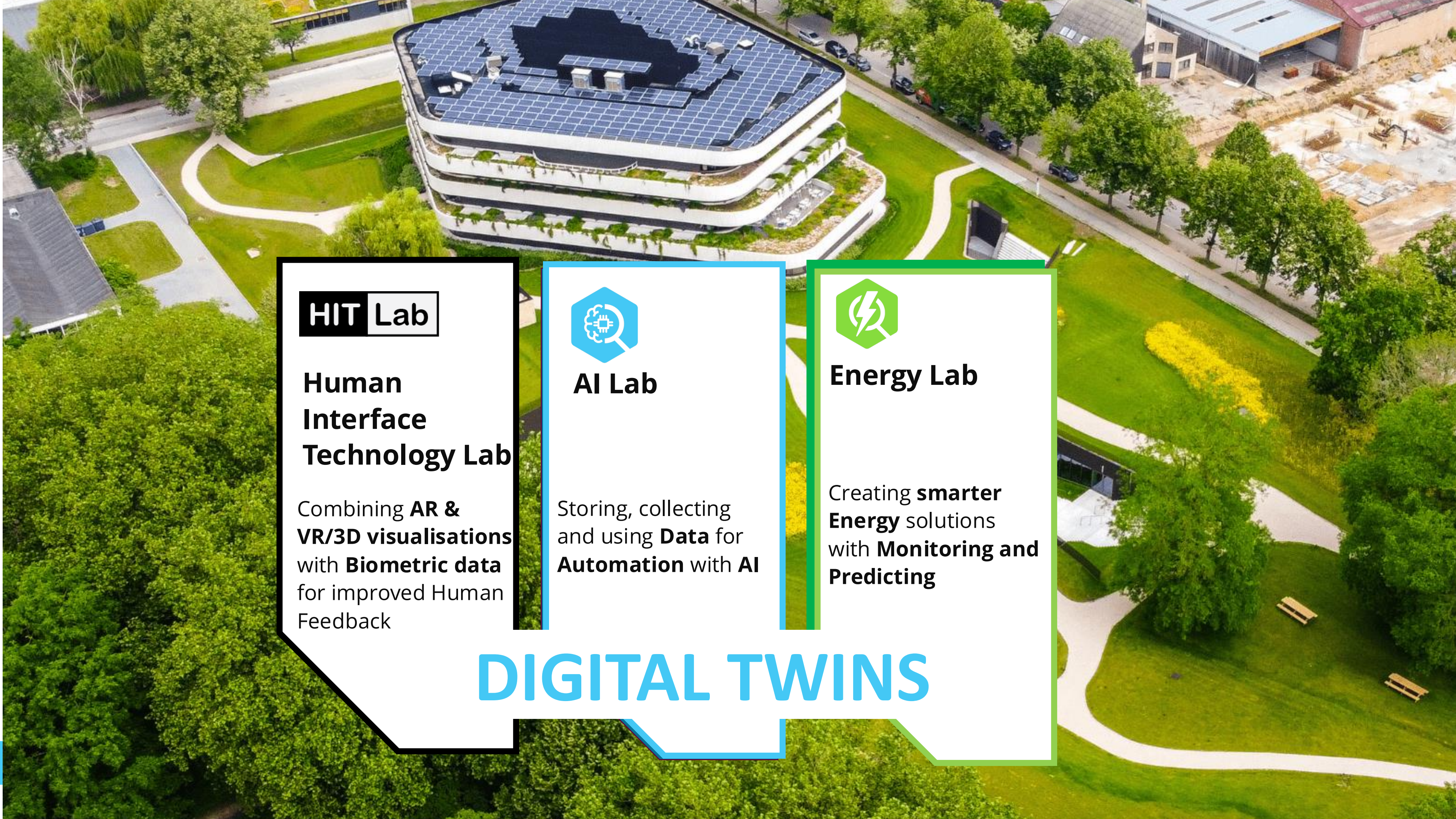


Introduction to Digital Twins

A practical decision-support tool
across the full lifecycle of systems.

Dr. Charlotte Larmuseau
Smart Technology Research coordinator



HIT Lab

Human Interface Technology Lab

Combining **AR & VR/3D visualisations** with **Biometric data** for improved Human Feedback



AI Lab

Storing, collecting and using **Data** for **Automation** with **AI**



Energy Lab

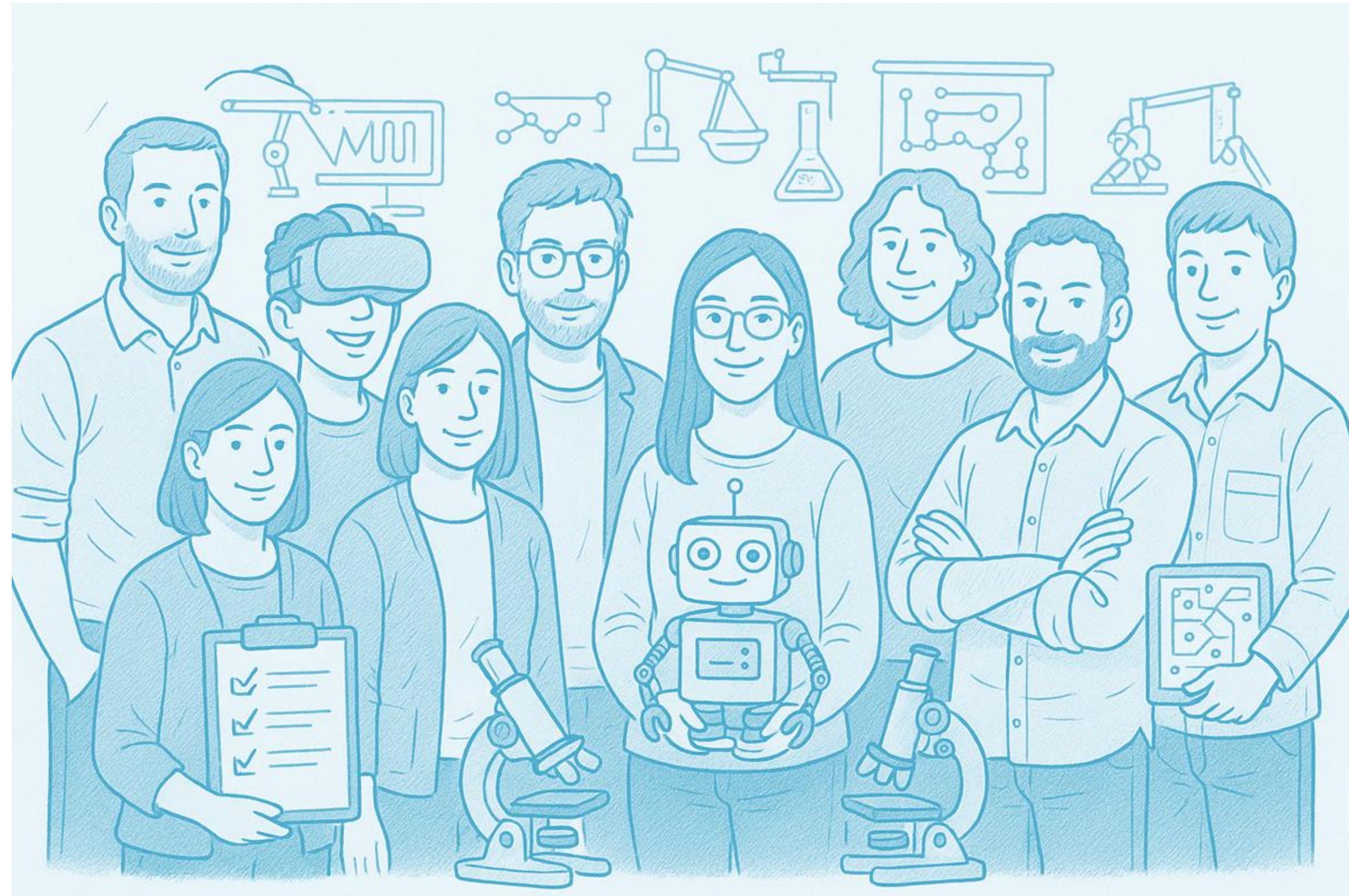
Creating **smarter Energy** solutions with **Monitoring and Predicting**

DIGITAL TWINS

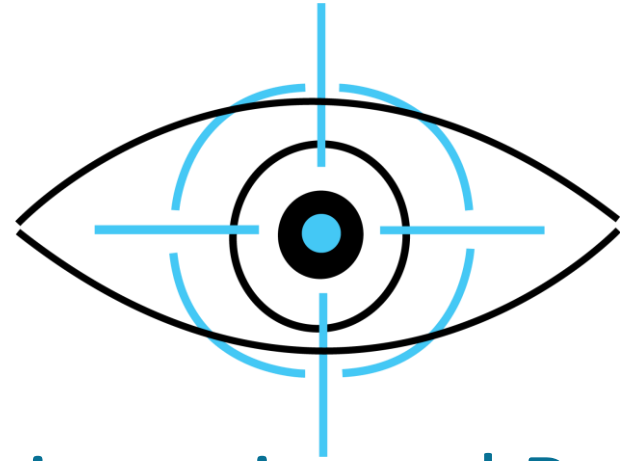
Smart Technology Lab – Who are we?

Interdisciplinarity at its best!

