to high crystallinity and very high interlayer strength for demanding robust parts in PA6.
- Arnite® ID 3040, a high-performance engineering plastics that combines high strength and impact resistance with excellent processing characteristics. With a melting point a 255° C, Arnite® ID 3040 is well suited for a broad range of automotive, electrical & electronic consumer goods applications.



“Additive manufacturing is quickly evolving from prototyping into mainstream manufacturing. One of the most important enablers is the capability to predict the behavior and performance of 3D printed parts in applications. Thanks to the collaboration with e-Xstream Engineering our customers now have the toolbox to design and predict reliable parts with the performance required for their application.

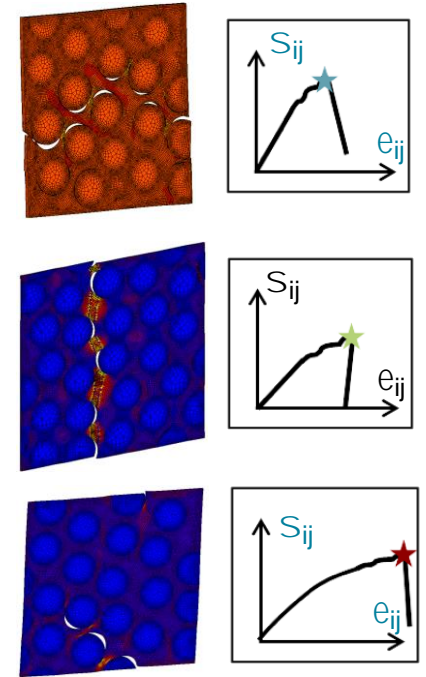
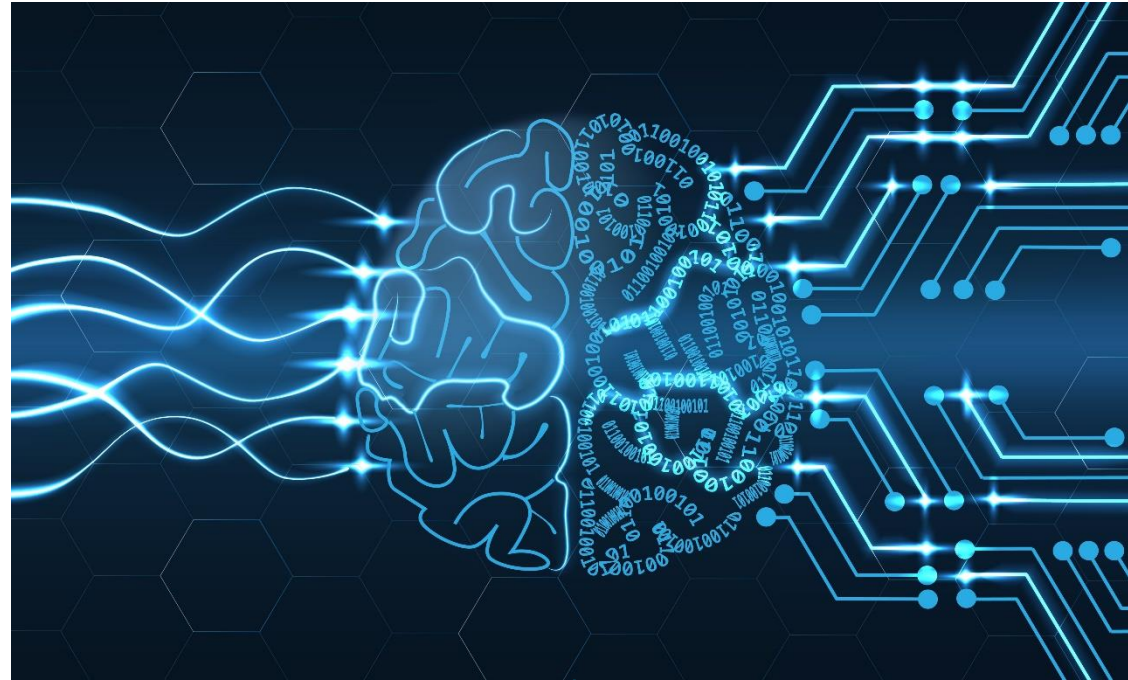
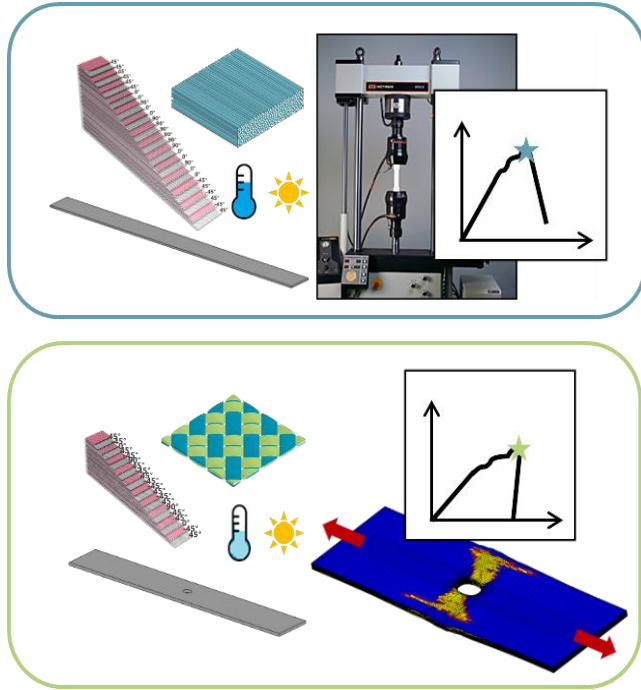
Nirali Surati, Product manager Additive Manufacturing Solids at DSM



