



AWK'23

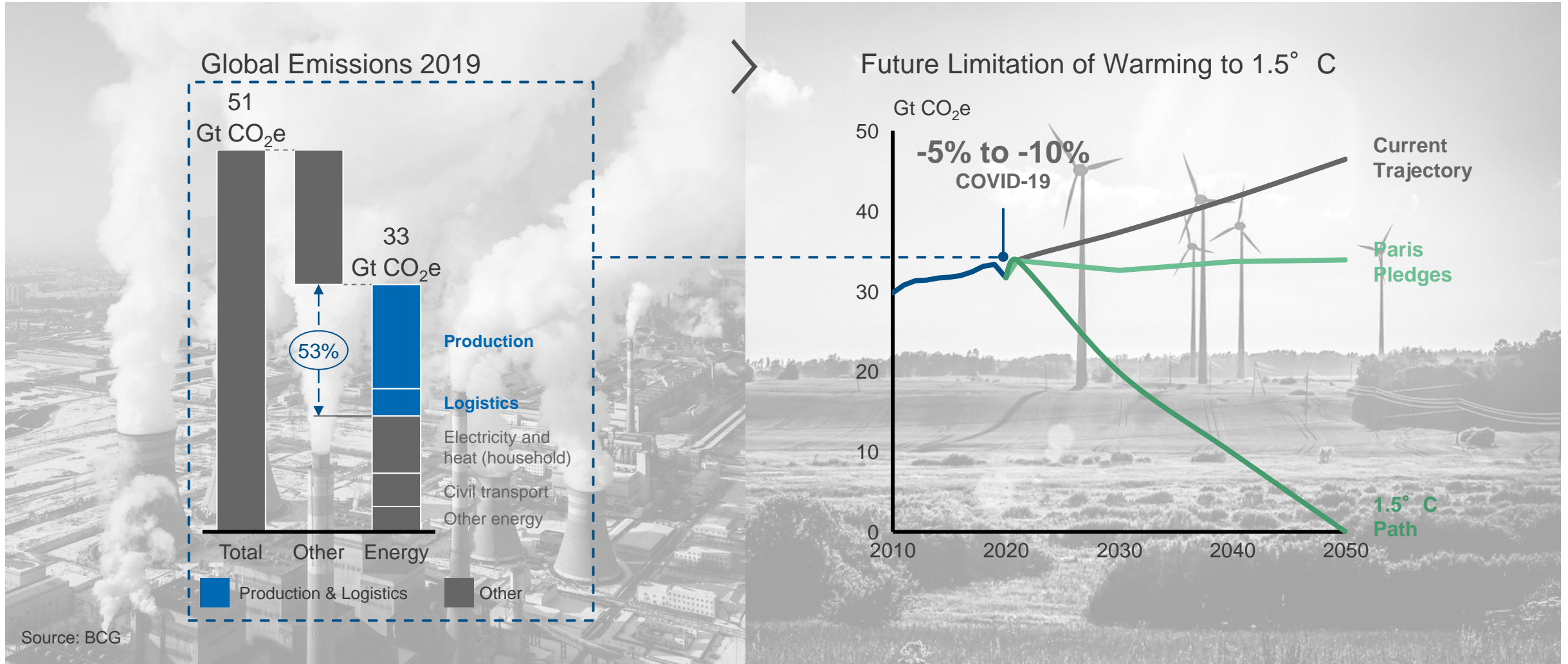
WWW.AWK-AACHEN.DE 11. / 12. MAI 2023

Sustainable Production-as-a-Service

Expert presentation – Session 3
Dr. Tilman Buchner

Empower Green Production

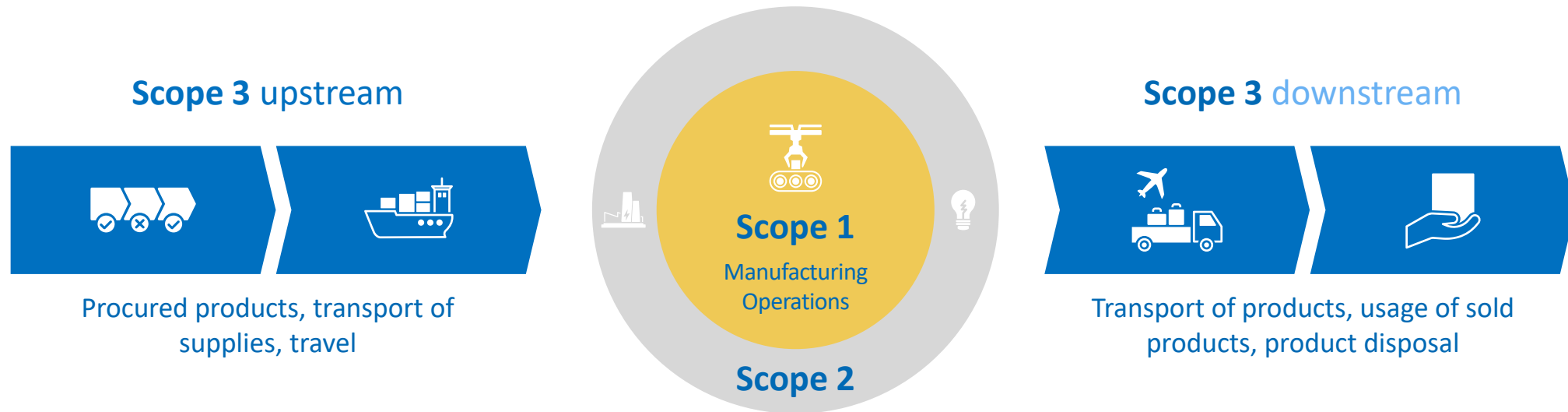
How to master an engineering challenge of epic proportion



To reach net-zero, full range of scope 1-3 must be used ...

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Illustrative



In most companies
Scope 3 is responsible
for around 80% of a
company's emissions

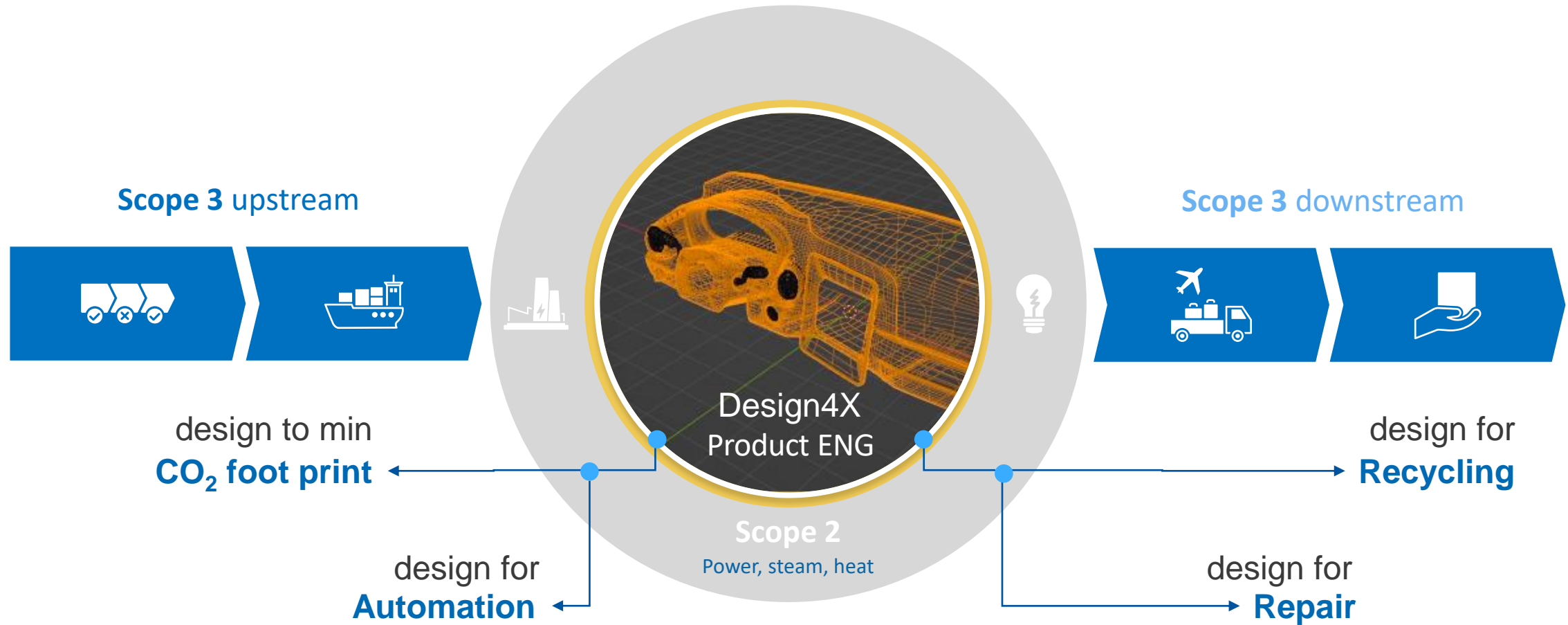
BCG: The Climate Actions Companies
Should Take Today