AI Engineers
XR Developers
3D Artists
Experimental Psychologists
Industrial Engineers
Computer Scientists

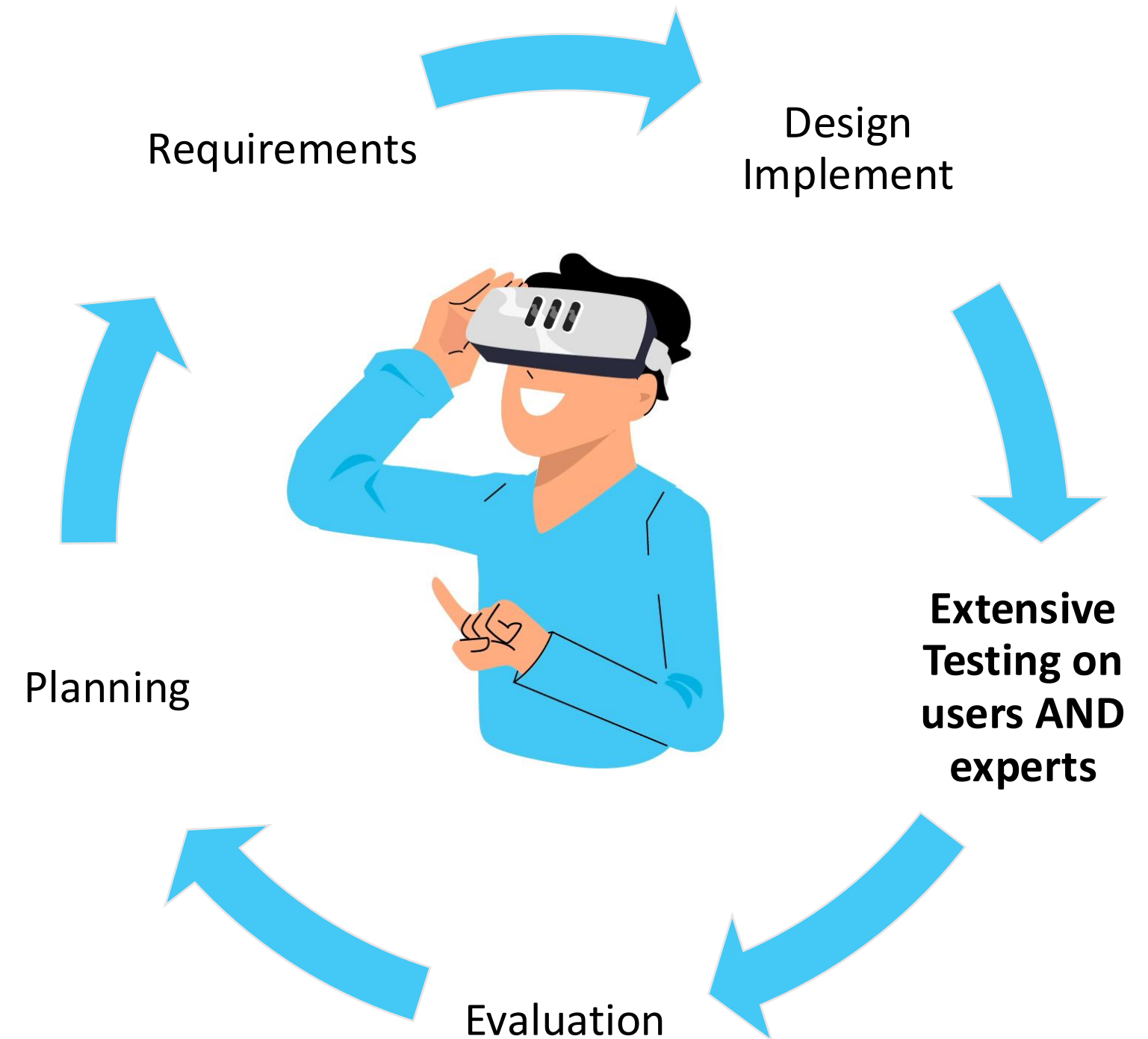


Smart Technology Research – What can we do for you?



Practice-oriented Research
R&D for companies and organizations
Customized innovative applications
Customized training

Participate in projects:
TETRA/COOCK+/EFRO/5G/O&O/
Interreg/ICON/InnoVET/
Smart Education/
EFRO/...



“Digital twins connect the physical and digital worlds
— turning data into decisions”



<https://hexagon.com/resources/insights/digital-twin/report>

HEXAGON

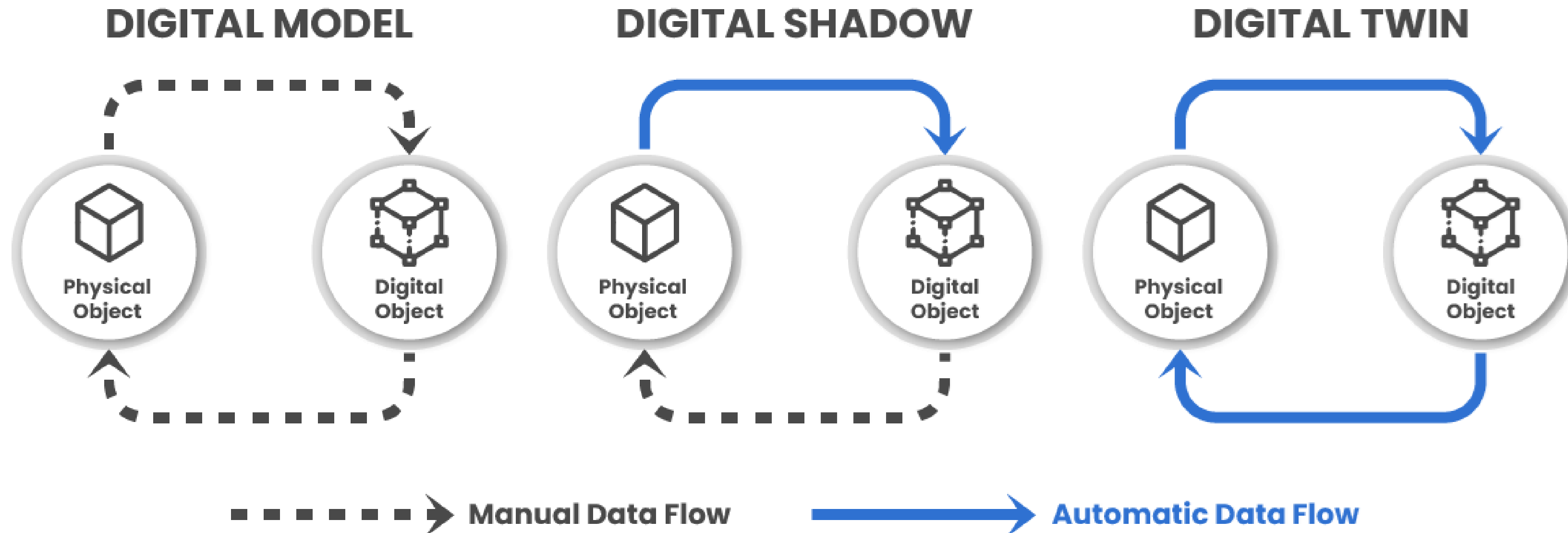
The Digital Twin Industry Report

Insights from top executives

96%
of leaders say
digital twins are
worth the climb

Digital twin —
a precise digital
representation of the
physical world that uses
dynamic data to simulate,
analyse, monitor and
optimise performance

The digital twin lifecycle of a production system



Different terminology based on the nature of the connection between the real and the digital production system.

[Werner Kritzinger, Matthias Karner, Georg Traar, Jan Henjes, Wilfried Sihn, Digital Twin in manufacturing: A categorical literature review and classification, IFAC-PapersOnLine, Volume 51, Issue 11, 2018]

Data is essential for digital twins



Starting with Digital Twins

Technical



- Sensors
- Data collection
- Simulation model
- Cloud / IoT
- Cybersecurity

Business



- Efficiency gains
- Cost reduction
- Predictive maintenance
- Faster decision-making

Organizational



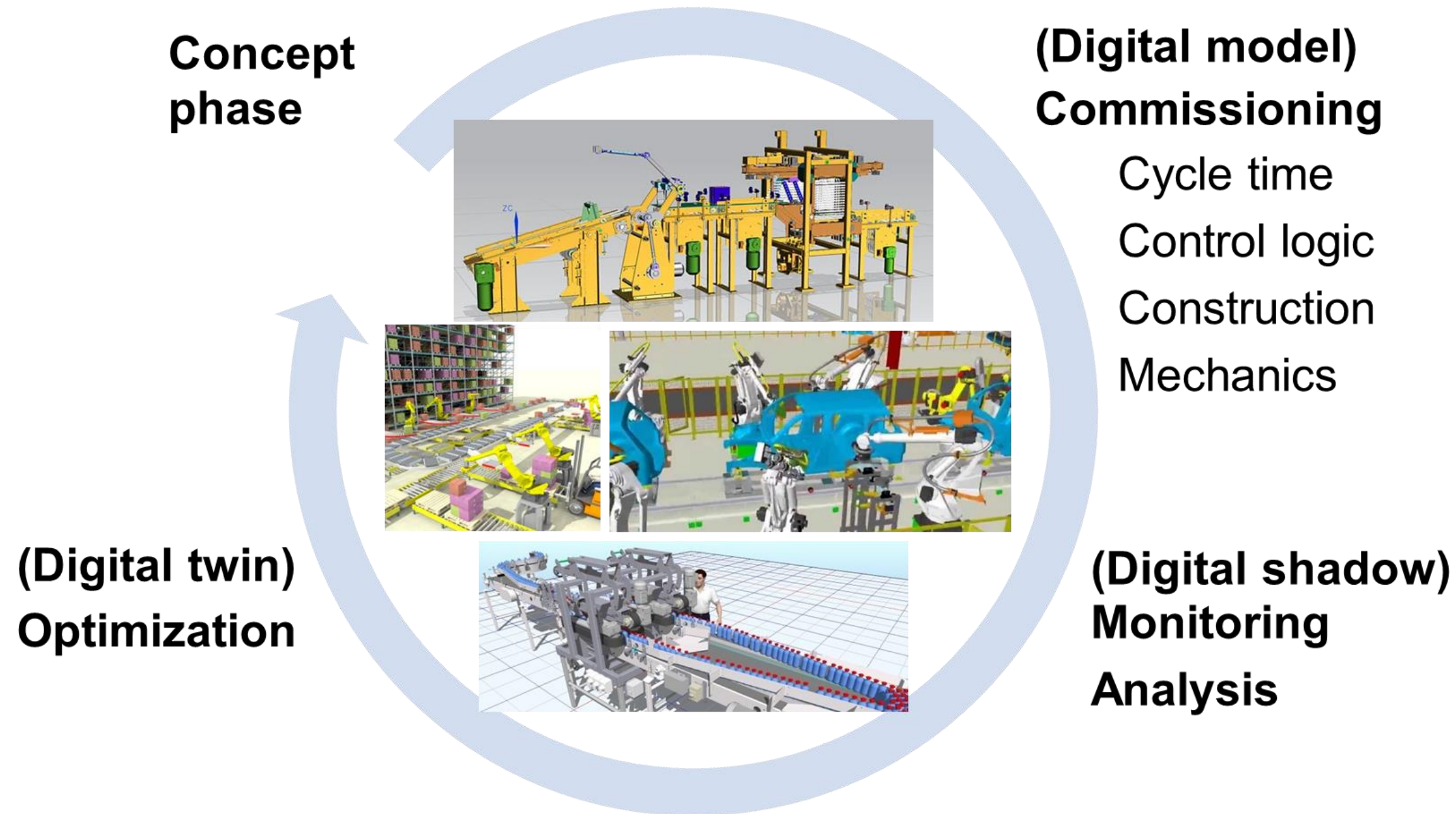
- Production
- IT • Finance
- Management
- Data governance

