SINTEF Seminar 19 April 2017, Mo Industry Park: "Det grønne og digitale skiftet"

# Noen perspektiver på Digitalisering i prosess-industri

Duncan Akporiaye

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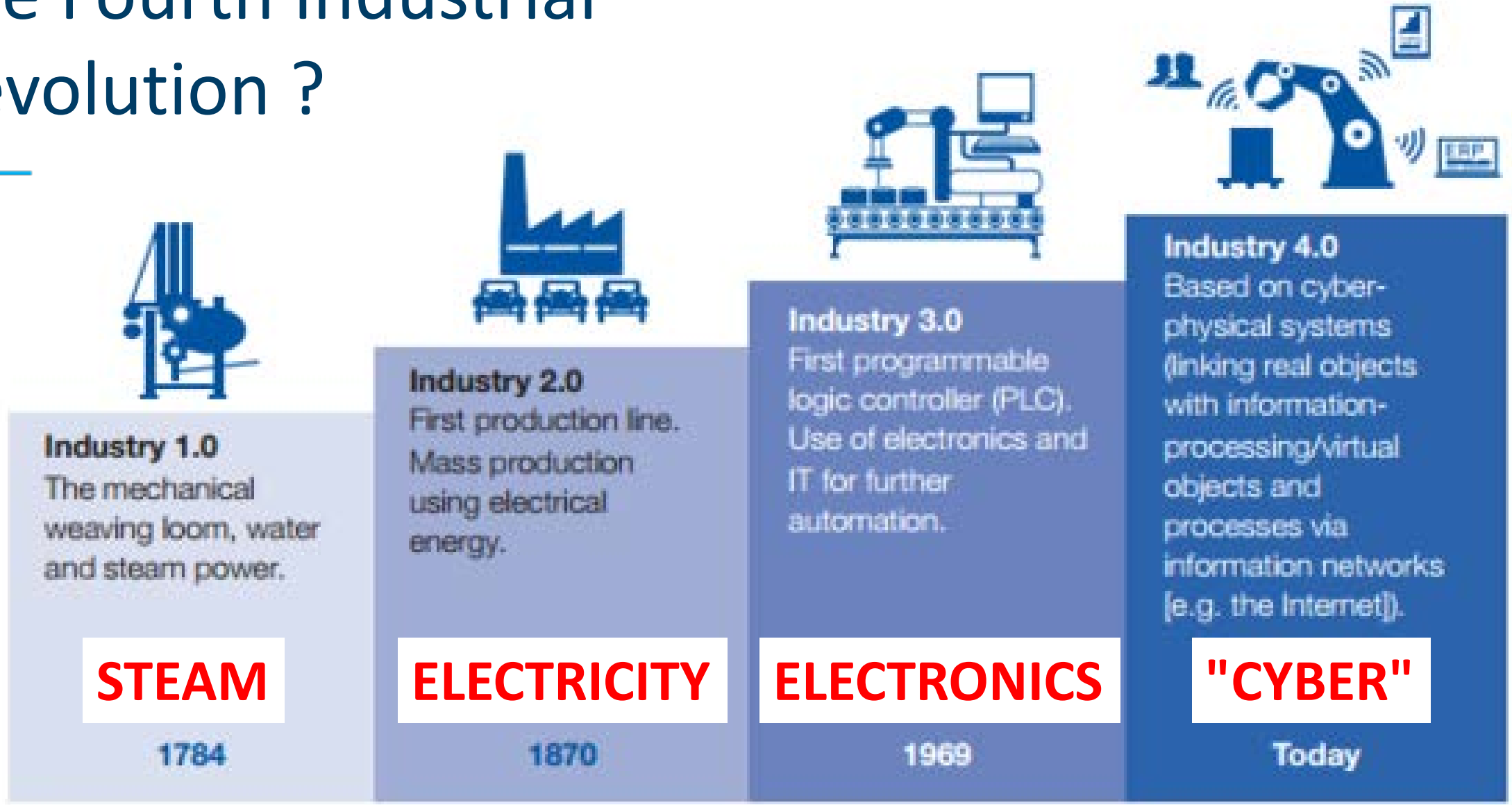
# Structure

- Industry 4.0
- Digital Technology $\Rightarrow$ Process Industry
- Process Industry $\Rightarrow$ Digital Technology?


