Role of Digital Twin and Big Data Analytics

in Projects and Asset Life Cycle Management

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Content

- Introduction and Overview
- Project Digital Twin
- Operations & Maintenance Digital Twin
- Big Data Analytics
- Applications of Big Data Analytics
- Overall Architecture of Systems

Poll Question

For what purpose your company is using Digital Twin?

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Poll Question

For what purpose your company is using Big Data Analysis?

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Introduction and Overview

Digitalization

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Digitalization Provides

Digitalization Enables

The Organisation	**Data-Driven** Real-time insights for faster and better decision-making	**Innovative** A culture of constantly applying new way of working with digital at the core	**Collaboration** Platforms that support more efficient teaming and data sharing across functions
The Worker	**Empowerment** Equipping employees with the relevant information at the right time to make decisions	**Increasing Safety** Leveraging on smart devices and sensors to create a safe environment	**Value-Led** Value based analytics enabled across the entire work force
The Facility/ Plant	**Reliable** Connected plants to predict issues and prescribe mitigating actions	**Higher Production** Dynamic production scheduling, planning and monitoring leading to increased production	**Efficient** Monitor and deploy resources where needed to improve operation efficiency

Using Sensors, Connectivity, Cloud, Models, Analytics/AI, Mobility

The Connected Plant Worker

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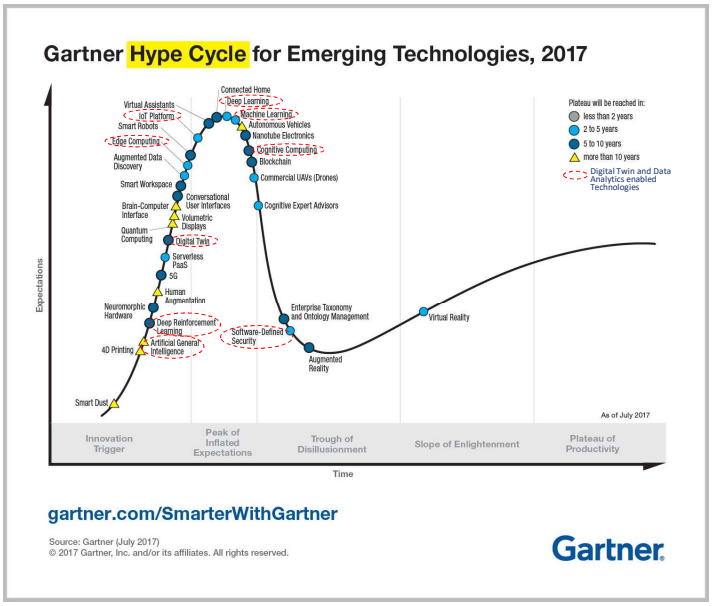
Technologies Supporting Digitalization

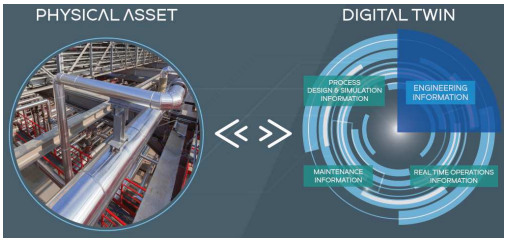


Why Digital Twin?

- CII analyzed the performance of 975 light and heavy industrial projects in its benchmarking database
  - Only 5.4% met “best in class” predictability in terms of cost and schedule

What is Digital Twin?

- Virtual Representation of a Physical Asset
- True version of reality in terms of data and information
- Posseses static and dynamic data and information



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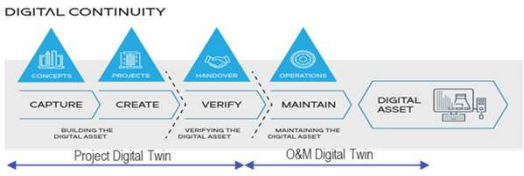
Digital Twin for Projects vs Operations & Maintenance

- 5D representation of project execution phase
- Also houses O&M operating data and work orders
- 'Single source of truth'



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Value Proposition of Digital Twin

- Better chance to identify risks earlier - for clash detection and construction planning
- Visualize and estimate impact of proposed change in design
- Eliminates any errors, inconsistencies, constraints and bring efficiency in EPFC
- Monitors plant performance and operate & maintain in an efficient, effective way
- Improves production and efficiency, reduces opex and enhances uptime of the plant
- Enables to gain efficiency - manpower optimization, improved operations, reduced accidents, and faster time-to-market
- Enhances information management and collaboration

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What is Big Data Analytics?