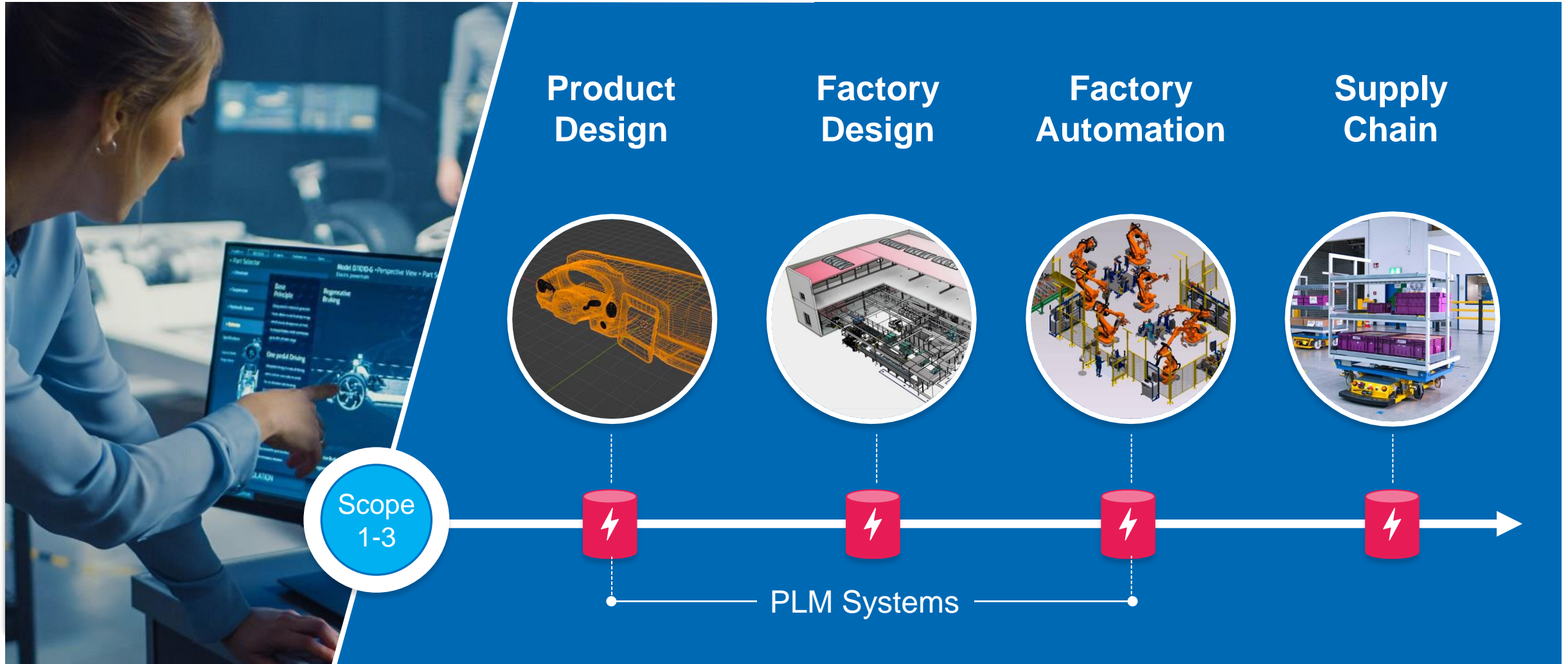
Audi e-tron: 6,000
parts manu. by 300
different suppliers at
550 loc. in 37 count.

DER SPIEGEL: So viel China steckt
in einem deutschen Audi

The problem must be thought from the beginning ...

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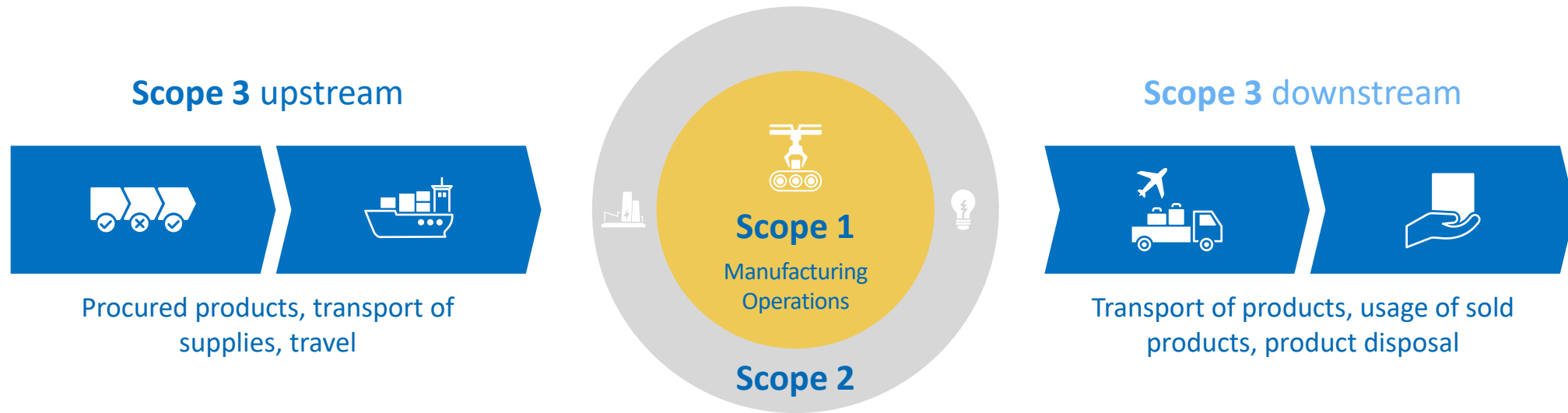




What contribution can Manu-Ops make to CO₂ savings?

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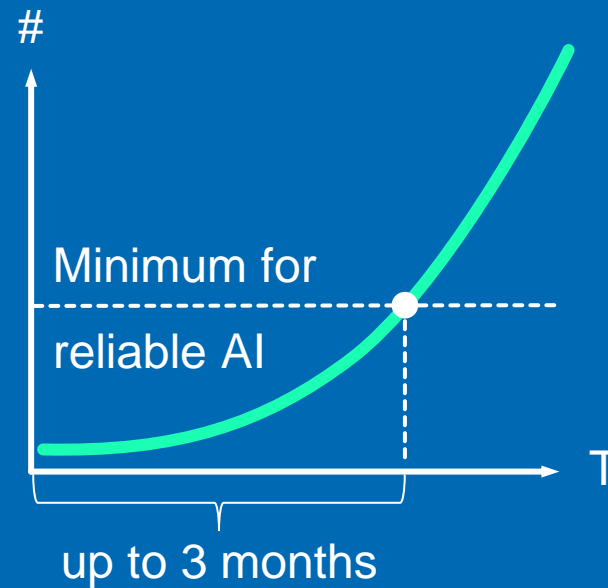
Illustrative



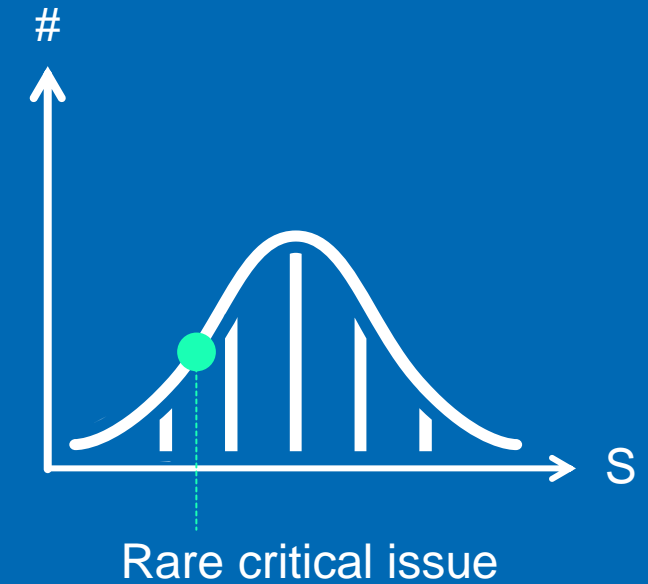
Lack of data @SOP prevents using AI. The result is waste of resources ...