2012, Germany

# The Fourth Industrial revolution ?

**Data ⇒ Global Access**



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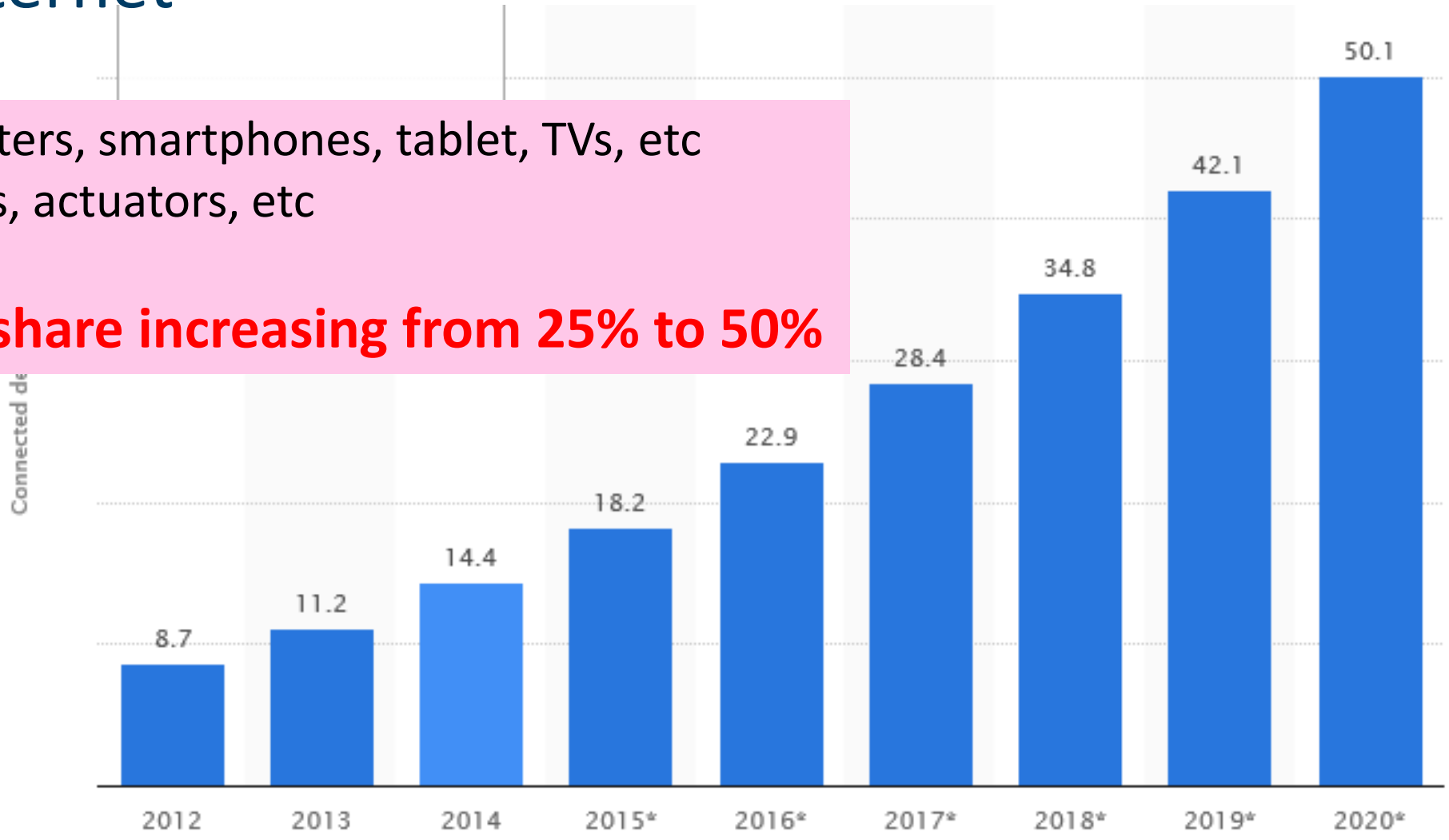
# By 2020 an estimated 30 – 50 billion devices connected to the internet

1/3 computers, smartphones, tablet, TVs, etc
2/3 sensors, actuators, etc

**Industry share increasing from 25% to 50%**




https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/



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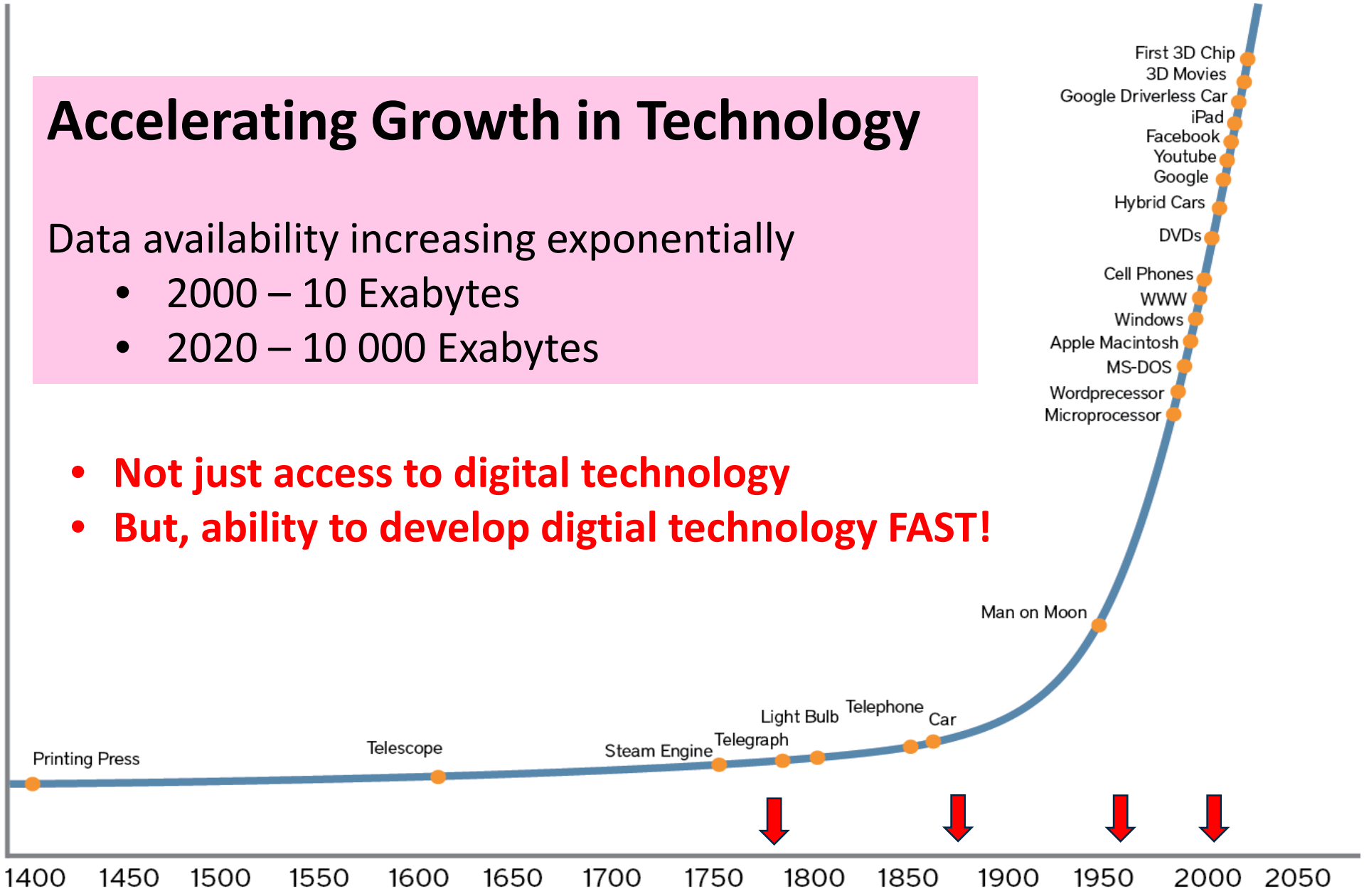
# Accelerating Growth in Technology