- Applies statistical tools and algorithms on historical data to make better decisions
- Uses power of Data Analytics, Machine Learning and Artificial Intelligence on structured & unstructured data, pictures, graphics, speech and videos to predict and prescribe

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Value Proposition of Big Data Analytics

- Insight from the past projects data to improve the current project performance
- Machine Learning/AI and the Digital Twin “digital library” reduces time to market and enhance project accuracy
- Predictive O&M layer to the physics based models predict anomalies and improve plant performance
- More cash flow and NPV for the whole life cycle of the plant

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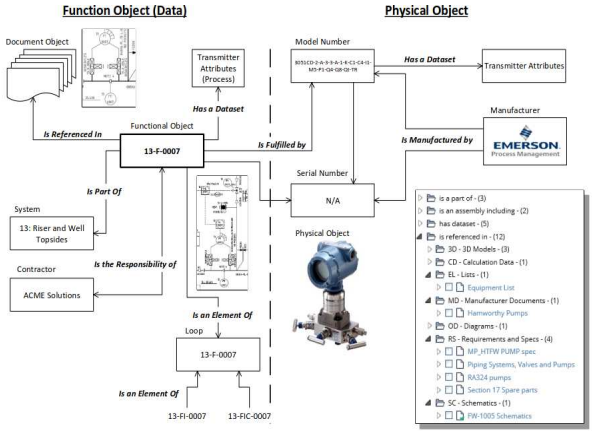
Project Digital Twin

Project Digital Twin – Technologies and Information Management

- 3D model and Object Orientated Data Structure
- **Class** contains a set of characteristics
- Class Models used to standardize characteristics of individual **components**
- **Relationships** defined between Classes
- **Relationships** (also instances of Classes) defined between drawing/document and each represented component
- Graphical user interface and grid type control display the corresponding characteristic of a component



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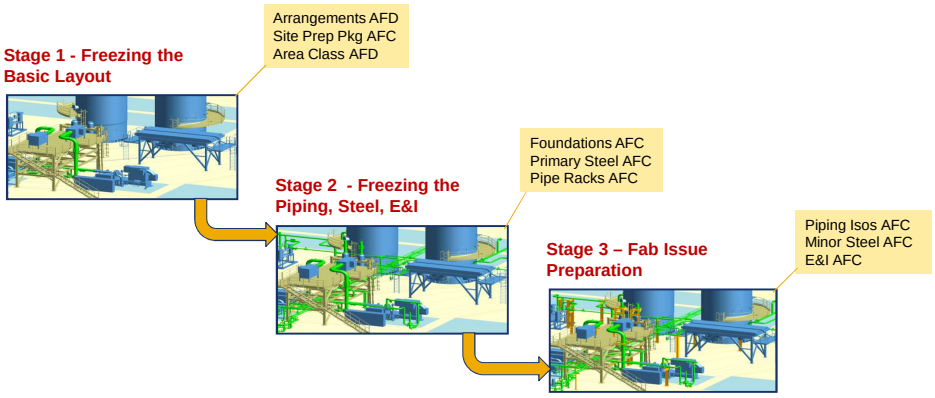
Project Digital Twin – Staged Execution

- Staged execution and object engineering approach to represent the virtual view of a physical plant in all aspects of its data and information



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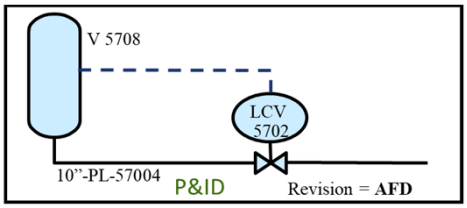
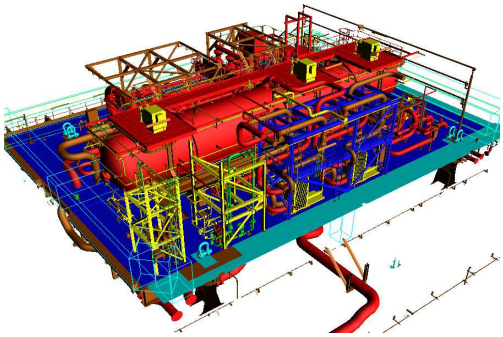
Project Digital Twin – Object Engineering





