Digital Twin Customer Experience

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Digital twin customer experience
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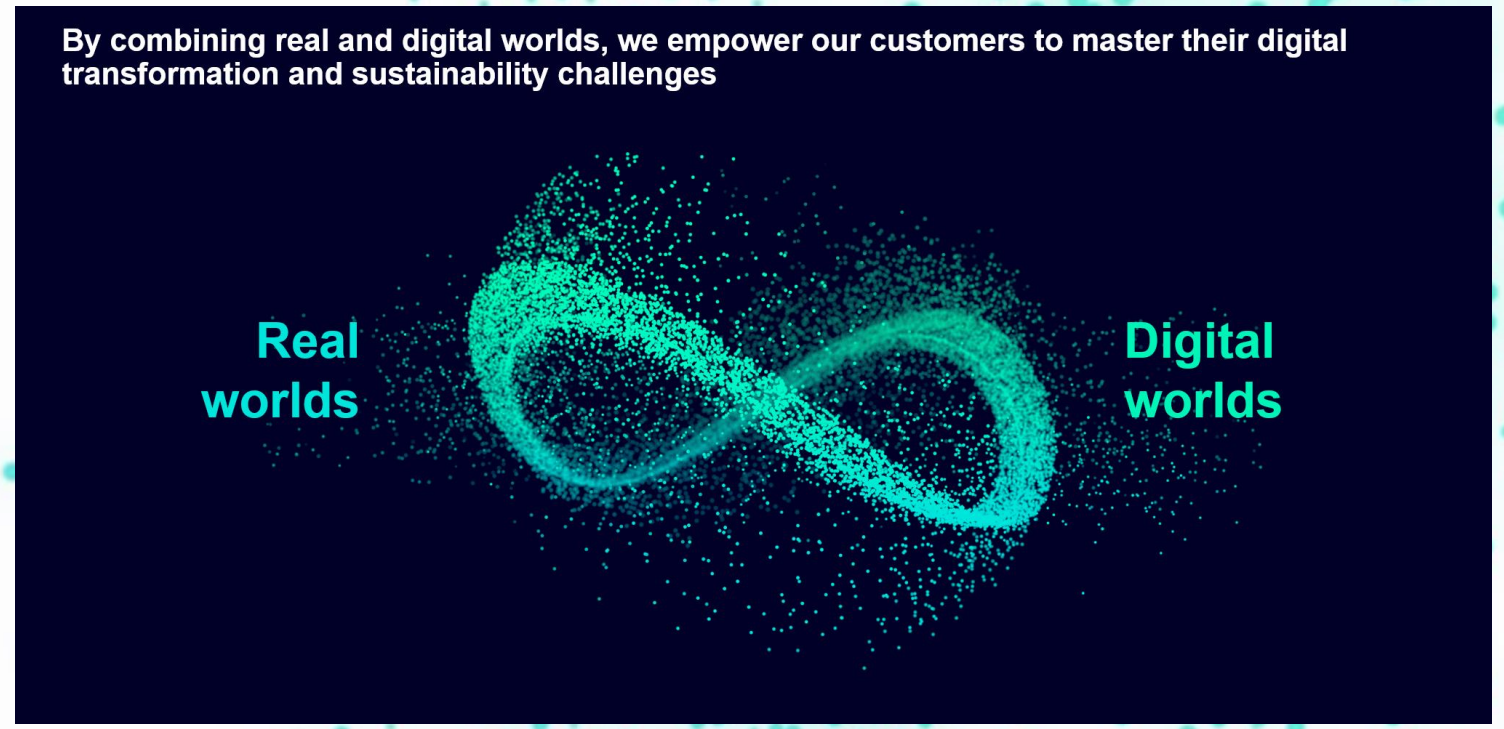
Mining demand and definition