Data availability increasing exponentially

- 2000 – 10 Exabytes
- 2020 – 10 000 Exabytes

- **Not just access to digital technology**
- **But, ability to develop digtial technology FAST!**




http://changamkamkenya.blogspot.no/2016/08/the-awesome-potential-of-big-data-predictive-analytics-in-africa.html



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# Opportunities for New Digital technology

**Automation and Robotics**

Physical and software robots work autonomously or collaborate with humans

**Sensors**

Record physical conditions (machines, environment etc.) and transmit electronic signals

**Big Data Analytics**

Advanced analytics generate insights from pools of structured and unstructured data

**Artificial Intelligence**

Intelligent machines support humans to solve problems and make decisions

**3D Printing**

Combination of software, hardware and materials optimizes 3D printing

**Industrial IoT**

Connection of smart sensors, devices and equipment to the network

**Mobility and Devices**

Combination of networks, devices and software allows interaction from everywhere

**IT/OT Convergence**

Harmonizing wider-usage IT with purpose-built OT

**Cloud**

Network of servers allow data to be stored and accessed, and programmes run, from virtually everywhere

**Platforms, Specific Applications**

Broad range of software and services add industry-specific value



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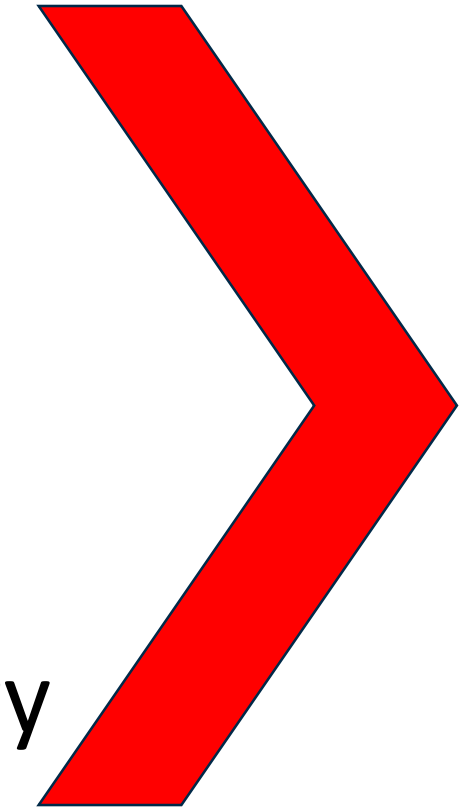
# Impact of Digitalisation on our mind-set

**Digital technology**

- Data Access
- Data Processing
- Digital Technology



**Process Industry**

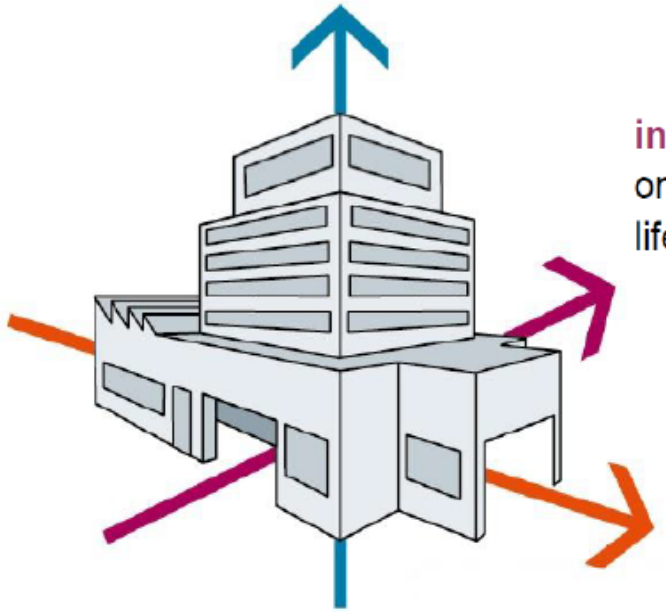
Innovations in Current and future operations

# Industry 4.0: Dimensions

*integration of SAP, MES, PIMS, EMS, MM, WFM, DA etc.*

**vertical integration**
of all relevant business, production and automation processes

*digital engineering, integrated engineering, creation of modular and reusable design data, integration of the plant operators, customer integrated engineering*