Object Type	Object Name	OE Status Code
Line	10"-PL-57004	2
Vessel	V-63020	3
Instrument	LCV-5702	1

Object Engineering Design Status Codes

- OE Status 1 – Preliminary Modeling
- OE Status 2 – Pending Vendor Confirmation
- OE Status 3 – Engineering Complete
- OE Status 4 – Approved Vendor Data
- OE Status 5 – Issued to Fabrication

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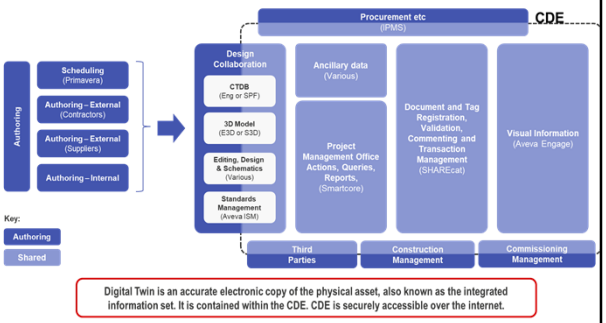
Project Digital Twin – Data Centric

- All documents/data at a centralized place
- Digital Twin is founded on well-managed asset information – users use intelligent engineering and design information
- All vendors data and documents are injected into Digital Twin and reflected in Twin specific to equipment, pipe or device



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Project Digital Twin – Project Performance

- Displays performance of project, keeping the engineering and PFC data up to date is an ongoing task
- Depicts project progress both in terms of schedule (4D) and costs (5D)
- Integration of 4D and 5D to project mgmt and control helps in managing project performance

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Project Digital Twin – Fabrication & Construction

- Share Digital Twin with strategic suppliers/ fabricators
- Interfaces helps in developing the engineering work package and consistent with construction work face package - assess constructability issues during engineering phase
- Construction supervisor access documents/ data
- Construction supervisor/ worker can visualize any system or equipment of the plant

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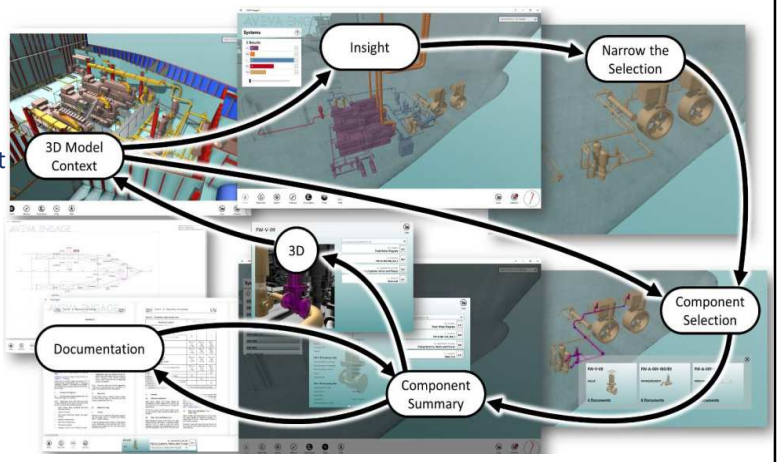
Digital Twin – User Experience

- Hyperlinks used to access information but, more use is made of symbolic representation and iconography
- Explore 3D model by walking around it & clipping view
- Transparent views thru model used to illustrate location of individual components & the extent of systems
- With this capability, solution may be used to plan remote activities



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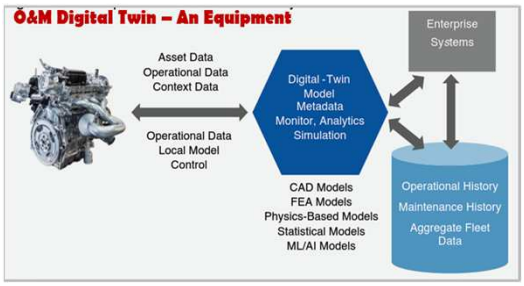
Operations & Maintenance Digital Twin