Data availability at SOP

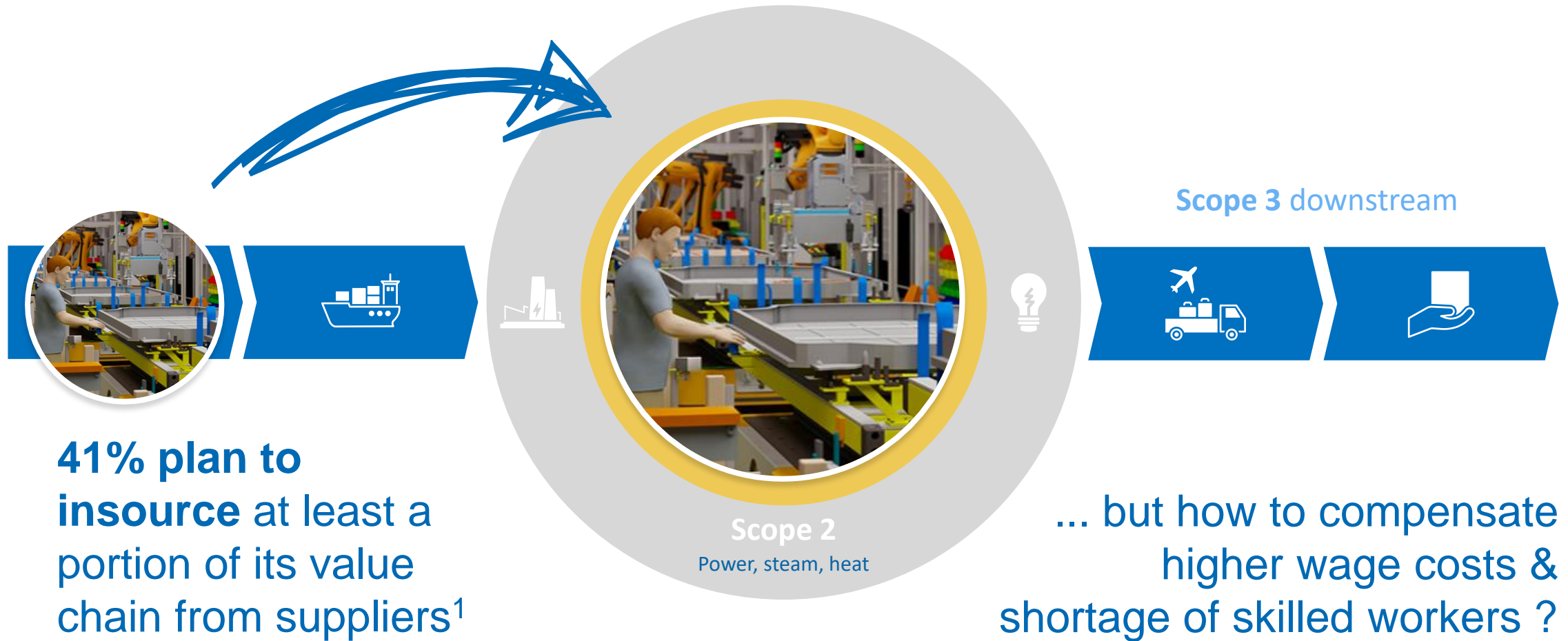


Coverage of scenarios



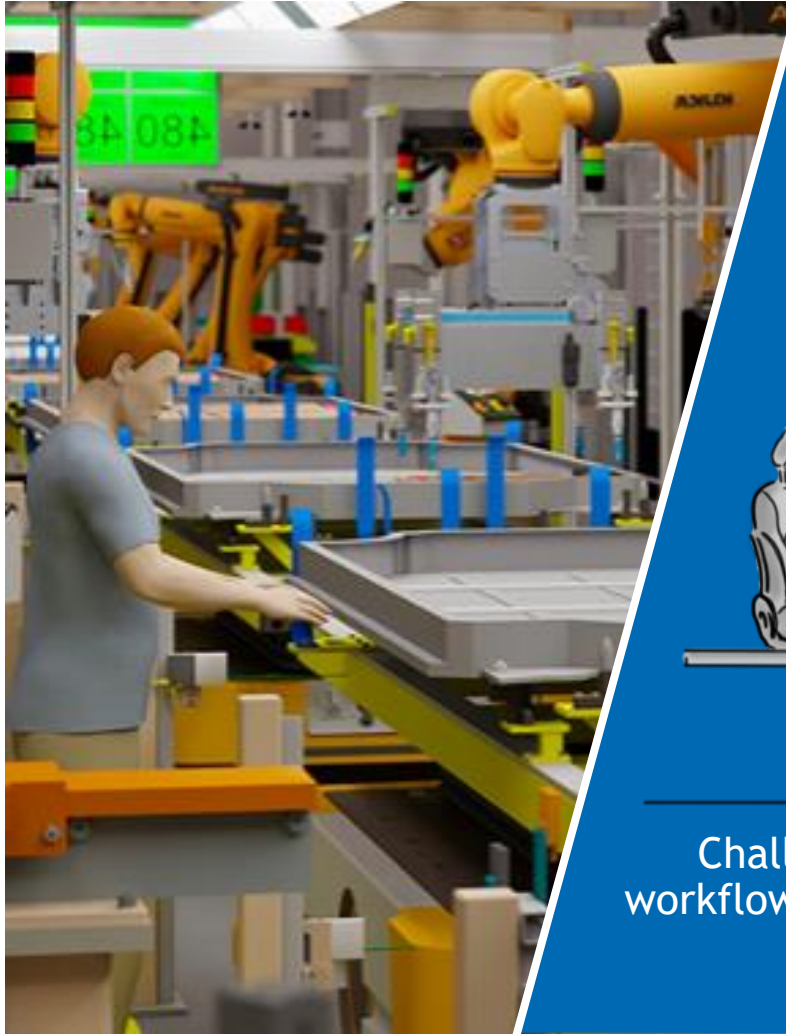
Reduce global sourcing by relocating production ...

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Source: ¹ BCG study "Boosting Resilience with Production as a Service"

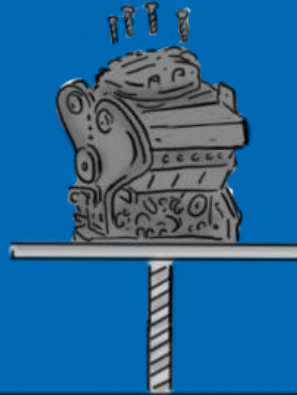
Many operations are too versatile for traditional automation **AWK'23**



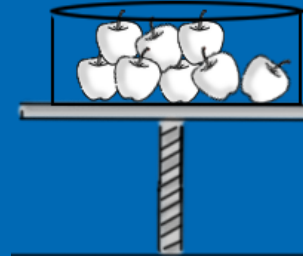
... because robotic systems lack a situational understanding / causal model of the real world