**integrated engineering**
on the project planning and the entire life cycle of facilities and equipment

*integration of customers, supply chain, data recording of the whole process*

**horizontal integration**
along the value added networks over production processes



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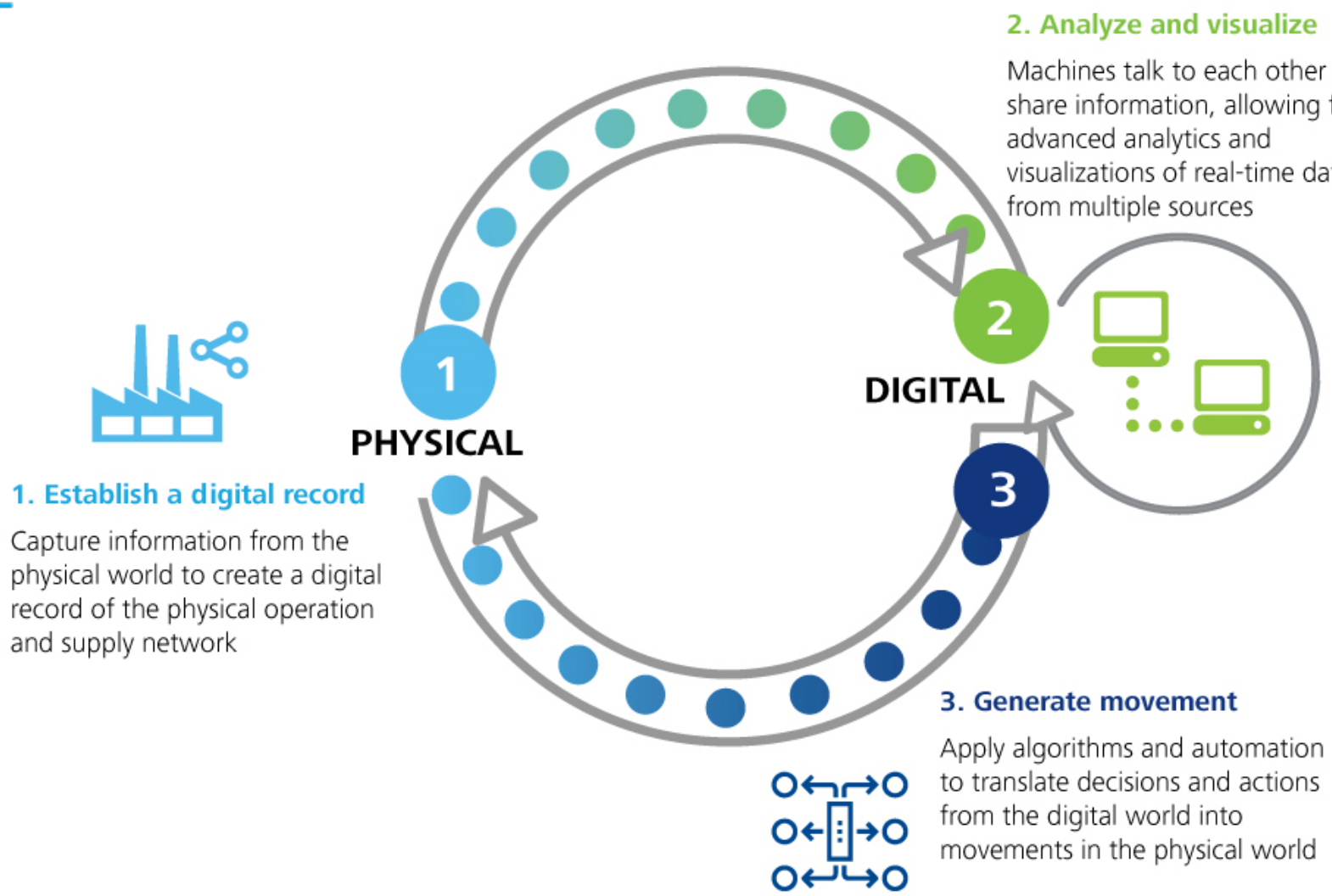
# Physical → Digital → Physical of Industry 4.0?

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# Data and Advanced Analytics for Fuel Efficient Coatings - AkzoNobel

- Analyses of more than 3.5 billion data points to determine the right coating for a specific ship.
- These coatings reduce biofouling, thereby reducing drag and boosting fuel efficiency.




https://www.ucl.ac.uk/bartlett/energy/news/oct/2015/tool-can-predict-impact-fouling-control-coatings-ship-efficiency

# Drones – Increasing efficiency and safety

- Sky-Futures industry drone inspection in the **Gulf of Mexico**. Its examination of a derrick, heli-deck and four cranes on a drill ship was completed in **2 days** rather than the usual **17 days**. Meanwhile, others are aiming for use of drone at oil tankers, liquid natural gas (LNG) carriers and the **Process industrial sector**.

- Drones can have high-definition still, thermal and video camera, Gas **sensors** for monitoring air quality, smoke plumes or traces of gas or vapor, sending images and data to a cloud platform for analysis



http://emag.directindustry.com/article-long/oilgas-inspection-drones-are-taking-off/

# Augmented Reality Eyewear  for Visualizing Information - Air Liquide

- Connected eyewear, integrated into a safety helmet to pass on vital real-time information while keeping the wearer's hands free: feasibility tests at Air Liquide.
- It conveys sounds and images to remote support teams, who can then deliver immediate technical assessments or adjustments. The instructions are passed on visually – and instantly – on the screen of the field worker’s glasses



https://www.airliquide.com/connected-innovation/connect-digital-technology-heart-our-factories.

