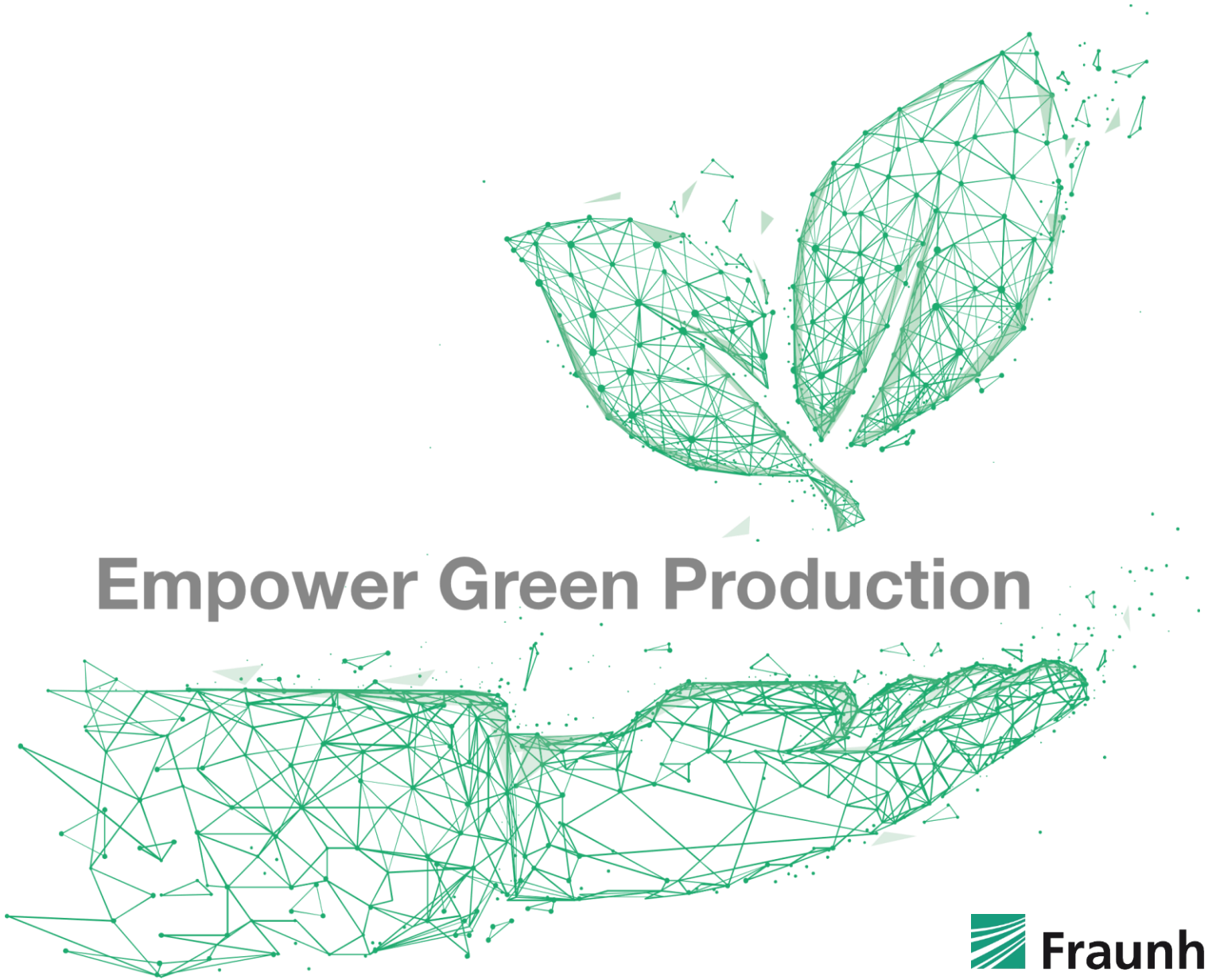

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Data Structures for Resilience in Life Cycle Sustainability

Keynote – Session 1

Prof. Dr.-Ing. Robert Schmitt

Fraunhofer IPT

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Data Structures for Resilience in Life Cycle Sustainability

© Brett Ryder
Data Deluge
2009

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Data Structures for Resilience in Life Cycle Sustainability

Meaningful data instead of data deluge: Sustainable data structures for sustainable production.

*Our sensor, software and autonomous technologies free customers to navigate **the internet of things data deluge** that's essentially been holding industry back from profitable, scalable, sustainable growth.*

#Sustainability
#Digitalization
#Resilience

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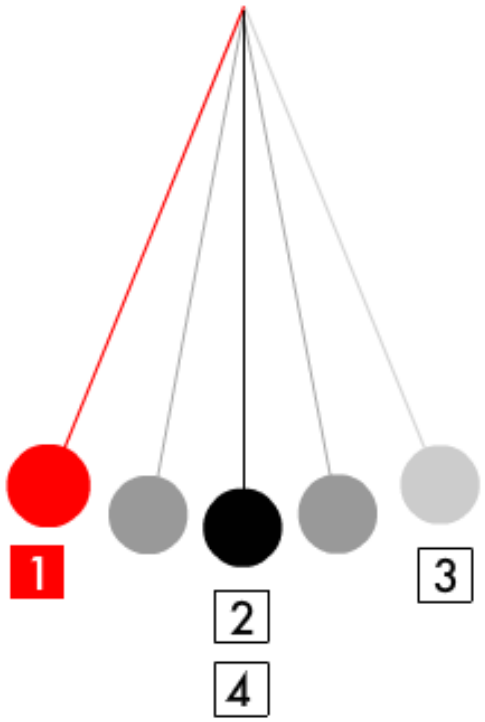
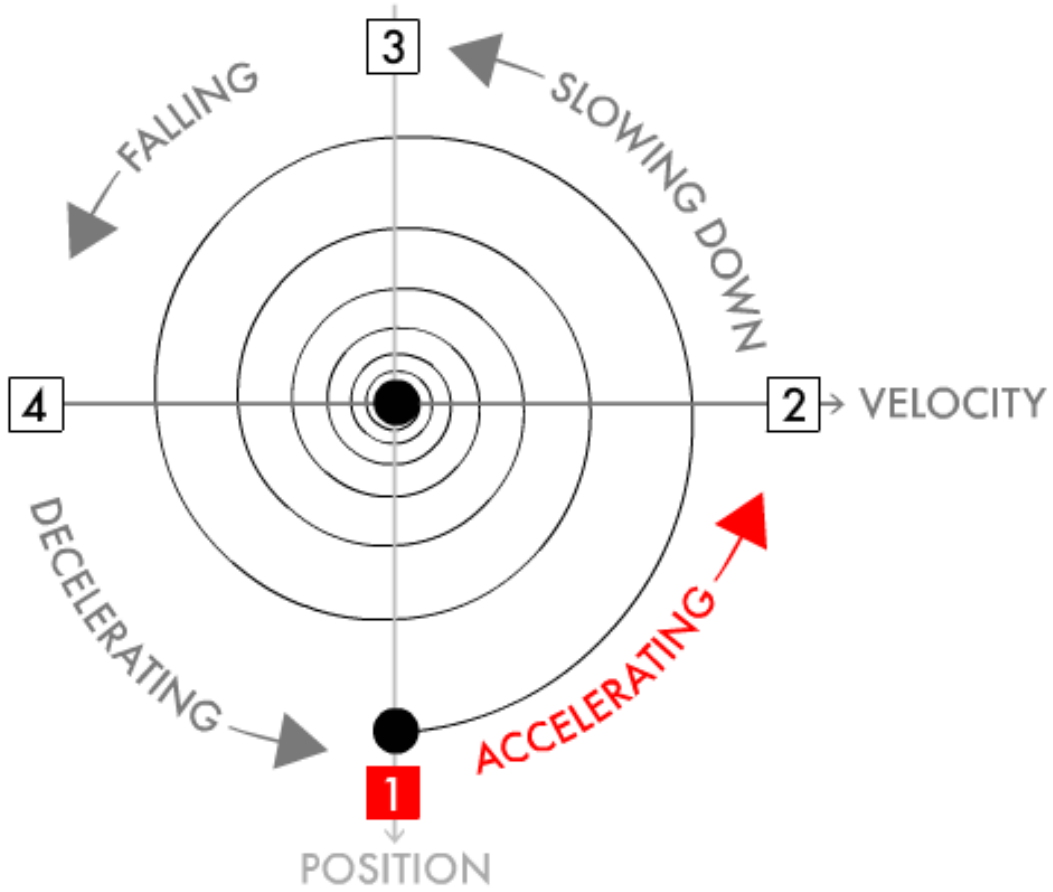
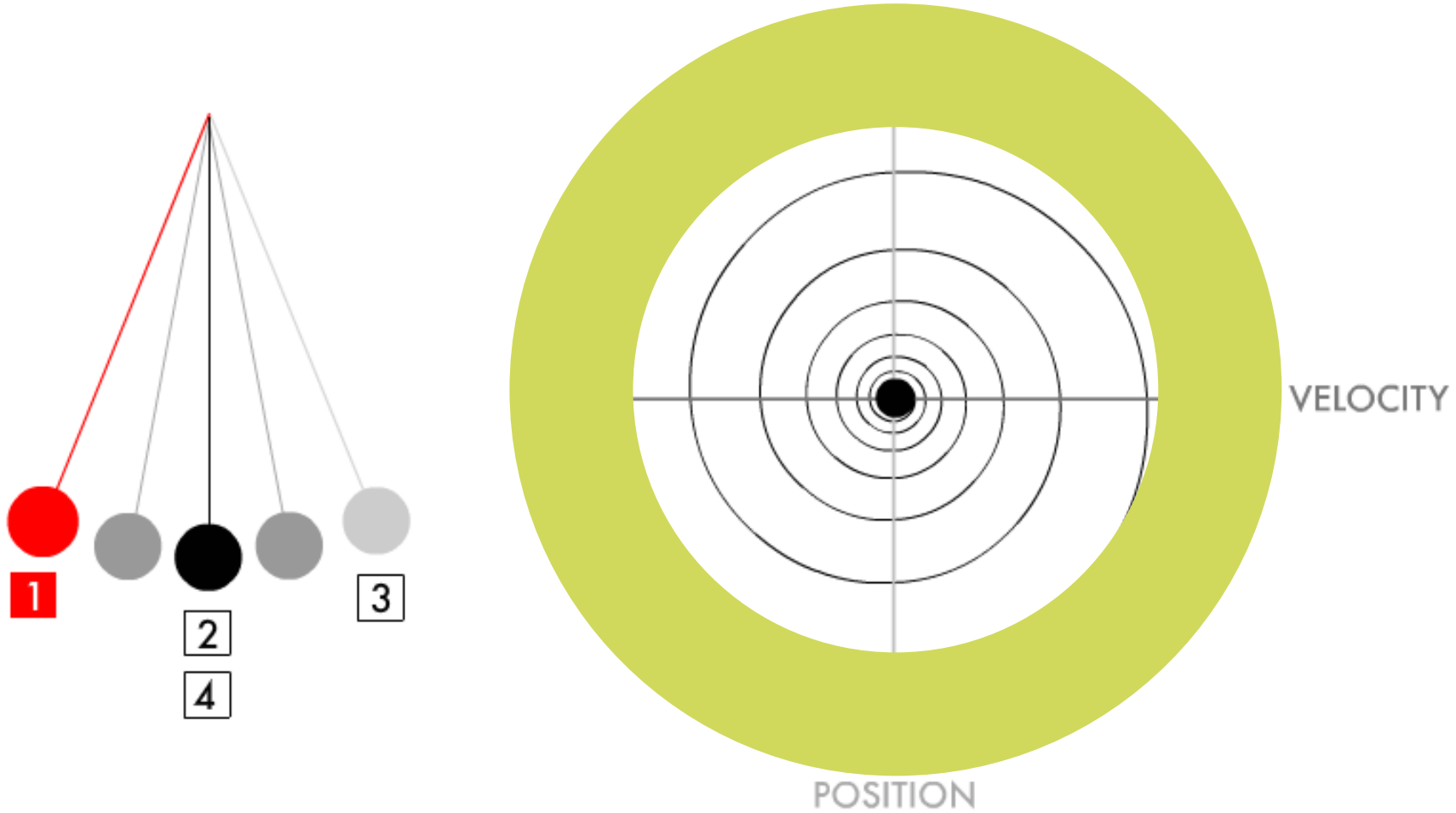
Circular Economy as Phase Space
Data Structures for Resilience in Life Cycle Sustainability





