

Digital Twins in Smart Manufacturing – Training Day 1

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Introduction

Name: Joonas Kortelainen

University: Satakunta University of Applied Sciences

Education: M. Eng (Tech)

Duties: Lecturer, simulation, 3D printing and machine vision

Research focus: Simulations, 3D Printing usability and usability of machine vision in industry



Learning outcomes of the training

- Understand the possibilities of a digital twin
- Start thinking of the factory of tomorrow, before even investing a dime into it
- Gain knowledge on how to identify the potential use cases for a digital twin

Content of the training

- Get to know what a digital twin is
- How is it beneficial
- Who uses it
- How it's done in simplest form (From Virtual to Physical)
- How it's done in simplest form (From Physical to Virtual)

Schedule of the Digital Twins training

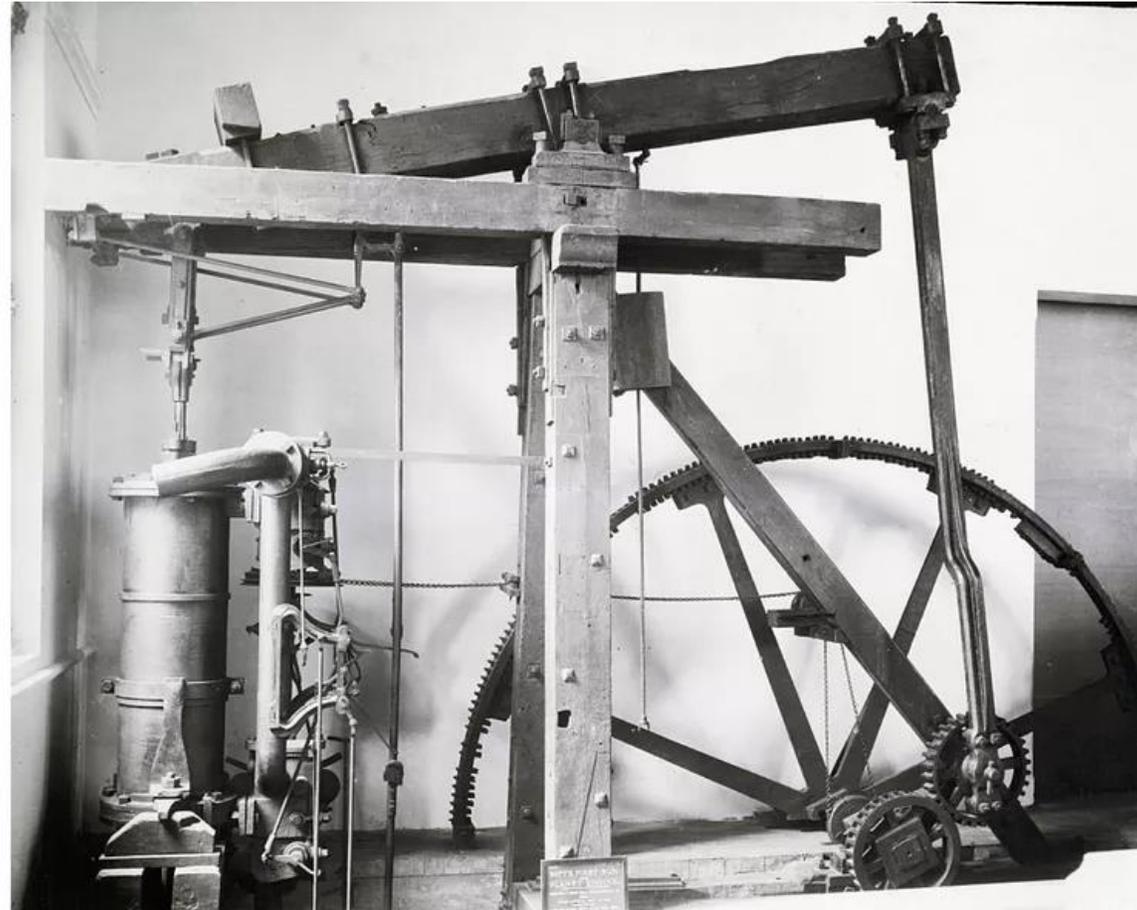
Mon 08.02.2021	Tue 09.02.2021	Wed 10.02.2021	Thu 11.02.2021	Fri 12.02.2021
Webinar: Digital Twins in Smart manufacturing + briefing for assignment 1	Assignment 1 <i>(Inquiry-Based Learning at your own time)</i>	Webinar: Examples of Digital models and Digital shadows + briefing for assignment 2	Assignment 2 <i>(Inquiry-Based Learning at your own time)</i>	Webinar: On-site: How to make a digital model/shadow yourself
Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2	Independent work	Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2	Independent work	Webinar schedule (CET): 14.00-14.55 Part 1 14.55-15.05 Break 15.05-16.00 Part 2

Agenda

- Industrial revolution(s)
- Smart manufacturing
- History
- Different theories of a digital twin
- What is a digital twin in its stages
- Where is it used