# “Factory of the Future” - Solvay/Butachimie /Siemens

- Industry platform using integrated software, digitalization guarantees a trouble-free, continuous exchange of data from plant design through installation, operation and modernization to engineering and cloud-based services.
- Continuous data updates mean the plant can use a virtual twin – equivalent to the physical plant in every respect – for the simulation and optimization of commissioning, operation and maintenance.
- Tasks relating to process engineering, electrical planning and automation technology can be performed simultaneously



https://www.siemens.com/customer-magazine/en/home/industry/big-data-opportunities-for-the-chemical-industry/simulation-instead-of-risk.html

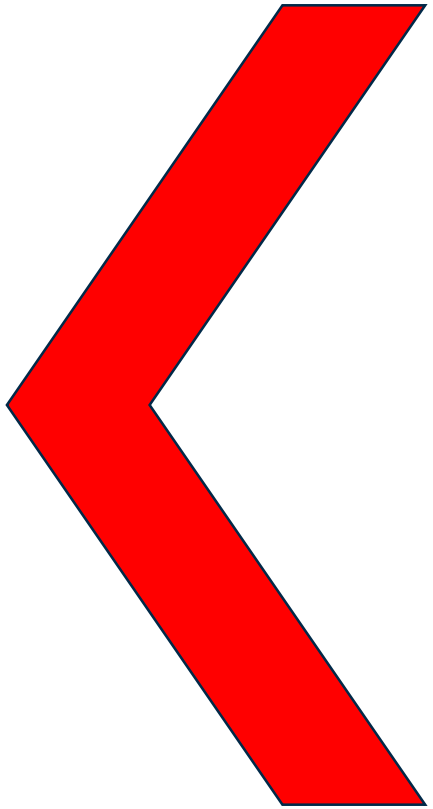
# Digital Twin

- A digital representation of a physical operation that represents the structure and behavior in real life. Allows observation of the behavior and learn from the past and present operations to make predictions about future operations.
- A ***first born digital twin***™, a model created to simulate the plant before it is even built, enables engineers to test a physical asset twin before anything is constructed. This allows for the process, equipment, and operations to be analyzed and optimized for safety, reliability, and profitability.
- Once the first born digital twin is optimized, a company can give birth to the physical asset twin. Once the physical asset is up and running, the connection between the digital twins continues as operations are continuously monitored, adjusted, and optimized based on real-time data.