Human



- Skills
- Trust • Privacy
- Human-in-the-loop
- Acceptance

The digital twin lifecycle of a production system

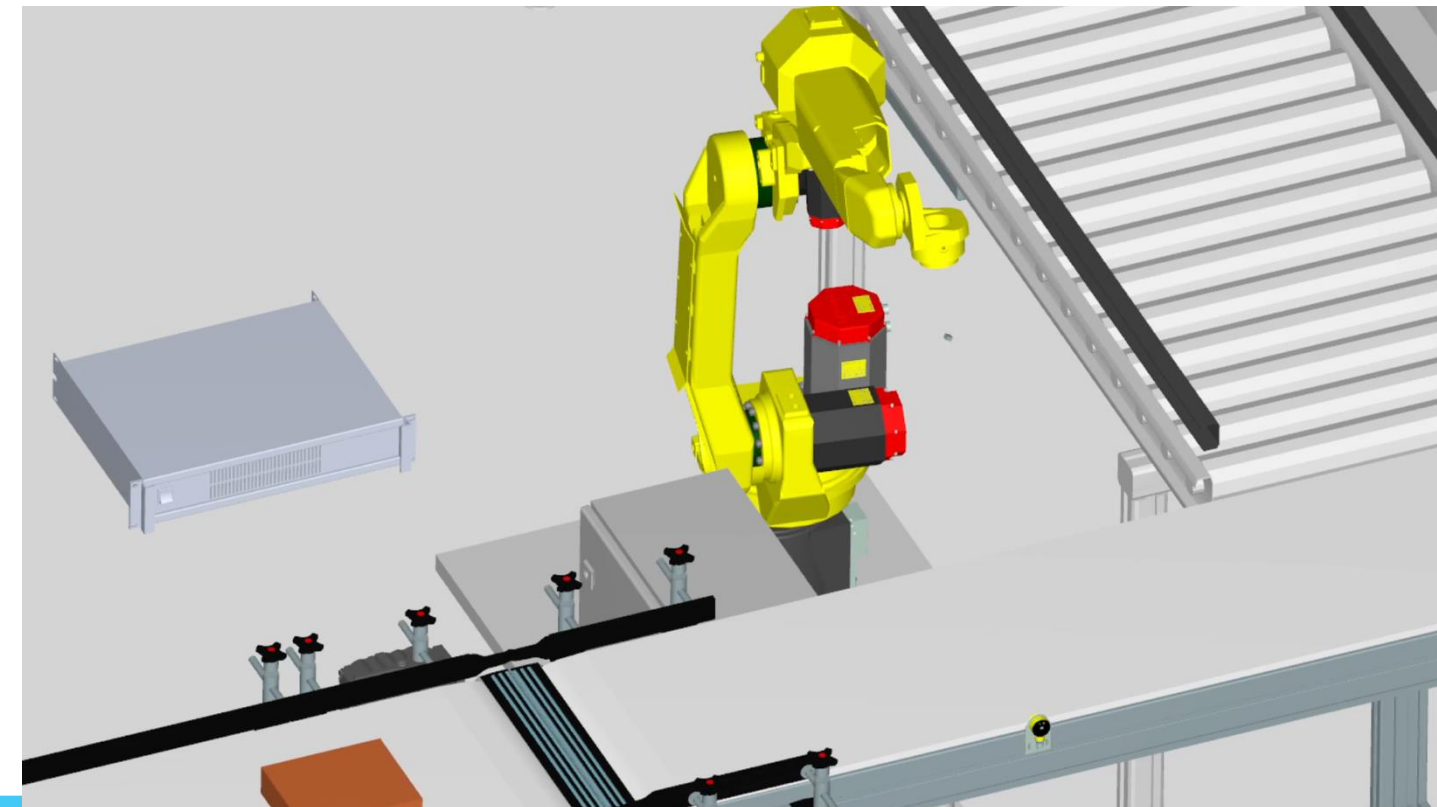
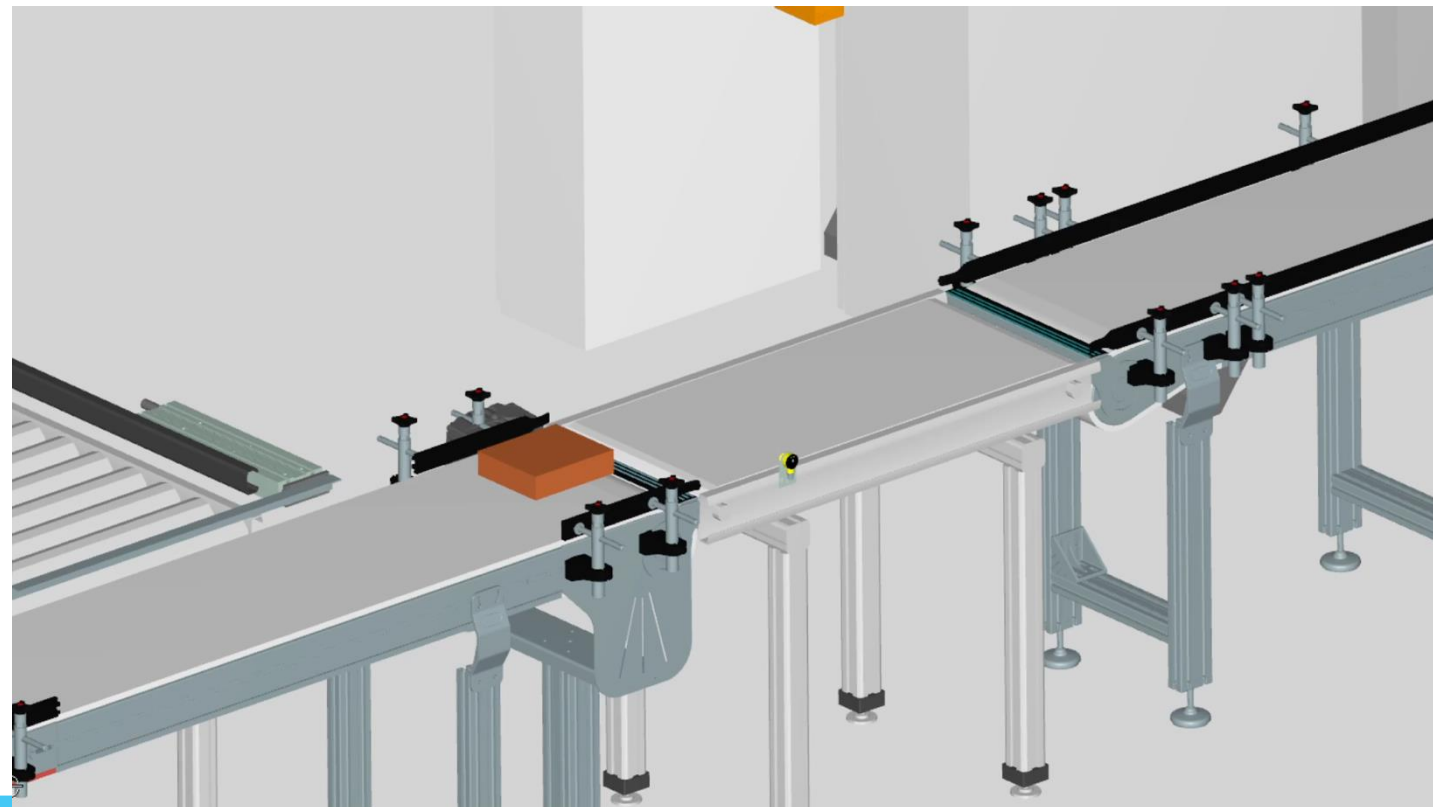
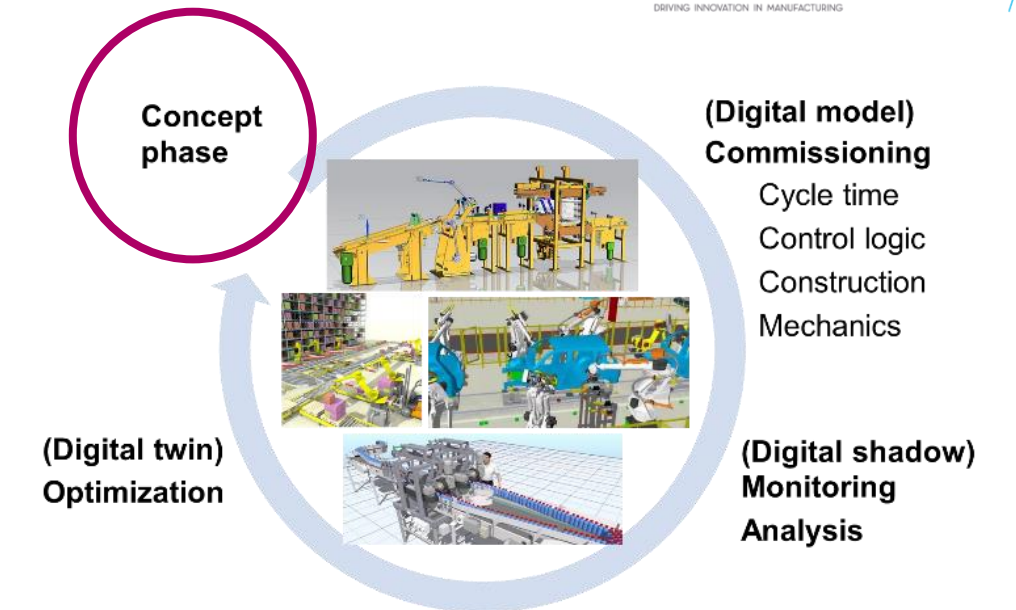


