SEMINARIESERIEN INDUSTRY 4.0

(BACK TO) THE FUTURE WITH DIGITAL TWINS AND LOW CODE DEVELOPMENT

presented by Alessio Bucaioni

WHO AM I?

- BSc, MSc, PhD in computer science
- Software engineer at Arcticus Systems and IKG Group
- Fitness, espresso, food, photography, music, movies…

WHAT IS A DIGITAL TWIN ?

1. **University of Cincinnati**: "A digital model of the real machine…"
2. **University of British Columbia**: "A living model continually…"
3. **University of Stuttgart**: "A digital representation that …"
4. **Politecnico di Milano**: "A virtual and computerized…"
5. **Chalmers:** "A digital copy of a real factory, machine…"
6. **Beijing Institute of Technology:** "A dynamic model in the…"
7. **The Pennsylvania State University:** "A rigorous validation for…"

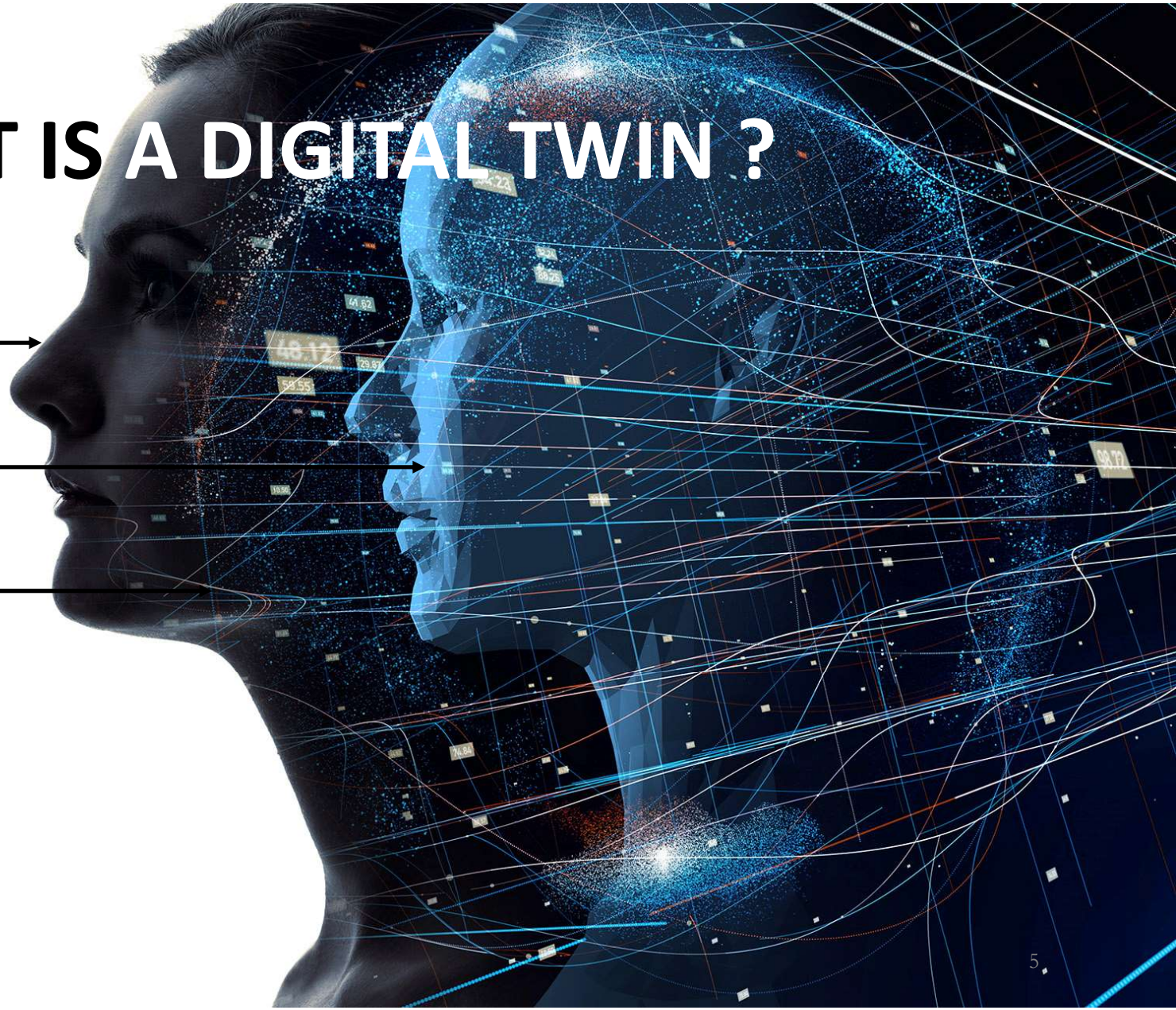
digital

physical

model

real-time

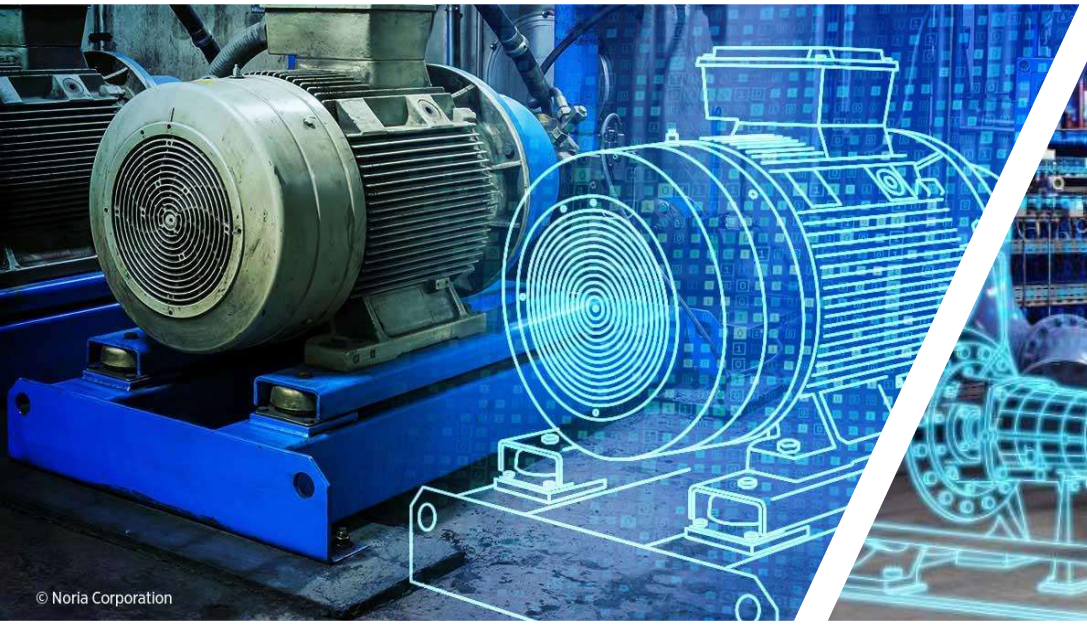
WHAT IS A DIGITAL TWIN ?