Dorling, D.: Slowdown: The End of the Great Acceleration-and Why It's Good for the Planet, the Economy, and Our Lives, 2020

Circular Economy as Phase Space
Data Structures for Resilience in Life Cycle Sustainability



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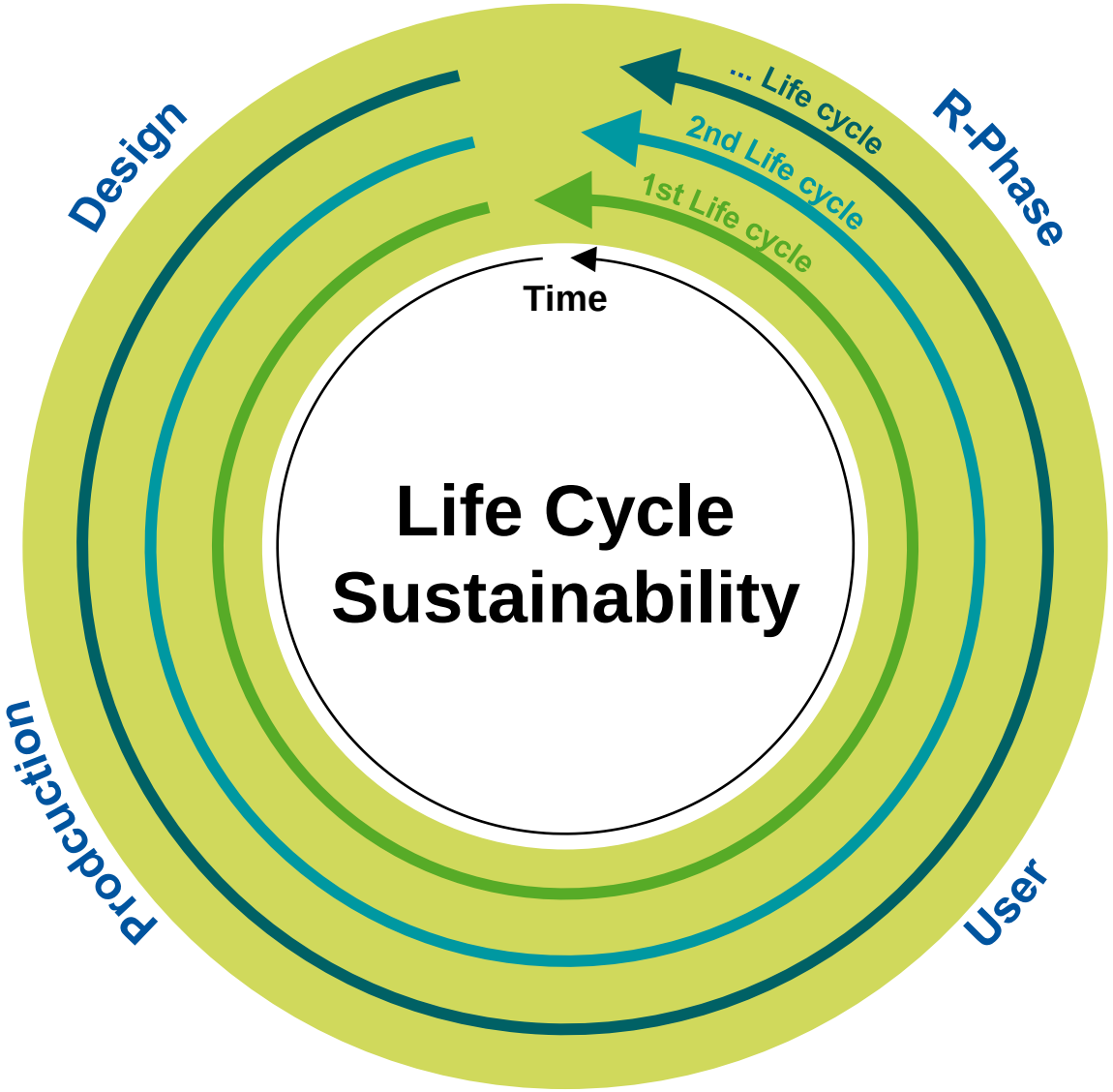