Digital twin customer experience

- Grinding mill
- Belt conveyor
- Transportation process

Takeaways



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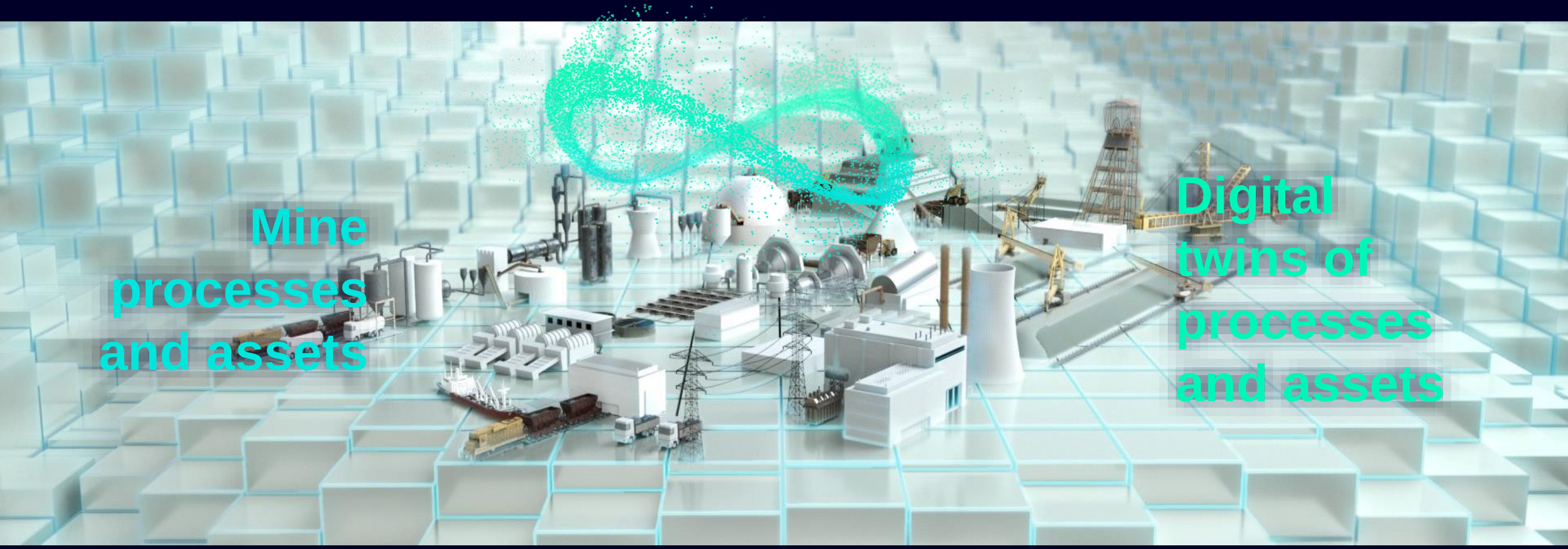
By combining real and digital worlds, we empower our customers to master their digital transformation and sustainability challenges



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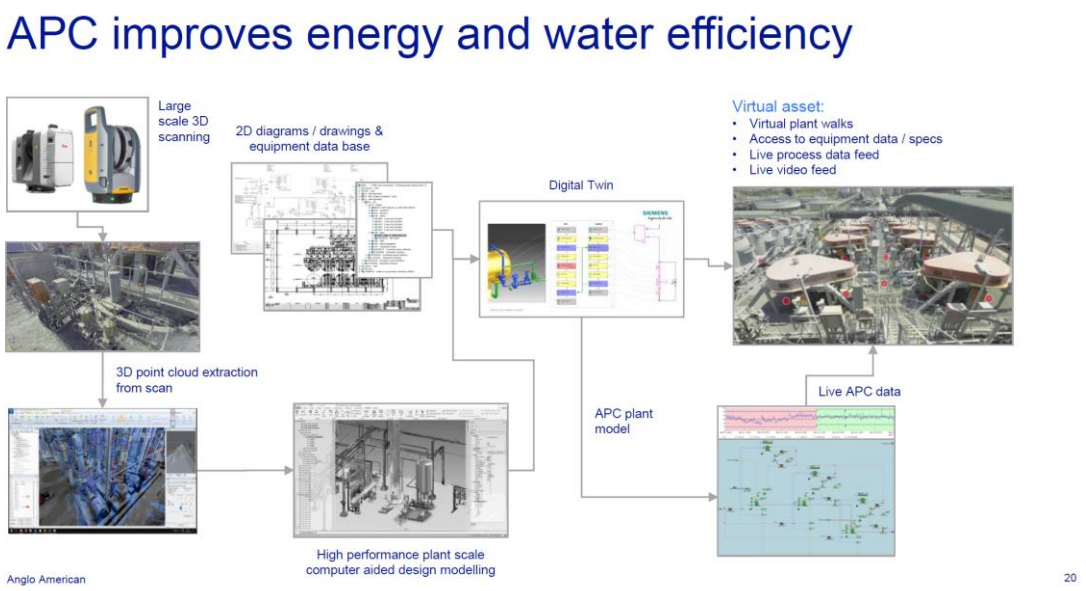
Mining demand for digital twins is undoubtful and reveals a multitude of focus areas …