O&M Digital Twin – Foundation

- Foundation is still the Project Digital Twin with additional features of O&M phase
- For O&M Digital Twin - Push relevant project process data, equipment/ devices design data and supplier data/ documents from EPC phase to O&M systems



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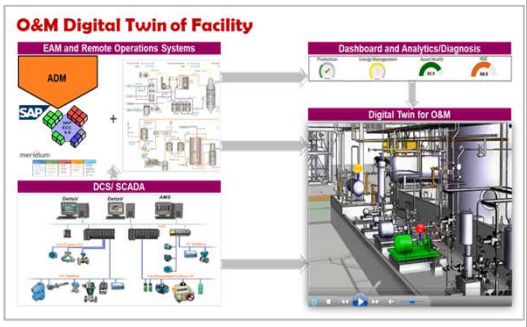
O&M Digital Twin – Building

- Real-time operating data
- O&M Digital Twin have proper tagging of instruments of as-built plant
- Interfaces with Asset Management System



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O&M Digital Twin - Functionalities

- Digital Twin is a continuously learning system
- Digital Twin predicts asset behavior and capacity to deliver on specific outcomes when combined with Big Data Analytics
- Digital Twin informs what you need to do with assets on physical twin
- Digital Twin is a *system of systems* - Big Data Analytics incl. DNNs, combined with physics-based modeling techniques

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Learning with Digital Twin

- Familiarization
  - For training e.g. safety information
  - For Construction prior to installation
- Training and eLearning
  - Training activities: simulating movement around facility, following correct processes to service etc.
  - VR allows fully immersive experience

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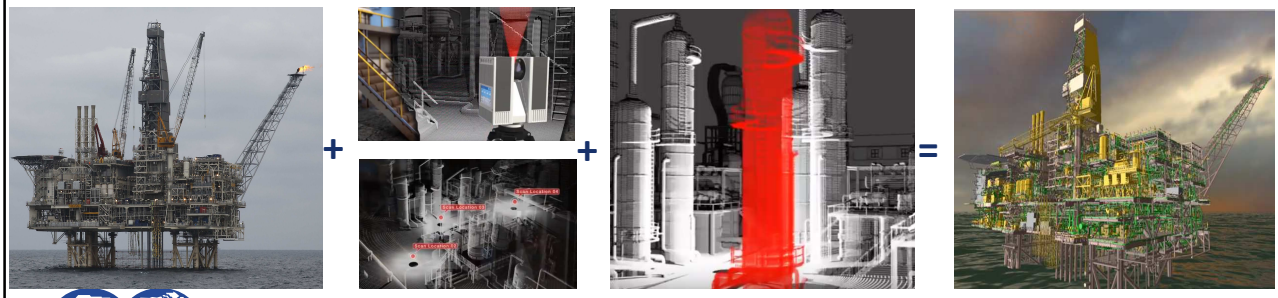
Digital Twin for Existing Facility

Physical Plant	3D Laser Scanning	LFM Technology Register thru LFM Server & LFM Point Cloud	Digital Twin Brownfield 3D Model & 3D Data Capture including Tagging



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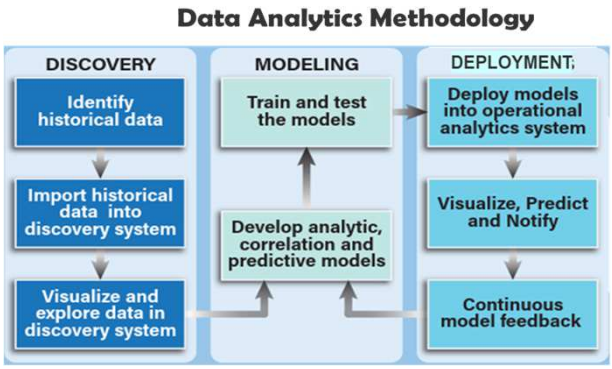
Big Data Analytics

Data Analytics

- Applies power of analytics to make better decisions
- Big Data technologies can process very large data sets containing variety of data types
- When combined with predictive techniques, it provides insight into degradation/anomalies/risk encountered or projecting future/intel