Physical entity

Virtual entity

Connections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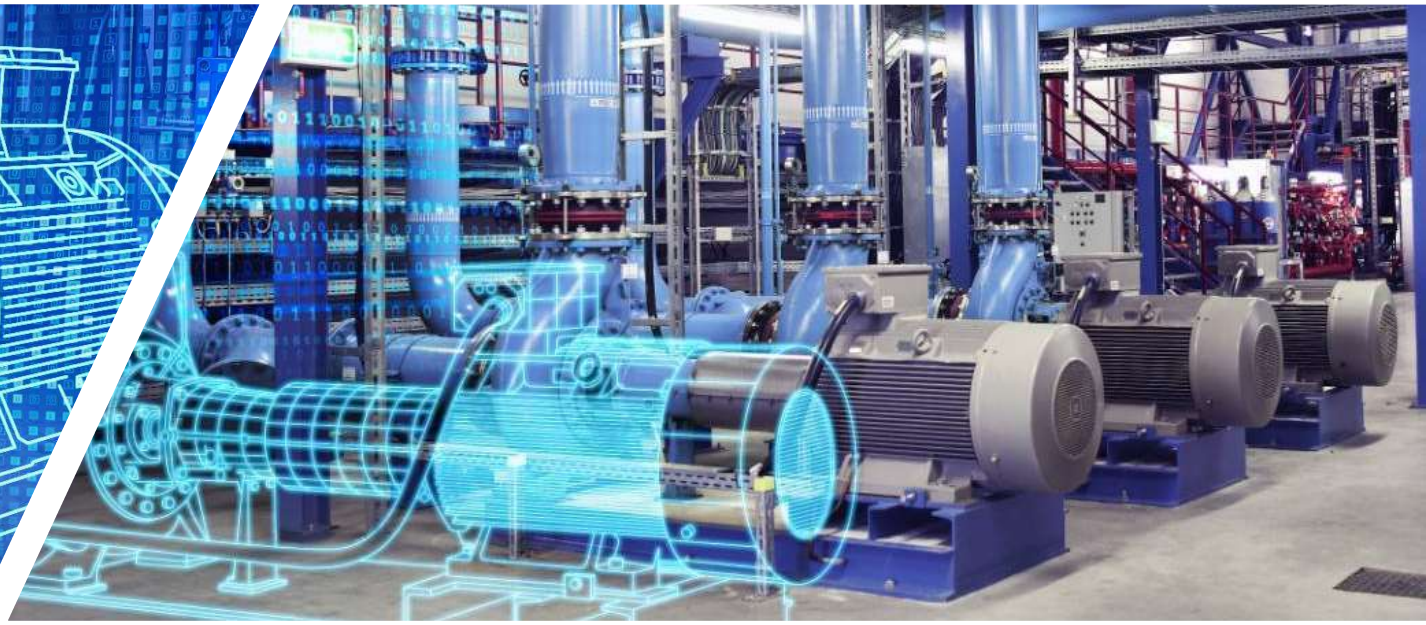
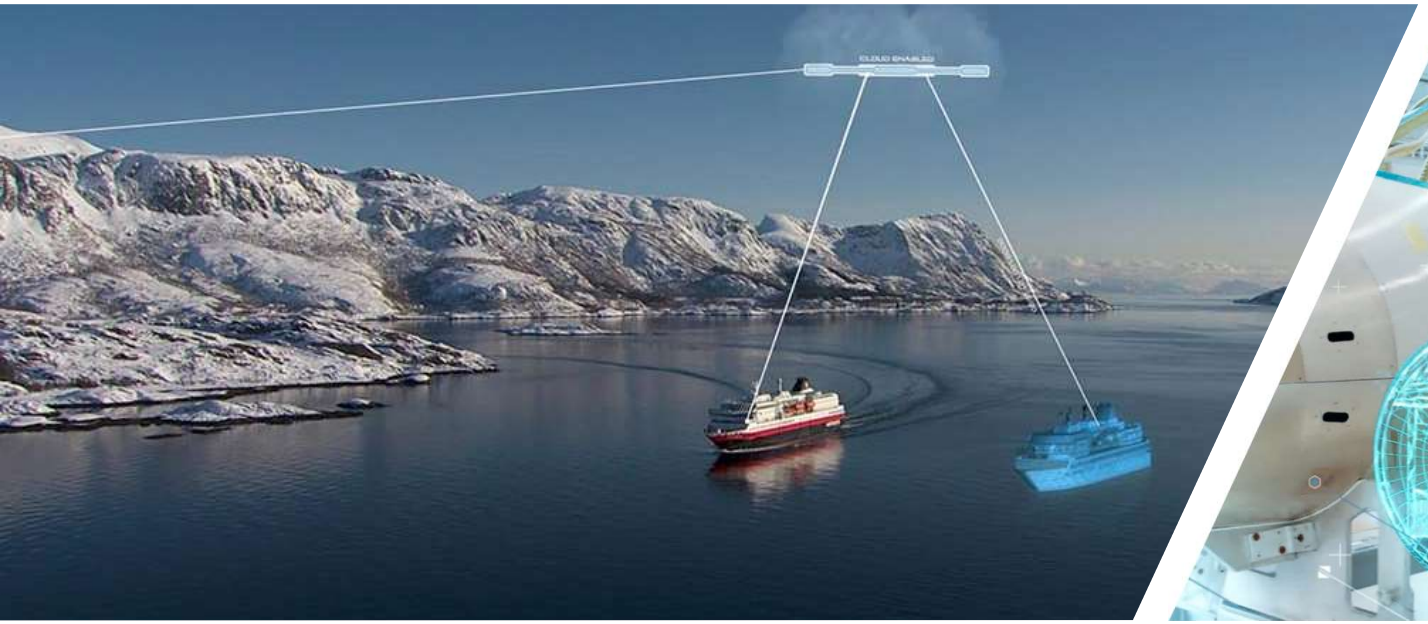