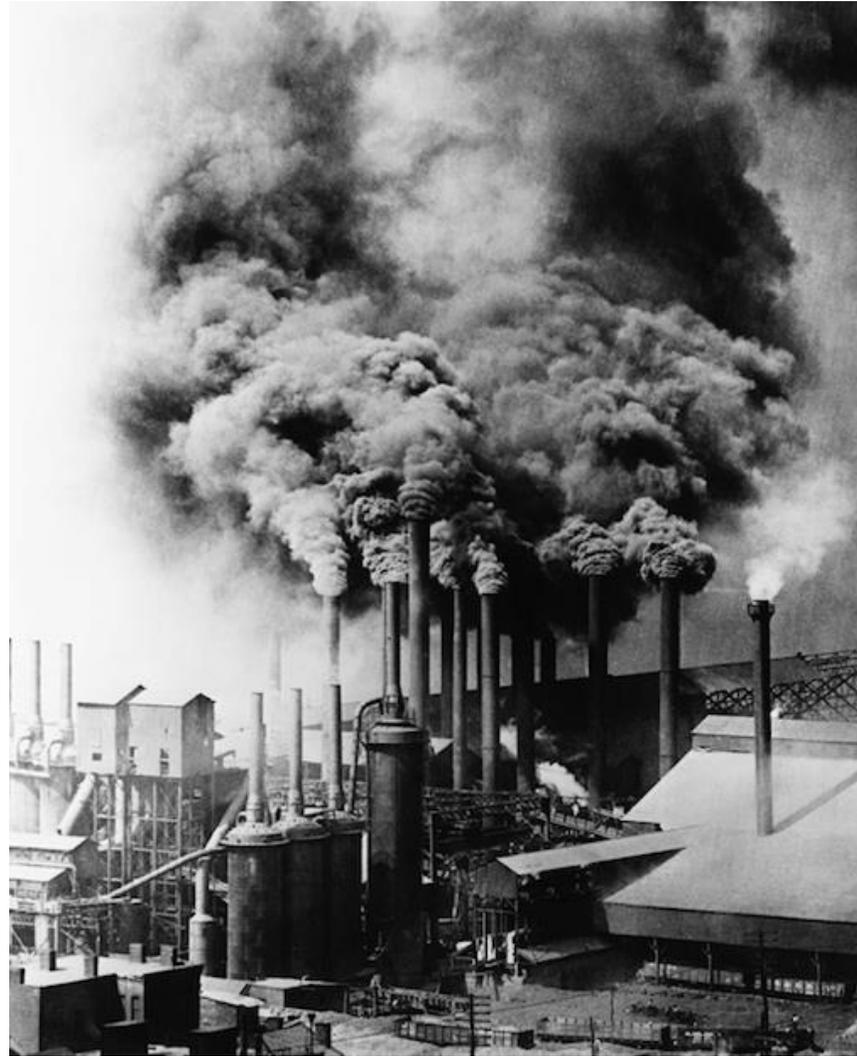
Industrial revolution(s)