… from mission-critical asset parts (e.g. mills)



Quote Anglo American Technical and Innovation Update, 11 May 2021

… to entire processes (e.g. conveying/ transportation)

Quote Challenge of CODELCO, Chuquicamata Division, September 2020

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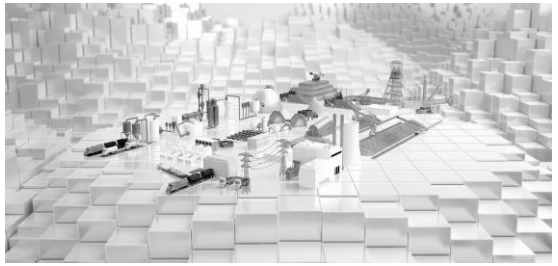
Digital twin definition relevant for mining processes and assets

Quote Wikipedia, the free encyclopedia

A digital twin can be used for monitoring, diagnostics and prognostics to optimize asset performance and utilization. In this field, sensory data can be combined with historical data, human expertise and fleet and simulation learning to improve the outcome of prognostics. Therefore, complex prognostics and intelligent maintenance system platforms can use digital twins in finding the root cause of issues and improve productivity

End of quote



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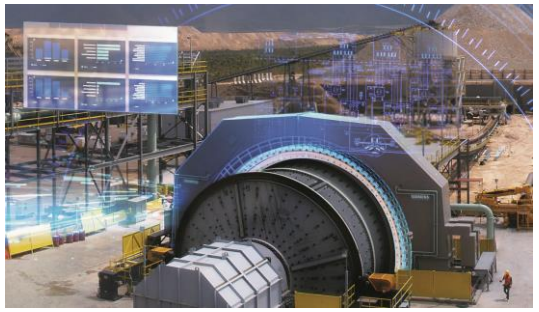
Digital twins prerequisites are frequently site data and human expertise

Real world

Monitoring

Diagnostics

Prognostics



Digital twin to

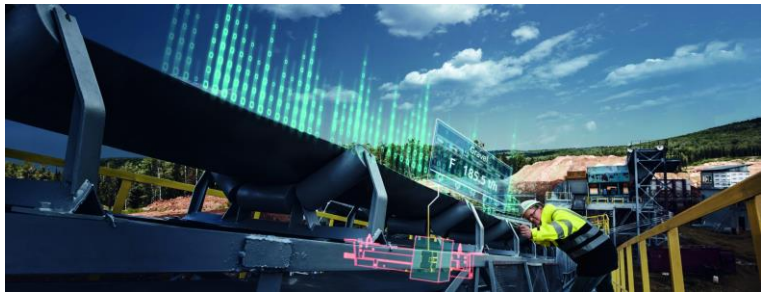
optimize asset performance and utilization

Real world

Sensor & historical data

Human expertise

Simulation learning



Digital twin to

improve the outcome of prognostics

Real world

Complex prognostics

Intelligent maintenance platforms

Digital twin to

find root cause of issues

improve productivity

Digital twin examples for a grinding mill, belt conveyor and transportation process ▷

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Digital twin customer experience
Example gearless mill

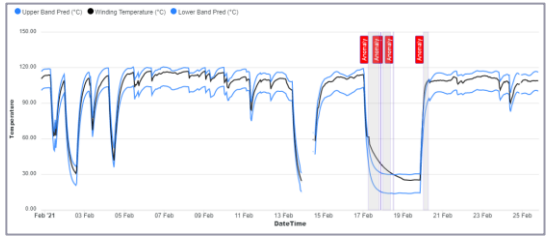
Real world
Monitoring
Diagnostics
Prognostics

Digital twin to
optimize asset performance
and utilization

Optimum operation / maintenance

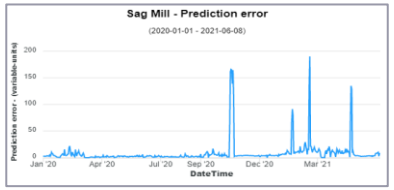
Operation KPI (Anomalies)

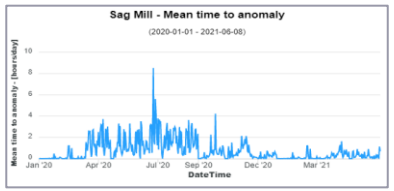
How is the **actual status**?