DIGITAL TWIN ADVANTAGES

Increased monitoring

Reducing Time to Market

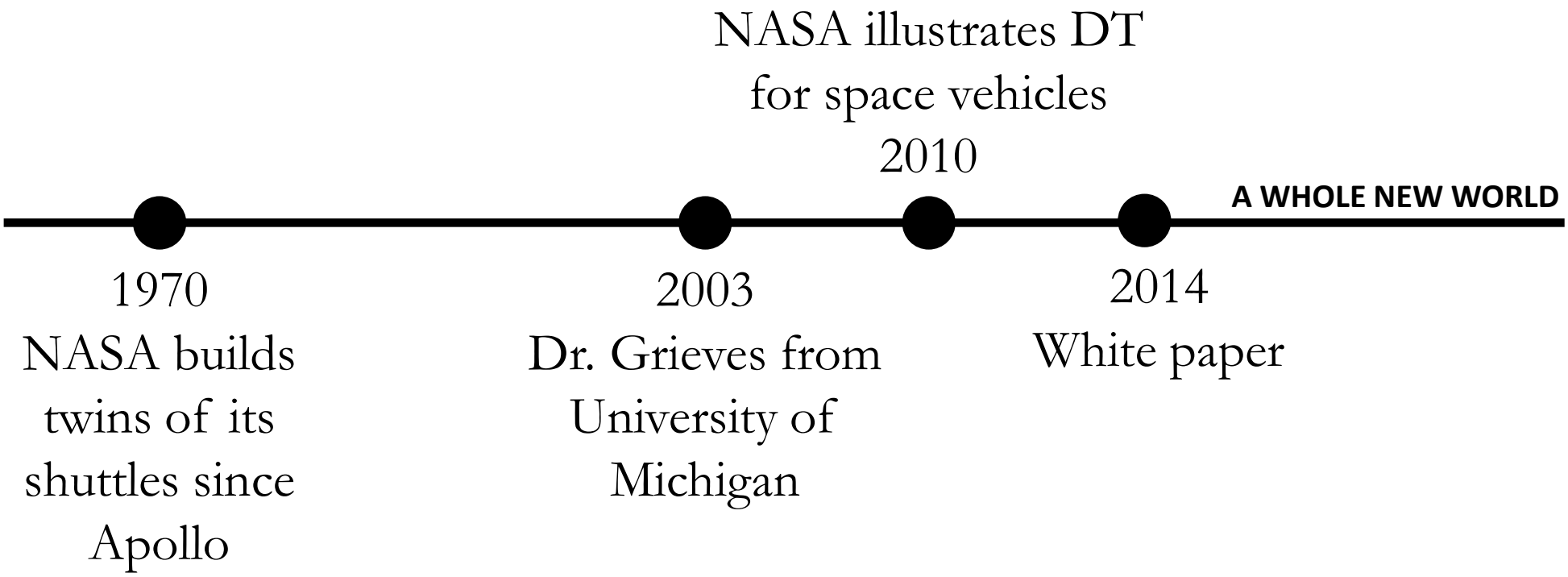
Keeping Optimal Operation

Reducing Energy Consumption

Reducing Maintenance Cost

Increasing User Engagement

BACK TO THE FUTURE



CYBER-PHISICAL SYSTEM

vs DIGITAL TWIN

DIGITAL TWIN: SO WHAT?