The digital twin lifecycle of a production system

Demonstration 0 - Concept phase

Comparison of different concepts

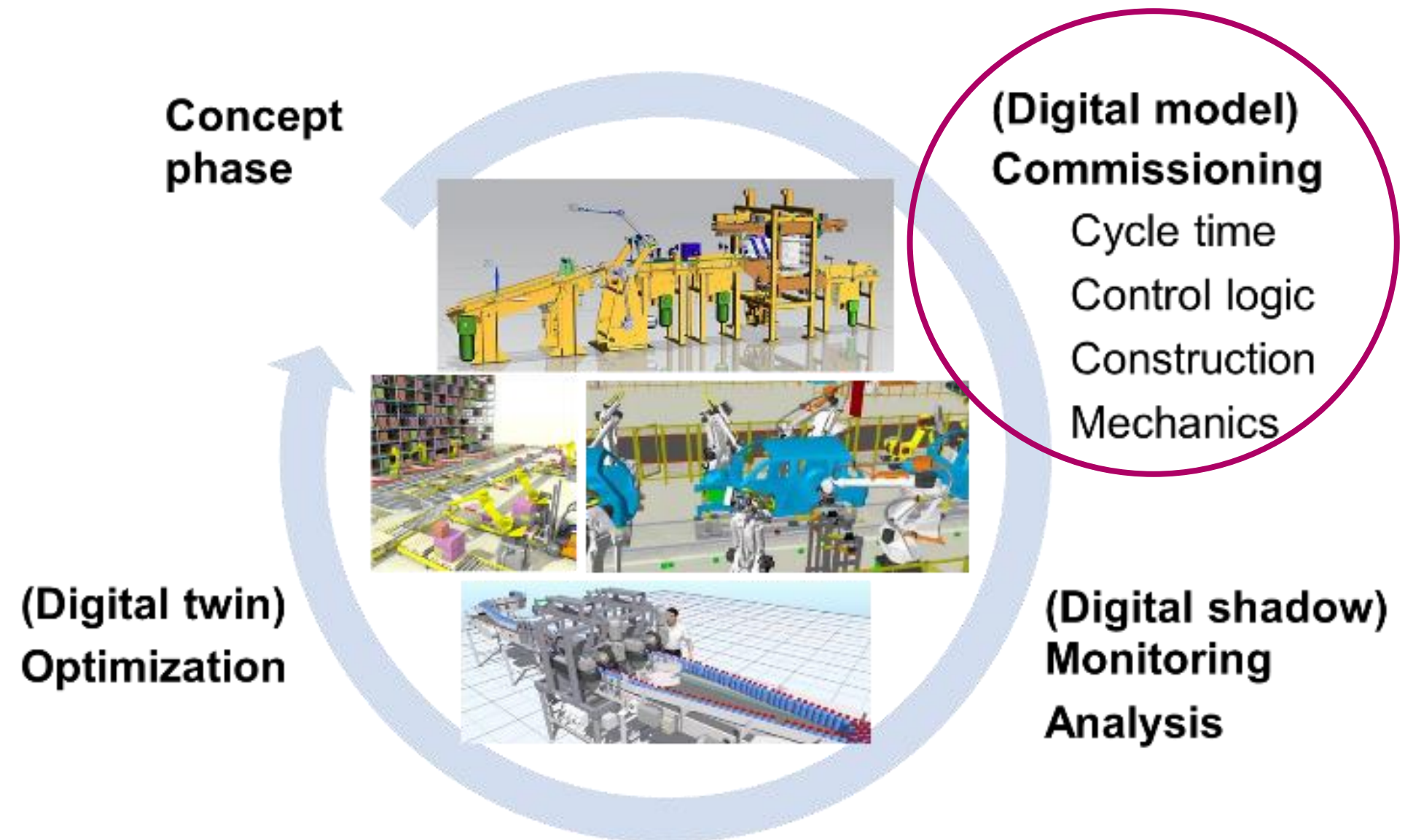
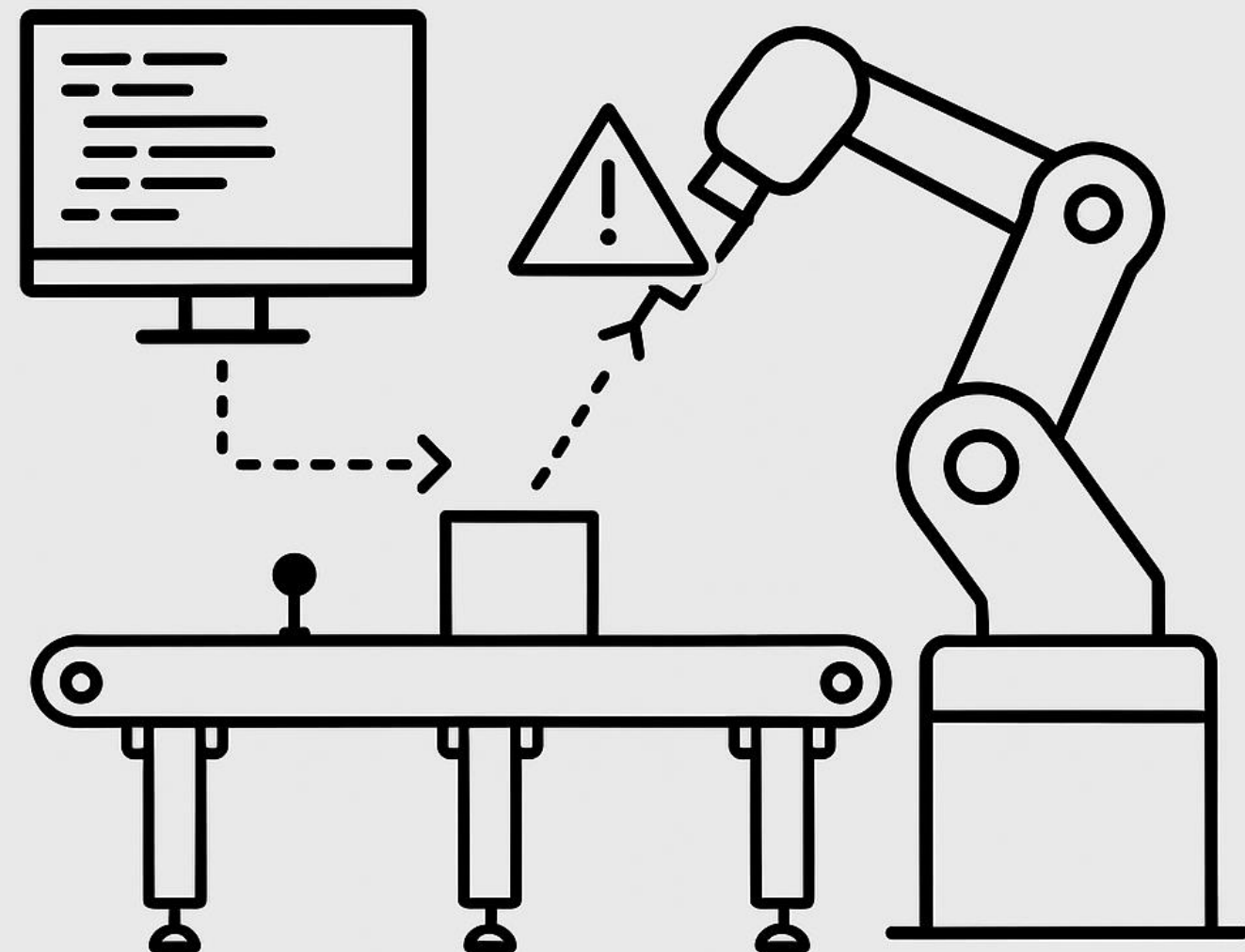
Cost | Cycle time | Accuracy | Etc.