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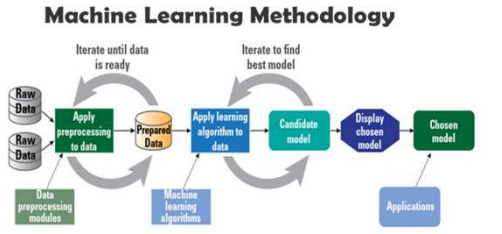
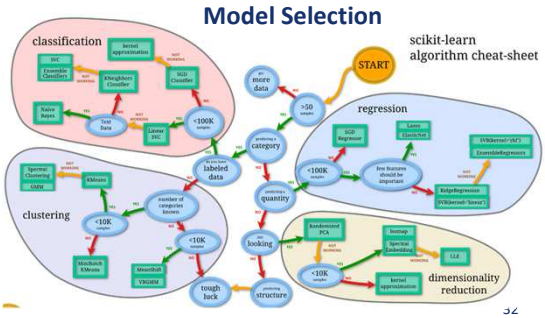
Machine Learning

- Method of data analysis that automates analytical model building
- Machine Learning models look for data and patterns and try to learn from those
- A method how much machine can learn and make decisions with minimal human intervention





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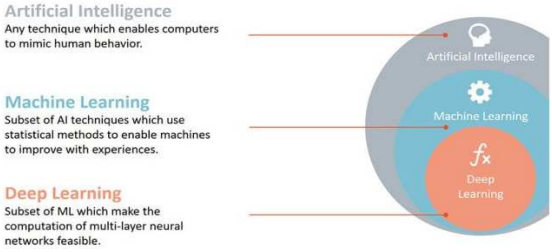
Artificial Intelligence

- AI emulates humans and makes it possible for machines to learn from experience
- AI combine large amounts of data with fast, iterative processing and intelligent algorithms
- AI includes many theories, methods, technologies, and following subfields:
  - **Machine Learning**
  - **Neural network**
  - **Deep learning**
  - **Cognitive Computing**
  - **Computer Vision**
  - **Natural language processing (NLP)**



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Big Data Analytics Methodology

Transforming data from being a *Consumer of Resources* to being an *Asset for the Company*

Data Capture/ Monitoring/ Management	Modeling/Analytics	Diagnosis/ Insight/ Predict/ Visualization/ Alerts	Action
▪ Historical and Current Real-Time data ▪ Secure and Private or Public Cloud	▪ Engineering & technical modeling expertise ▪ Data analytics of structured and unstructured data	▪ Diagnosis/ Prediction know-how ▪ High-Tech Visualization ▪ Simulation to detect problems	▪ Machine-to-Machine and Machine-to-Human actions ▪ Optimize System & Process ▪ Just-in-time Technical support

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Applications of Big Data Analytics

Big Data Analytics *across Project and Asset Life Cycle*

Improved Execution and Mitigate Risks

- Projects Insight
- Project Monitoring & Control
- Project Health

Optimize Operations & Increased Efficiency

- Improved Production/ Yield
- Reduced Trips/ Shutdowns
- Energy Management
- Meet Market Needs

Enhanced Uptime & Reduce Expenditures

- Rotating & Static Equipment Maintenance
- Shutdown and Turnaround
- Corrosion

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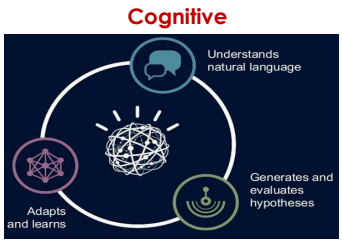
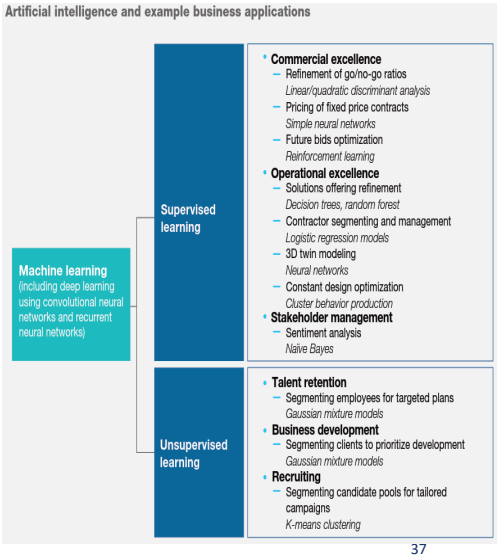
Projects - Insight