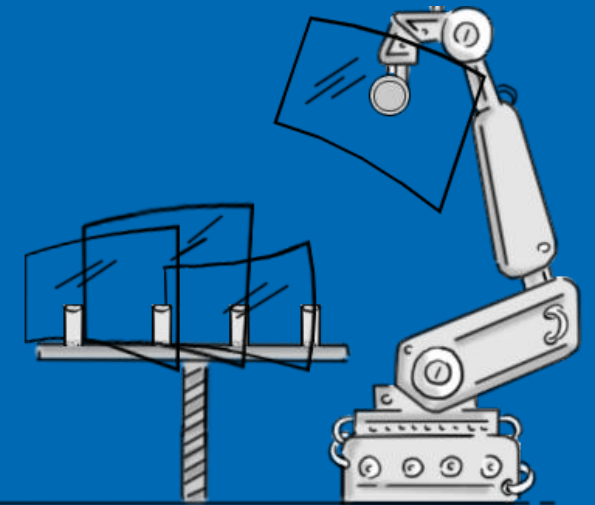
Challenging workflow sequence



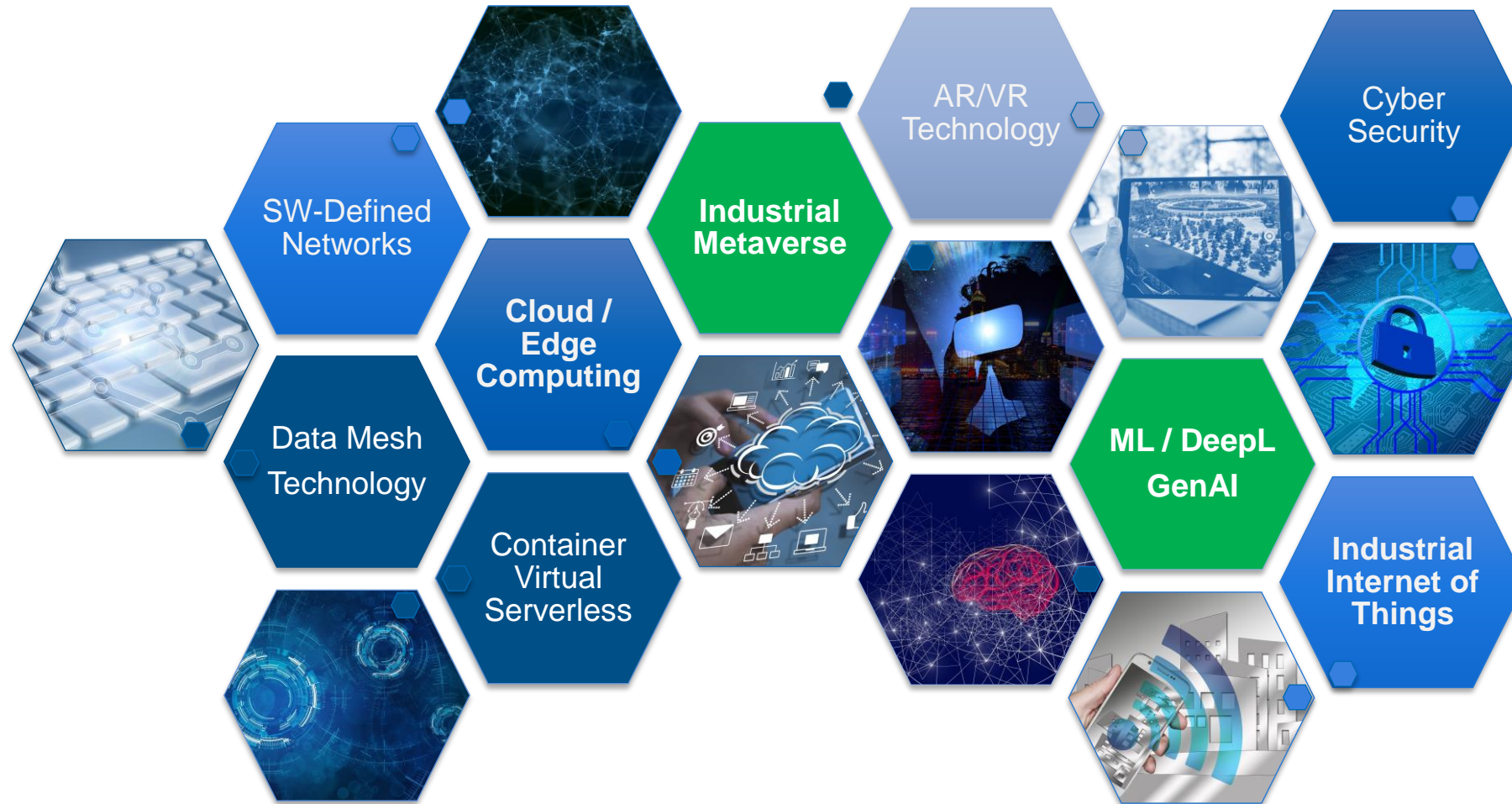
Low accessibility of assembly locations

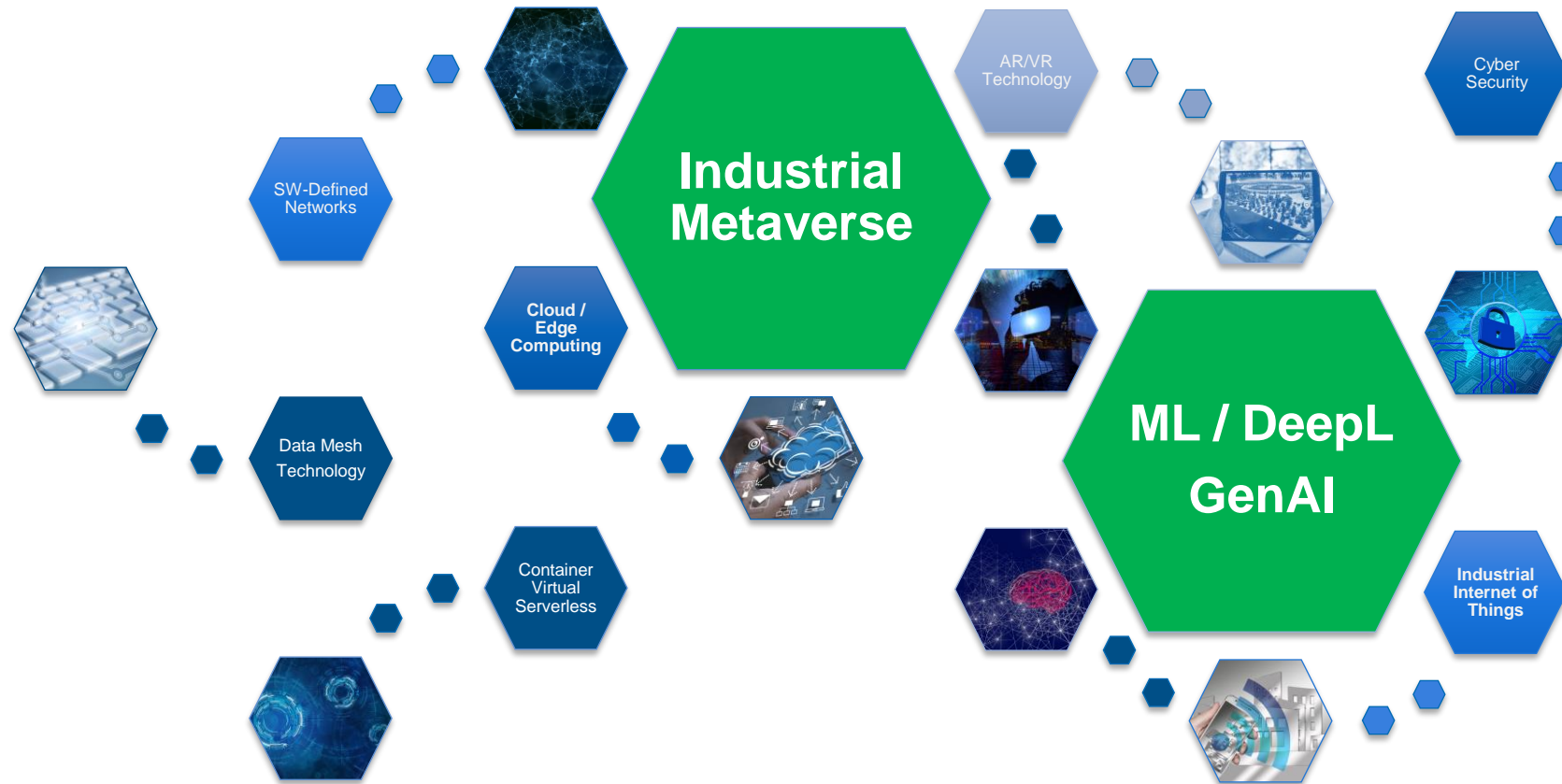


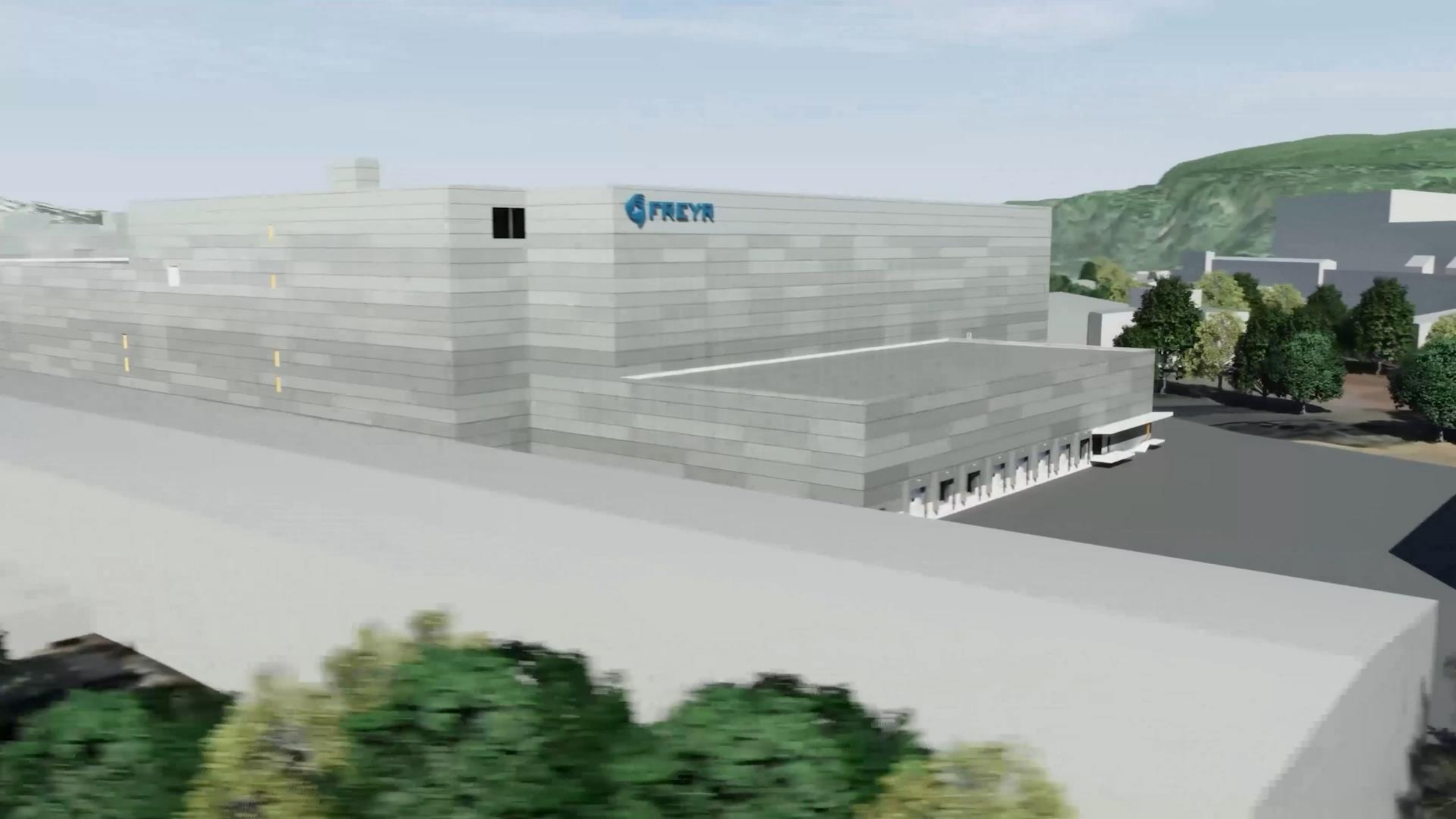
Complex handling of flexible components

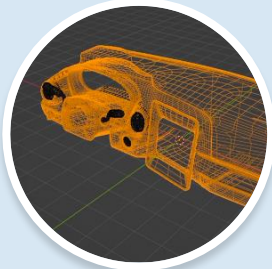


Adaptable handling of geometrical variances



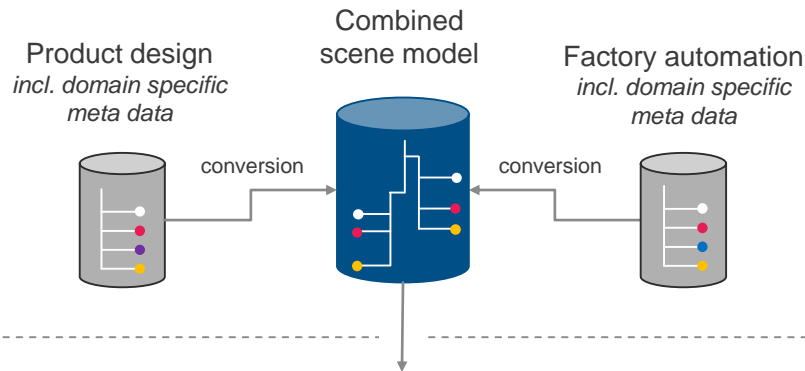






Engineering

Low data inter-operability prevents sustainable engineering



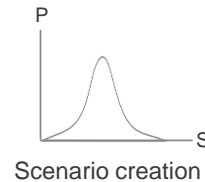
Integrated Factory Model

Improve collaboration across application domains by using combined scene models



Manufacturing

Lack of production data at SOP prevents using AI - the result is waste of resources



Scene generation



Photorealistic rendering

SIM-2-Reality

Use photorealistic rendering & synthetic data generation to provide AI training data at Start of Production (SOP)



Manual Operations

Because handling tasks are too versatile for traditional robotics, labor-intensive ops is outsourced



Real-time (I)IoT data



Photorealistic Scenes

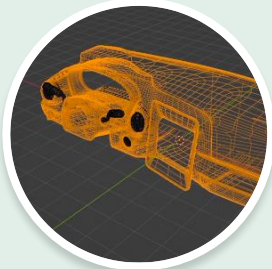


Generative AI

Cognitive Robotics

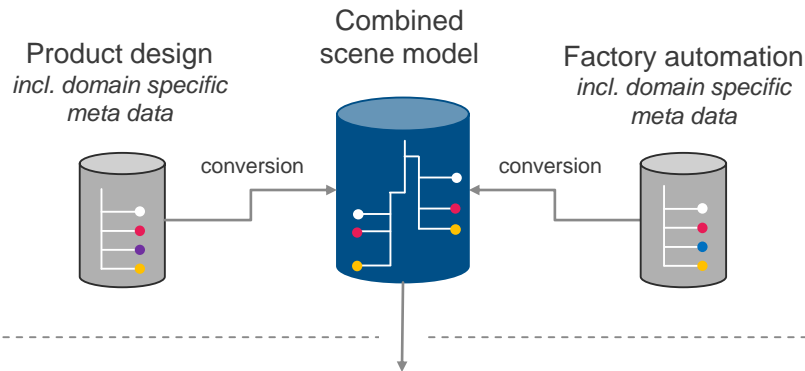
Build causal models of the real world by applying GenAI approach to enable new robotic capabilities in manufacturing operations

Source: BCG



Engineering

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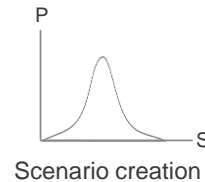
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Scenario creation



Scene generation



Photorealistic rendering

SIM-2-Reality

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Real-time (I)IoT data



Photorealistic Scenes



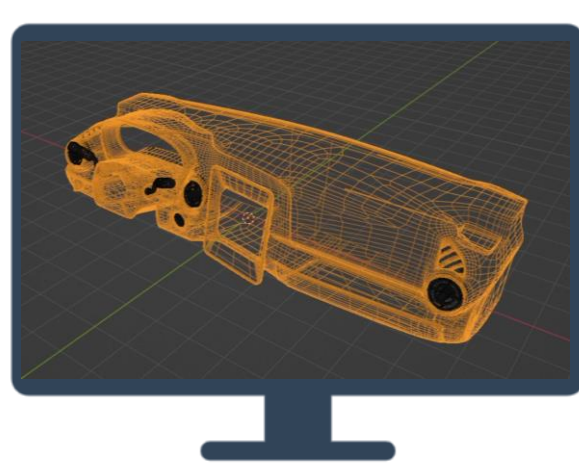
Generative AI

Cognitive Robotics

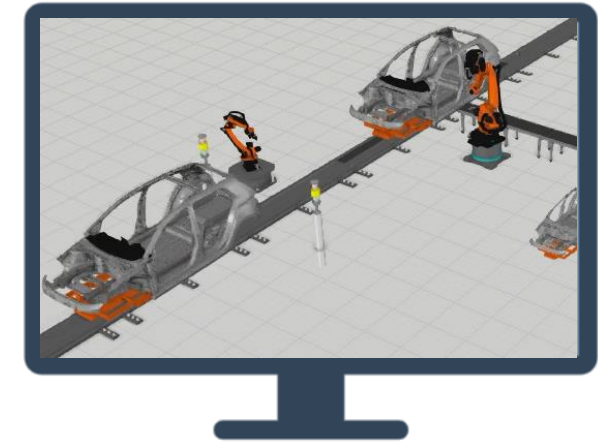
Build causal models of the real world by applying GenAI approach to enable new robotic capabilities in manufacturing operations