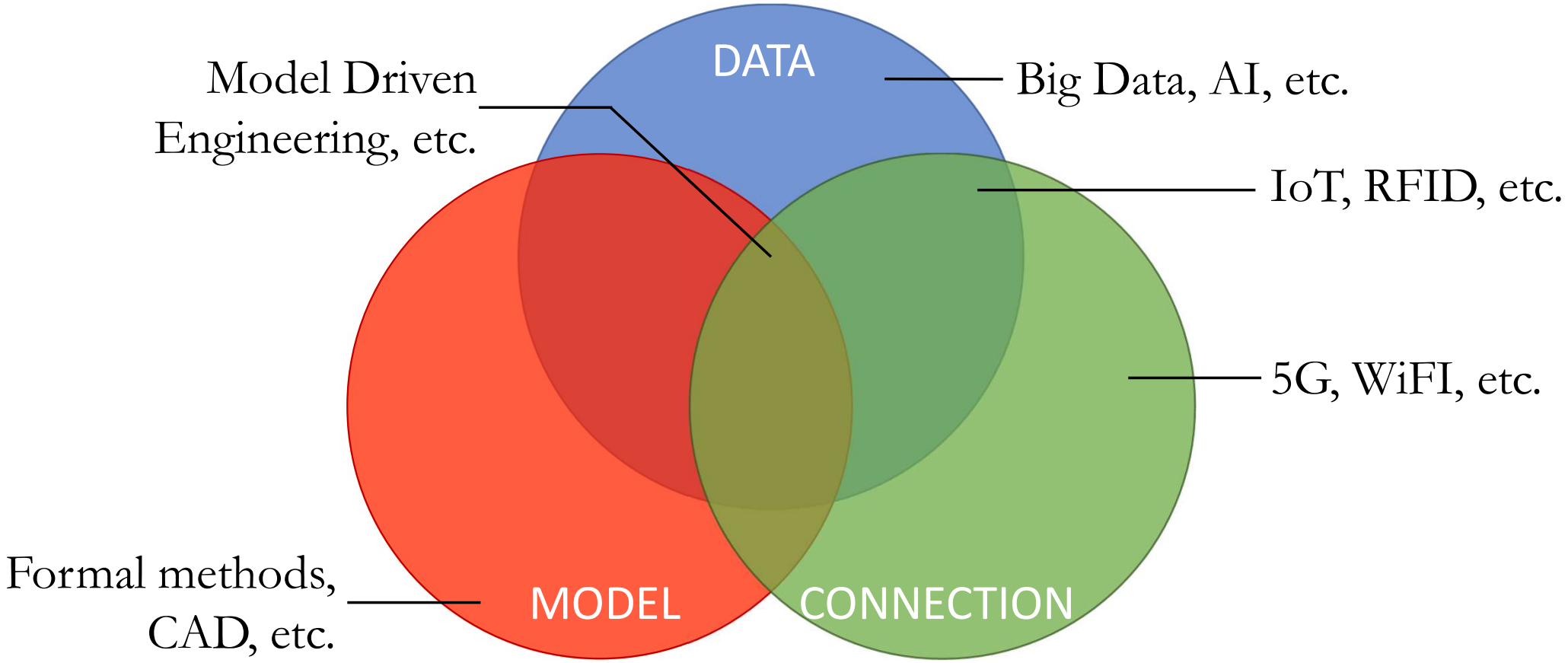
Data

Model

Connection

ABC
1+2=3
A
C
A
B

DIGITAL TWIN TECHNOLOGIES



MODEL DRIVEN ENGINEERING

2000

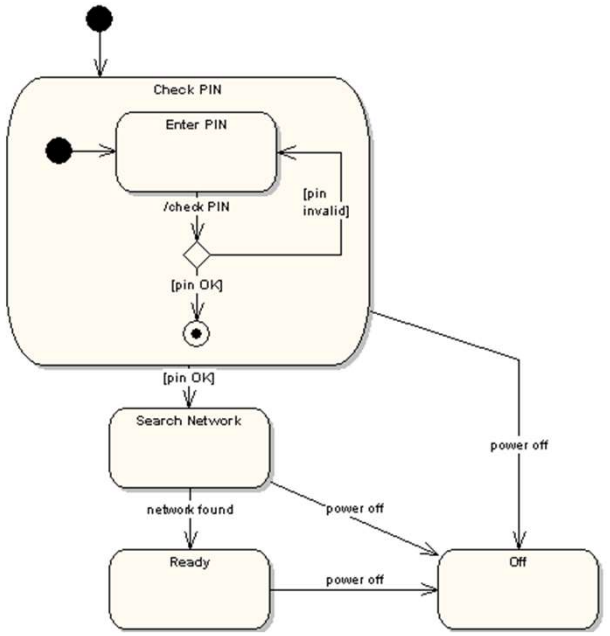
Baker, Loyd, et al. *"Foundational concepts for model driven system design."*