First industrial revolution



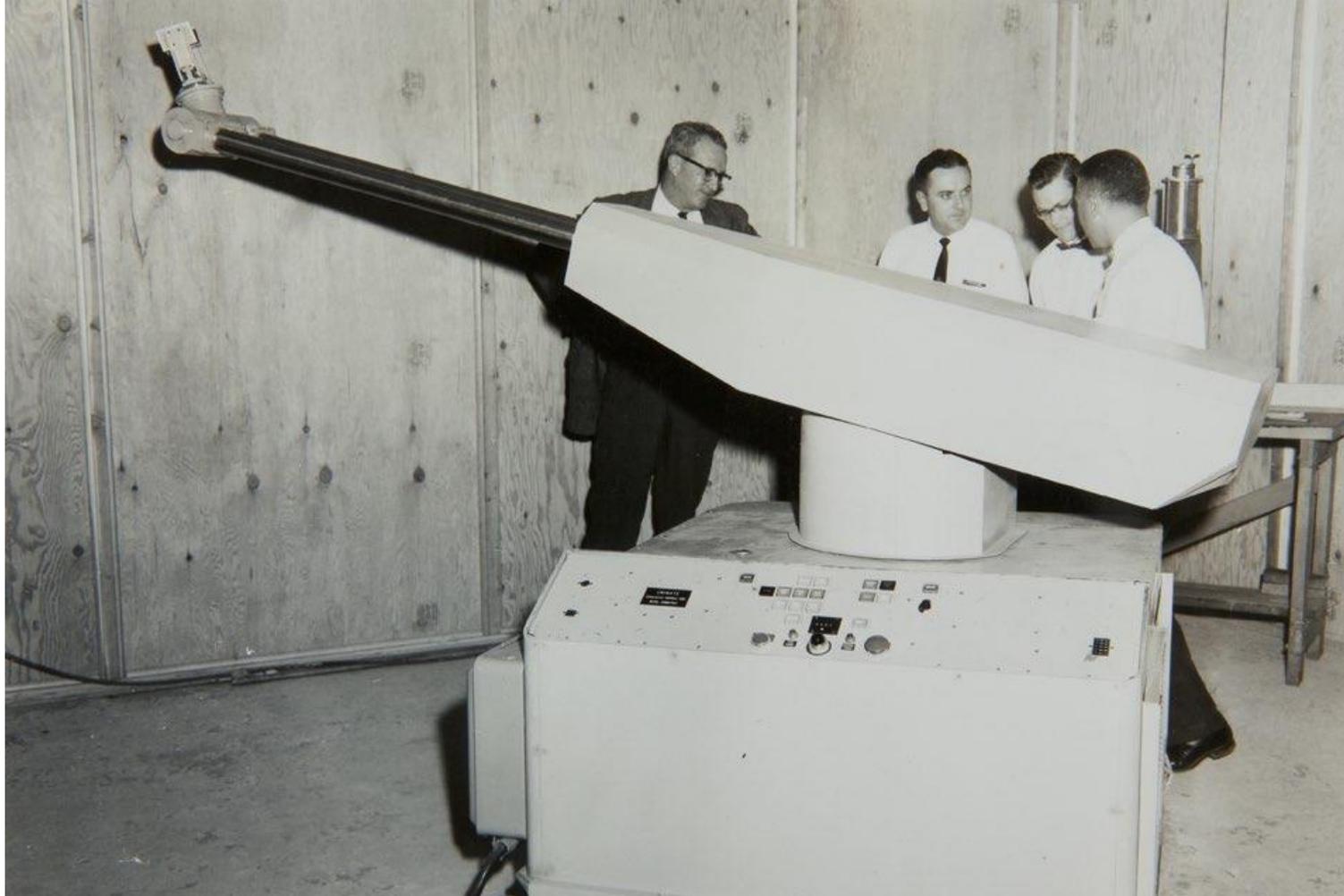
Bettmann/Contributor/Getty Images

Second industrial revolution, Industry 2.0



Bettmann/CORBIS

Industry 3.0



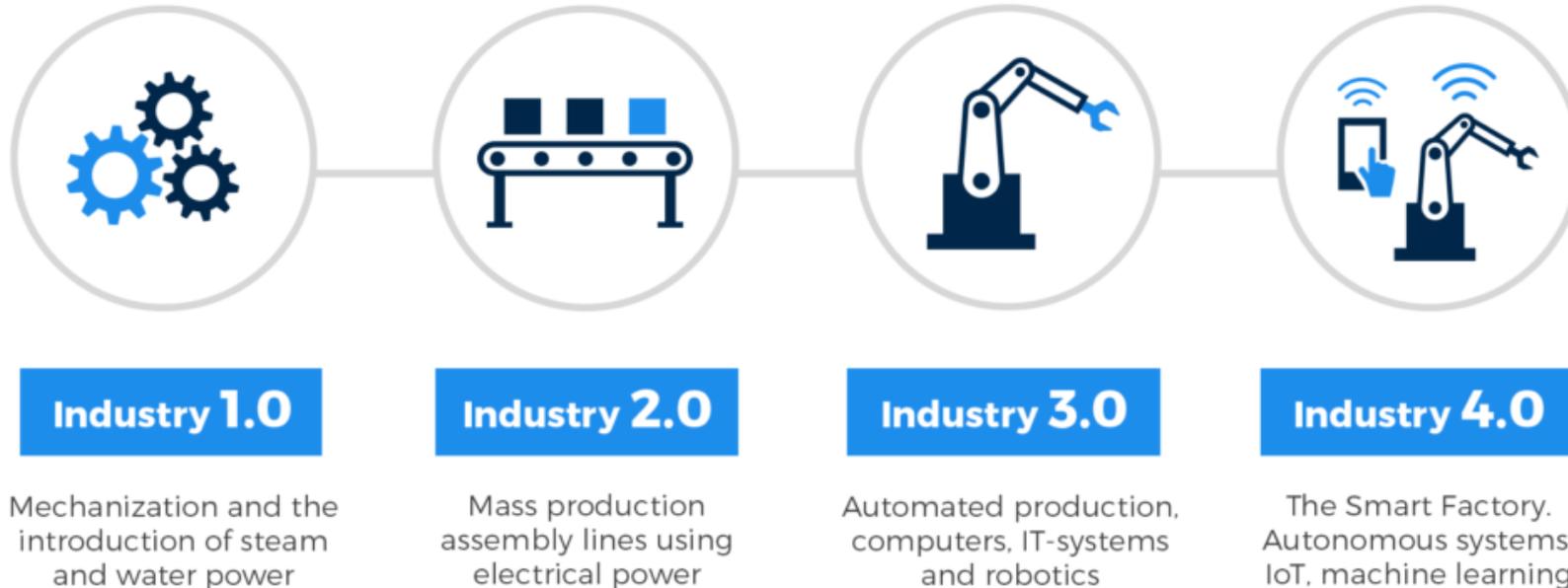
Kawasaki robots

Industry 4.0



Quick recap

The Four Industrial Revolutions



Picture: spectralengines.com

**Where does this all
bring us?**

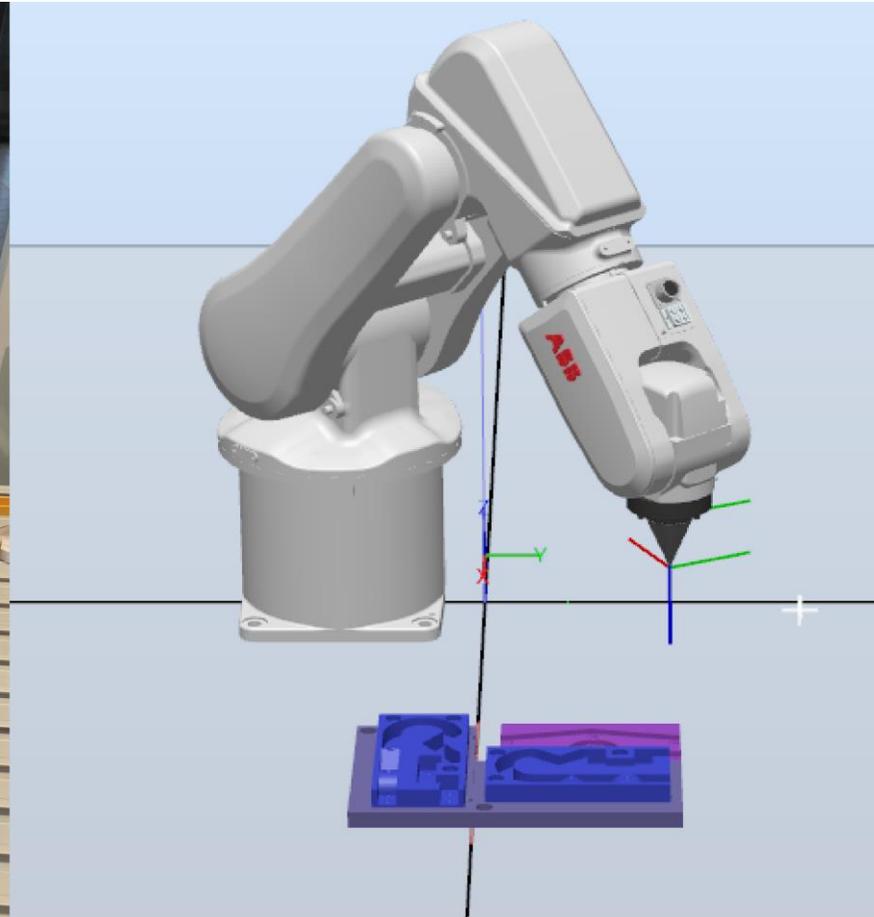
Smart manufacturing

- Using intelligent manufacturing processes connected to their digital twins with a real-time connection
- Digital twin predicting and analysing the processes all the time
- Real-time expert knowledge based support to the processes through digital twin
- Expert knowledge utilizes AI, IoT, Big data analysis and cloud computing in decision making
- Solving the challenges with the help of AI and deep learning

(Evjemo et. al. 2020; Wan 2019)