Source: BCG

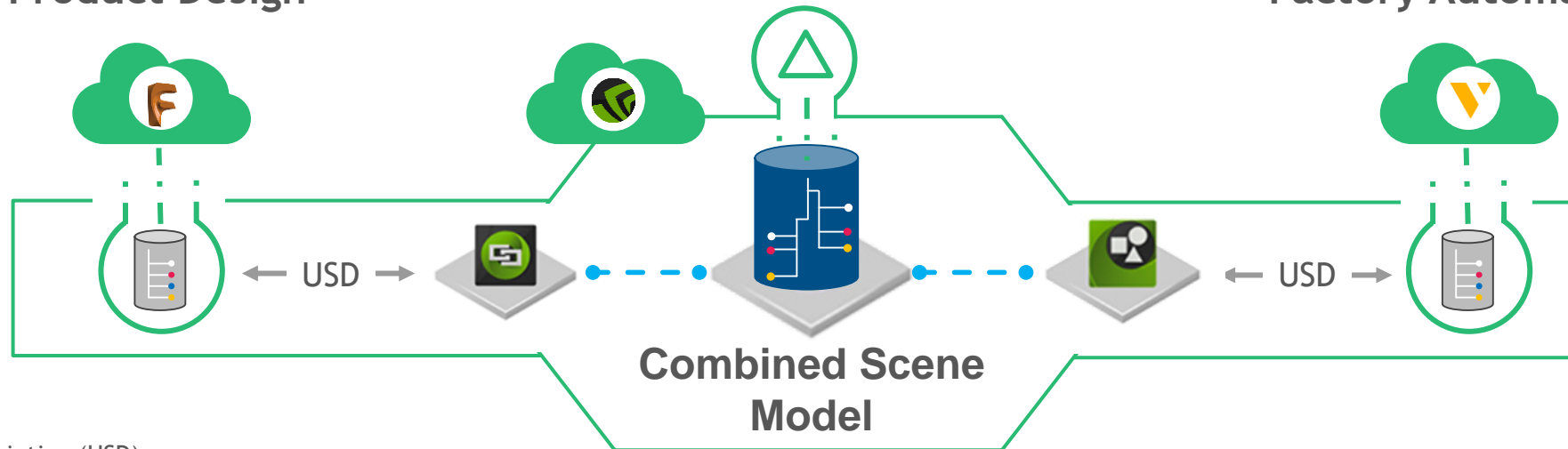
Paradigm shift in collaborative ENG across app domains ... **AWK'23**



Product Design

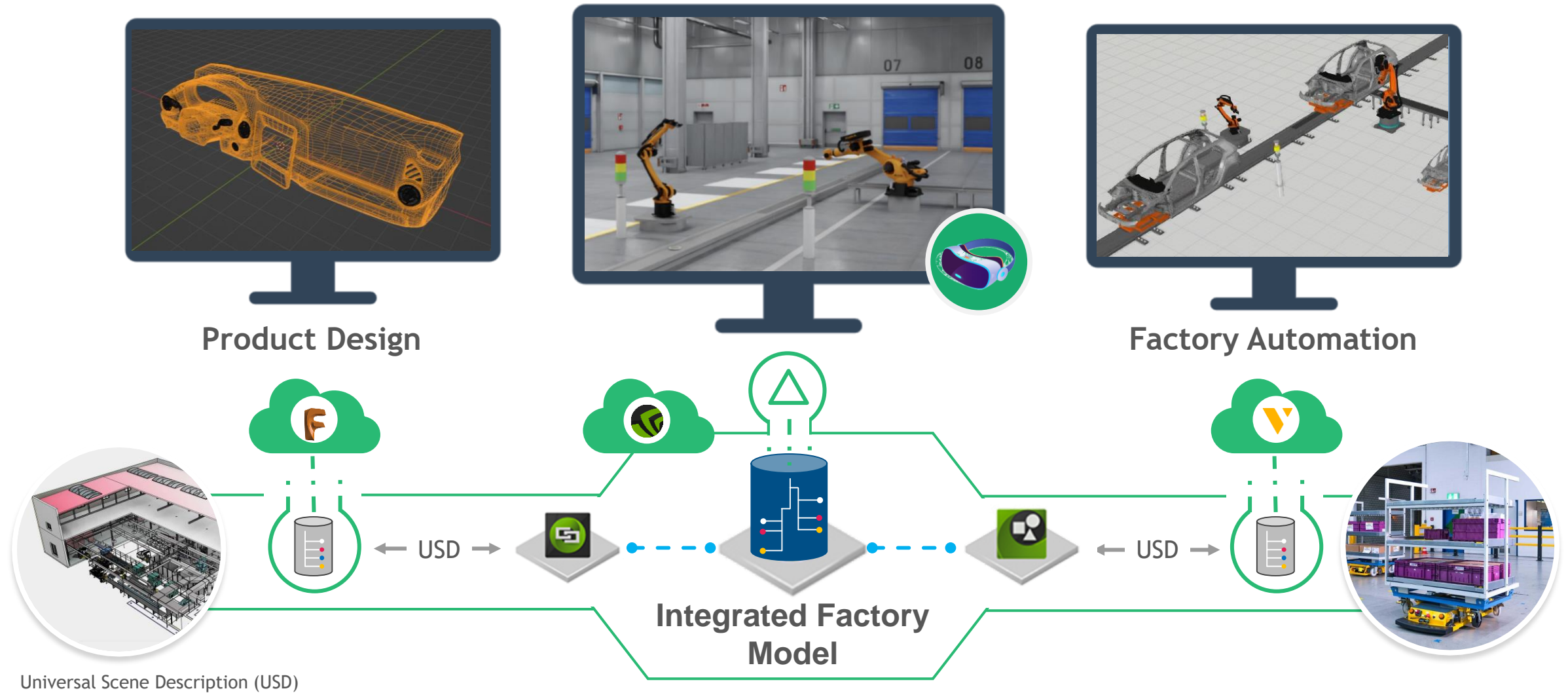


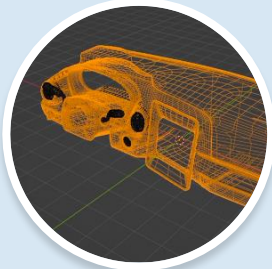
Factory Automation



Universal Scene Description (USD)

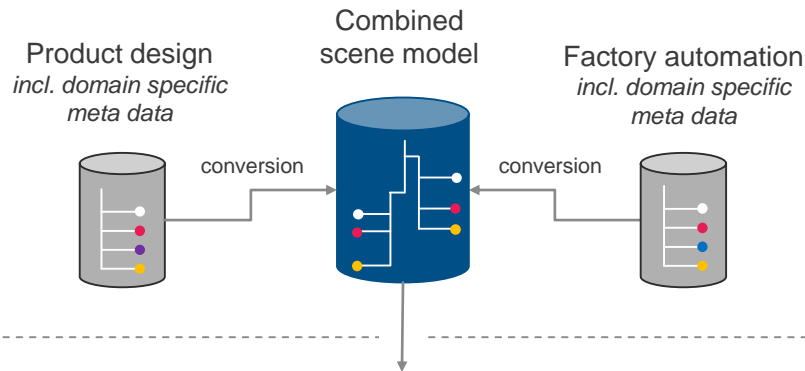
... enables sustainable product- / production system design **AWK'23**





Engineering

Low data inter-operability prevents sustainable engineering



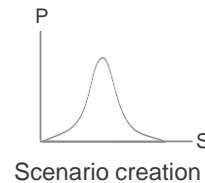
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Real-time (I)IoT data



Photorealistic Scenes

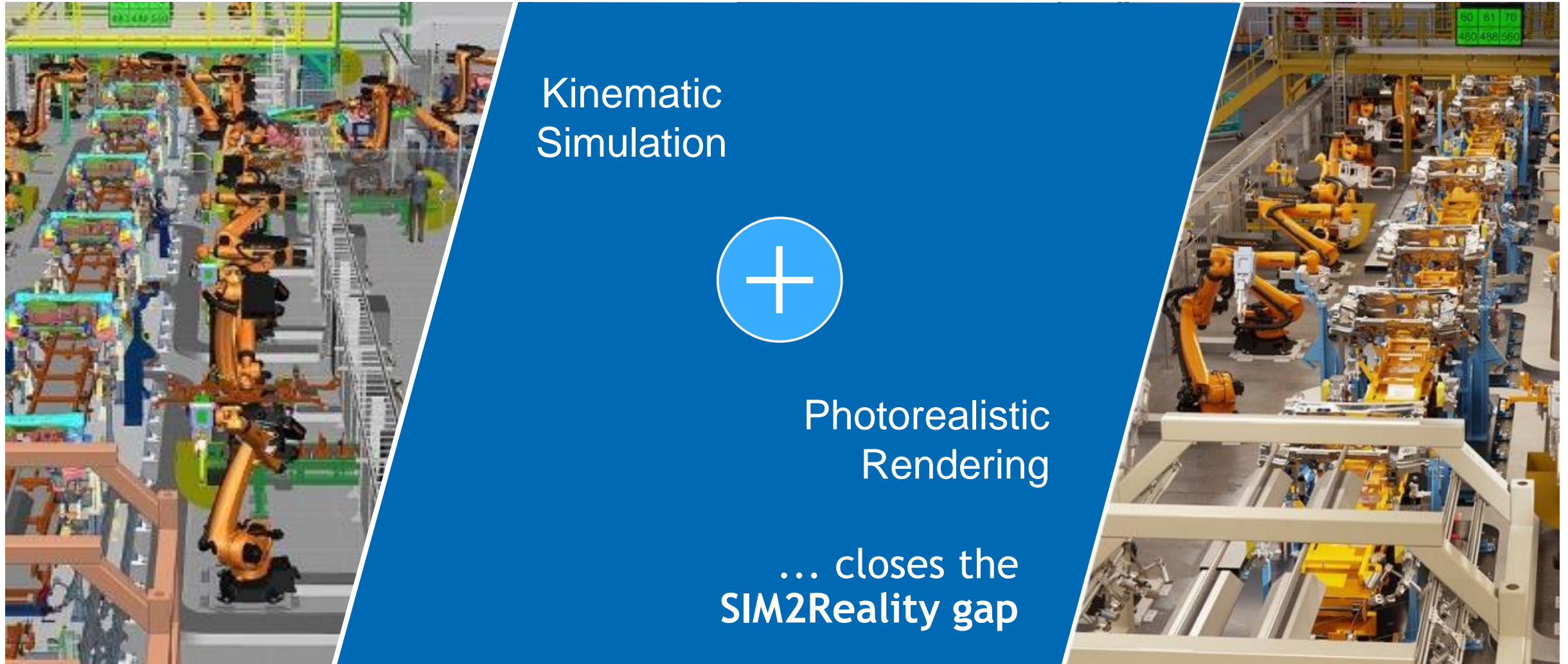


Generative AI

Cognitive Robotics

Build causal models of the real world by applying GenAI approach to enable new robotic capabilities in manufacturing operations

Source: BCG



In a next steps its about building scenarios of reality ...