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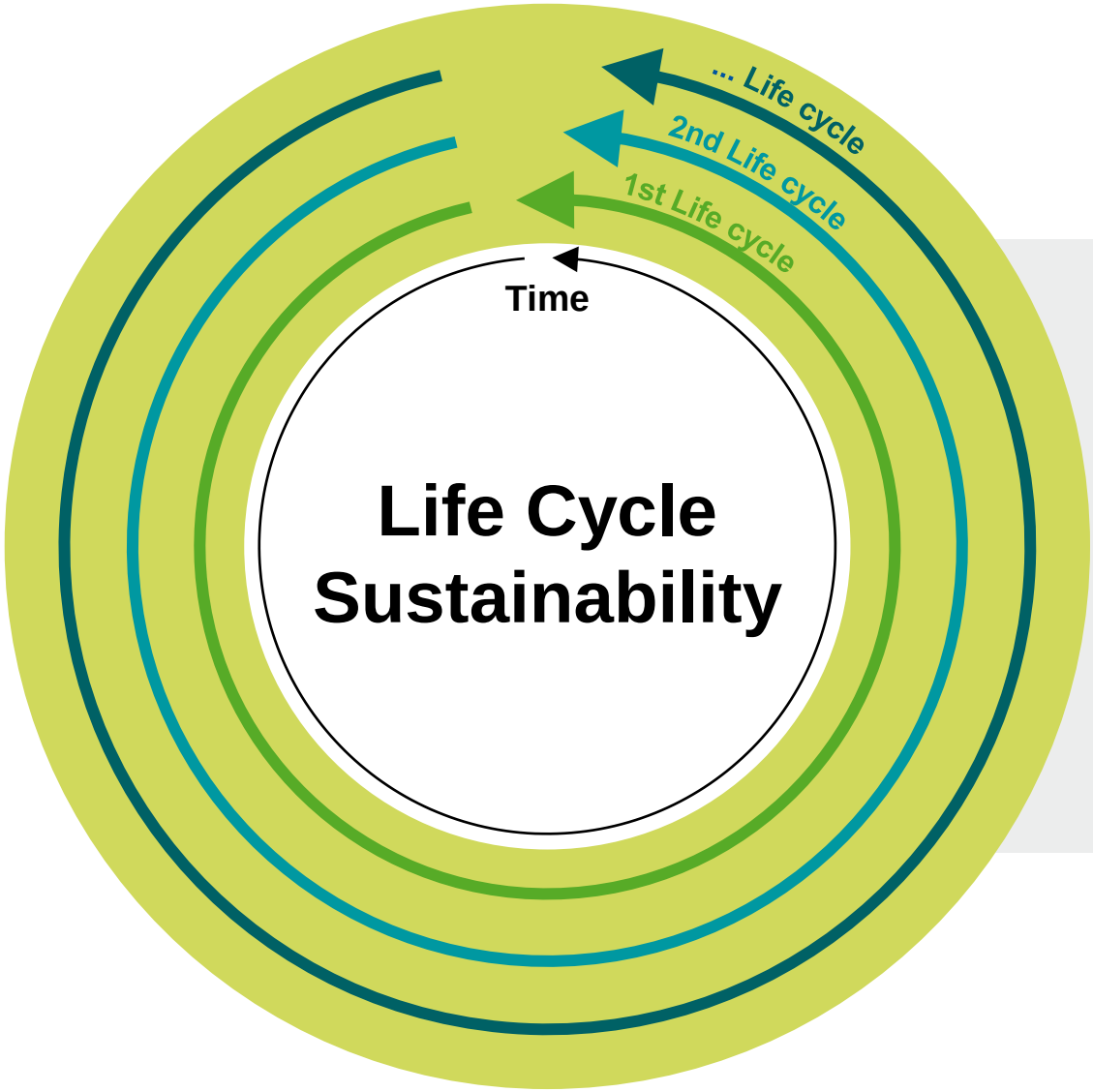
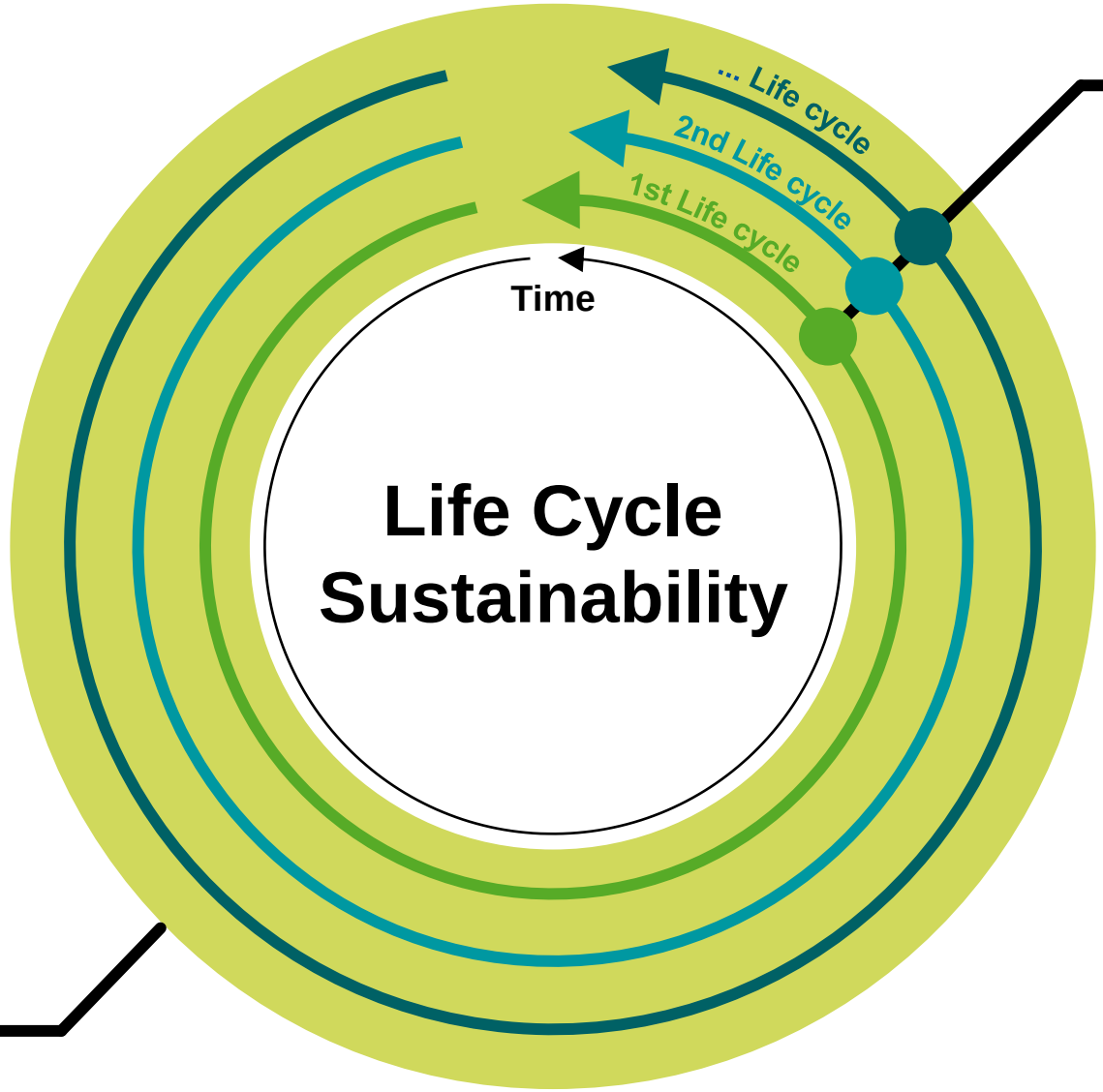
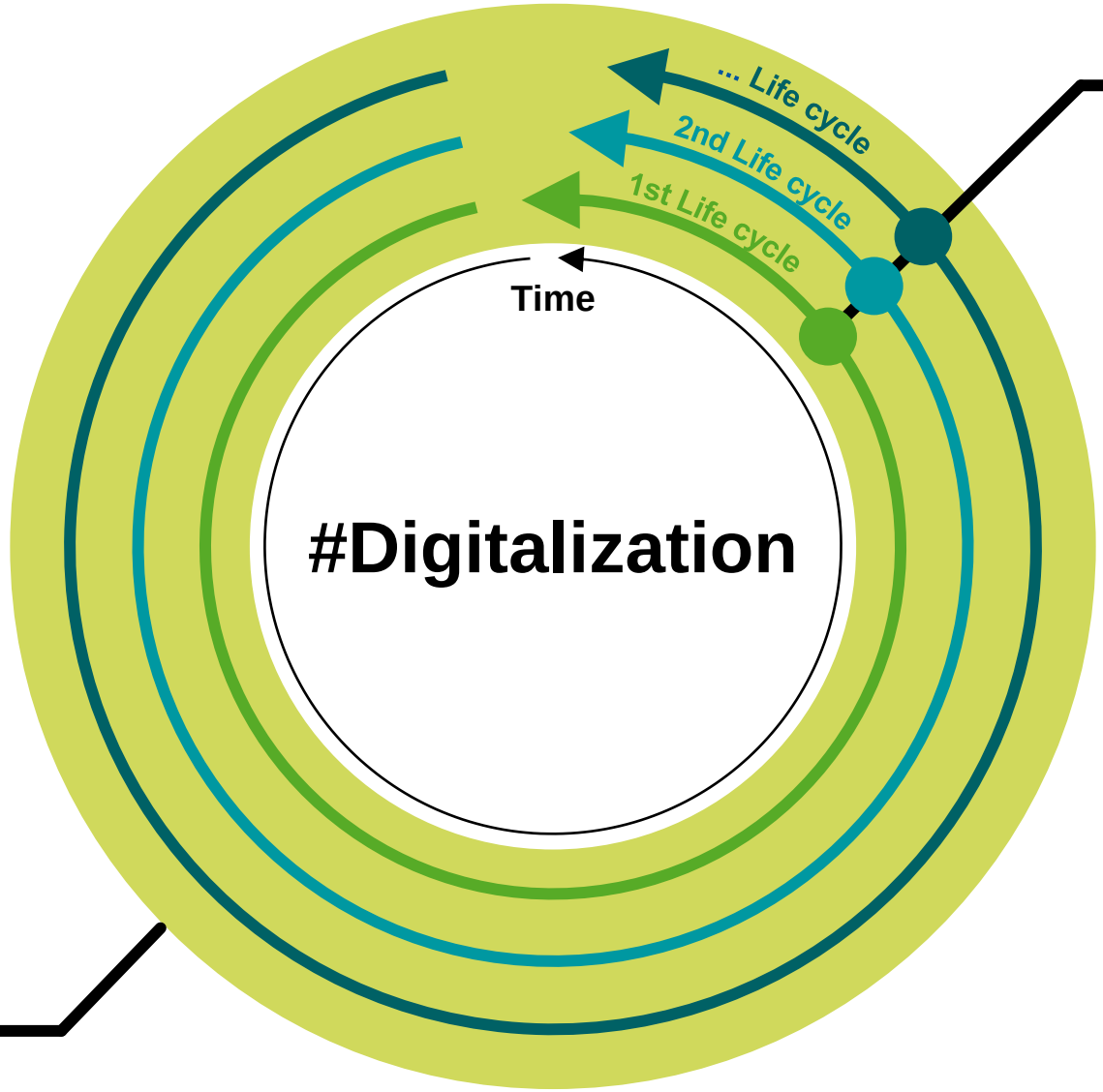


Life Cycle Sustainability is the objective fulfillment of defined sustainability criteria over the entire life cycle of a product, including consideration of previous and subsequent life cycles of the product itself or individual components.