MODEL DRIVEN ENGINEERING

```
10111001 00000000
11010010 10100001
00000100 00000000
10001001 00000000
00001110 10001011
00000000 00011110
00000000 00000010
10111001 00000000
11100001 00000011
00010000 11000011
10001001 10100011
00001110 00000100
00000010 00000000
```

```
MOV CX,1234
MOV DS:[0],CX

MOV CX,4321
MOV DS:[2],CX

MOV AX,DS:[0]
MOV BX,DS:[2]

ADD AX,BX

MOV DS:[4],AX
```

```
public Heap unRemoveMax(int i)
{
Finds the last node w/o right child
    int p = (N + 1)/2;
Checks if it can become the parent of i
    if (heap[p] < heap[i]) return null;
Demotes all ancestors of j and
makes the former leaf j the root of the
    N++;
    heap[N] = PullDown(1,i);
    heap[1] = N;
Done!
    return this;
}
```



Machine code

Models

MODEL DRIVEN ENGINEERING

```
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Done!
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}
```
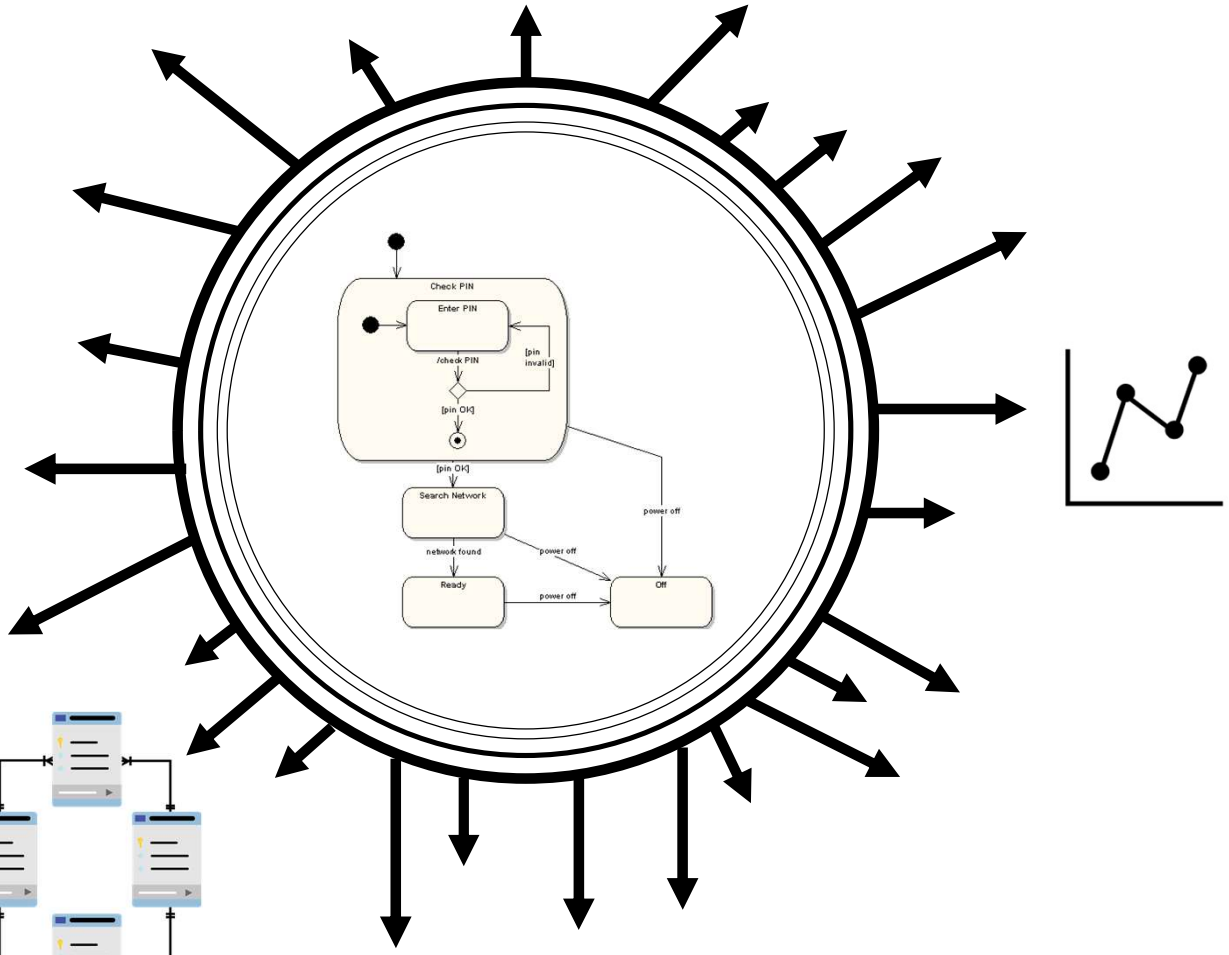
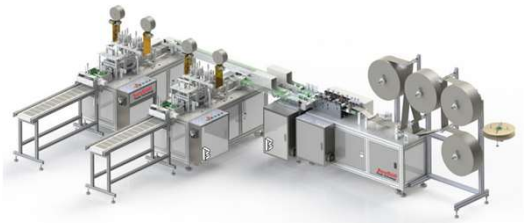
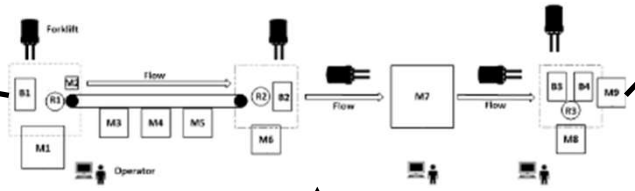
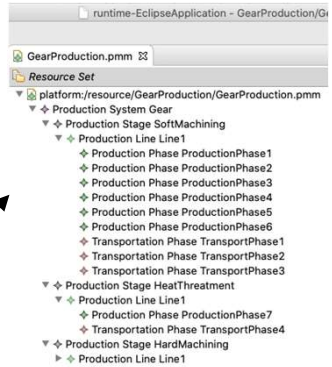
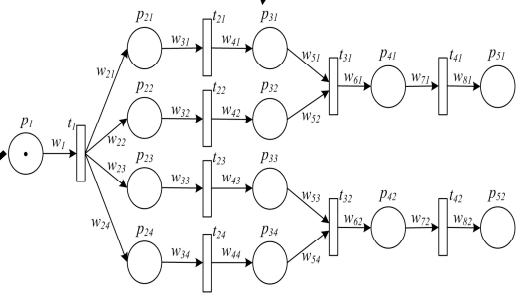