AWK'23



Photorealistic
Rendering



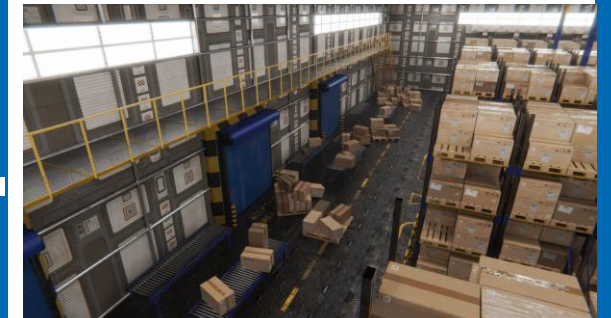
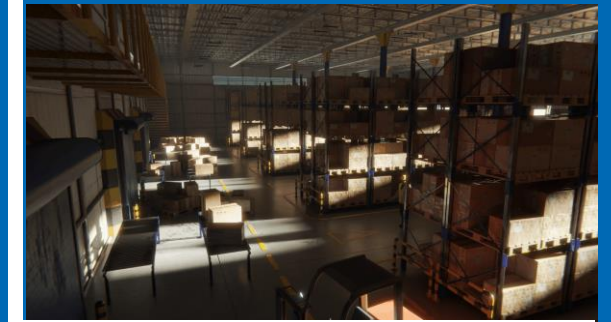
Synthetic
data
generation

Source: Sky Engine AI

Outdoor **weather**
& indoor **lighting**

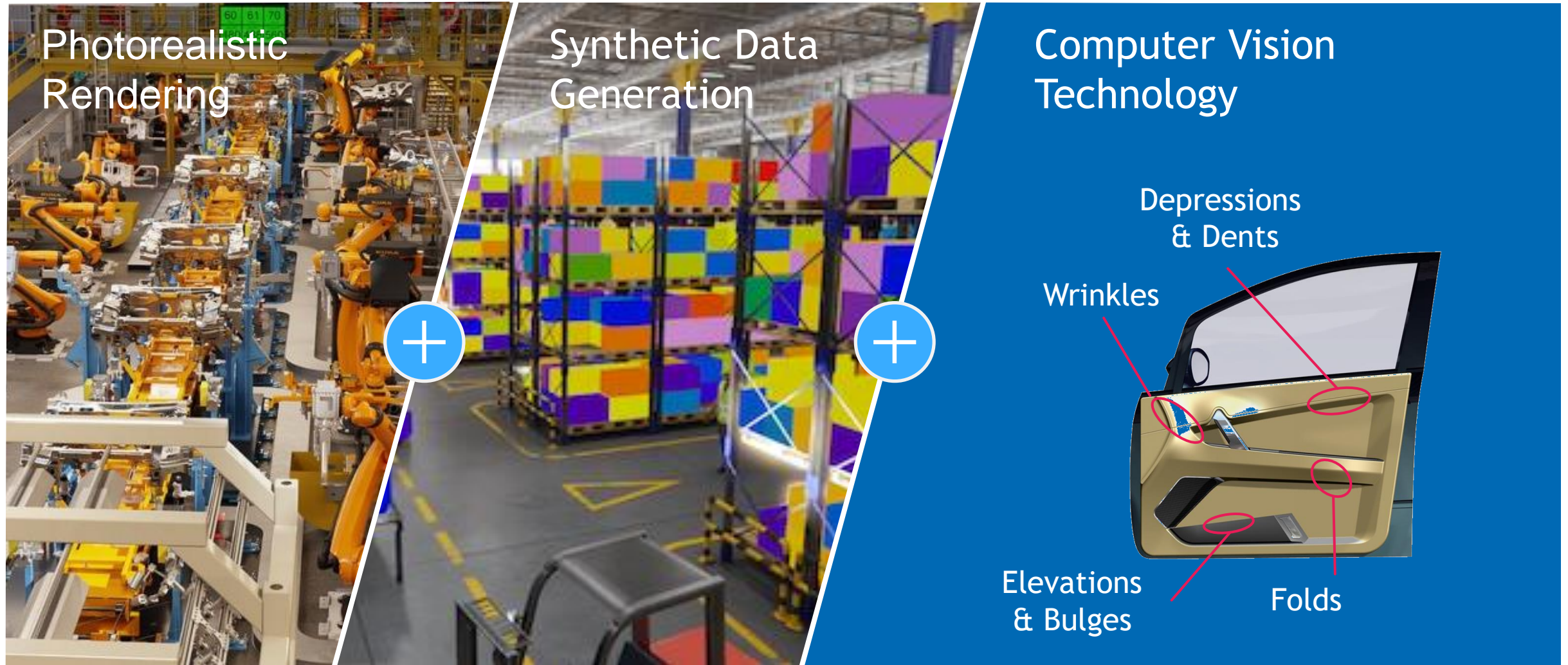
Object materials
(e.g. walls, floor)

Object placement
(e.g. packages,
vehicles, shelves)



... to enable AI Quality Defect Detection at SOP

AWK'23



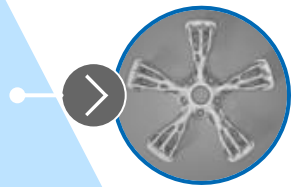
Avoid scrap using synthetic data & photorealistic rendering **AWK'23**

Rendering

Synth Data

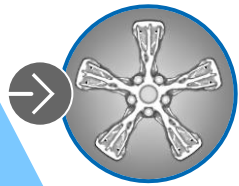
Train AI

Identify **Quality Defects** at Start of Production (SOP)



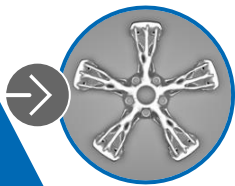
Additive failure

Surplus structures from previous processes



Missing parts

Broken out structures



Surface errors

Scratches, color defects, ...



Engineering & Simulation

Manufacturing Operations

aws

AUTODESK

BCG

SIEMENS



SOFTWARE
DEFINED
AUTOMATION

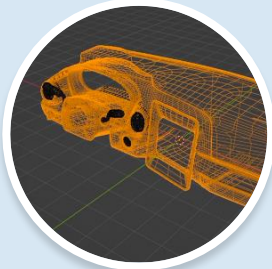


CloudRAIL

WZL
RWTHAACHEN

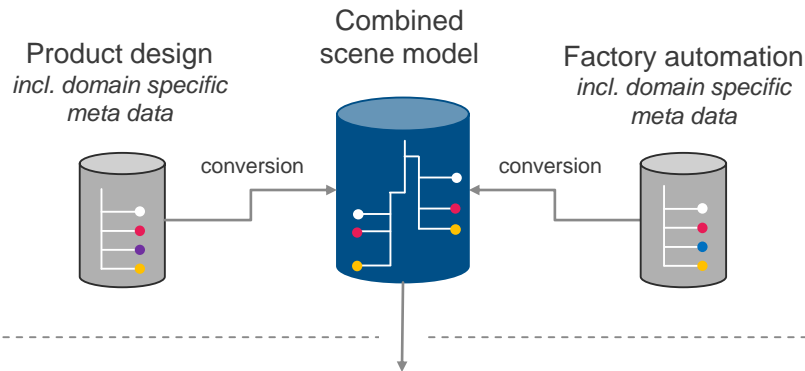


AACHEN CENTER
FOR ADDITIVE
MANUFACTURING



Engineering

Low data inter-operability prevents sustainable engineering



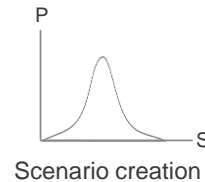
Integrated Factory Model

Improve collaboration across app. domains by using combined scene models



Manufacturing

Lack of production data at SOP prevents optimization - the result is scrap



Scene generation



Photorealistic rendering

SIM-2-Reality

Use photorealistic rendering & synthetic data generation to provide AI training data at SOP