R-Strategies

Sustainability criteria

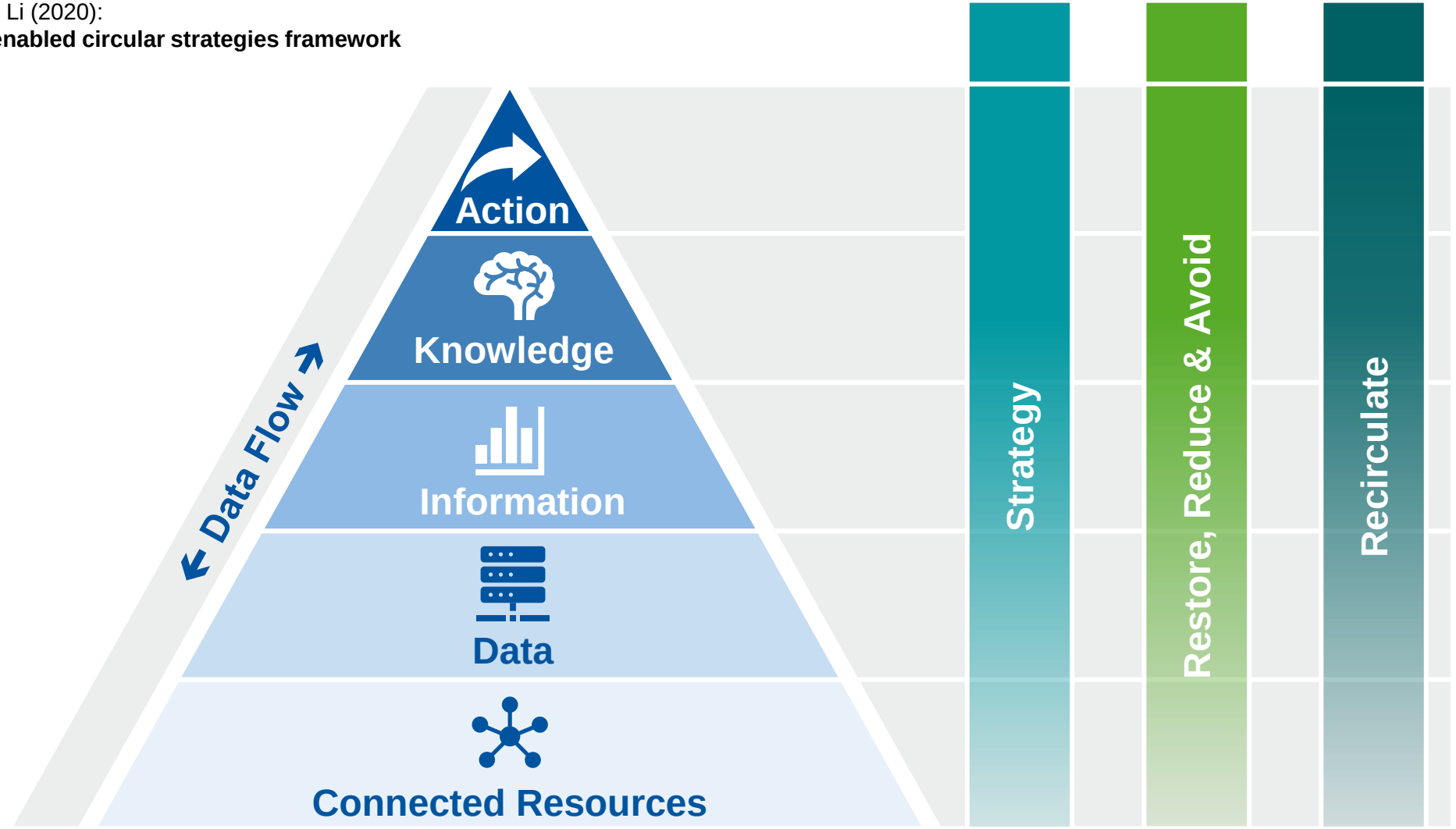


R-Strategies

Sustainability criteria

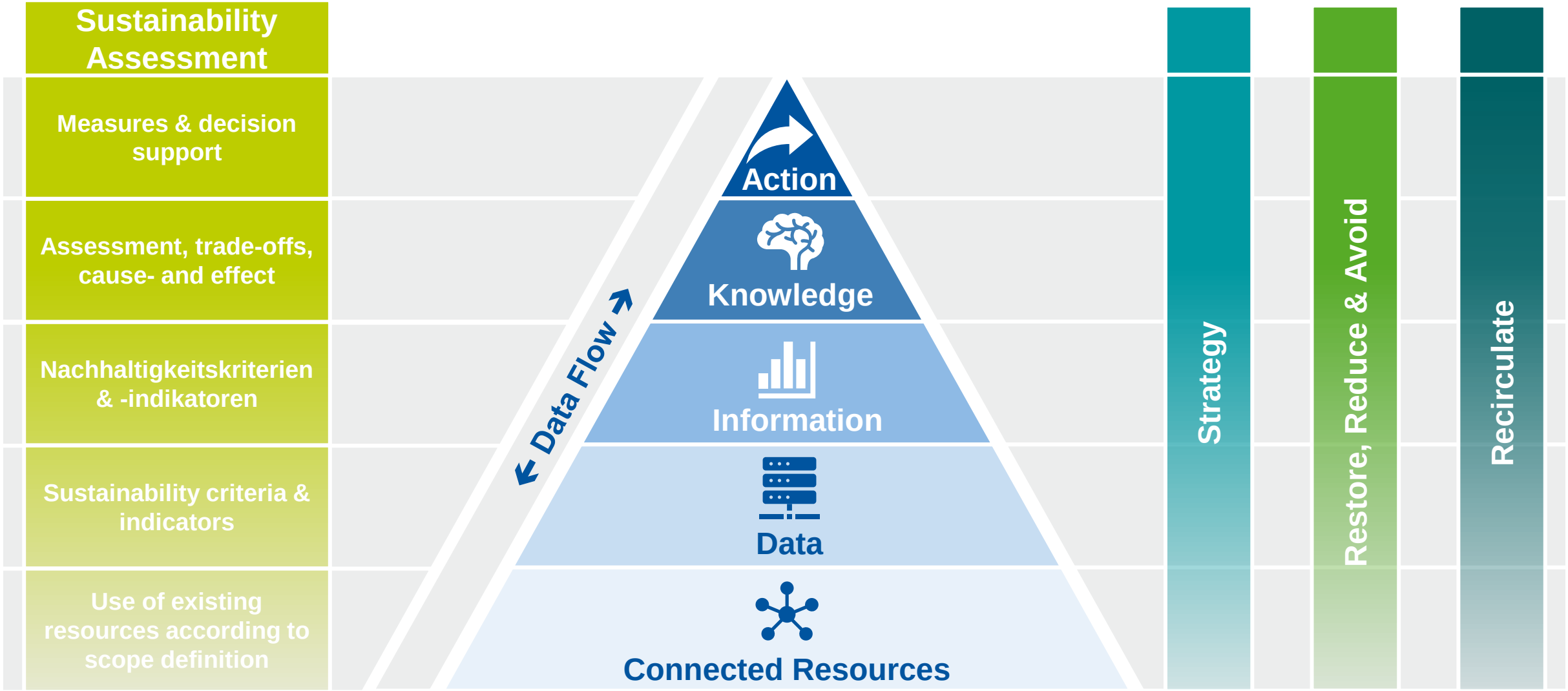
Datengetriebene Circular Economy aus Sicht der Wissenspyramide
Data Structures for Resilience in Life Cycle Sustainability

E. Kristoffersen, F. Blomsma, P. Mikale, J. Li (2020):
The smart circular economy: A digital-enabled circular strategies framework for manufacturing companies



Datengetriebene Circular Economy aus Sicht der Wissenspyramide

Data Structures for Resilience in Life Cycle Sustainability



Contextualized information is a necessary enabler of #LifeCycleSustainability.

Data Structures for Resilience in Life Cycle Sustainability

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2023
Recycling-optimized material mix
Repair-friendly Design
20+ Years of lifetime
Updatable software

1989

Recycling-optimized material mix

Repair-friedly Design

20+ Years of lifetime

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2023

?

1989

1989

0.859	0.327	0.698
0.411	0.333	0.254
0.833	0.031	0.353
0.827	0.178	0.730
0.308	0.567	0.334
0.462	0.599	0.926
0.353	0.208	0.386
0.510	0.048	0.410
0.792	0.724	0.270
0.506	0.423	0.030
0.594	0.141	0.503
0.270	0.992	0.781
0.156	0.848	0.634
0.501	0.138	0.680