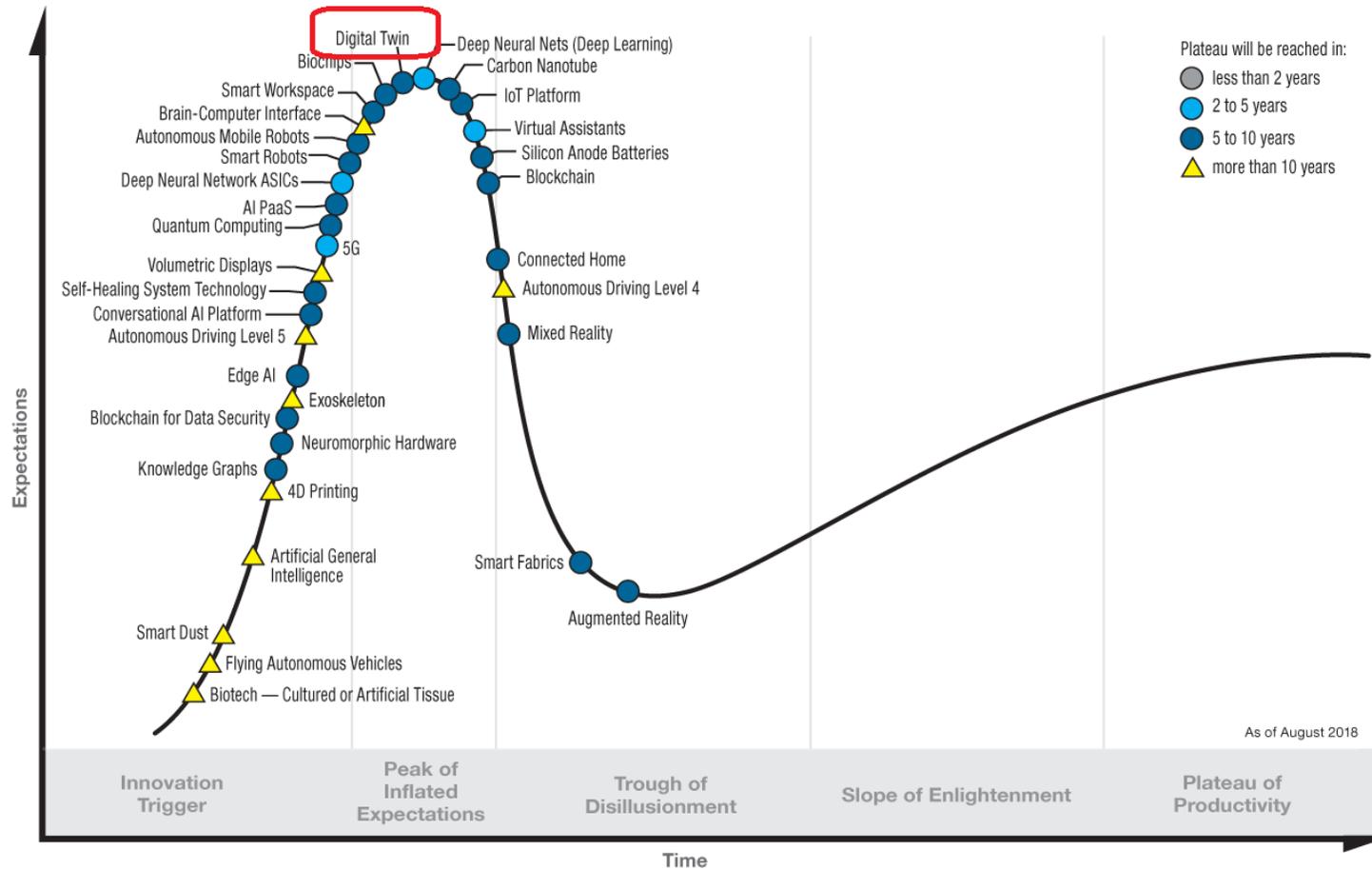


Digital Twin



Hype C

Hype Cycle for Emerging Technologies, 2018



gartner.com/SmarterWithGartner

Source: Gartner (August 2018)
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History

- **NASA thought about it and came up with some type of a concept in 1970s**
- **The first “Digital Twin” concept and idea came in 2002**
 - **Michael Grieves**

History

Conceptual Ideal for PLM

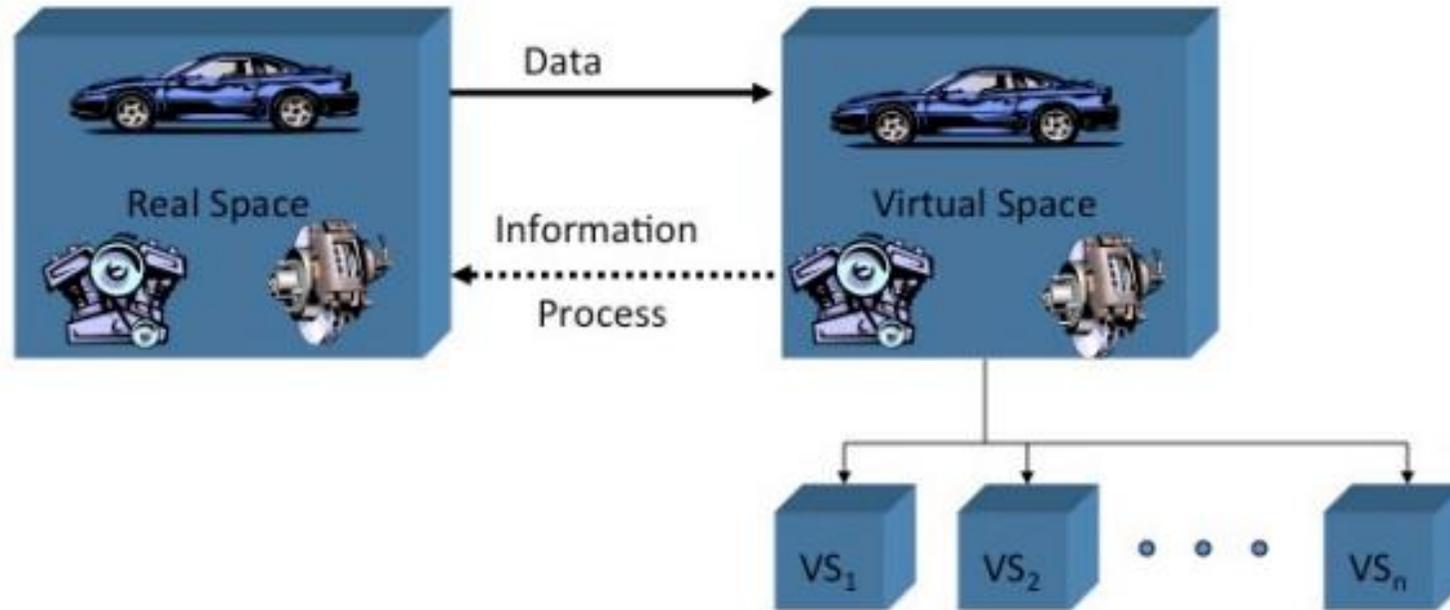


Figure 3

Different theories of a Digital Twin

Different theories or concepts of a Digital Twin

- Original digital twin concept
- NASA's digital twin concept
- 5-dimensional digital twin concept
- Model based digital twin concept

