## DIGITAL TWINS

***A Digital Twin provides a holistic view of a product, from genesis over manufacturing and his lifetime in the market until to disposal.***

***Digital Twin (DT):*** A digital representation of some aspects of a (real) thing (the original).

***Original:*** The thing (including humans and animals) that is or will be augmented by a Digital Twin.

## CAPABILITIES

Digital Twins may be classified along their capabilities:

- ***MONITOR*** the Original and its environment.
- ***OPERATE*** the Original in its environment.
- ***DUMP*** (historical) data from the Original for later analysis.
- ***ELABORATE*** responses from the Original's observations.
- ***LEARN*** and improve a model of the Original's world.
- ***SIMULATE*** alternatives and decide for actions on the Original.

## TECHNOLOGIES

Digital Twins require dedicated technologies:

- **Sensors** are measuring a multitude of product and environment characteristics and yield the data foundation for the DT.
- **Communication Links** transport the sensor data to any processing layer, be it a computer “on the Edge" (at the machine / sensor level) or a cloud platform.
- **Storage & DLT** keep raw and processed data in place.
- **Data Analytics** makes first analyses on historical data.
- **Machine Learning** is used to learn correlations between sensor data and events impacting the DT.
- **Causal Models & other AI** provide understanding and infer deeper insights, such as failure root causes.
- **Actuators**, such as servo motors, are the physical feedback channel of an original to the real world.
- **Identity Management & Discovery** assures that only authorized persons and/or machines are interacting with the DT or the original.

## EXAMPLES

### *Schindler Ahead – MSK*

MODELS

From time-based or usage-based to predictive maint-enance by using a non-intrusive modular sensor kit (MSK) connecting old portfolios of various brands with modern data analytics. By detecting breakdowns early and using data analytics repairs are initiated more quickly reducing the down time for customers. Learning form data enables predictive maintenance to prevent breakdowns or plan downtime for maintenance in low traffic hours.

### *TWINJECTOR*

MODELS

TWINJECTOR is a Digital Twin designed for the Injection Molding industry. It integrates live data from multiple sources, from the sensor edge and including ERP and external data. TWINJECTOR is built on a modular and flexible access architecture and therefore allows to fulfil all HiFive criteria for Digital Twins: Providing Variety, Volatility, Velocity, Volume and Visibility of data anywhere, anytime.

### *Railigent® on Locomotives*

MODELS

Railigent® makes intelligent use of rail data and allows rail operators to improve the return from their assets. Artificial intelligence and sophisticated data analytics are the key to achieve up to 100% availability, optimized maintenance and improved operations. Railigent gives better understanding of rail data, generates valuable information and get more out of the system.

### *Executable Specifications*

MODELS

Complex functionality and behavior may be specified using a simplified, yet precise dialect of the Unified Modeling Language (UML). KnowGravity Inc.'s CASSANDRA/xUML enables early validation by simulation and supports verification of the Original against the simulation (the Digital Twin).

### *TH06 Helicopter Simulator*

MODELS

Full-Flight Simulator (EASA Level D) for the TH06 Super Puma transport helicopter to train the whole range of missions, including winch rescue, cargo flight and technical breakdowns (emergency situations). This saves fuel and avoids noise; normal procedures and dangerous situations can be trained safely and reproducibly.