The digital twin lifecycle of a production system

Demonstration 1 - Digital model commissioning of industrial control systems

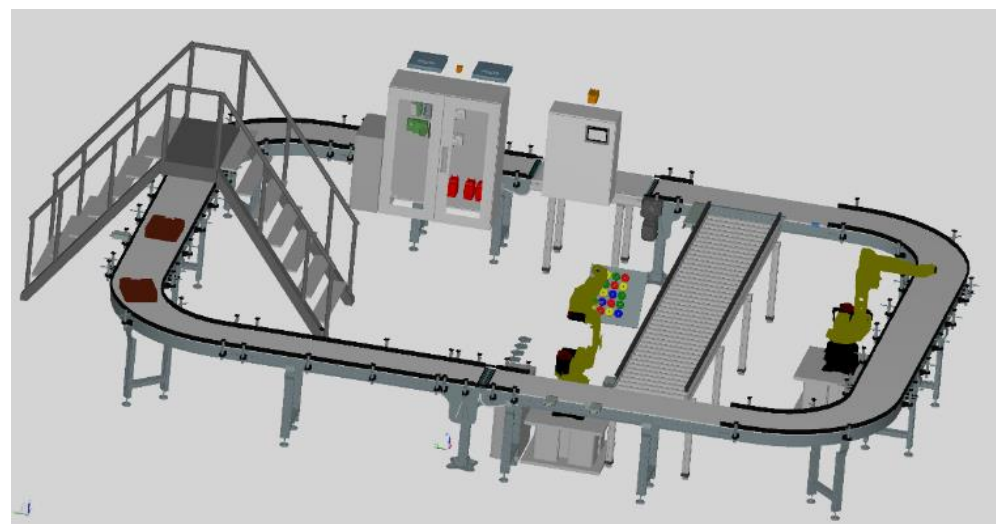
VIRTUAL DETECTION OF A (LOGICAL) PROGRAMMING ERROR



The digital twin lifecycle of a production system

Demonstration 2 - Realization of a digital shadow

Synchronisation between real and digital environment



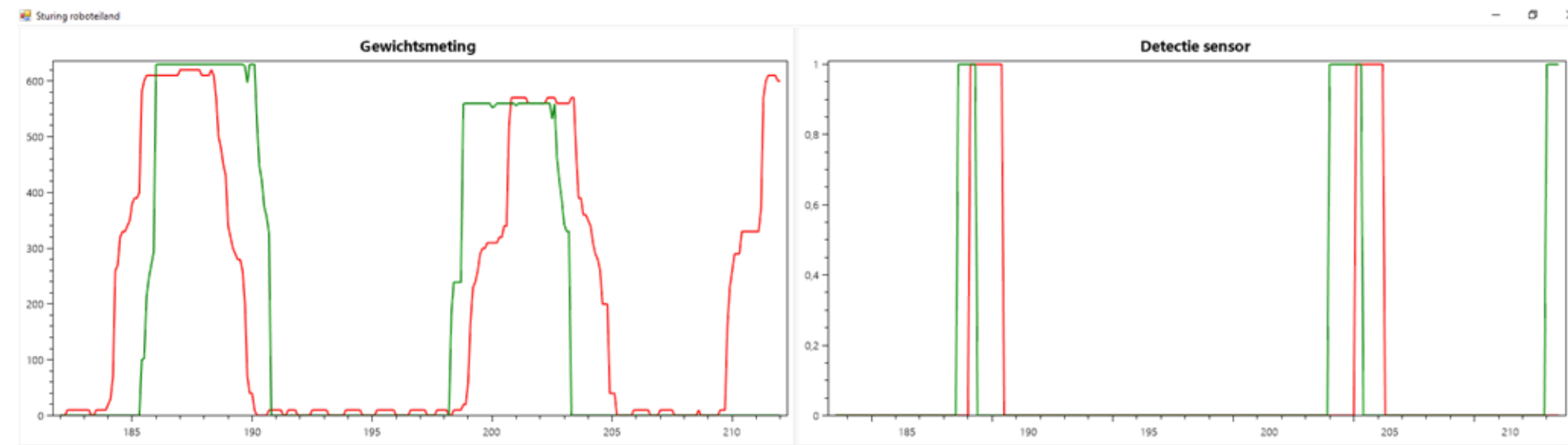
Concept
phase

(Digital model)
Commissioning

Cycle time
Control logic
Construction
Mechanics

(Digital twin)
Optimization

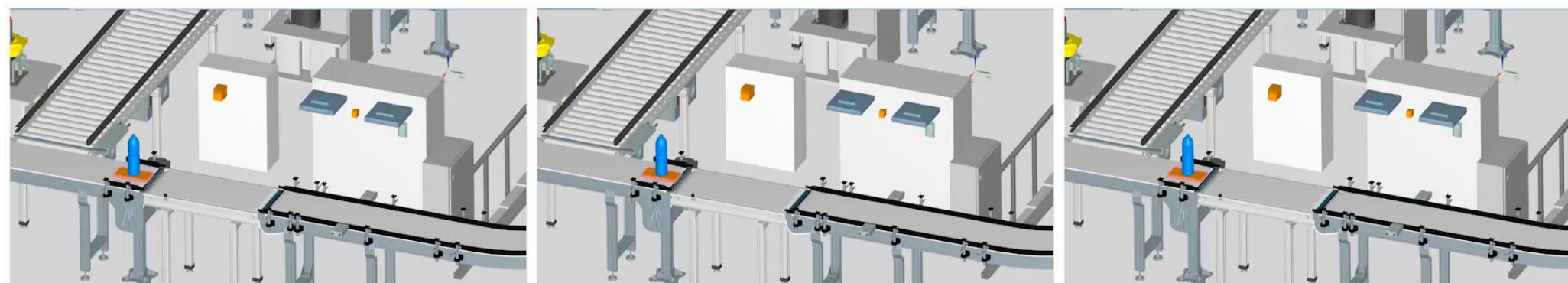
(Digital shadow)
Monitoring
Analysis



The digital twin lifecycle of a production system

Demonstration 3 - Step towards a digital twin

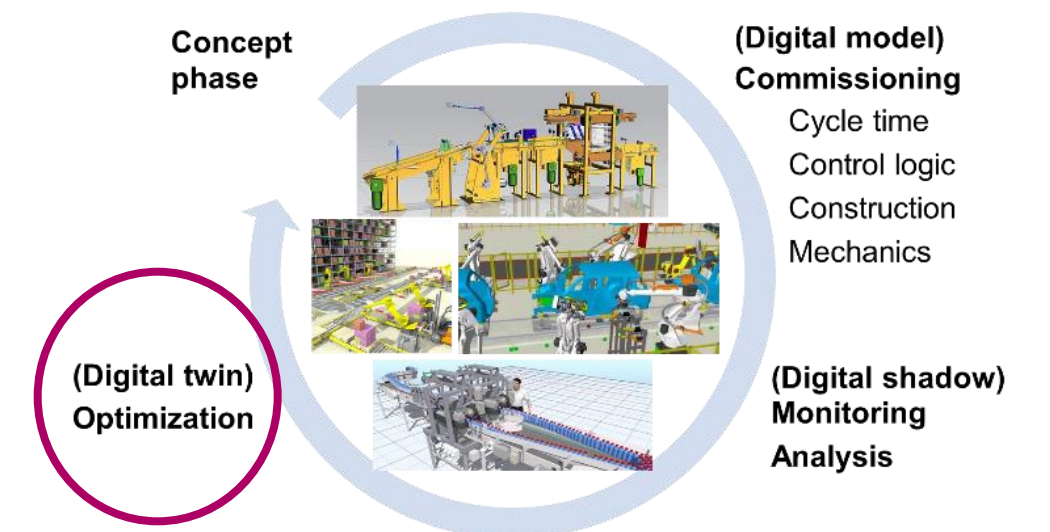
Virtual tuning of the control parameters



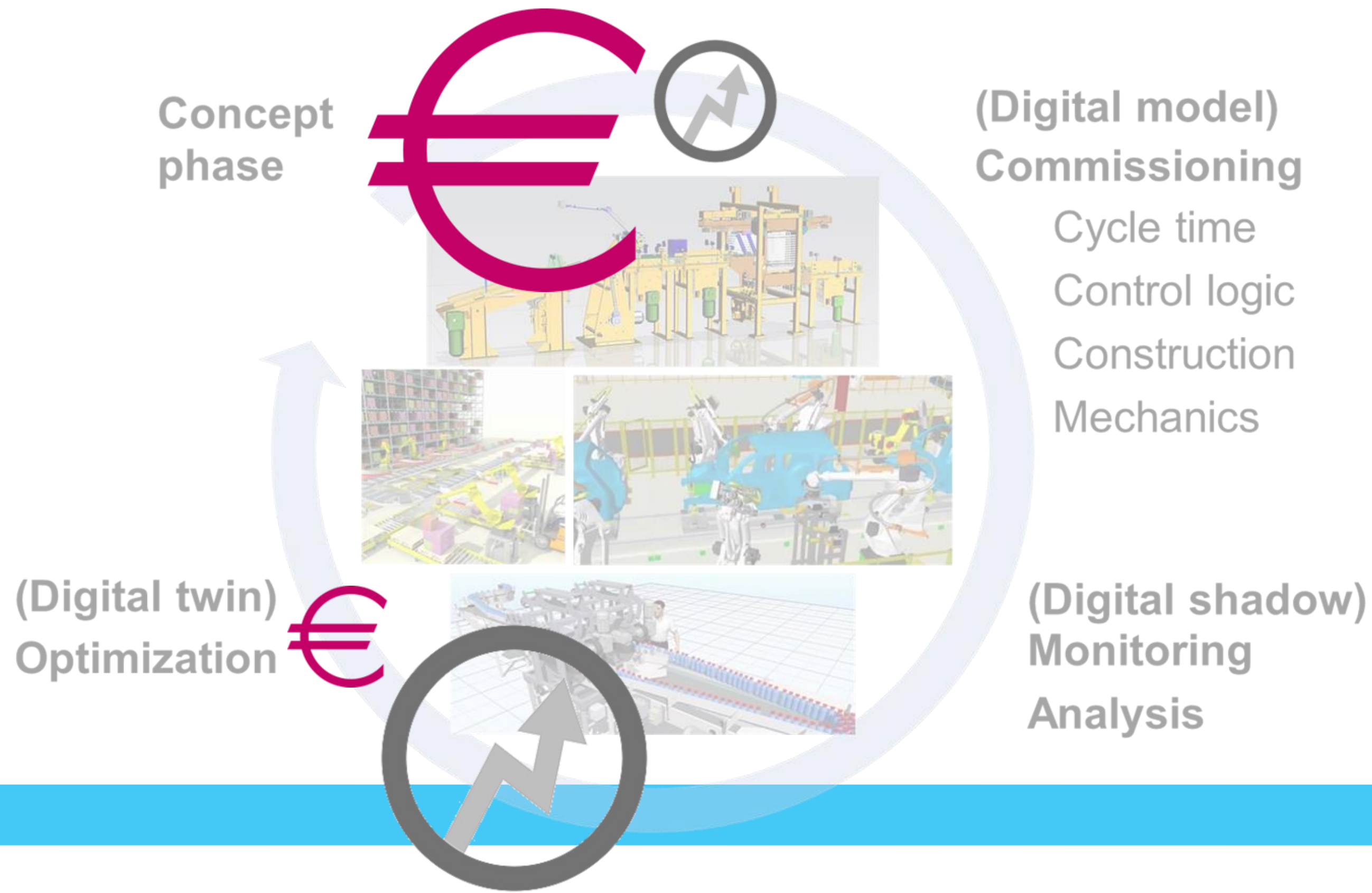
Scenario 1

Scenario 2

Scenario 3



Cost-benefit analysis



AI enhances the intelligence of the digital twin,

The digital twin serves as a powerful, context-rich data source for **AI**

Anomaly detection:

Machine vibrates more than usual



Predictive Analytics:

Motor will fail after 40 operating hours



Smart dashboards:

Filtering irrelevant data via AI – dynamic adjustment

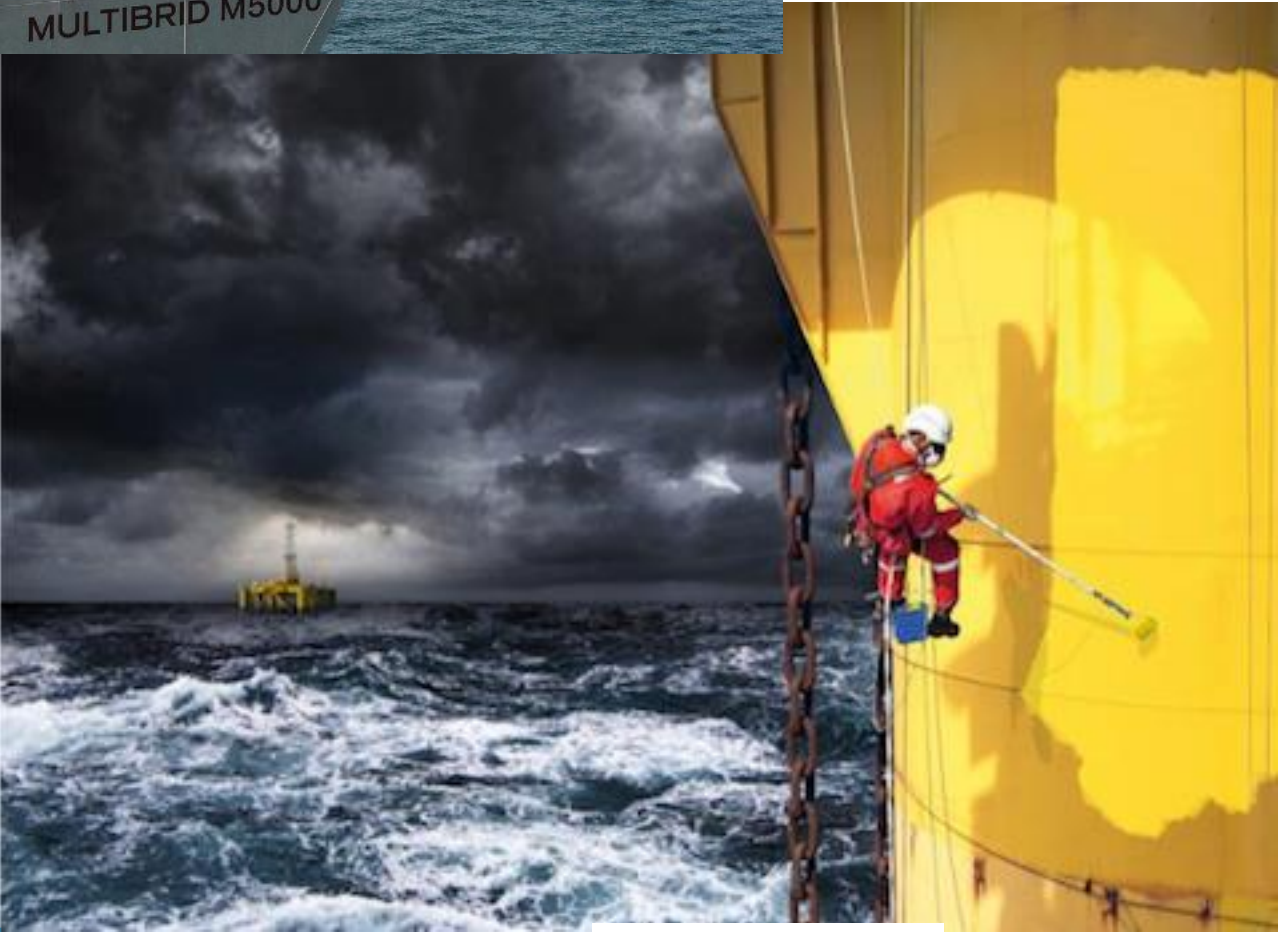


Reinforcement learning:

Robots learn to assemble autonomously (first virtually, then in reality)



Digital Twins in Offshore? Why?



Digital twins in offshore

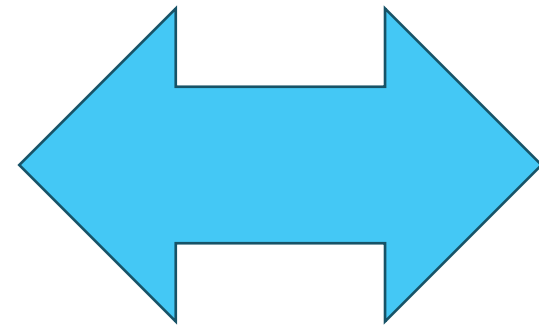
Aspect	Manufacturing	Offshore
ENVIRONMENT	Controllable (factory hall)	Extreme and unpredictable (sea, weather, corrosion)
SCALE	Machines & production lines	Large-scale infrastructure (wind farm, platform)
DATA	Mainly internal, repetitive	External (weather data, wave movements) + internal SCADA
OBJECTIVES	Efficiency & cost reduction	Safety, reliability & continuity
INTERVENTION	On-site maintenance is relatively easy	On-site maintenance is expensive, dangerous, time-consuming

Digital twins is offshore

Manufacturing industry

Focus on

- Efficiency
- Product quality
- Reducing human error
- Safety



Offshore industry

Focus on

- Reliability (early anomaly detection, ...)
- Maintenance optimization (predictive servicing,...)
- Safety (storm prediction, ...)
- Cost control (reduce downtime, extend component life....)

Marine Spatial Planning North Sea Basin

North C Neutral

Optimisation and decision support toolkit for a Greater North Sea Basin

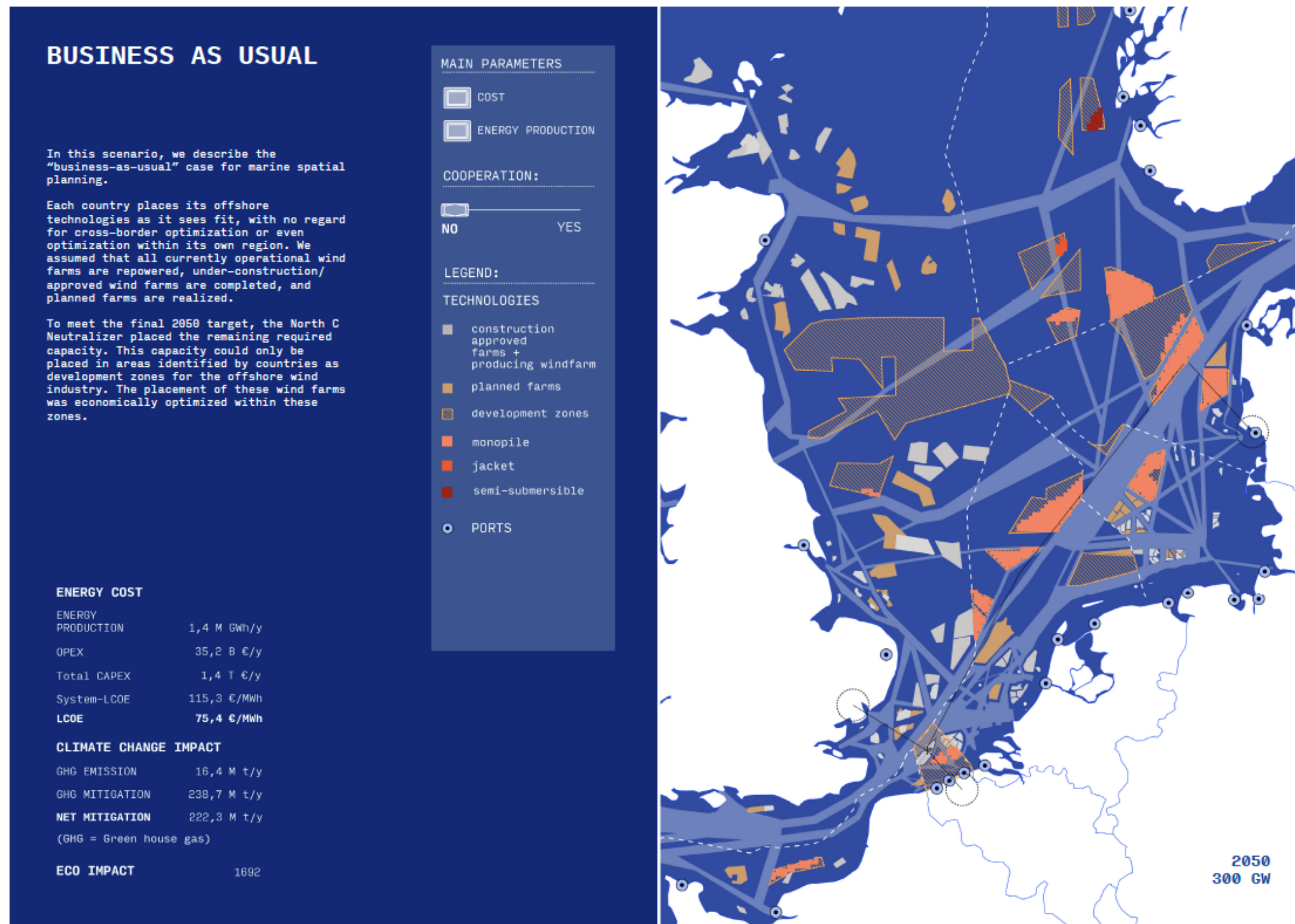
North C Neutral: Optimazation model for anyone managing (a portion of) the North Sea Basin

Offshore wind, grid infrastructure, ports, shipping, ecology, fisheries and other marine functions all compete for limited space.

By ORG Urbanism & Architecture BV



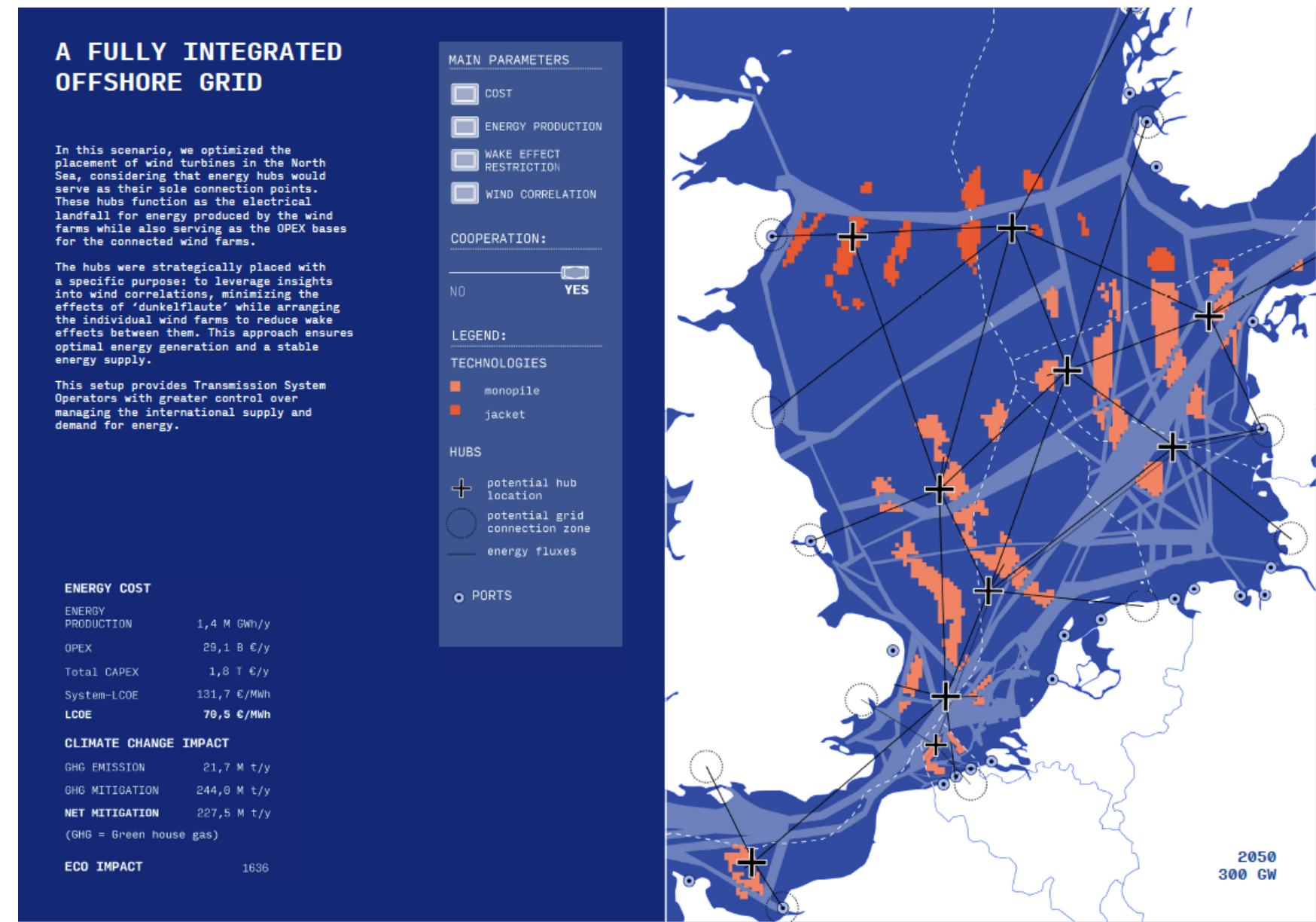
Baseline scenario for 2050 – 300 GW target