- AI powered algorithms focus on overcoming industry's greatest challenges – cost, schedule, safety
- AI algorithm based on learning from past – need of critical mass of data
- Cognitive ingests vast amounts of structured & unstructured data
- Cognitive Insight - interacts with humans naturally, learn from interaction and recommends probabilistic reasoning
- Provides employees right information at the right time





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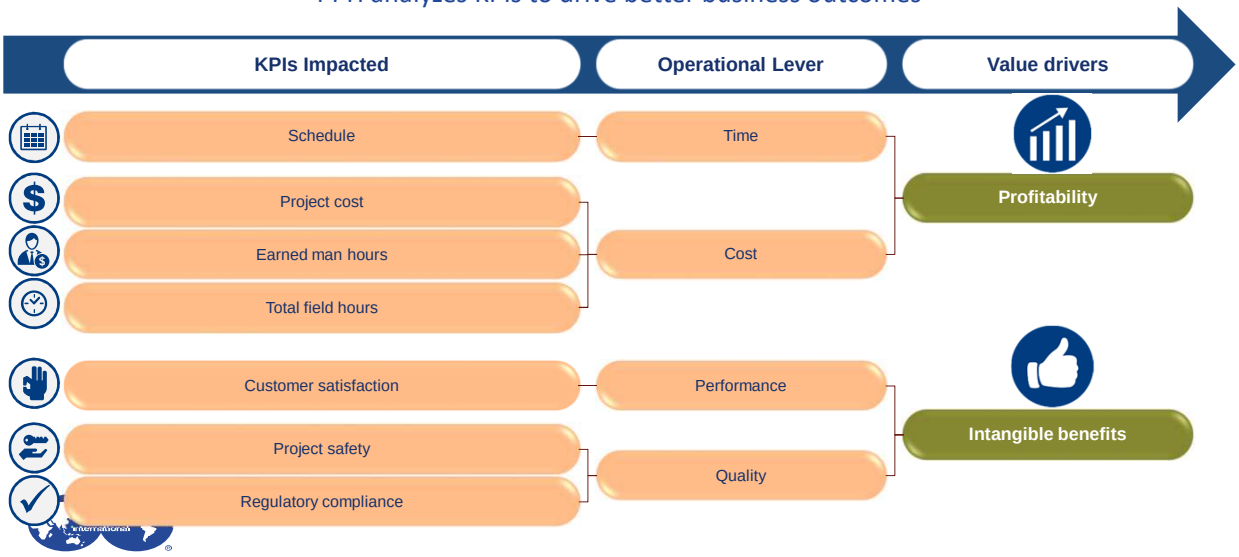
Predictive Project Health *KPIs*

PPH analyzes KPIs to drive better business outcomes



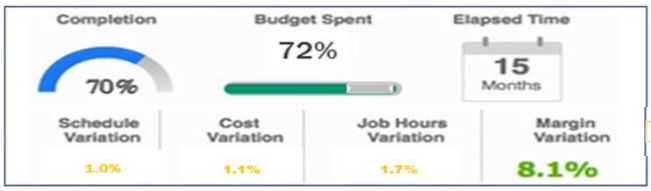
Project Monitoring & Control

Historical Projects Data, Documents & Lessons Learned

Data Analytics & AI

Prediction & Actions

Overall



Engineering

Procurement

Construction

Predict Project Health *Dashboard Outcomes*

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PPH Outputs

Project Root Cause Analysis

- How well project is performing on each KPI and if not, what root causes

Project Reference Class Comparison

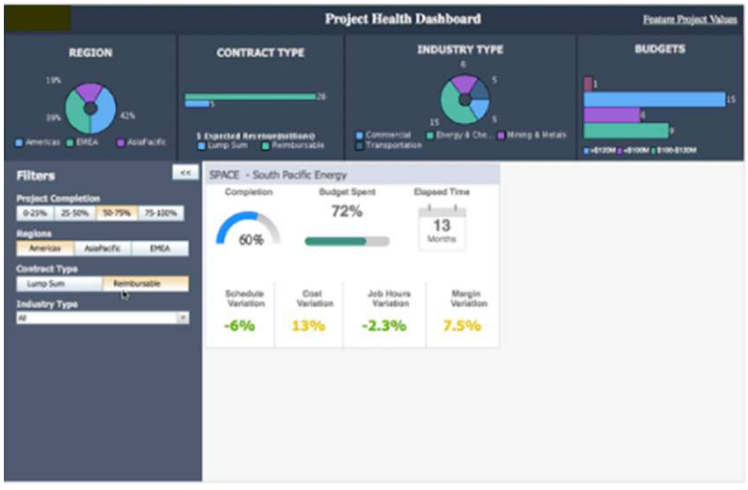
- Project health of current project compared to historical projects