MODEL DRIVEN (DIGITAL TWIN) EXAMPLE









WHAT IS LOW CODE DEVELOPMENT ?

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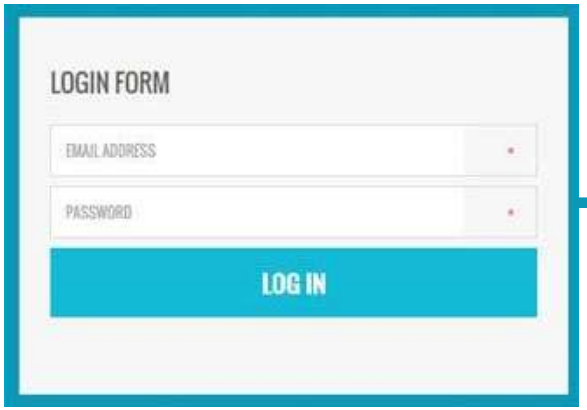
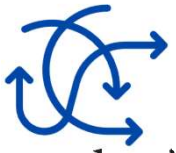



```
<form action="action_page.php">
  <div class="imgcontainer">
    <img src="img_avatar2.png" alt="Avatar" class="avatar">
  </div>

  <div class="container">
    <label><b>Username</b></label>
    <input type="text" placeholder="Enter Username" name="uname" required>

    <label><b>Password</b></label>
    <input type="password" placeholder="Enter Password" name="psw" required>

    <button type="submit">Login</button>
    <input type="checkbox" checked="checked"> Remember me
  </div>

  <div class="container" style="background-color:#f1f1f1">
    <button type="button" class="cancelbtn">Cancel</button>
    <span class="psw">Forgot <a href="#">password?</a></span>
  </div>
</form>
```