- Reference case for future comparison
- Limited cross-border coordination
- Cost-optimized within predefined national zones
- Reveals bottlenecks in space and grid infrastructure
- For Belgium, the main impact is on space, ports and grid connections

Fully integrated offshore grid

- Same energy output, different system design
- Integrated grid lowers OPEX
- Higher upfront CAPEX for hubs and grid infrastructure
- Lower LCOE, but higher System-LCOE
- Better net GHG mitigation and slightly lower eco impact



Virtual Engineering ∞ eXperience for production and logistics environments



TETRA VE∞X project



Invisto



Virtual Commissioning

Een **productiesysteem** dimensioneren, de aansturingen logica (vb. industriële controllers ind. veiligheid) valideren of optimalisaties (vb. retrofit, capaciteitsuitbreiding of lay-out aanpassing) uittesten op een virtuele replica.

E ∞ X

Virtual prototyping

Een **product** of variant assembleren in de virtuele productieomgeving om zo directe (operator) feedback te krijgen omtrent de assembleerbaarheid (vb. fysieke bereikbaarheid, tijdsmetingen of ergonomische analyse)

E

∞

X

Virtual training

Een **productiemedewerker** opleiden via een laagdrempelige interactie met een 3D omgeving waarbinnen realistische productiescenario's afgespeeld worden (vb. operator, onderhoudstechniker, team lead of productiemanager).

E

∞

X

TETRA VE∞X

Virtual Engineering ∞ eXperience for production and logistics environments

Application cases



XRintelligence
Extended Reality



Virtual Commissioning

Compare

Software

Hardware

Recommendation

Services

Contact

⚙️ = Software is verified by developer/supplier



3DEXPERIENCE

- Discrete Event Simulation
- Logistics
- Virtual Commissioning
- Lay-out optimization
- Throughput analysis
- +3 more

Dassault Systèmes' 3DEXPERIENCE platform offers a collaborative digital environment that integrates various business functions. This platform aims to connect different stages of a product's...


[Read more](#)



AnyLogic ⚙️

- Discrete Event Simulation
- Logistics
- Agent based simulation
- Lay-out optimization
- Throughput analysis
- +1 more

AnyLogic is a versatile simulation software that supports multiple modeling methodologies, including discrete event, agent-based, and system dynamics, allowing users to create complex models that...


[Read more](#)



Campfire3D

Campfire3D is a spatial collaboration and 3D design review platform utilizing Augmented Reality (AR) and Virtual Reality (VR) for enterprise applications.


[Read more](#)



CIROS

- Robot Simulation
- Physics-based Emulation
- Logistics
- Robotics
- Virtual Commissioning

CIROS is a platform design using 3D simulation models in automation

[Would you like to provide feedback?](#)



dual
DIGITAL TWIN SIMULATIONS

Dual



EcoStruxure™ Machine Expert Twin ⚙️

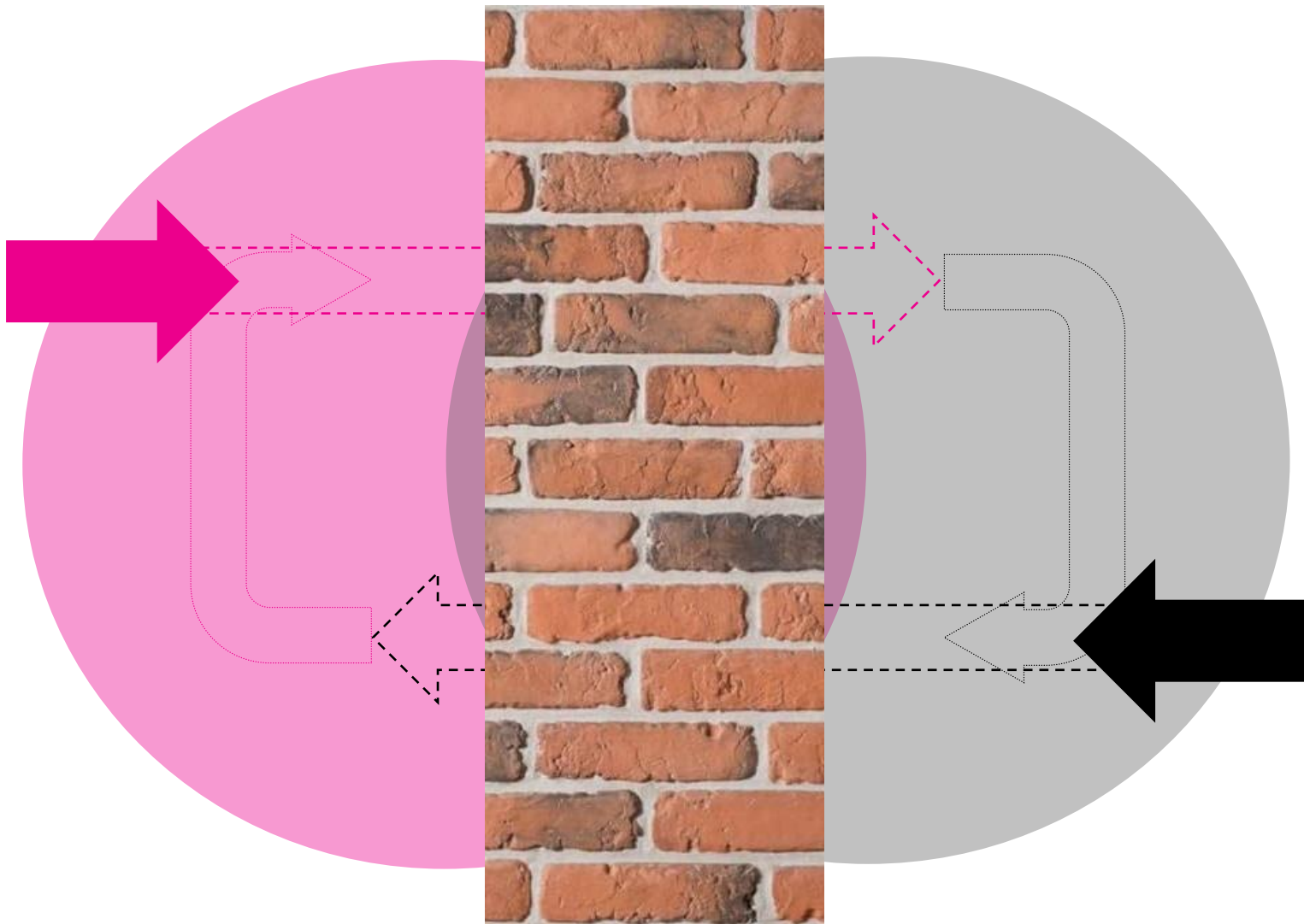
Sort by Name — Ascending (A → Z)



Challenge

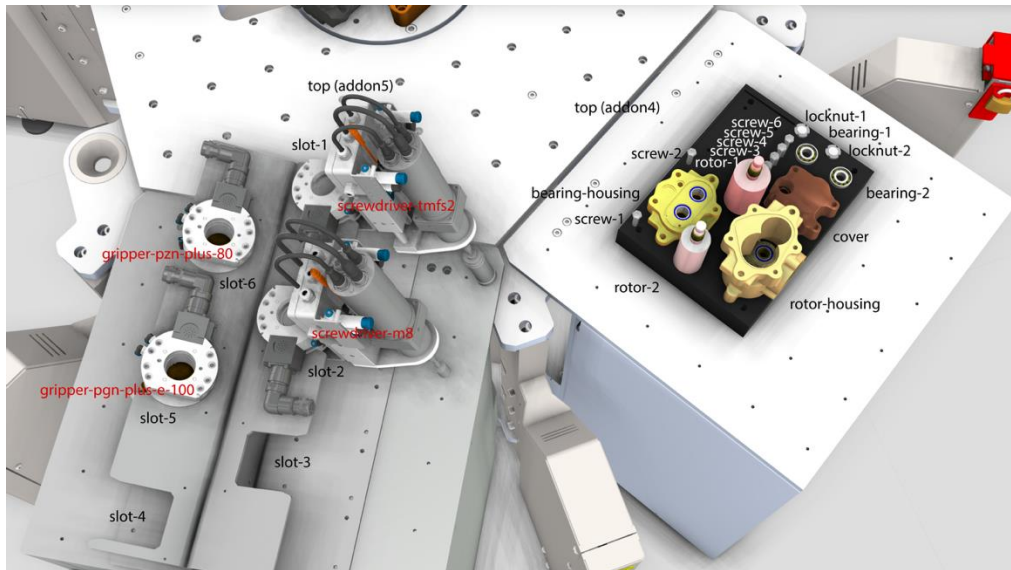
Virtual Engineering Platforms

Manufacturing scenarios strongly **depend on human actions**. Not only at normal operation, but certainly when things go wrong, the so-called **unhappy flow**.



Virtual Experience Platforms

User experience applications require a decent **level of detail** to validate and train **realistic manufacturing scenarios**.