# Impact of Digitalisation on our mind-set

**Digital technology**

Innovations for the New Digital Process Industry

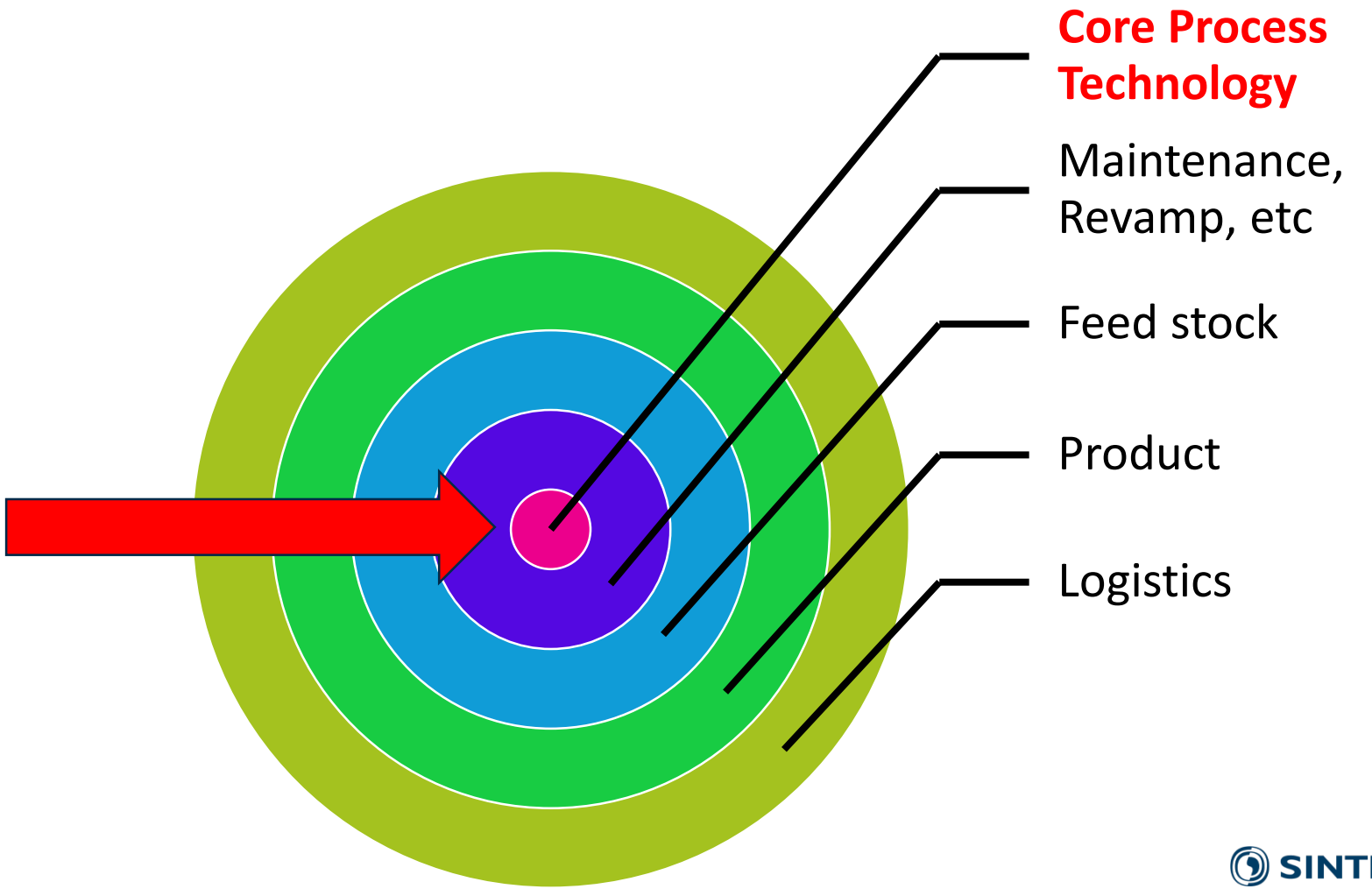


**Process Industry**

- Why does my process look like this?
- How would it look without conventional constraints?

# Impact of technology on core process

Allowing Digital approaches to impact
The core of the Process.



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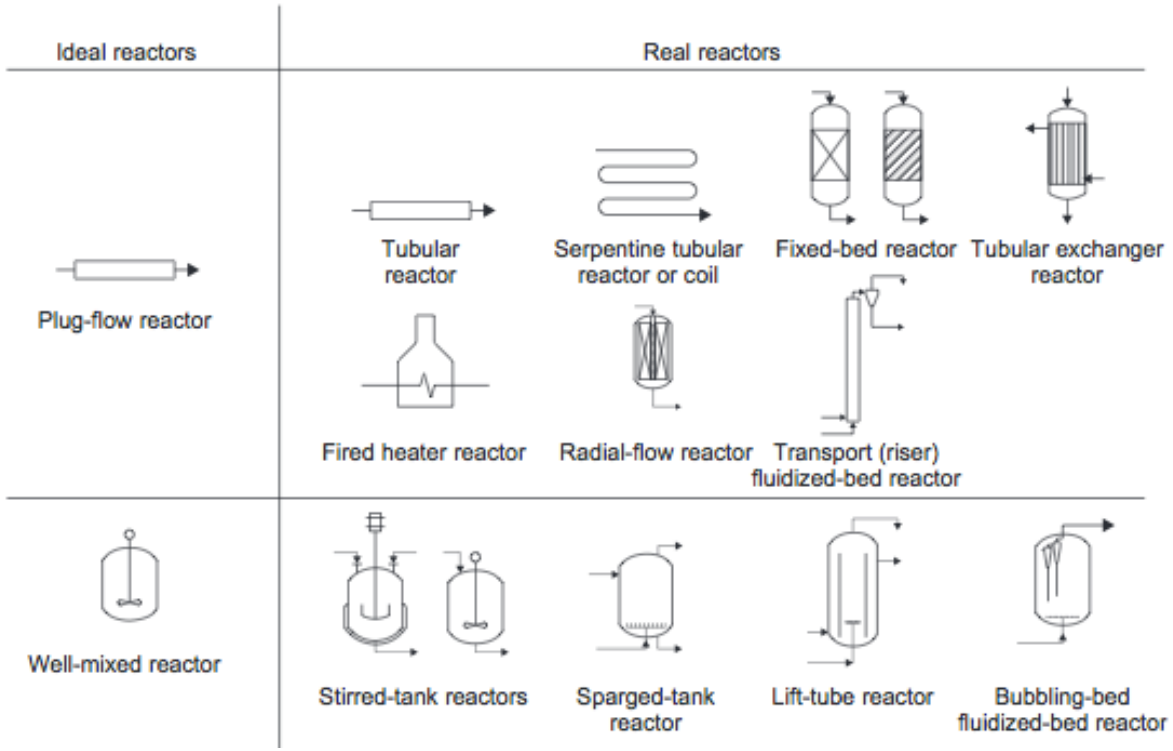
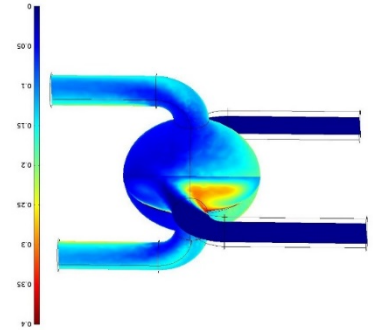
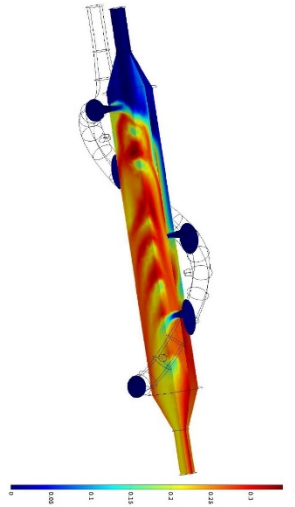
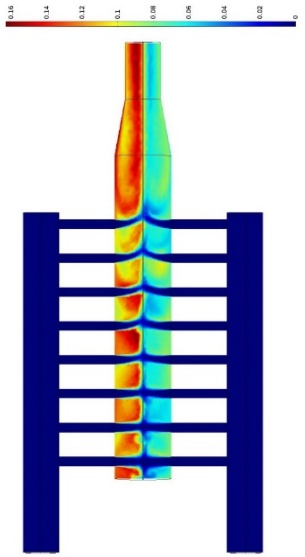
# Chemical Process Industry - From Batch to Continuous