Project Progress Curve

- Actual and planned progress of project at every discipline and component of the project

Project Prediction Reports

- How forecasts compare to the model predictions and actual at every step of the project



Operations - Remote

Remote Operations has three functionalities:

Process Reliability

Monitor & Predict KPIs

- Track operations & equipment performance
- Displays key KPIs
- Provides early event detection
- Predict process/operations upset using Machine Learning/ Artificial Intelligence

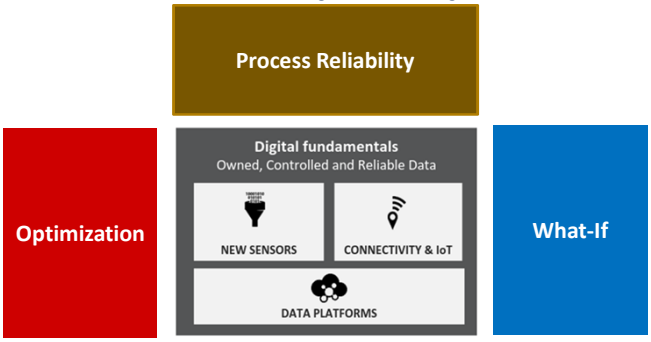
KPIs e.g.

- Energy Management
- Yield/ Production Improvement
- Equipment Uptime
- Chemical Consumption

Optimization

Optimize the Process/ Operations:

- Using data through simulations
- Delivers operational recommendations
- Maximize asset utilization
- Increase profitability



What-If

Performs Scenarios:

- Allows users to modify select parameters
- On-demand analysis
- Highlight potential economic impact and necessary operational changes

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Maintenance – Data Driven Asset Performance

Asset Performance

- **Condition based maintenance** – based on the operating condition of asset
- **Predictive maintenance** – based on the historical data and current condition of assets
- **Prescriptive maintenance** – predicting and identifying the problem but also giving options for remedy

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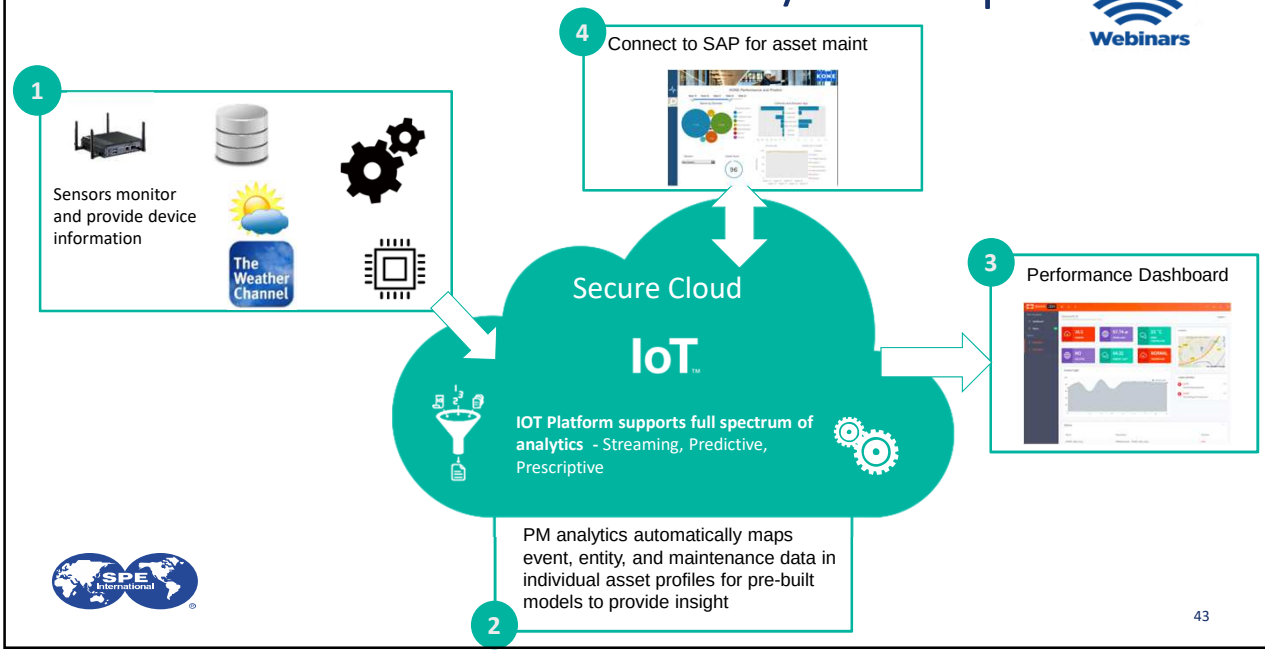
Maintenance – Predictive/ Prescriptive