2023

0.859 0.327 0.698
0.411 0.333 0.254
0.833 0.031 0.353
0.827 [illegible] 0.730
0.30[illegible].567 [illegible].334
0.462 0.599 [illegible].926
0.353 0.20[illegible] [illegible].386
0.510 0.[illegible] 0.410
0.792 0.[illegible]4 0.270
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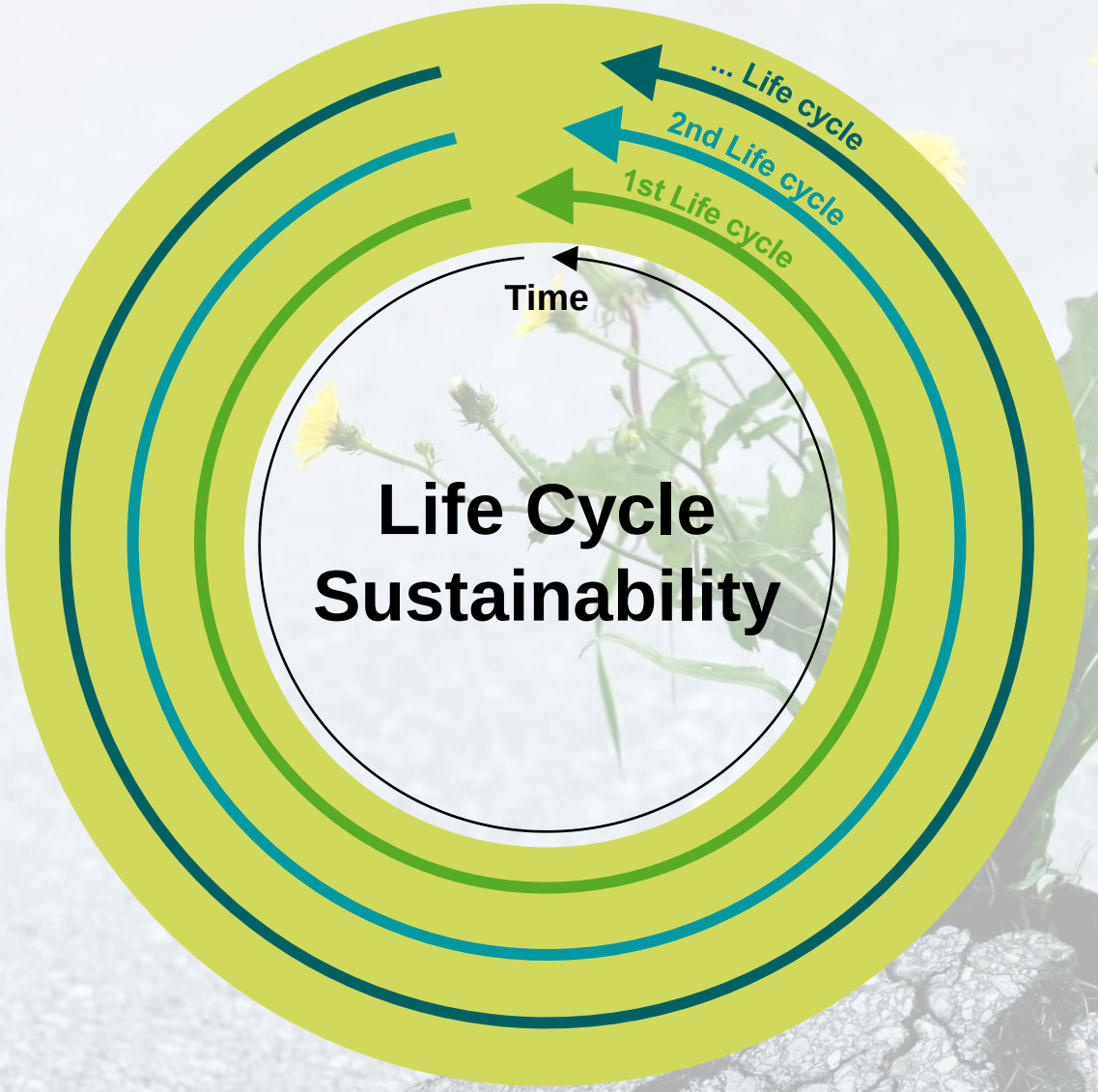
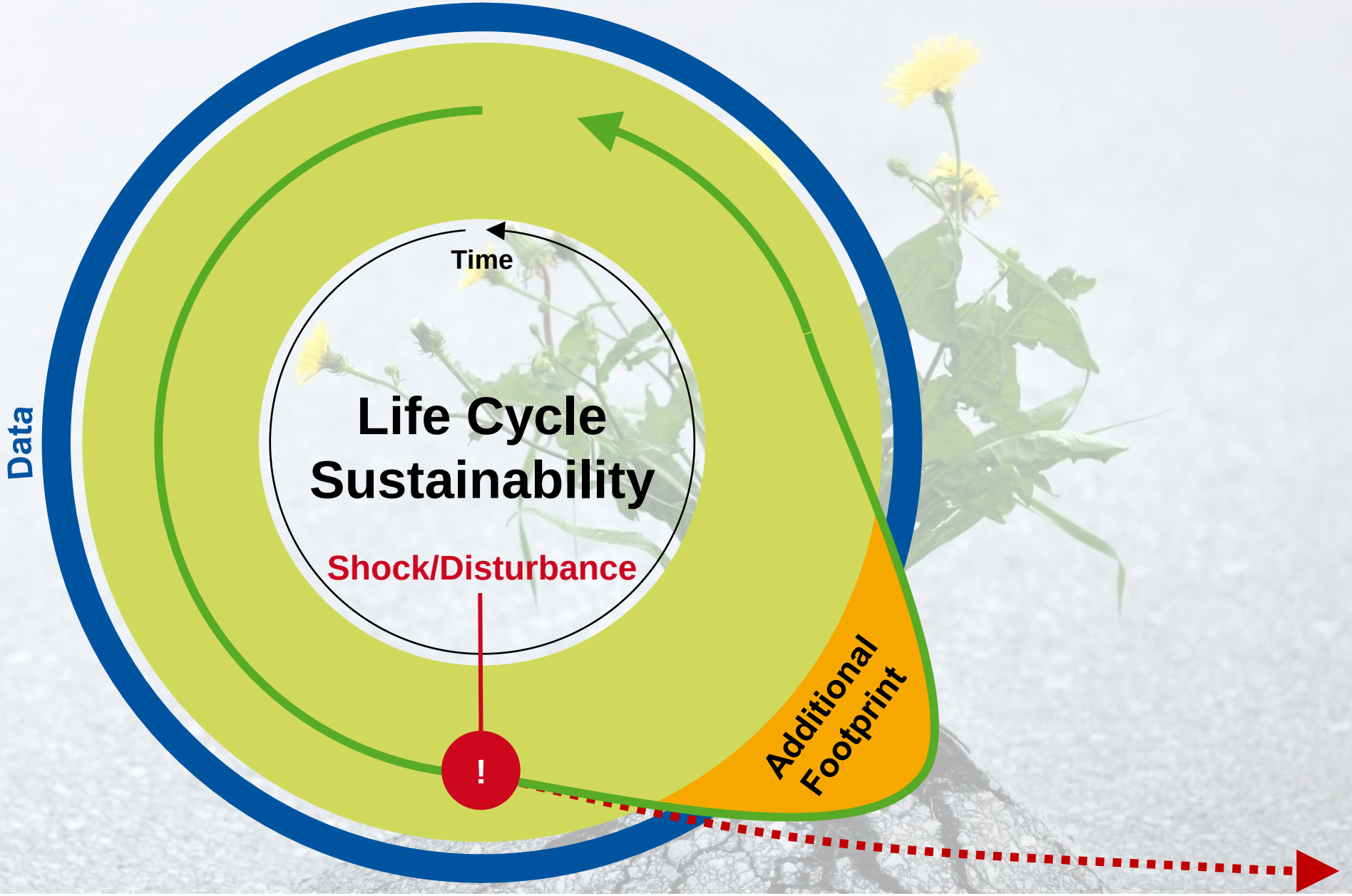
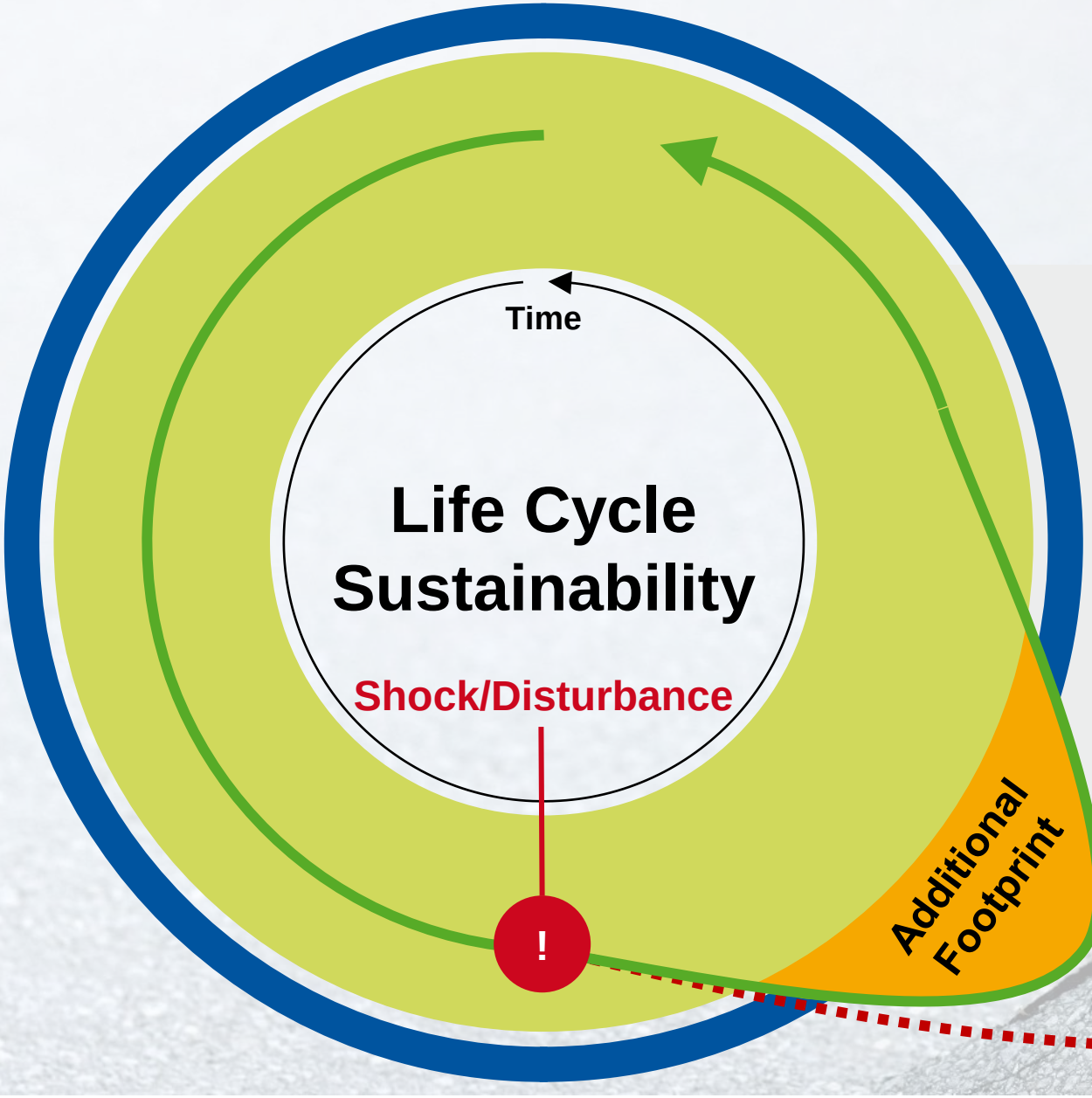
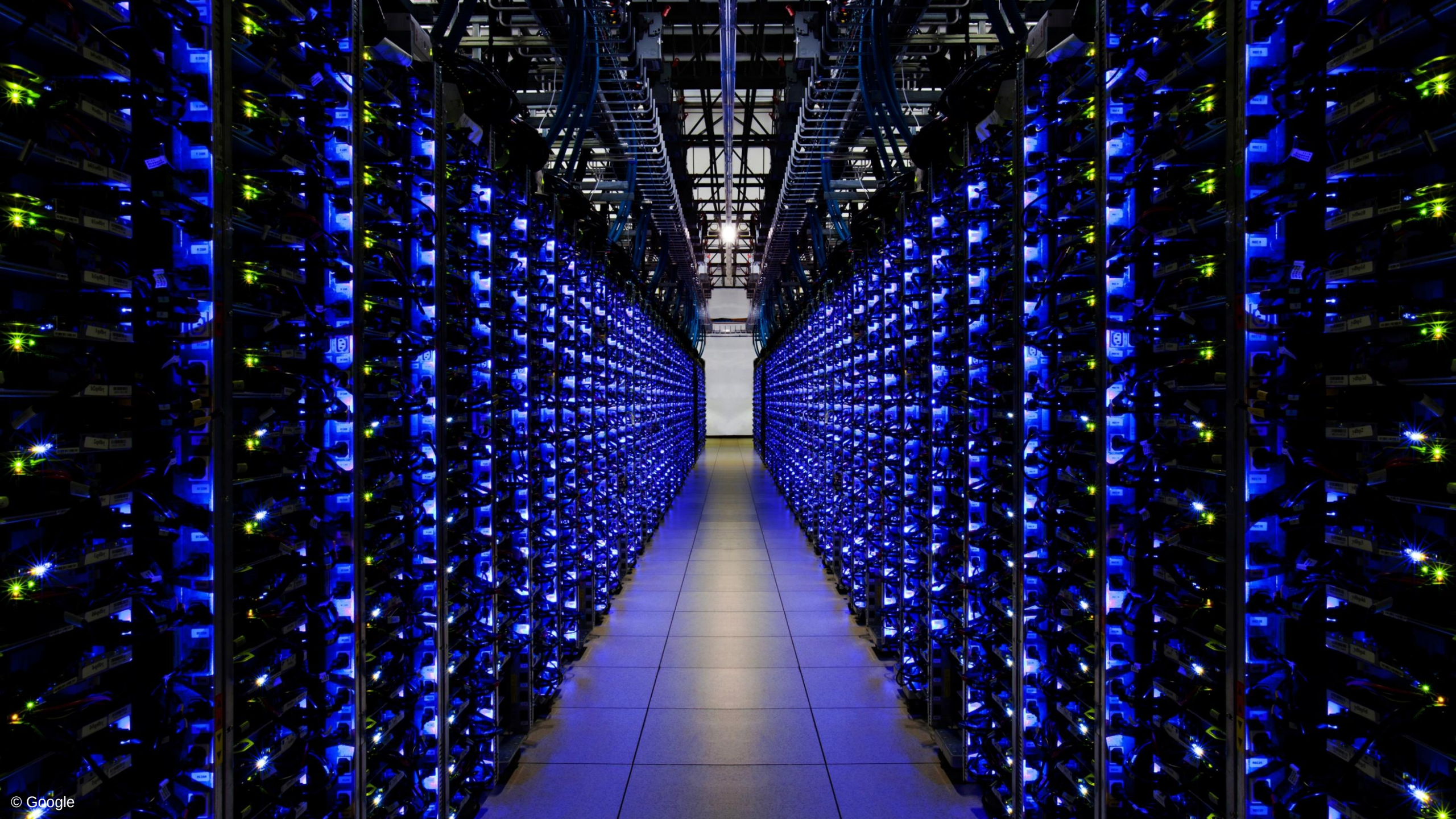