# 9. Artificial Intelligence (AI)

eX.I. → Artificial/Engineering Intelligence Applied to Materials

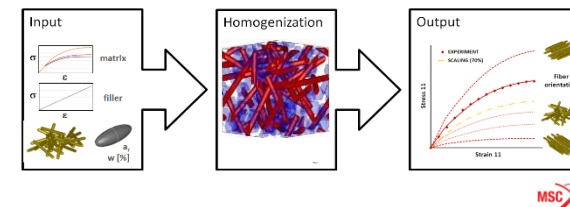
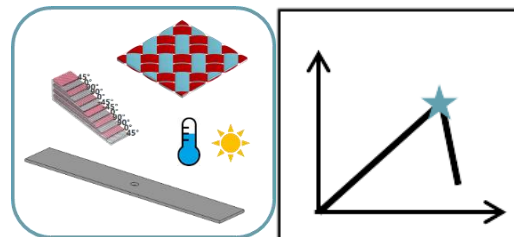
100,000+ Data Set



10,000+ RVE Simulations

Virtual Allowables

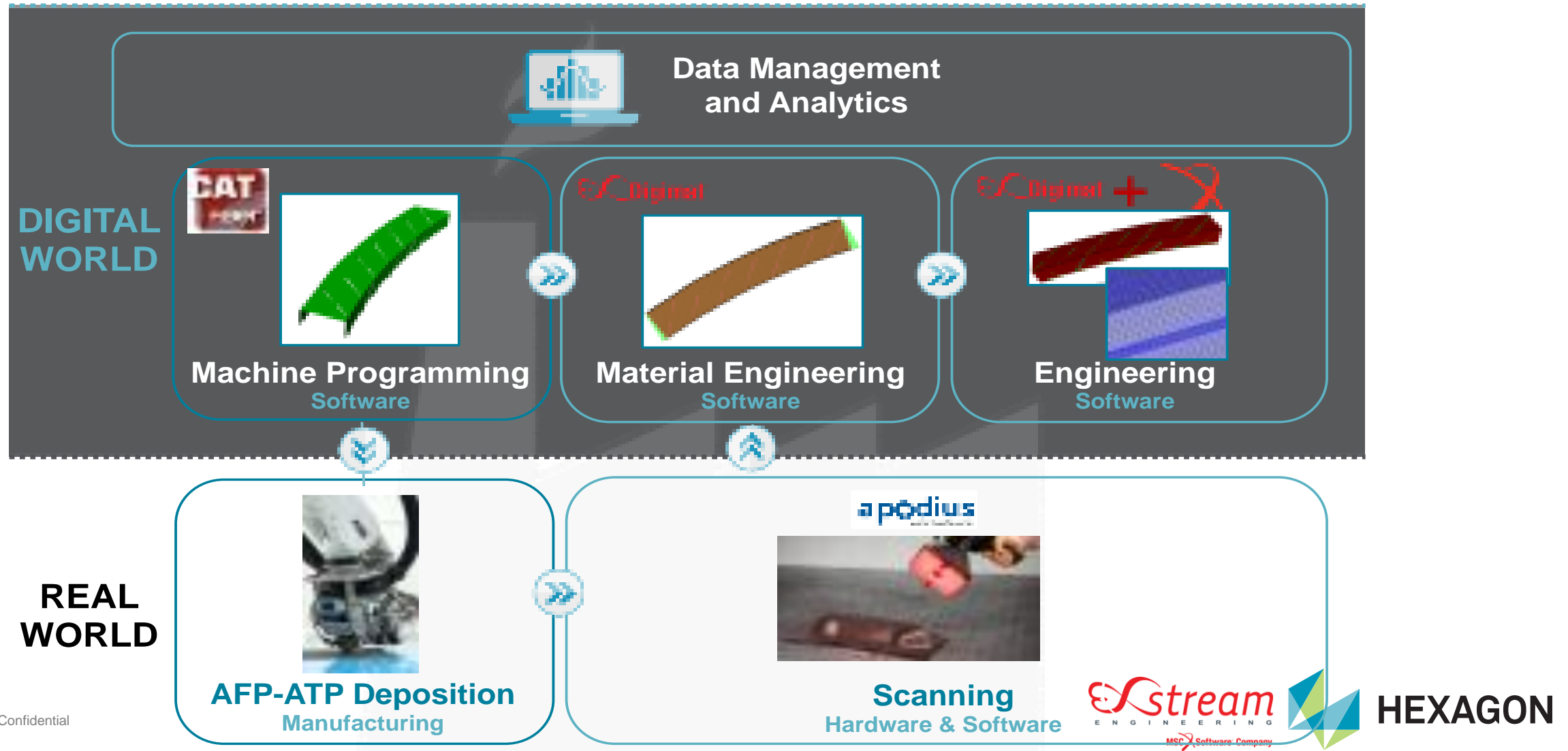
FE-based Hybrid





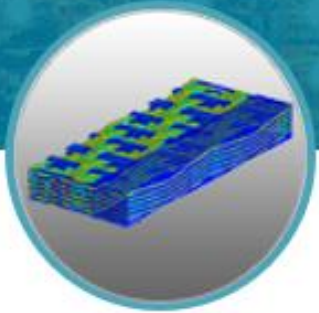
# 10. Digital Continuity & Material Twin

*Application to assess the effect of gaps in Automatic Tape Placement (ATP)*



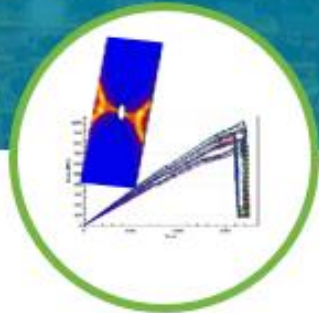
## CONCLUSION





### Virtual Material Engineering

*Virtually develop new materials and understand how they behave*



### Virtual Material Testing

*Save time & costs by virtually testing coupons*



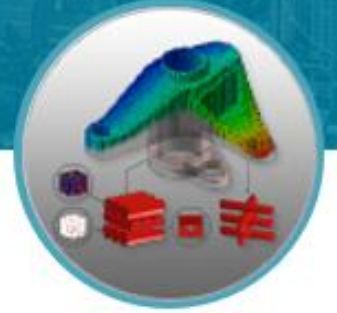
### Multiscale FEA

*Combine advanced material models and the local microstructure*



### Effect of Manufacturing

*Investigate effect of manufacturing like curing, defects, ...*



### Additive Manufacturing

*Virtually predict & optimize residual stress & warpage*

**DSM/e-Xstream engineering**  
**A winning Race Team to support your Materials and Components Design and Manufacturing Challenges**

# THANK YOU !!



**HEXAGON**

*Stream*  
ENGINEERING

MSC Software Company