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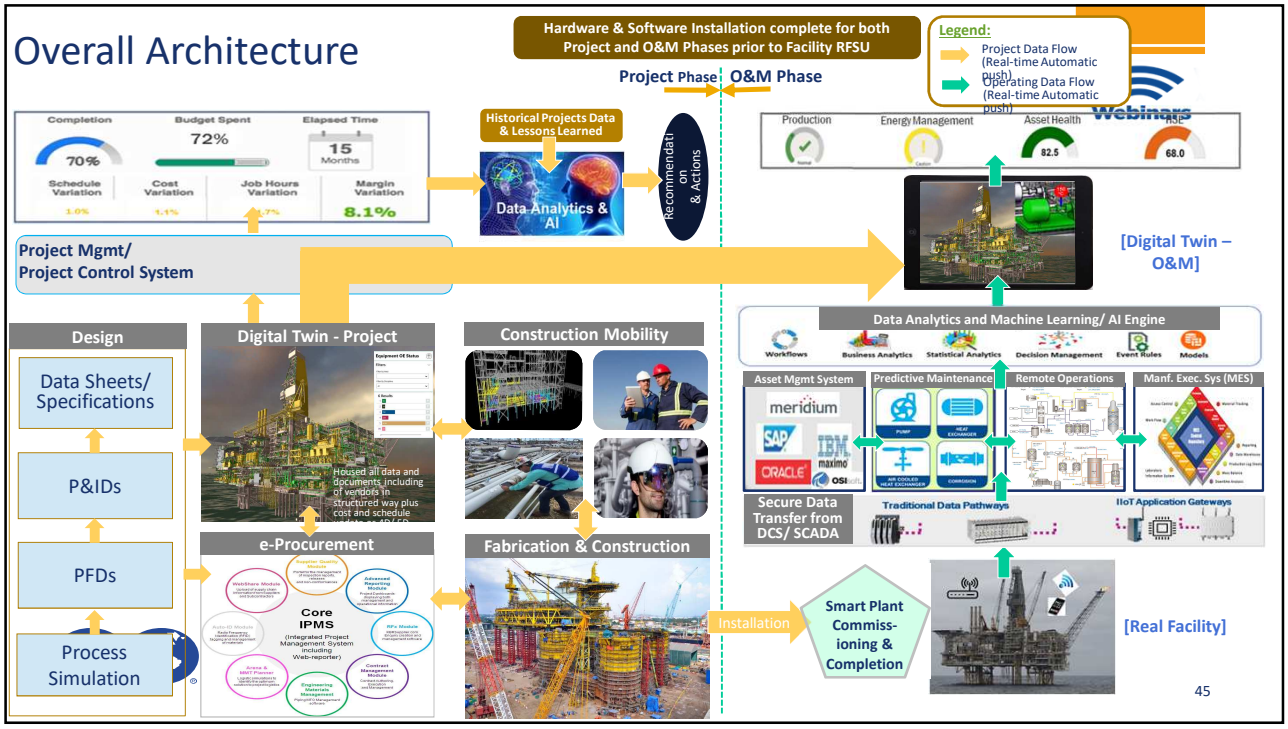
Overall Architecture of Digital Twin and Big Data Analytics Systems



Webinars

Thank you!

Questions?