KPI analysis (e.g. MTBA, MTTA[1])

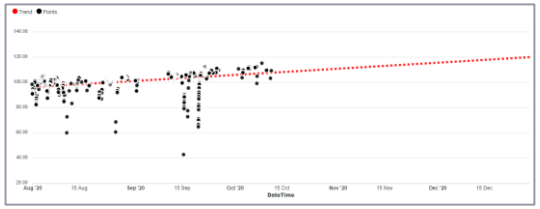
Deep **understanding**
What is happening?





Fingerprints

What are the **trends**?



Maintenance KPI (Plan)

Are the **maintenance tasks performed according plan**?
Can the **maintenance plan be optimized**?

1) MTBA Mean Time Between Anomaly, MTTA Mean Time to Anomaly

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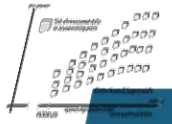
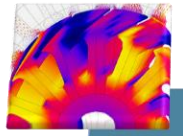
Digital twin customer experience
Example gearless mill

Solution based on three real-data-validated pillars



Fingerprint Analysis

- *Collection of fingerprints (measured data sets) from start-up as reference for later operation*
- *Comparison actual/ reference*



Mathematic Modelling

- Comparison w/ real values and deduction of trends
- **Models for**
  - Motor Thermal utilization
  - Motor heat exchangers efficiency
  - Electrical Performance
  - Performance CCV cooling system

Artificial Intelligence

- Beyond limits of mathematics
- **Artificial Intelligence**
  - Transformers
  - E-House
  - Bearings oil flow
  - Accumulator pressure
  - Pump activation frequency
  - Pump active duration
  - Stator alignment (airgap)

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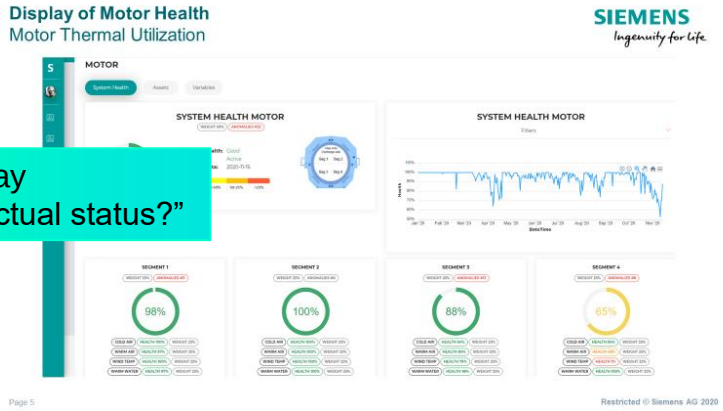
Digital twin customer experience
Example gearless mill

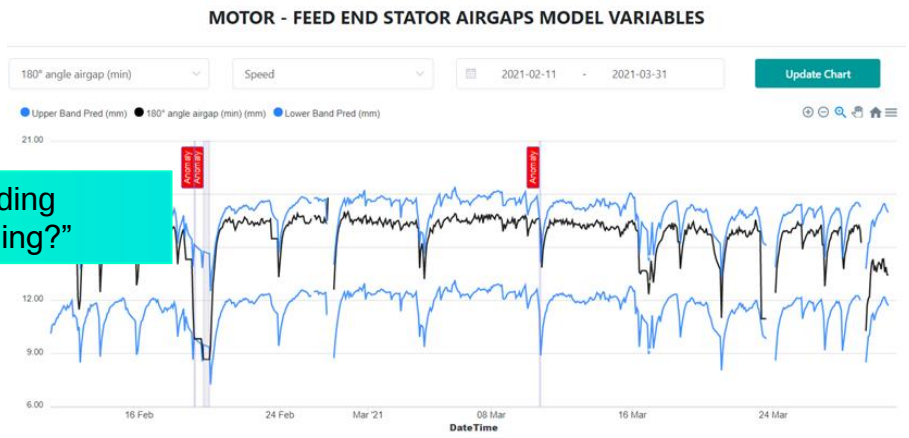
Real world
Monitoring
Diagnostics
Prognostics