# THE ADVENTURES OF A DIGITAL TWIN IN SYSTEMSLAND

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DATAHEAD ANALYTICS

THALES

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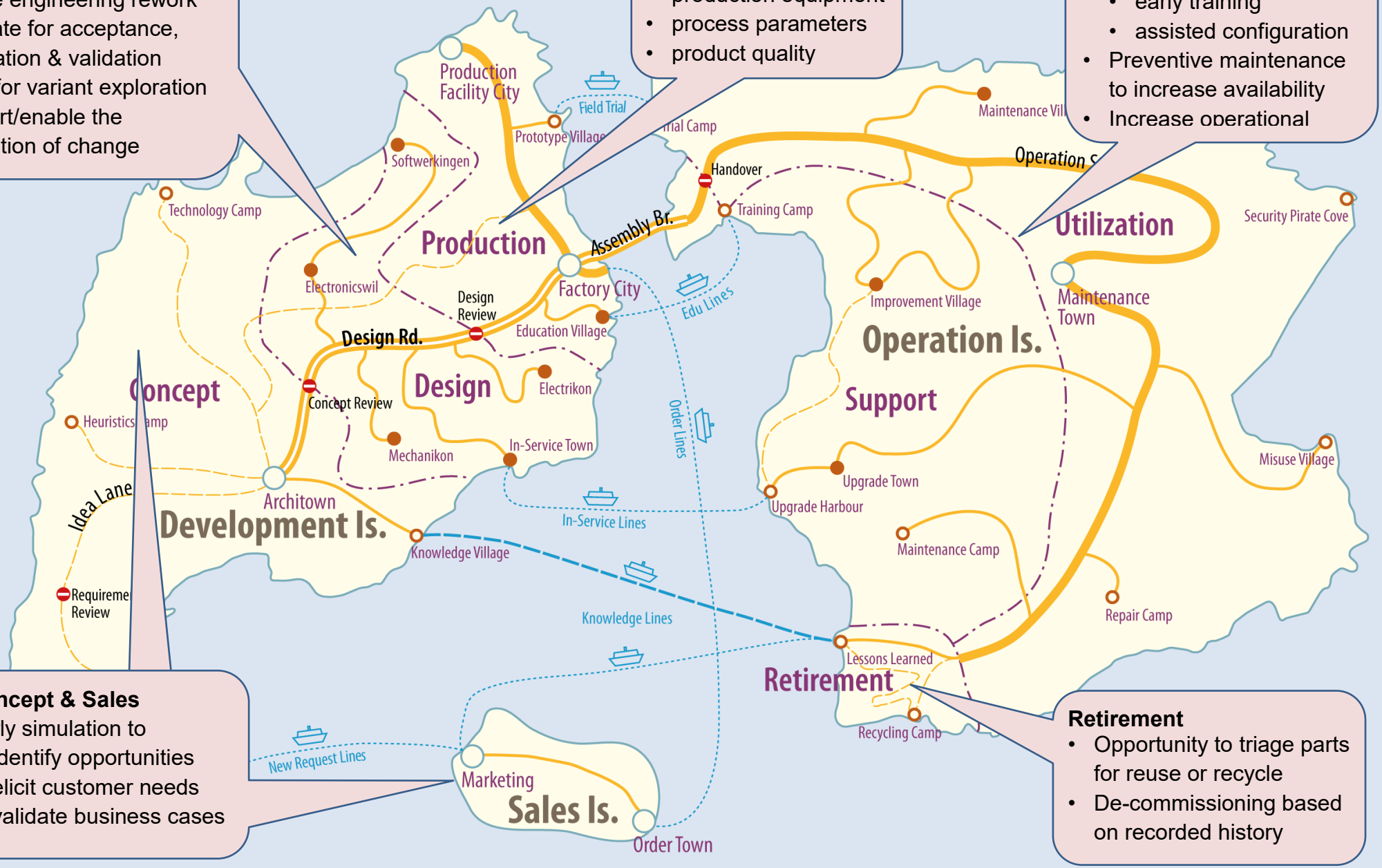
# Digital Twin Opportunities in Systemsland

**Design**
- Refine requirements to reduce engineering rework
- Simulate for acceptance, verification & validation
- Allow for variant exploration
- Support/enable the evaluation of change

**Production**
Monitor and optimize
- production equipment
- process parameters
- product quality

**Utilization & Support**
- Accelerate ramp-up by
  - early training
  - assisted configuration
- Preventive maintenance to increase availability
- Increase operational




**Concept & Sales**
Early simulation to
- identify opportunities
- elicit customer needs
- validate business cases

**Retirement**
- Opportunity to triage parts for reuse or recycle
- De-commissioning based on recorded history

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