Manual Operations

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Real-time (I)IoT data



Photorealistic Scenes



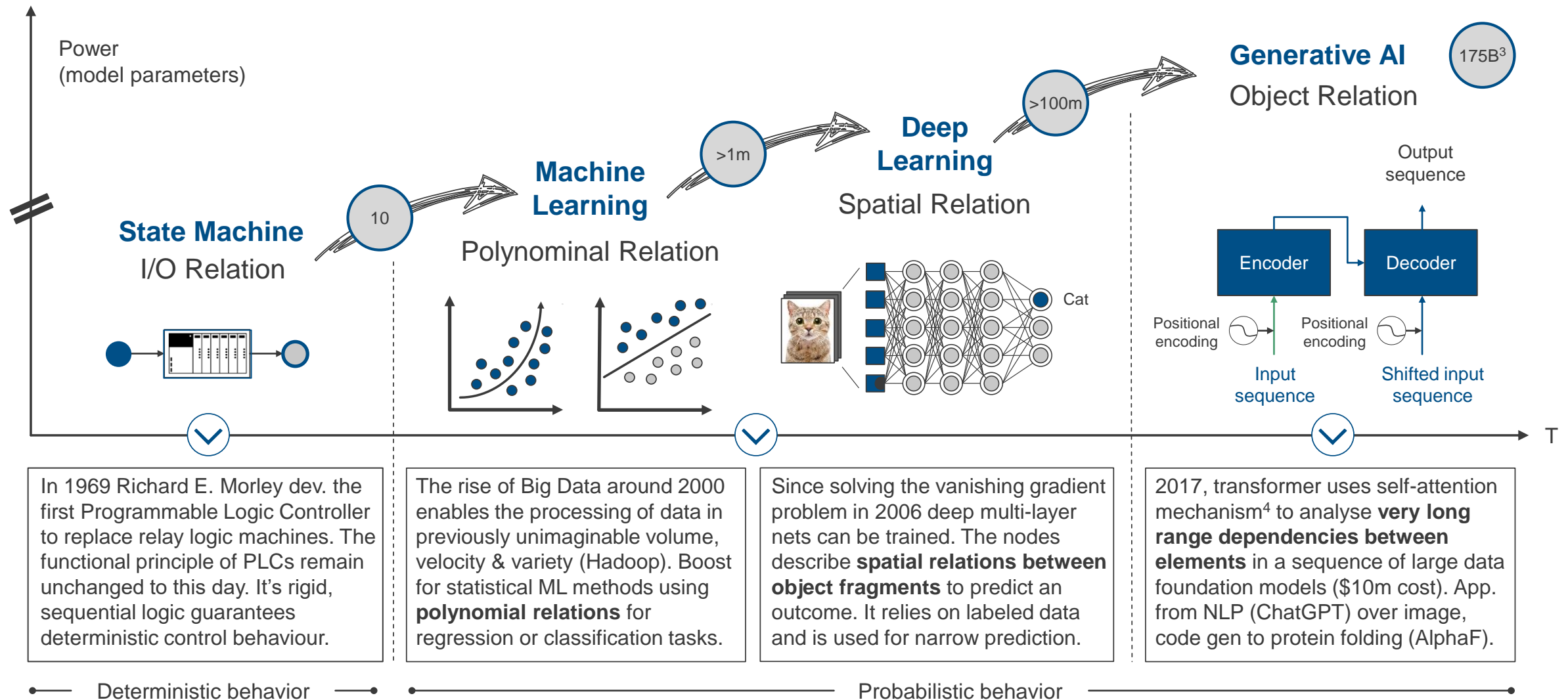
Generative AI

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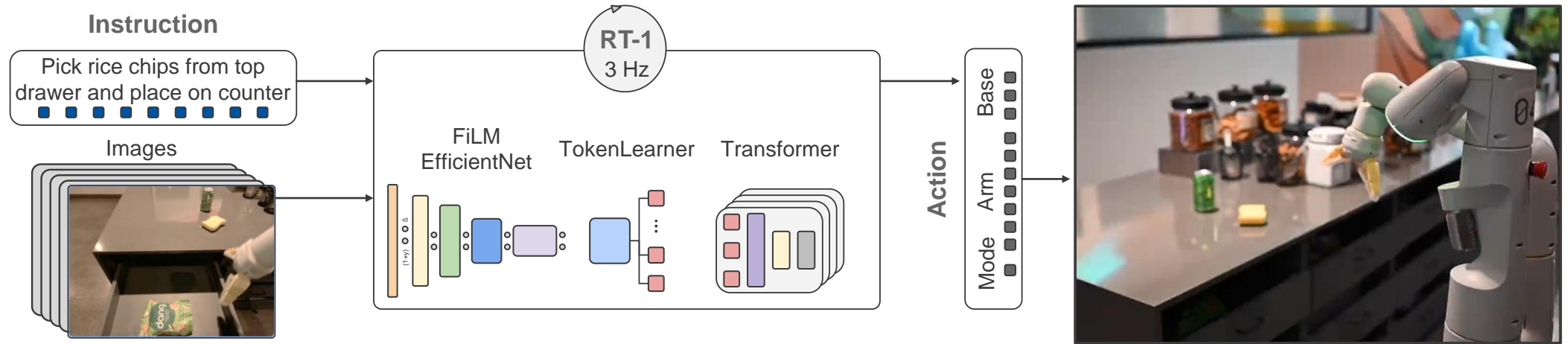
Build causal models of the real world by applying GenAI approach to enable new robotic capabilities in ManuOPS

Source: BCG

The evolution of AI is an evolution of relationship management



First robotic Transformer model for real-time control



Real World Challenge

- Robots did not benefit from GenAI so far because
- lack of large-scale & diverse robotic data
 - data collection is particularly expensive & challenging to create
 - inference models are not fast enough for real-time control

Source: Google Research

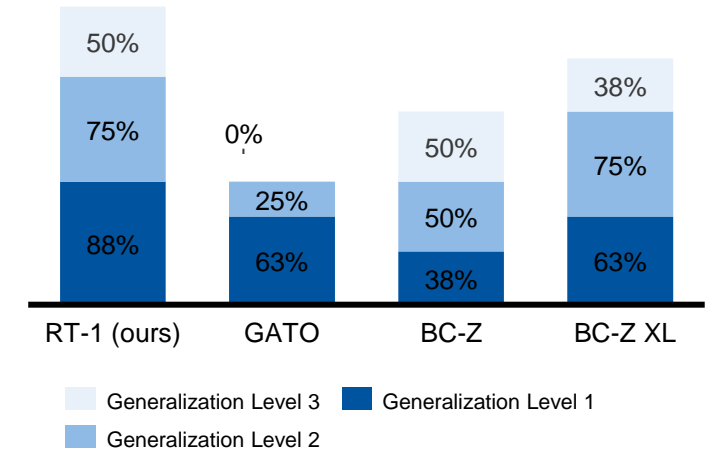
Multi-task Robotic

Transformer Model (RT-1) is built on a transformer architecture that takes a short history of images from a robot's camera along with task descriptions expressed in natural language as inputs and directly outputs tokenized robot actions.

Real World Data Set

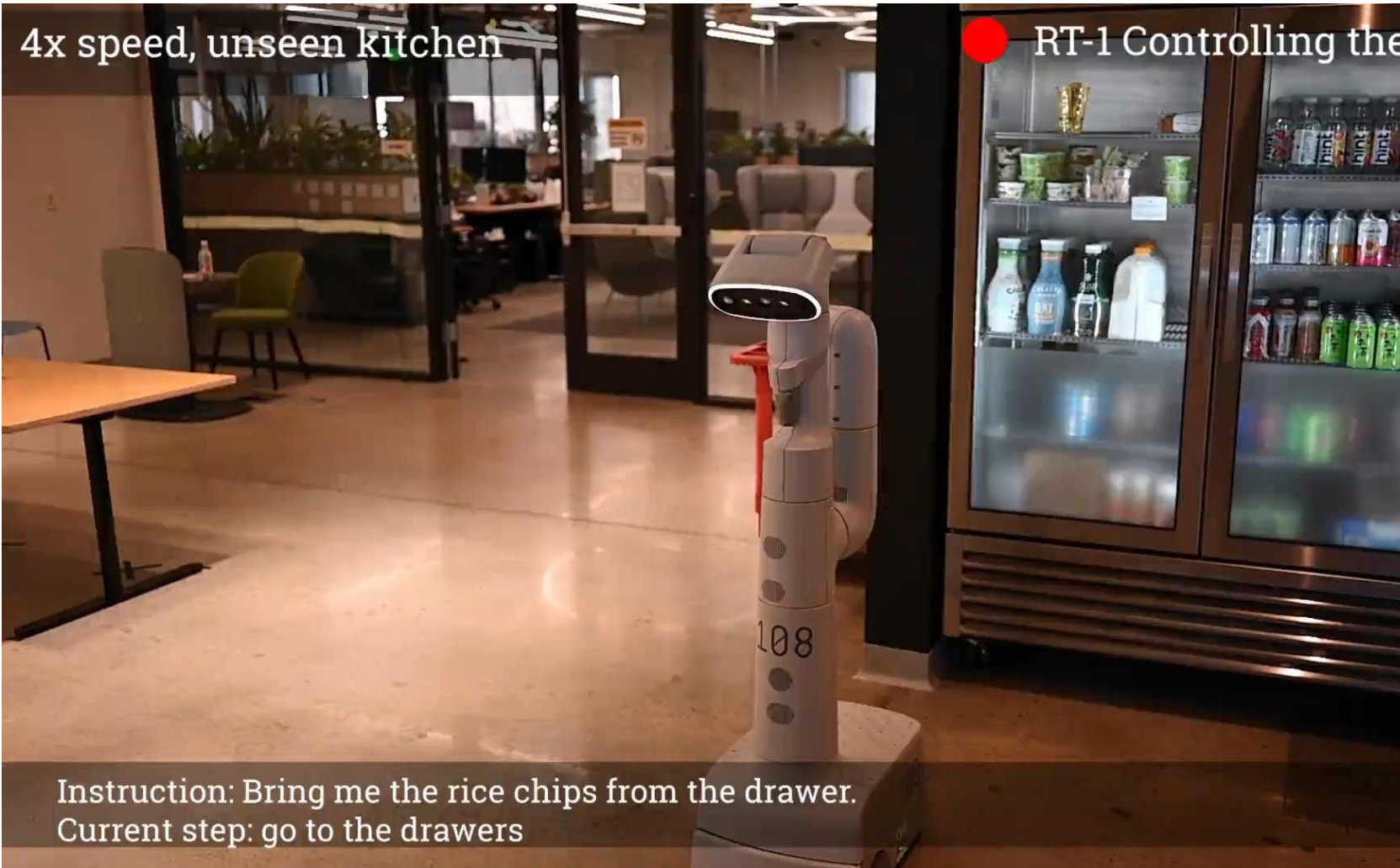
The RT-1 is trained on a large-scale, real-world robotics dataset of 130k episodes that cover 700+ tasks, collected using a fleet of 13 robots over 17 months.