Resilience in Life Cycle Sustainability refers to the ability to continue to maintain defined sustainability criteria over the entire life cycle in the face of an unexpected event, possibly with the inclusion of a limited additional footprint.



© Google

100 GB Data over 10 years

or

1 Ton of new crude steel


Data Structures
Action
Knowledge
Information
Data
Connected Ressources

Domain-adapted #DataStructures and data management enable resilient #LifeCycleSustainability and green production of the future.

Data Structures for Resilience in Life Cycle Sustainability

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5G as Backbone and Infrastructure for Green Production
Data Structures for Resilience in Life Cycle Sustainability

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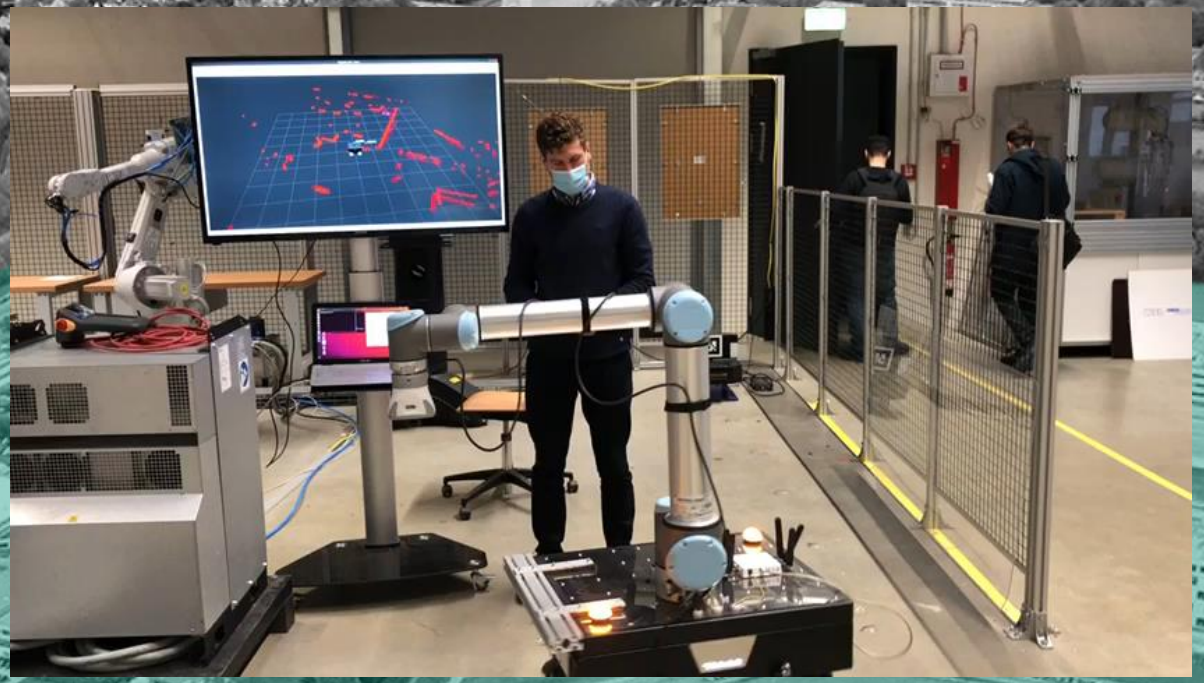
1 **Ultra-reliable low latency communication (URLLC) & TSN**
- < 1 ms end-to-end latency, <20 µs jitter
- 99,999% reliability

2 **Enhanced mobile broadband (eMBB)**
- < 10 Gbit/s bandwidth

3 **Massive machine-type communication (mMTC)**
- 100x connected devices (comp. to 4G)
- ~15 years battery life time



4 **Localization**
- < 1 m position resolution

5 **Cross-site communication**
- Site-to-site communication
- Enterprise cloud communication

6 **Slicing**
- Combine use cases with different criticality levels
- Combine public and private networks

…more at Institute Tour 7!

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5G as Backbone and Infrastructure for Green Production
Data Structures for Resilience in Life Cycle Sustainability

AWK'23

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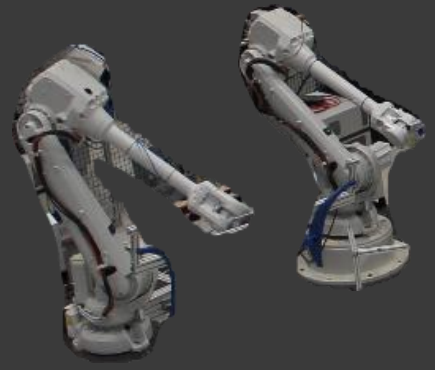