Original Digital Twins theory

- Based on the real space and virtual space
- Data exchange between them
- Can have multiple virtual spaces running simultaneously

Conceptual Ideal for PLM

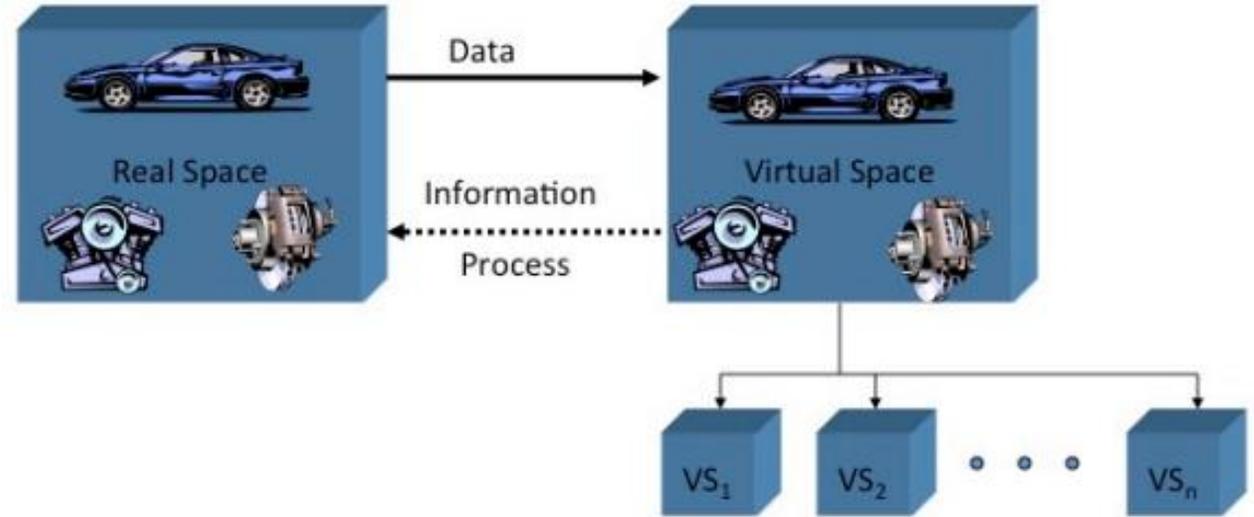


Figure 3

Dr. Michael Grieves, University of Michigan, Lurie Engineering Center, Dec 3, 2001

NASA's digital twin theory

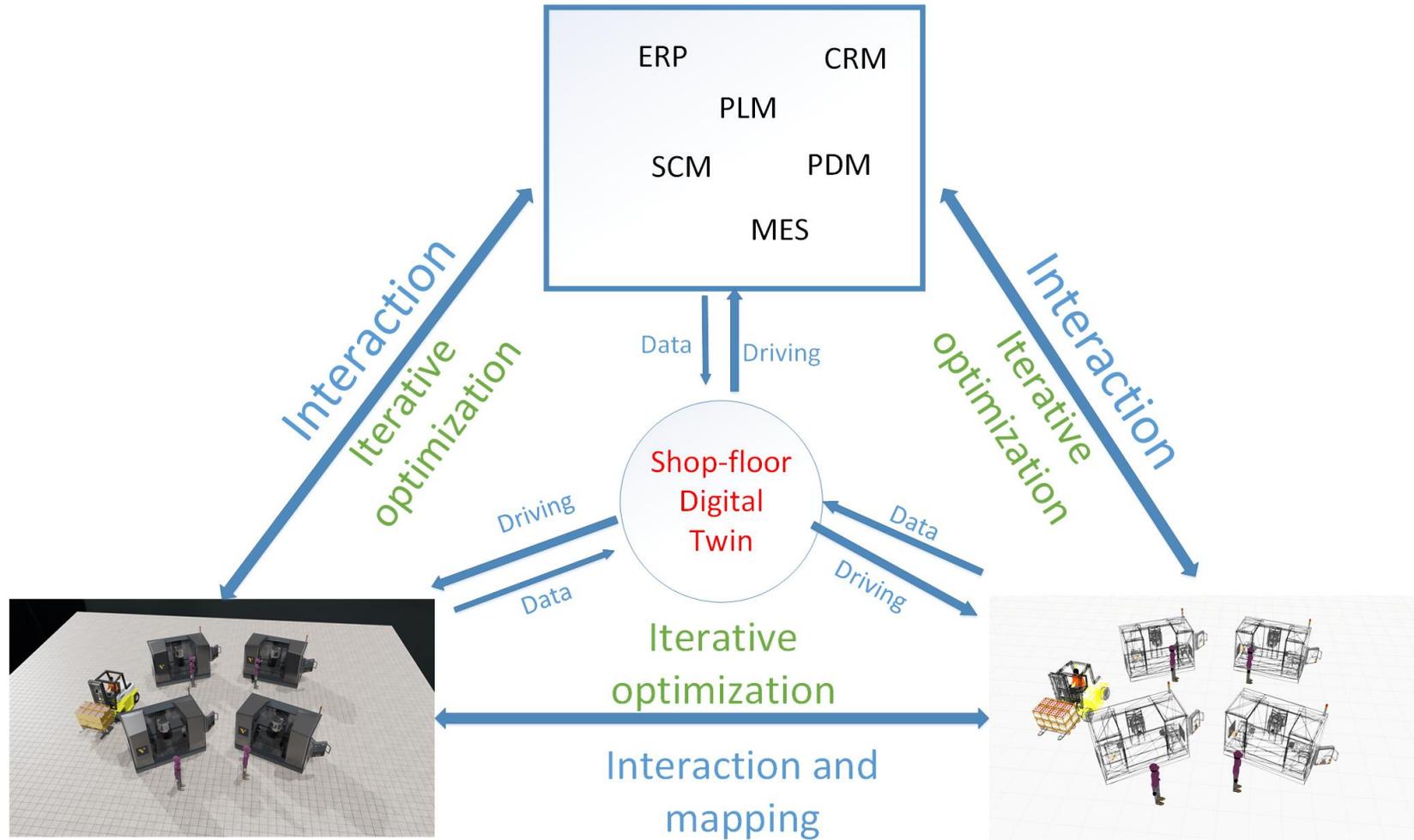
- Same as the first concept, but goes a lot deeper and more specific
- Uses history data