LOW CODE DEVELOPMENT ADVANTAGES

Rapidity

Privacy



Complexity reduction

Easier maintenance

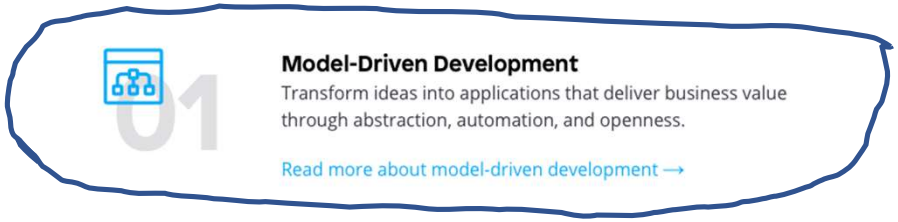
Cost reduction

Involvement of business profiles

LOW CODE DEVELOPMENT MANIFESTO

The 9 Essential Principles

Mendix is at the forefront of philosophical thought on low-code, setting the standards by which low-code platforms should be judged. The less we push ourselves into this, the greater value it will have for all our audiences — prospects, customers, the media, potential employees.



01

Model-Driven Development

Transform ideas into applications that deliver business value through abstraction, automation, and openness.

Read more about model-driven development →

02

Collaboration

Leverage a shared visual language to support the interchange of knowledge and ideas between business domain experts and developers.

Read more about collaboration →

03

Agility

Manage the full enterprise application development lifecycle with agile workstreams to eliminate bottlenecks, support iterative delivery and achieve shortest time-to-value.

Read more about agility →

BACK TO THE FUTURE

2000

Baker, Loyd, et al. *"Foundational concepts for model driven system design."*

WHAT MAKES A MODEL ?

PUTTING THE PIECES TOGETHER

PUTTING THE PIECES TOGETHER

- Models can help you in formalising your knowledge, systems and processes.
- You can manipulate (create, modify, delete) models automatically using software programs.
- Models can be used for realising and running (part of) your digital twin.
- Models can be used for realising (part of) your production system and process.

SO WHAT DO
WE DO NOW?
memegenerator.net

WE MAKE IT HAPPEN

You don't need to be great for starting, but you need to start for being great.

- Zig Ziglar

EXAMPLE OF RESEARCH PROJECTS

Alessio Bucaioni, *Assistant Professor*

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Divisions: ↘ Division of Computer Science and Software Engineering
↘ Division of Product Realisation
Research groups: ↘ Industrial Software Engineering
↘ Model-Based Engineering of Embedded Systems
↘ Product and Production Development
Web: ↘ Linkedin page

Biography | Research | Publications | Projects | PhD students | MSc theses

Project Title	Status
Automation in High-performance Cyber Physical Systems Development	active
DPAC - Dependable Platforms for Autonomous systems and Control	active
Modeling and Analyzing Event-based Autonomous Systems	active
PANORAMA - Boosting Design Efficiency for Heterogeneous³ Systems	active
Femmva - Functional- and execution-models in modern electronic vehicle architectures	finished
MBAT - Combined Model-based Analysis and Testing (Artemis/Vinnova)	finished
PreView: Developing Predictable Vehicle Software on Multi-core	finished
SynthSoft - Synthesizing Predictable Software for Distributed Embedded Systems	finished

UPCOMING SEMINARS*

- **A strategic view on the development and use of automation**, *Anna Granlund,* February 19
- **How to increase performance by focusing on the utilization of shared demand-related information**, *Paulina Myrelid,* March 26
- May 7 & June 4

*more information mdh.se/kalender/2020/maj/seminarieserien-industry-4.0

PRODUCTION ENGINEERING COURSES*

- **Industry 4.0 – Introduction,** from 2021-03-29 to 2021-06-06
- **Industry 4.0 – Realisation,** from 2021-03-29 to 2021-06-06
- **Industrialisation and Time-to-volume,** from 2021-03-29 to 2021-06-06

*more information mdh.se/premium

PRODUCTION ENGINEERING COURSES*

- **Industry 4.0 – In** 6-06
- **Industry 4.0 – R** 06
- **Industrialisatio** 29 to 2021-06-06

HURRY UP!

YOU CAN STILL APPLY

*more information mdh.se/premium

DO YOU HAVE QUESTIONS?

"Most misunderstandings in the world could be avoided if people would simply take the time to ask, "What else could this mean?"

— Shannon L. Alder

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