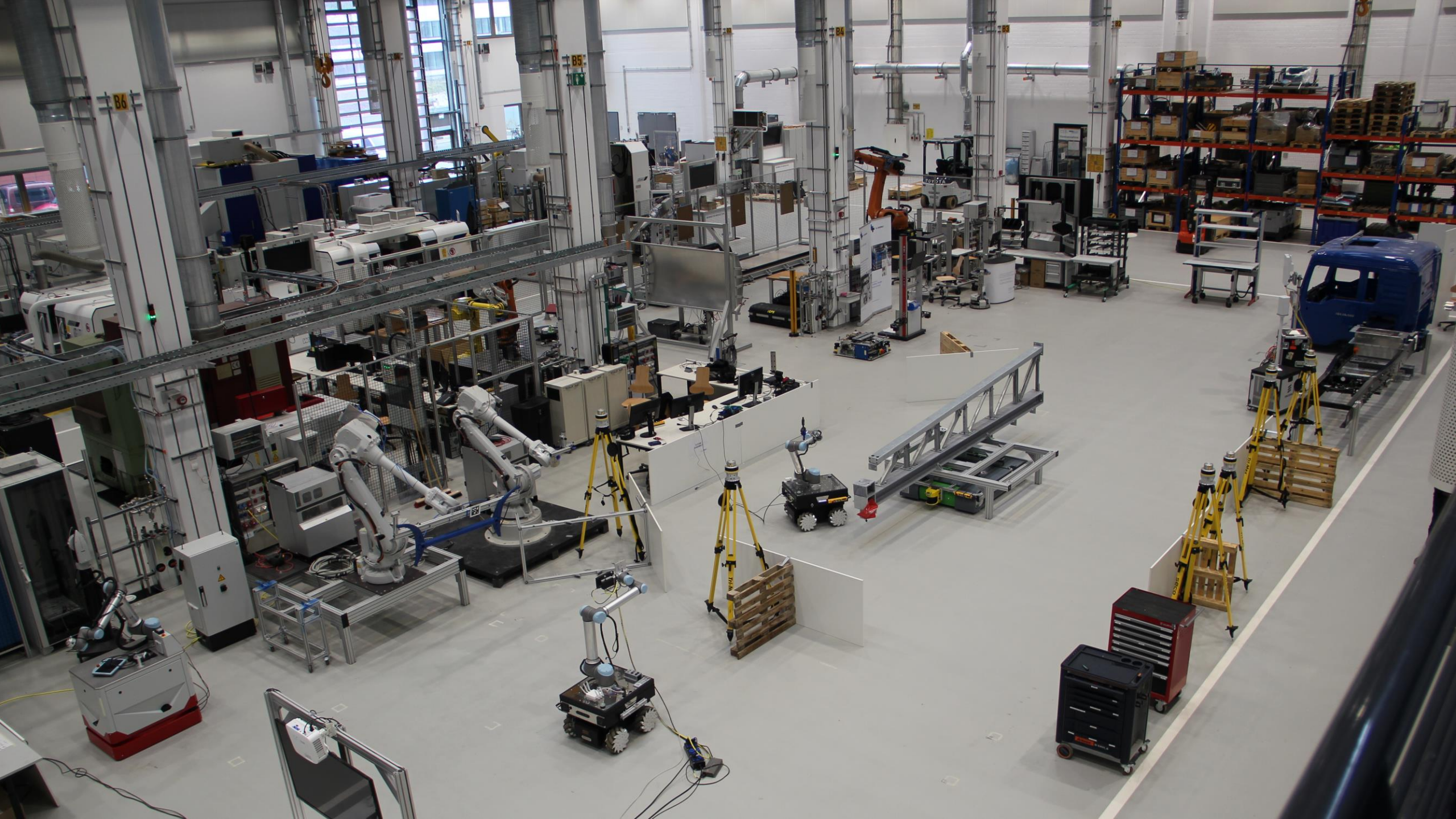
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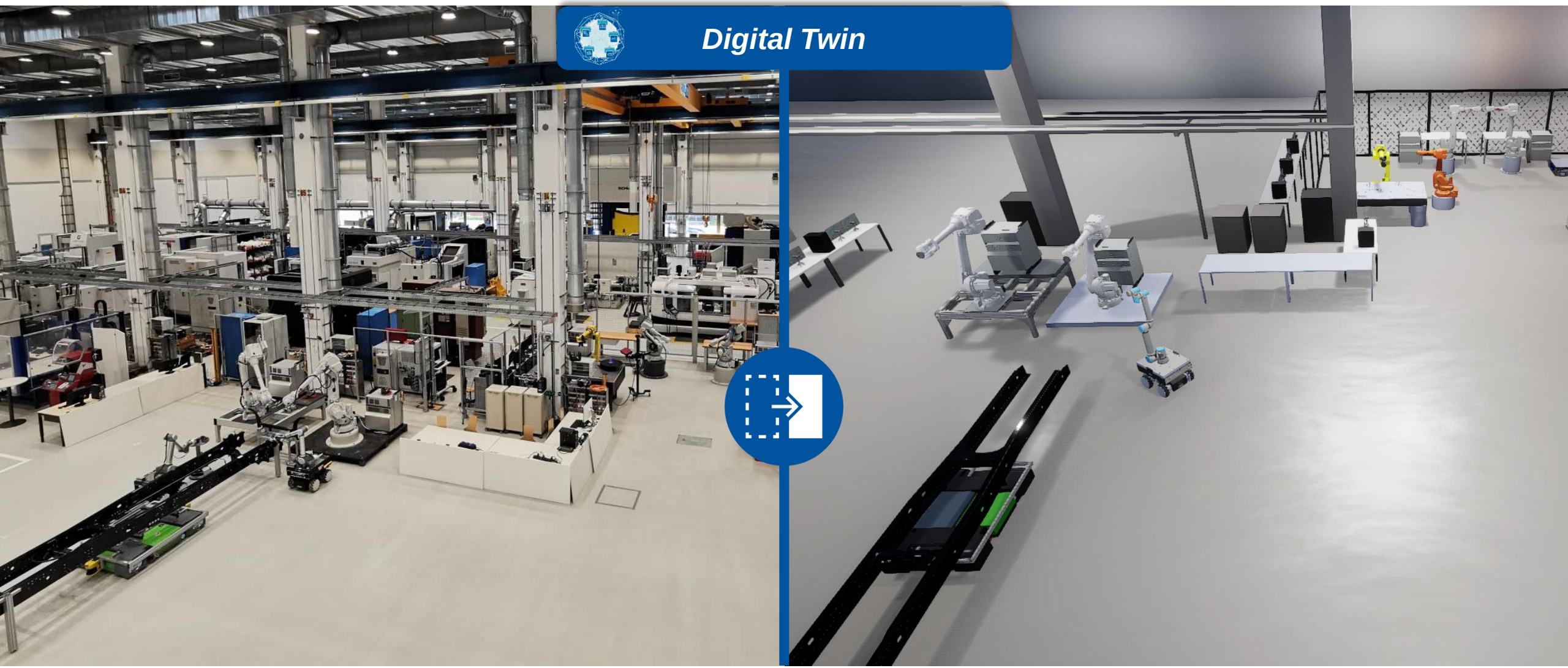
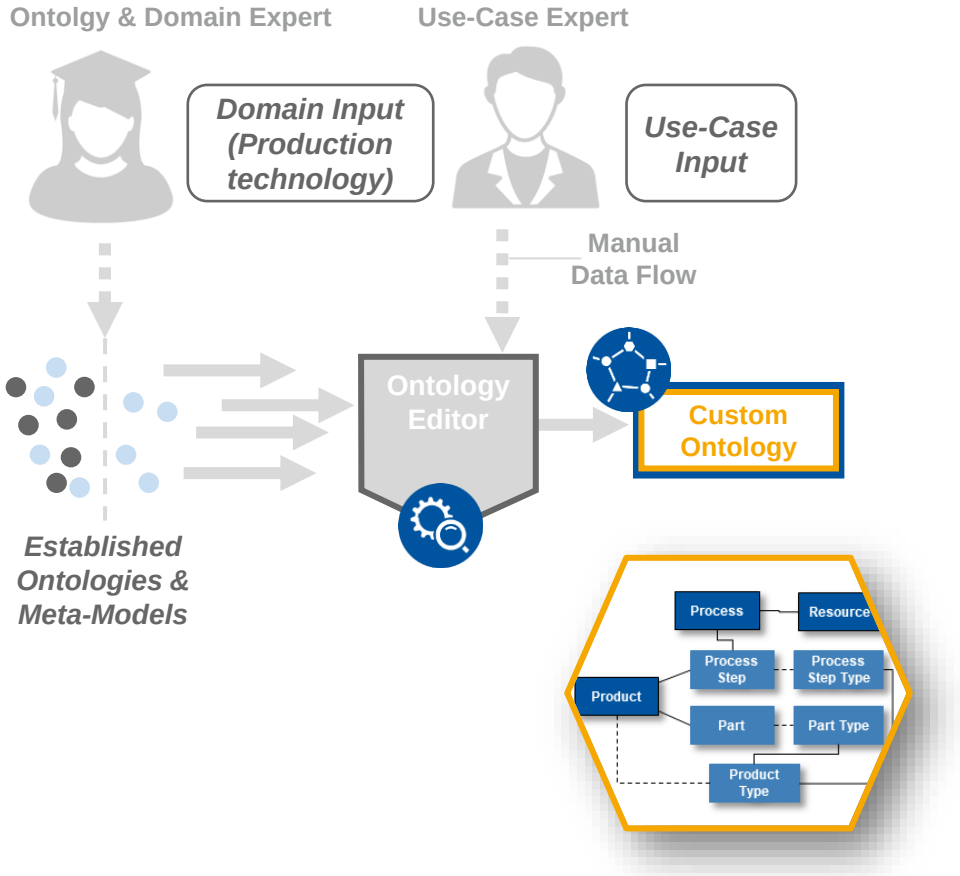
B5
B4
B3



Digital Twin Pipeline

Ontology-based Definition



Digital Twin Pipeline

Ontology-based Definition

Standardized Modeling

Ontolgy & Domain Expert

Use-Case Expert

Use-Case Expert

Domain Input (Production technology)

Use-Case Input

Static Use Case Data

Manual Data Flow

Automated Data Flow

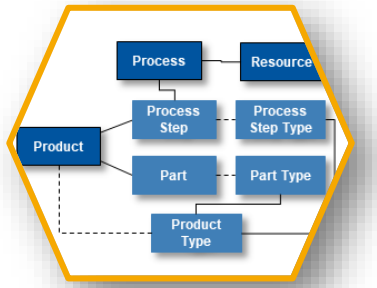
Ontology Editor

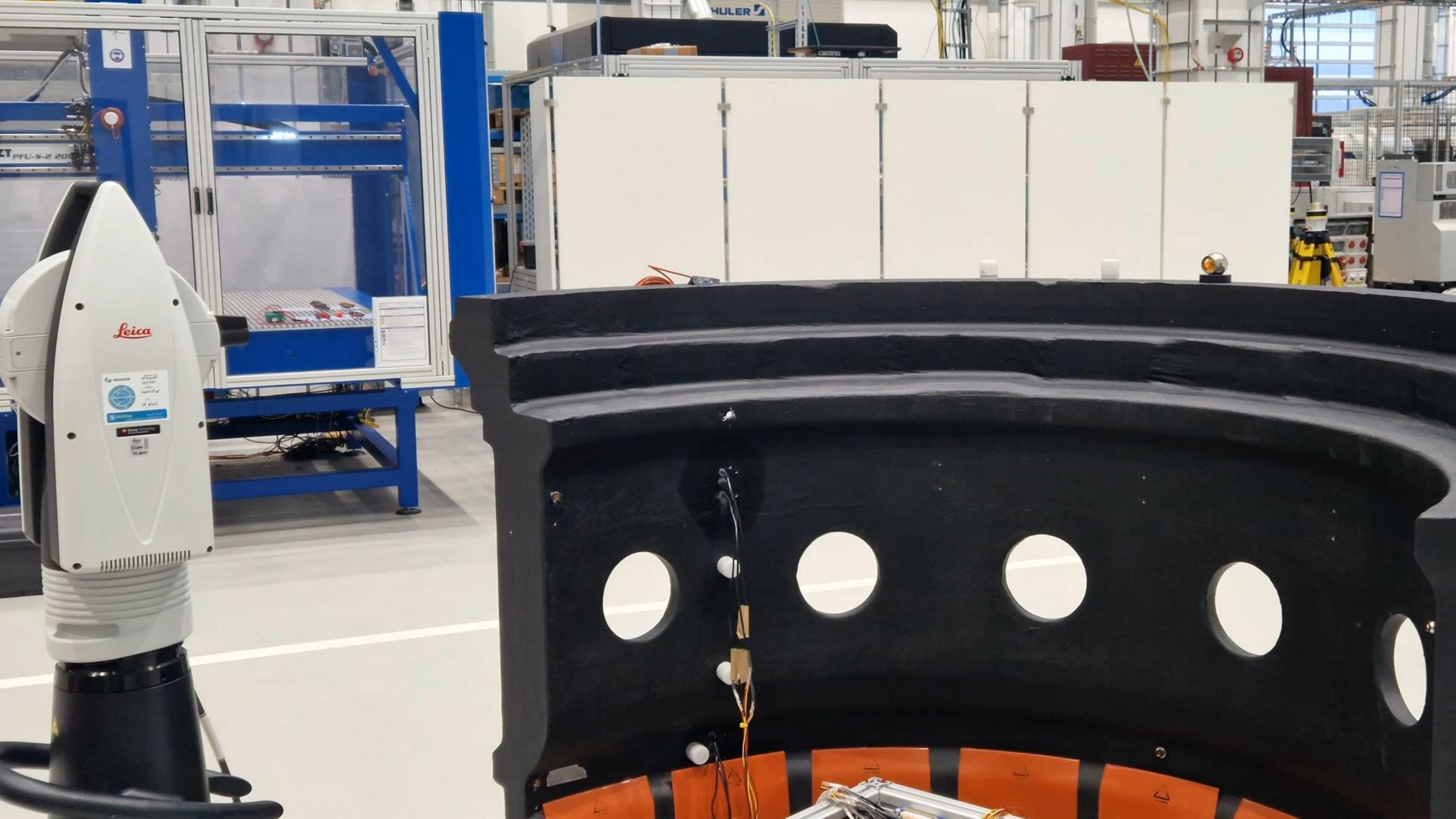
Custom Ontology

Model Generator

Description Model

Established Ontologies & Meta-Models




Leica

Digital Twin Pipeline

Ontology-based Definition

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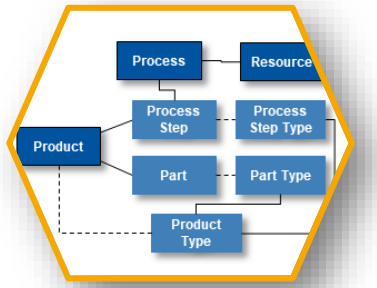