Ideal design of process

Traditional reactor geometries limiting process intensification



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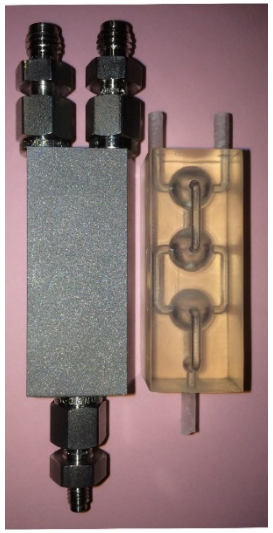
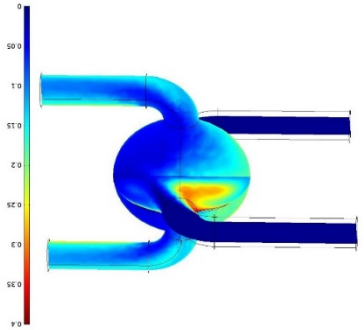
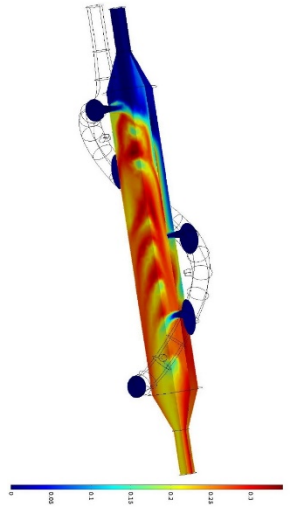
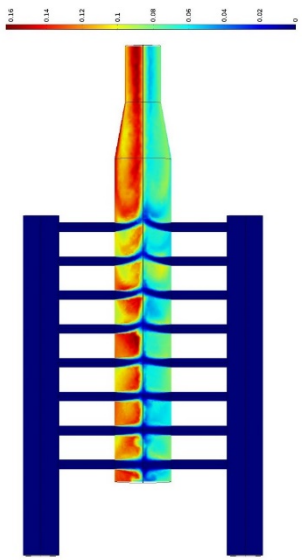
# Chemical Process Industry - From Batch to Continuous









**3D-Printing**

Novel reactor geometries
enabling process intensification

Ideal design
of process



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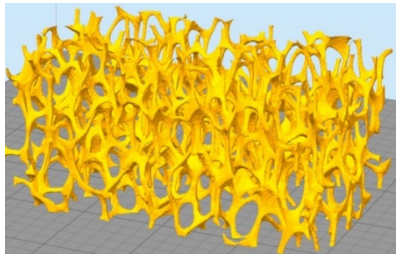
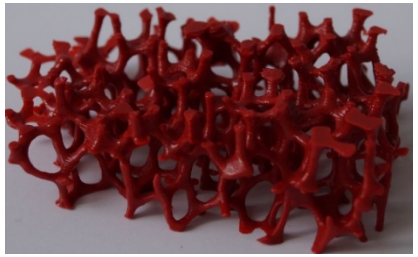
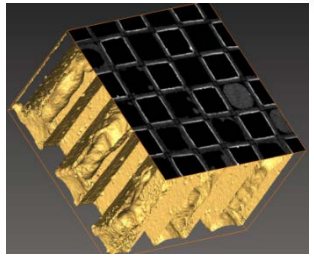
# PRINTCR3DIT: 3D-printing in Process Industries

- Implement a methodology to integrate **3D printing** in the **advanced design**, **modelling** and **manufacture** of structured catalysts and catalytic reactors with significant **cost reductions**, access to **new design strategies** and **faster lead times**.
- Increase the efficiency through **process intensification** with targeted goals to significantly **reduce the energy consumption, increased selectivities** and **longer lifetimes**.



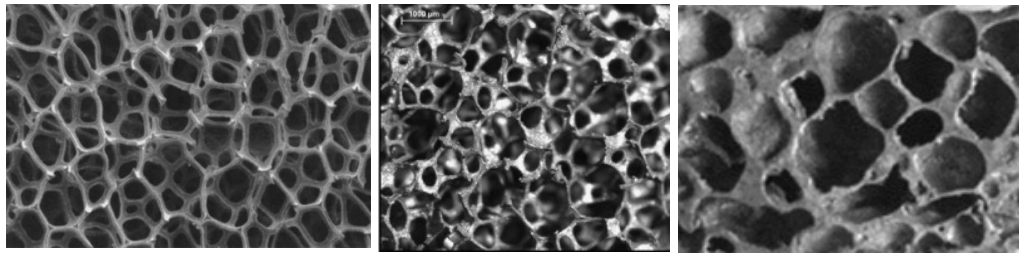


Coordinator: Carlos Grande (carlos.grande@sintef.no)
www.printcr3dit.eu

# Advanced materials structure

Foams/supports made by conventional methods. The structure is irregular, non-reproducible, and hard to optimize.