Extensive generalization abilities



Now replace the kitchen environment with a warehouse ... **AWK'23**

4x speed, unseen kitchen

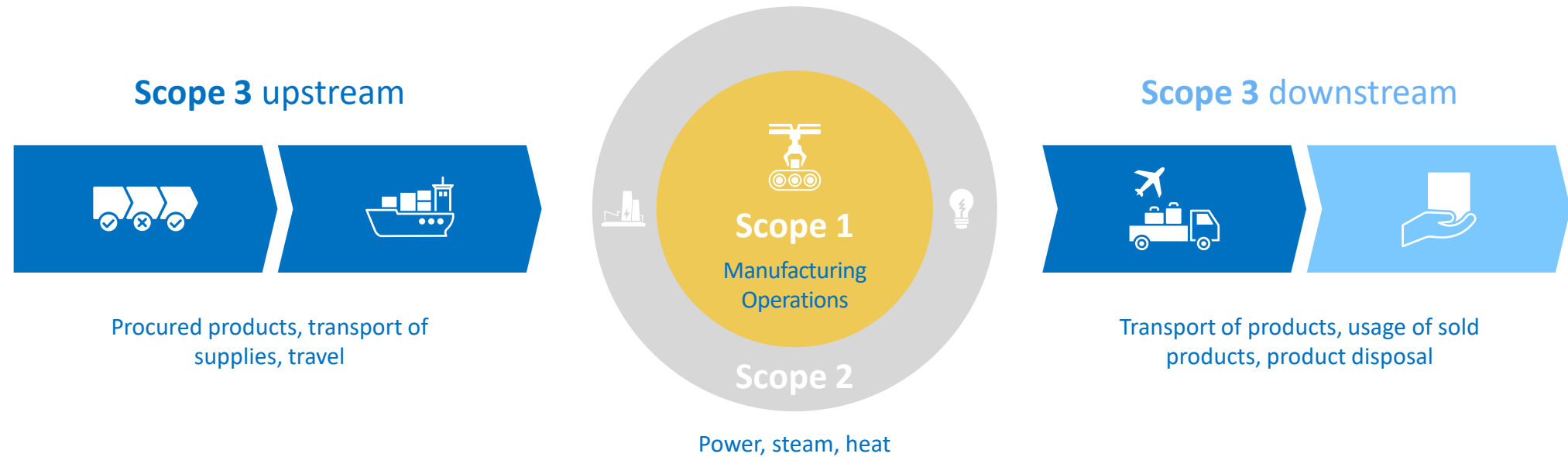


RT-1 Controlling the

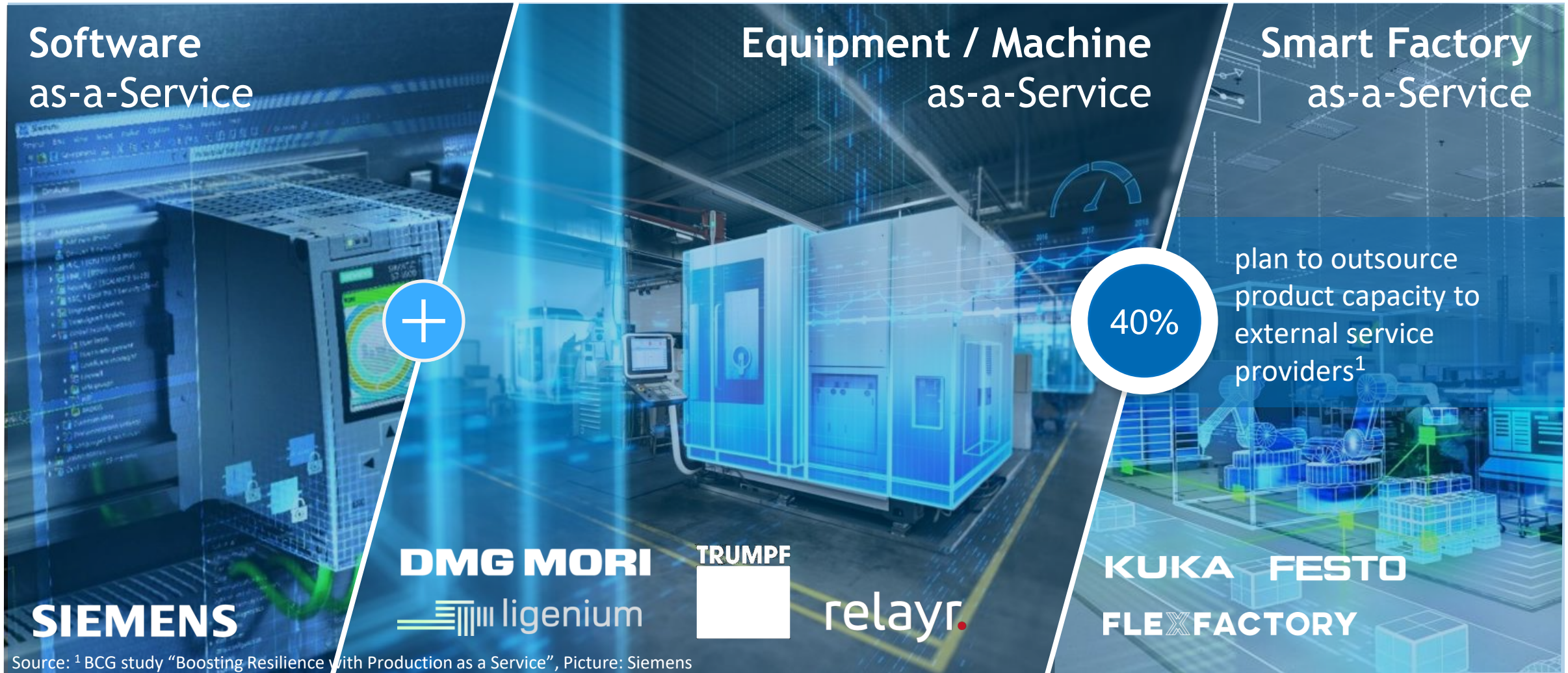
Instruction: Bring me the rice chips from the drawer.
Current step: go to the drawers



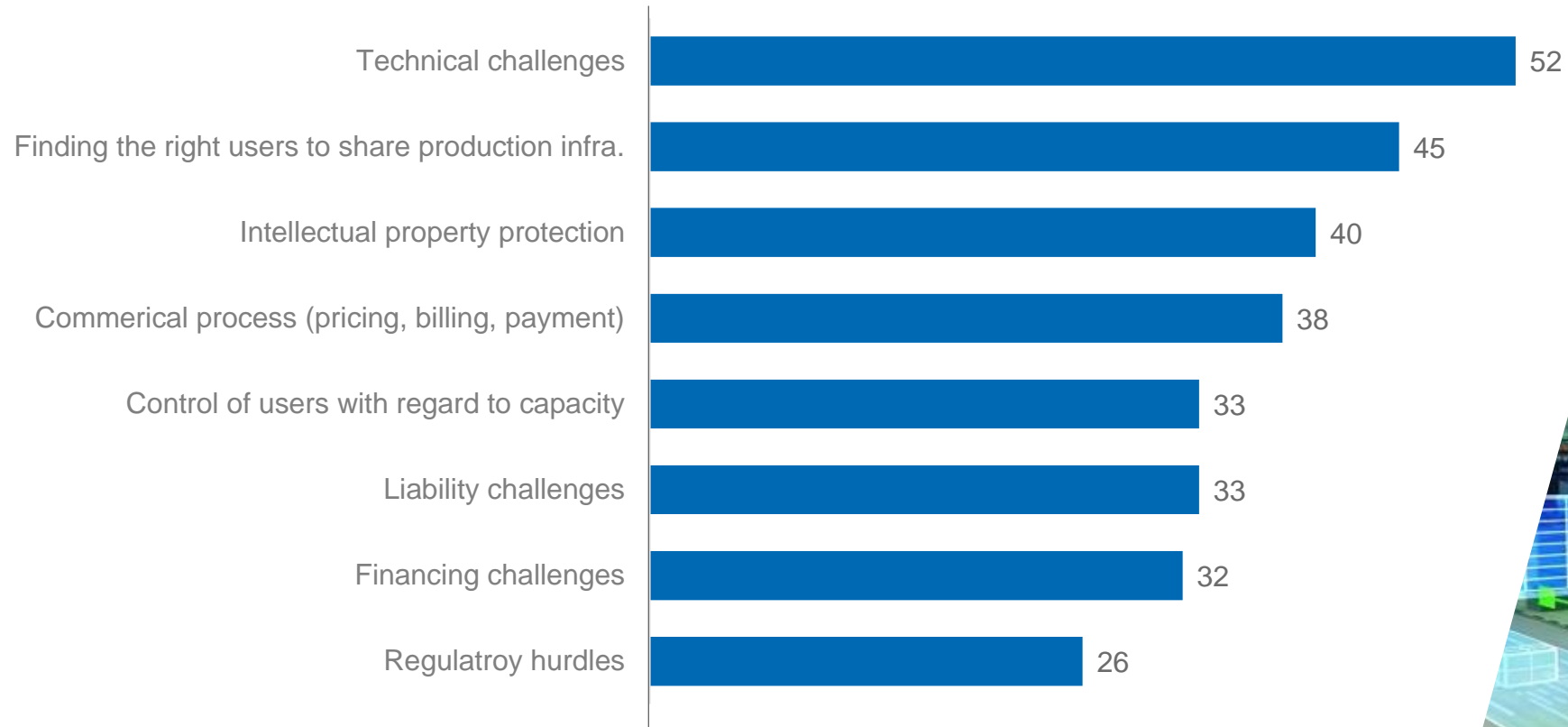
However, to achieve the climate targets, an additional rethink is required ...



... products should be able to be used for a significantly longer period of time



What prevents companies from using Production-aaS ?



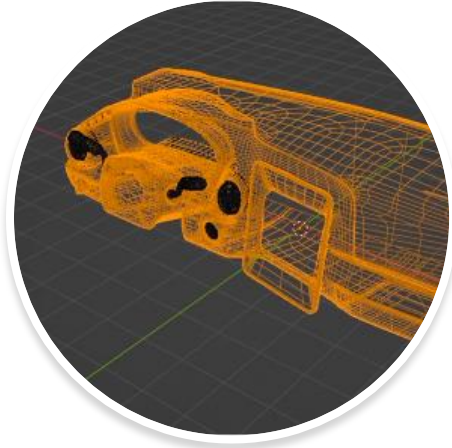
Source: BCG Factory of the Future survey 2022

Note: Survey question: "What do you see as main challenges to using production as a service?"

Respondents were asked to select their top three



It's an epic ENG challenge let's get started - time is running! **AWK'23**



Sustainable Engineering

Low data interoperability and lack of transparency along the value chain prevents **sustainable engineering**.

An **Integrated Factory Model** is needed that allows **design for** recycling, repair, re-use, automation ... from the ground up.



Close SIM-2-Reality

Production of **scrap** especially at SOP is a key scope 1 emitter.

Photorealistic rendering and **synthetic data generation** can help to close the SIM2reality gap and provide **training data @SOP** to prevent scrap.



Next level of Automation

Today, 50% of products come from "**best-cost countries**". To reduce CO₂ through global sourcing, **relocation into high-wage countries** is needed.

Progress in **GenAI** enables robots to **take over complex tasks** previously reserved for humans.



Production-aaS Model

To significantly reduce resource consumption, **products** must be able to be used for **much longer**.

This requires new **as-a-service business models** to make optimum use of **resources** in the sense of a **circular economy**.

It was a pleasure to speak on behalf of this group of experts **AWK'23**



Christoph Alt
ligenium GmbH



Philipp Blanke
Werkzeugmaschinenlabor
WZL der RWTH Aachen



Prof. Dr. Christian Brecher
Werkzeugmaschinenlabor
WZL der RWTH Aachen



Dr. Frank Breitenbach
EDAG Production Solutions
GmbH & Co. KG



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Group



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Dr. Alexander Engels
aiXbrain GmbH



Mathias Kaldenhoff
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SE & Co. KG



Oliver Petrovic
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Dr. Simon Rekers
DX FACTURE GmbH



Dr. Richard Schares
Makino Europe GmbH



Tilman Taubert
Cisco Systems, Inc.



Minh Trinh
Werkzeugmaschinenlabor
WZL der RWTH Aachen



Steffen Wurm
Werkzeugmaschinenlabor
WZL der RWTH Aachen



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THANK YOU



Dr. Tilman Buchner
Partner & Global Leader ICO
Boston Consulting Group