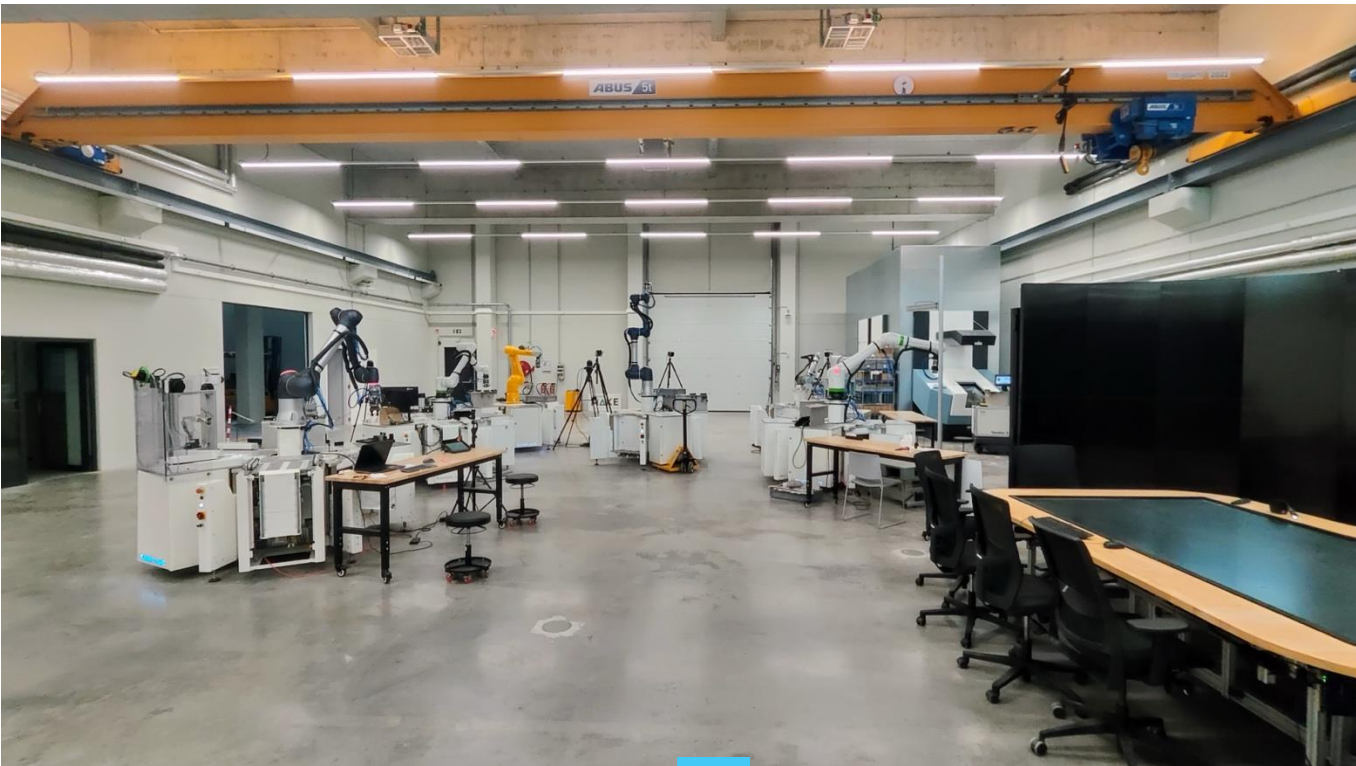


- Not easy to select an appropriate tool
- Labor intensive content creation and interaction
- Double work



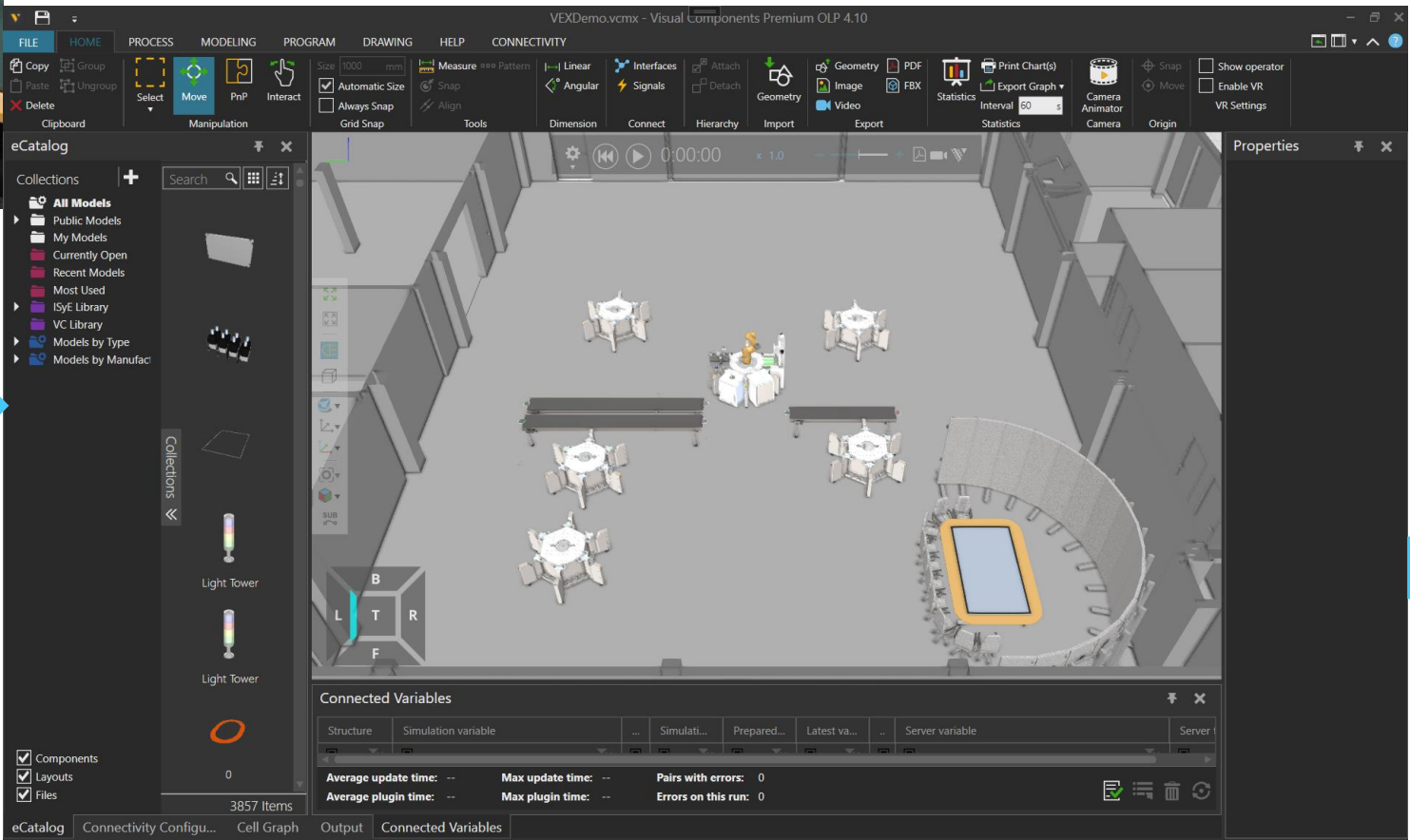
To XR or not to XR

VE[∞]X proof-of-concept scenario: Use case



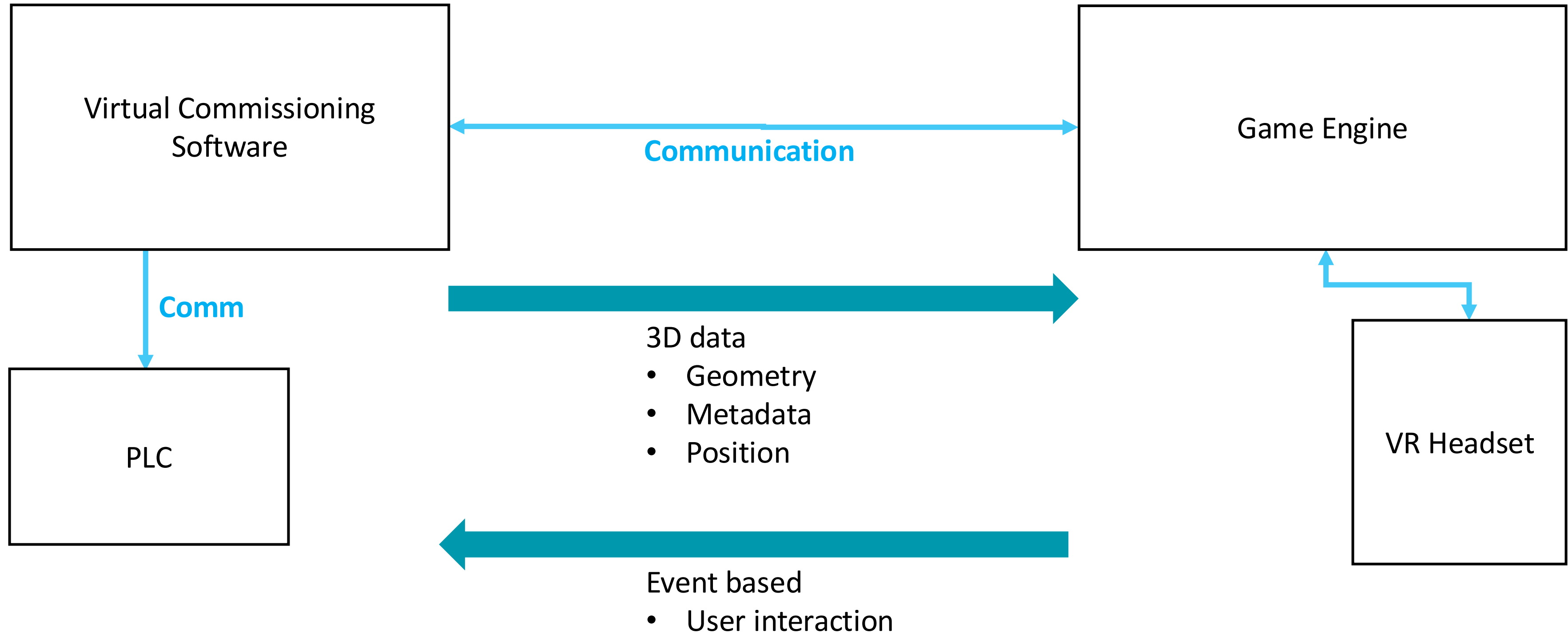
Flanders Make –
InfraFlex Lab

Visual Components – VEXDemo



VR

VE[∞]X proof-of-concept scenario: General



LYBOVER – XR for design where interactions with employees is relevant

Lybover is an industrial engineering company that designs, builds, and installs customized process solutions for industry.



Porsche Used Colocated Apple Vision Pros To Showcase Its New Drivetrain



XR can be valuable for sales, customer experience, product presentation, and stakeholder communication



Let's get in touch!
Charlotte.larmuseau@howest.be



Dr. Charlotte Larmuseau

<https://www.linkedin.com/in/charlotte-larmuseau-3401b851/>