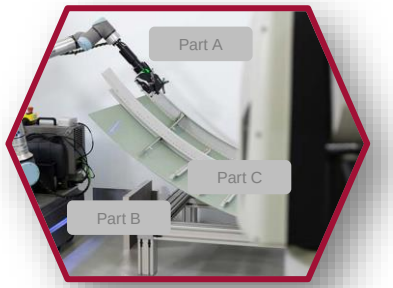

The Digital Twin Pipeline for Modeling
Data Structures for Resilience in Life Cycle Sustainability

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Digital Twin Pipeline

Ontology-based Definition

Ontolgy & Domain Expert

Domain Input (Production technology)

Established Ontologies & Meta-Models

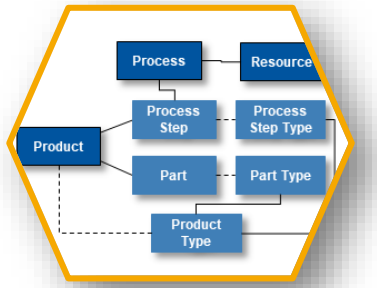
Use-Case Expert

Use-Case Input

Manual Data Flow

Ontology Editor

Custom Ontology



Standardized Modeling

Use-Case Expert

Static Use Case Data

Automated Data Flow

Model Generator

Description Model

Automated Deployment

No Manual Input required

Dynamical Use-Case Data

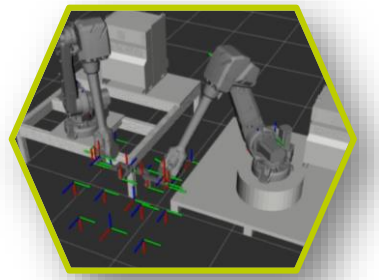
Generative Programming

Deploy-ment

Digital Twin

Communi-cation Processor

Real System



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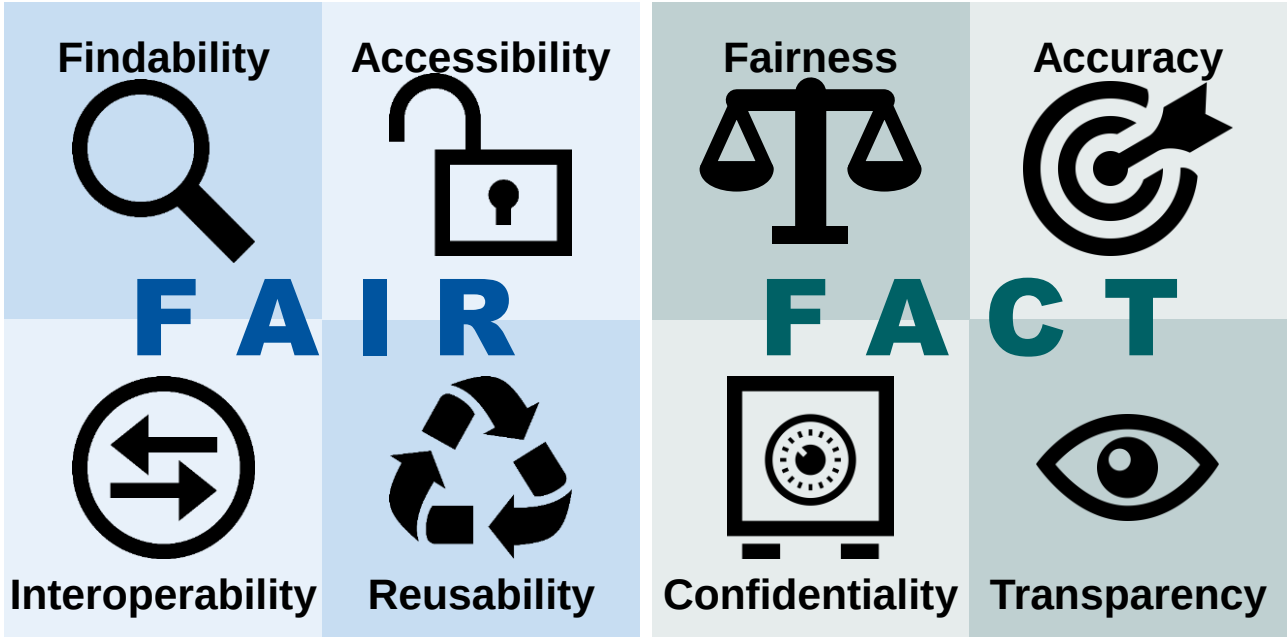
…more at Institute Tour 3!

Fazit

- Life Cycle Sustainability sets a new framework for production systems
- Level of detail of information increases in the analysis, planning, control and automation of systems
- Synchronization and standardization shift to the data sphere
- We need powerful data structures, designed for long periods of time and many stakeholders.
- Digitalization, resilience and sustainability constitute the internet of sustainable production

Production data management as a new discipline and a new job description



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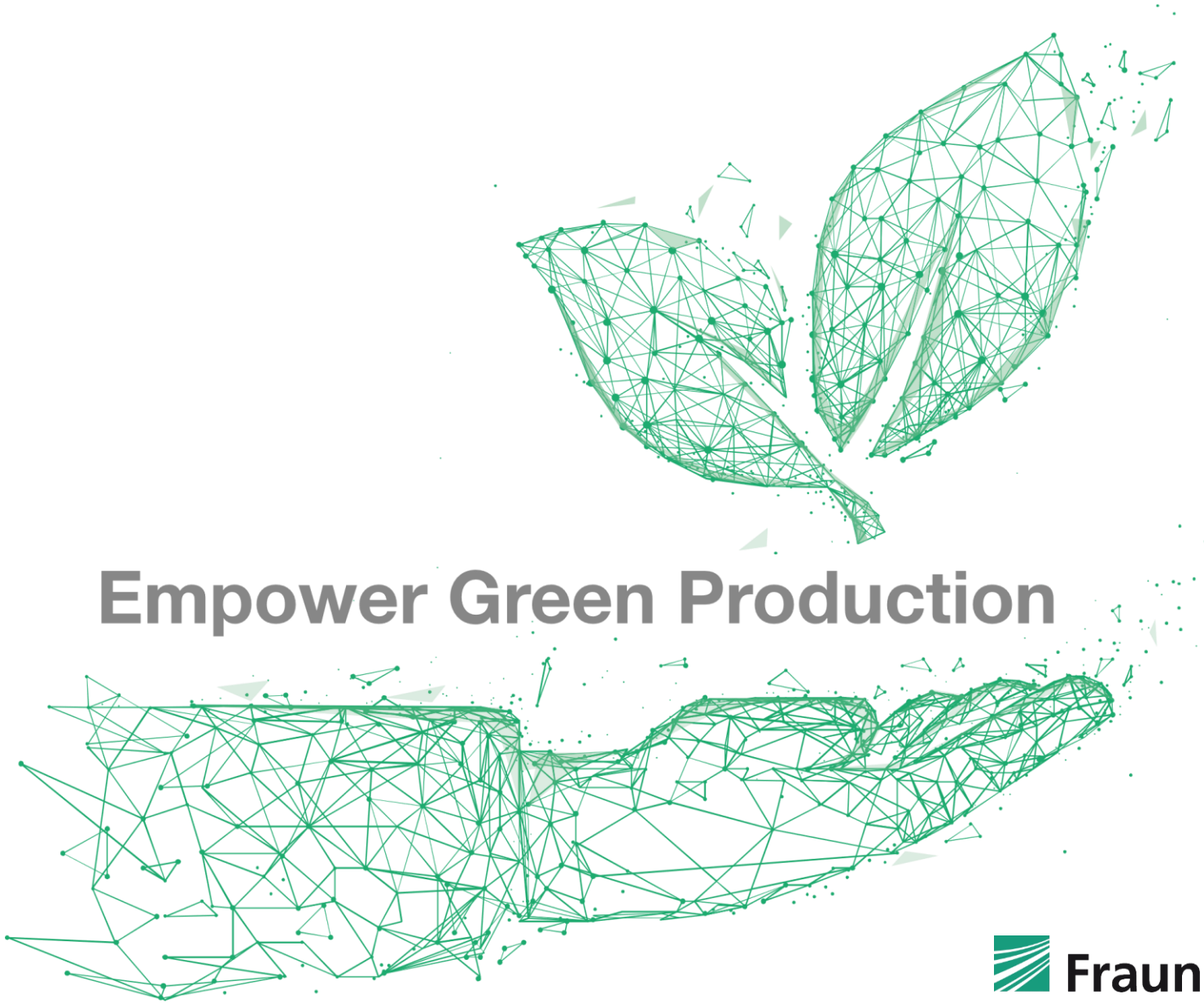

Thank you!

#Digitalization

#Sustainabiility

#Resilience

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