Digital twin to
optimize asset performance
and utilization

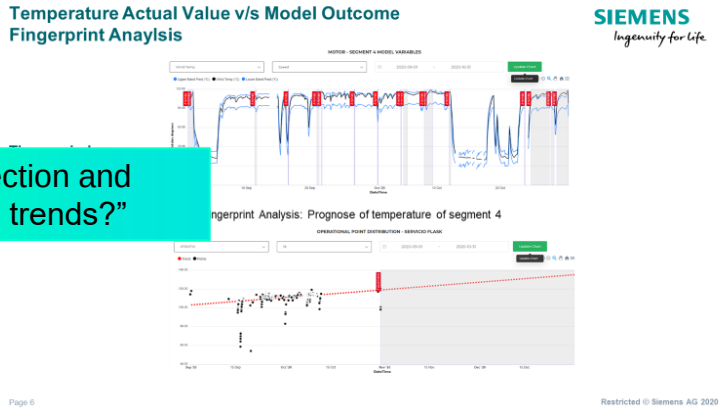
Intuitive display
“How is the actual status?”



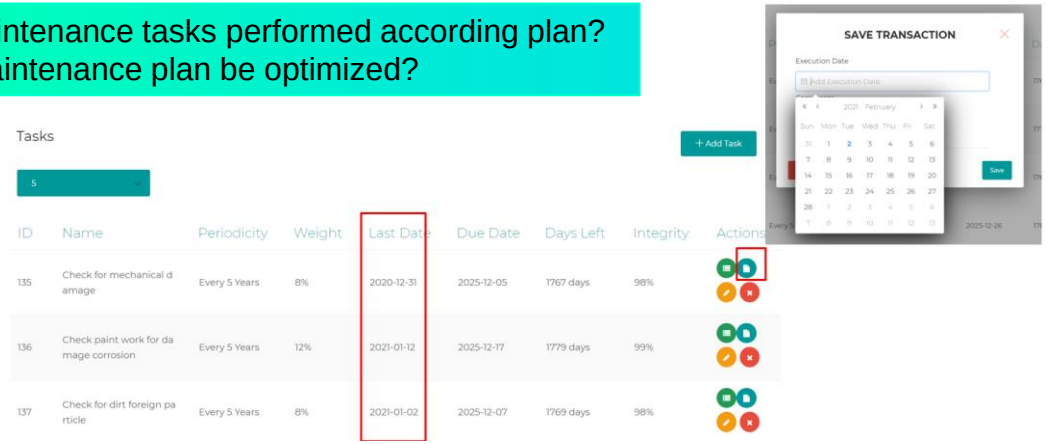
Deep understanding
“What is happening?”



Anomaly detection and
“What are the trends?”



Are the maintenance tasks performed according plan?
Can the maintenance plan be optimized?



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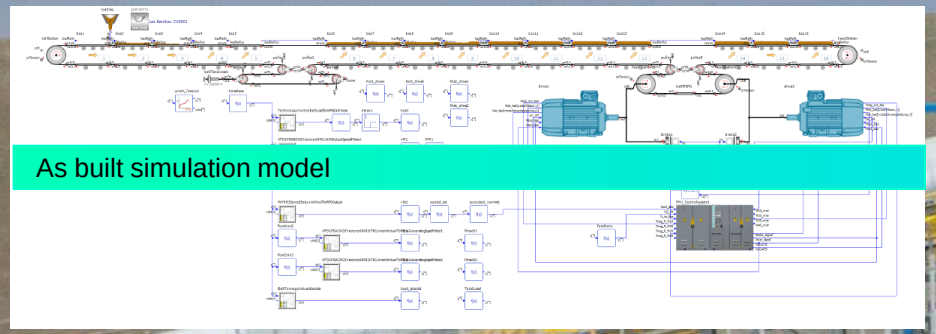
Digital twin customer experience
Example belt conveyor