Picture: NASA

5 part digital twin

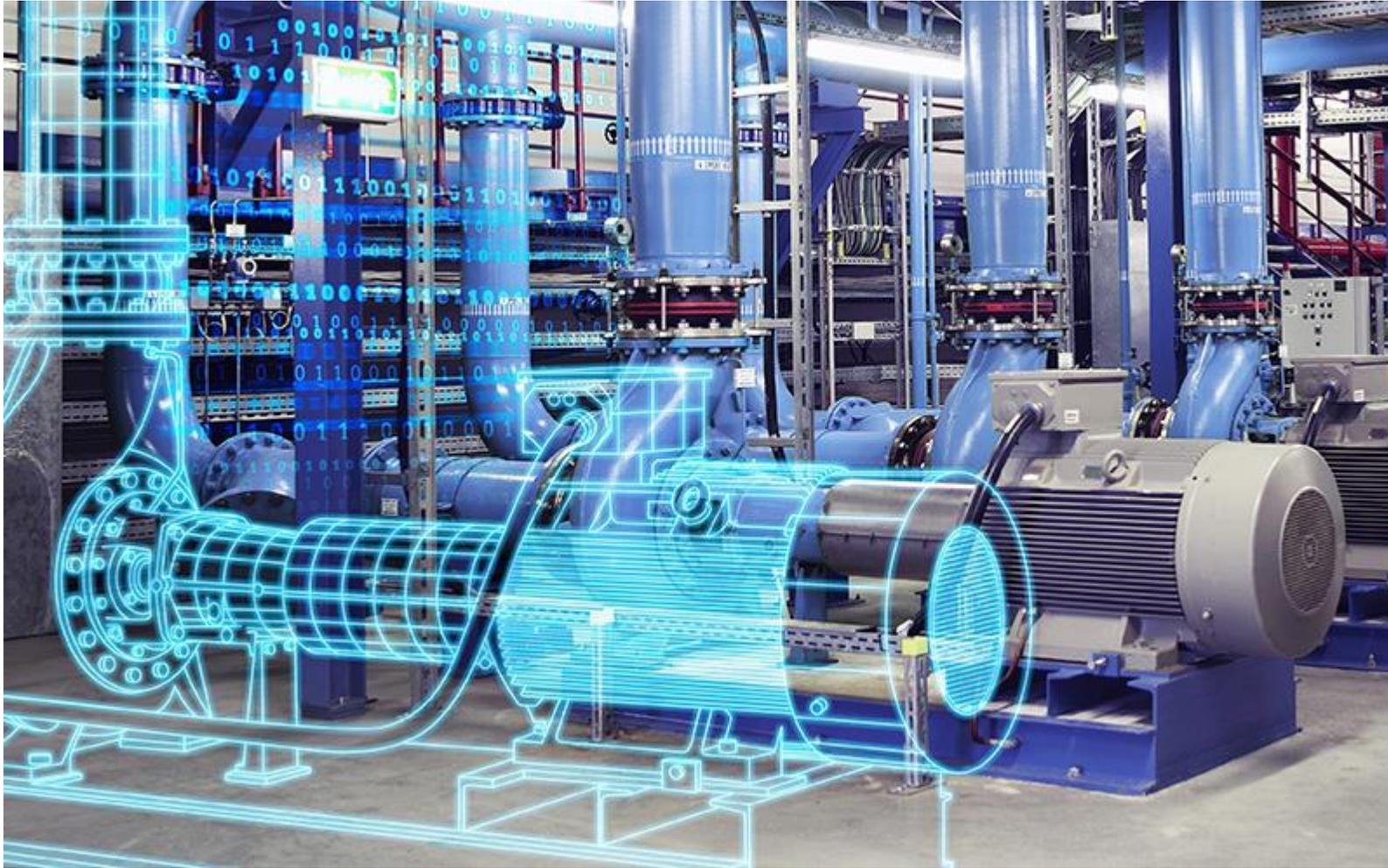
Shop-floor Service System



Physical Shop-floor

Virtual Shop-floor

Model based digital twin



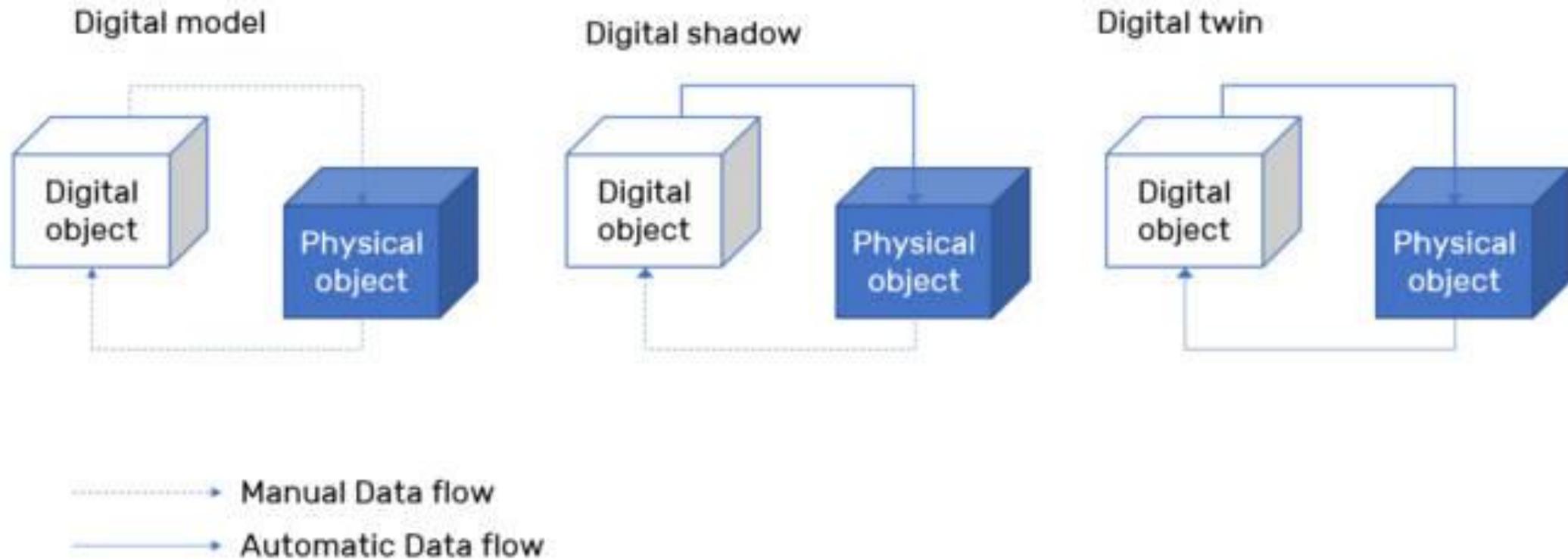
Picture:macs.eu

Theories conclusion

NASA's digital twin	5-dimensional digital twin	Model based digital twin
Product life-cycle analysis and forecasting problems	Taking notice of different systems in digital twin	Inspecting the real-time situation using a 3D model
Testing different scenarios in as realistic as possible digital environment	Real-time viewing of resources	Simulation of production plant management systems for different needs
Real-time probability calculation based on sensors and historical data	Accurate calculation of production capacity	Autonomous problem solving using artificial intelligence and trial-and-error learning

**Digital twin – not
everything is a digital
twin**

Different levels of a digital twin



Kritzinger, W. et al. (2018)

Where can it be used?

- Manufacturing
- Automotive
- Designing
- Utilities
- Products
- Healthcare
- Infrastructure
- Training

Who use it?



Picture: etteplan



Picture: GE



Picture: Siemens

Making your own digital twin in manufacturing

What's required information

- Physical part:
 - Dimensions
 - Sensor data
 - Materials
 - Dynamics
 - Workflow information

Softwares:

- 3D-Modeling software
- Simulation software
- Software for controlling the simulation
- Connection between virtual and physical



Softwares on how to do it “easily” and in simple form in manufacturing

SIEMENS

Ingenuity for life

 **VISUAL
COMPONENTS**

Assignment 1

- Go search on the internet for a digital twin in use.
- Explain it or showcase it in a few sentences, and link to the source.
- Comment two other posts

<https://padlet.com/joonasjohankortelainen/9dnmec47wvzkvgjh>

Link will be in the chat!

Thank you!

Questions?