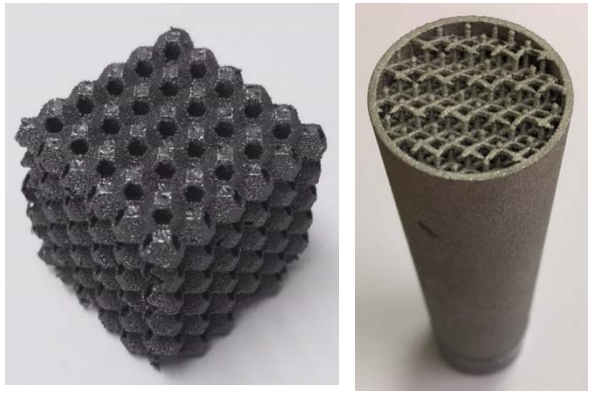
Metal



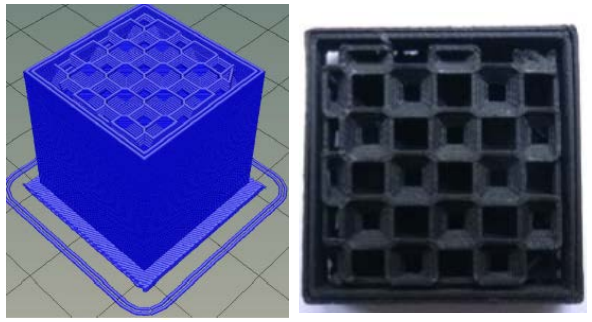
Silicon carbide

Highly regular catalyst supports produced by 3D printing enabling full optimization through computer modelling.

Metal



Silicon carbide





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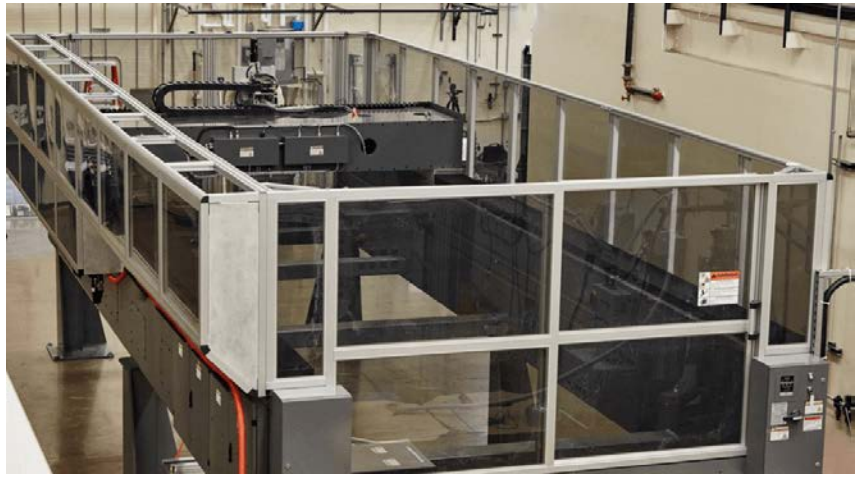
# 3D printing - size not a limiting factor?

European Space agency  is 3D printing a lunar habitat in artificial sandstone using a binder jetting.


Company EFESTO has specialized in large-format metal 3D printing in materials such as steel, stainless steel, Titanium, Inconel and other metal alloys.



Big Area Additive Manufacturing (BAAM) prints whole car frames



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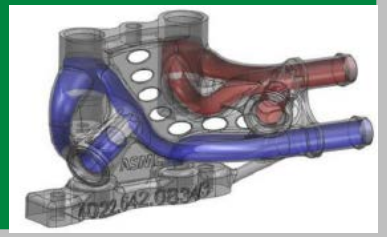
# 3D Printing – Strengths and challenges

## Geometrical freedom

- "Impossible" geometries incl. internal features
- Topology-optimised parts
- Lattice structures
- Integrated functions



## Fast turnaround

- Fast prototypes
- No tooling needed
- Spare parts on demand
- Mass customisation

R&D

## Productivity and cost issues

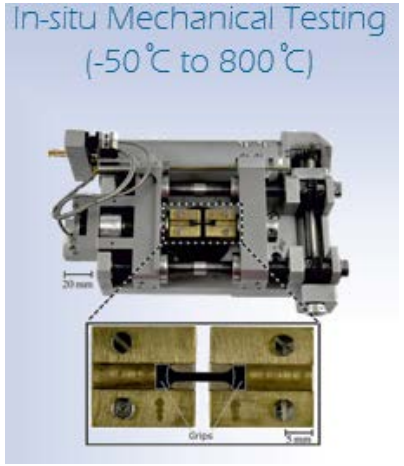
- Long cycle time
- Expensive raw materials
- Need for post-processing incl. manual steps

## Part properties

- Surface finish
- Tolerances
- Mechanical properties
- Repeatability

# *MKRAM+ Project*

- Establish a "materials technology basis" for selected AM materials and processes
- R&D on mechanical performance and material models
- Establish guidelines for achieving optimal properties and reducing part-to-part variation
- Further develop a toolbox for characterising and testing powders and fabricated parts






Forskningsrådet

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SINTEF Raufoss manufacturing

NTNU
Norwegian University of Science and Technology

GKN AEROSPACE

KONGSBERG AUTOMOTIVE

Nammo

AS OMBE Smart

Teeness

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# Flexible, intensified, modular plants

**Characteristics**

- Miniaturized equipment
- Intensified heat & mass transfer
- Possibly modular setup

*Containerized modular plant from F³ Factory project*

**Benefits**

- Product uniformity
- Sustainability
- Fast adaption to market demand
- Innovative products



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http://www.consens-spire.eu/case-study/case-study-1-intensified-synthesis-of-organic-compounds/

# Opportunities for Digital approaches also in Research

| | | |
|---|---|---|
| **Digital R&D** | • Big Data Analytics, machine learning, artificial Intelligence, virtual experimentation<br>• Robotics, autonomous systems | Increased efficiency in R&D |
| | | Increased R&D success rates, time to market |
| | | Easier transition to industrial scale |


Thank you!


Technology for a better society