Real world
Sensor & historical data
Human expertise
Simulation learning

Digital twin to
improve the outcome of prognostics

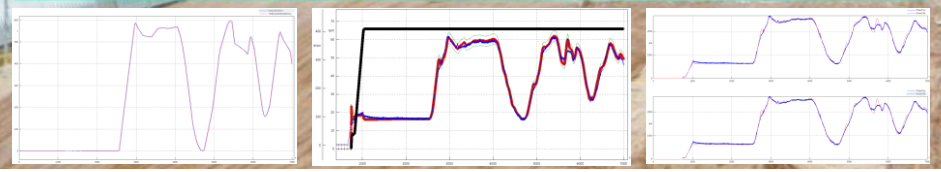
Digital twin of a belt conveyor

- Site altitude 4,200 m NN
- Length total / Lift 2,569 m / 228 m
- Capacity 9,400 t/h
- Belt width / speed 1,829 mm / 6,5 m/s
- Power / Torque 2 x 4,400 kW / 637 kNm



As built simulation model

Real-data-validation on total load, motor torque and power



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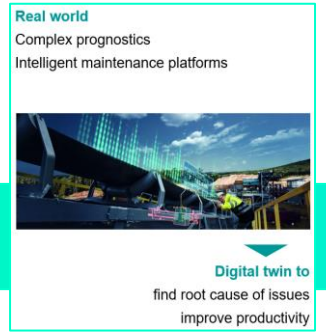
Digital twin of a belt conveyor
Example event analysis



Goal: understand the root cause of an incident

Digital Twin to **understand events sequence and key parameters evolution**

With a Digital Twin real-data-validated simulation:

1. **incidents are virtually reproduced**
2. **root causes and effects are transparent (hence understood)**
3. **similar problems are avoided in the future**

Events sequence example (fictive):

1. **Root-cause:** conveying jam in discharge area
2. Belt is braked by the accumulated material
3. Drive station continues operation
4. Belt is pulled out of the tensioning station
5. Drive station continues to pull the belt
6. **Effects:** belt deformation, dropped material, damaged idlers

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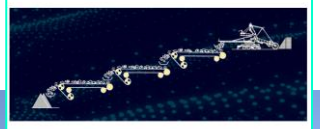
Digital twin customer experience
Example transportation process

Real world
Complex prognostics
Intelligent maintenance platforms



Digital twin to
find root cause of issues
improve productivity

Digital Twin functionalities for a transportation process (selection)

Simulation

Health Status

KPIs and Reports

Event Analysis & Classification

Downtime Identification

Operation Data Base

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Digital twin of a conveyor line
Functionality example operation data base

Goal: Assign typical root causes and countermeasures to failure modes

Target users  **e. g. Superintendent Conveying, Process Engineer …**

Example failure mode “Misalignment of belt”:

Failure Mode	Root Cause	Countermeasures	Preventive measures
Example 1 of 330: Misalignment of belt	Material is not fed in the center of the belt	Change the conditions in the feeding station	Install off-track detectors (misalignment switches) behind the feeding station
	Caking on pulleys	Increase the efficiency of the belt cleaner	Increase the inspection interval for the belt cleaner
	Alignment of idler-stations are wrong	Check the idler-stations	Increase the inspection interval for the idlers (e.g. use thermal camera)
	Wind or rain influence the local friction conditions between belt and idlers	Install covers or hoods on the conveyor	

- **330 typical conveyor failures included,** based on solid operational experience (VDI, belt supplier)
- **Data base can be extended by customer** with own cases
- **Maintenance optimization** through fast recommendation of potential countermeasures and predictive measures

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Digital twin customer experience
Takeaways

- Mining demand for digital twins is undoubtful
  and ranges from mission-critical assets up to entire processes
- A digital twin can be used for monitoring, diagnostics and prognostics to optimize performance and utilization
- Within a digital twin, sensor data are combined with historical data, human expertise and simulation
- Our complex prognostics and intelligent maintenance solutions use digital twins to find root causes and improve productivity
- Our digital twin based solutions for Mining can be integrated in company's ecosystem as well as in upper- level Siemens solutions e. g. Digital Mine, Stockyard Management, MES etc.

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