Ethylene Middle East Technology Conference

EMET CONFERENCE

The Reality of Digital Twins

Tolu Sodeinde
Senior Digital Consultant, AVEVA
February 14, 2019

Ethylene Middle East Technology Conference
EMET CONFERENCE

Outline

- Digitalization in Today' Paradigm
- What is Digital Twin?
- Purposes and Challenges
- Digital Twins in Industrial Operations
- How Digital Twins are Transforming Work

Ethylene Middle East Technology Conference
EMET CONFERENCE

Digitalization in Today's Paradigm

Digitization, Digitalization, Digital Transformation

Digitization	Digitalization	Digital Transformation
The conversion of products to digital format and the concomitant inventions that ensue.	The innovation of business models and processes that exploit digital opportunities.	The systems-level restructuring of economies, institutions, and society that occurs through digital diffusion.

Source: MIT Sloan Management Review

- ***Digitization*** *is digital capture of information – instruments, sensors, 3D/2D/1D engineering, video, data entry.*
- ***Digitalization*** *is deriving "knowledge" and "wisdom" using processes and models.*
- ***Digital Transformation*** *is a system-level transformation of work activities".*

NASA – Pairing and Mirroring

- A precursor to digital twin.
- Predicated by NASA's pairing technology.
- Pairing of digital objects and physical objects pioneered by NASA in early days of space exploration.
- Not a replacement of physical asset

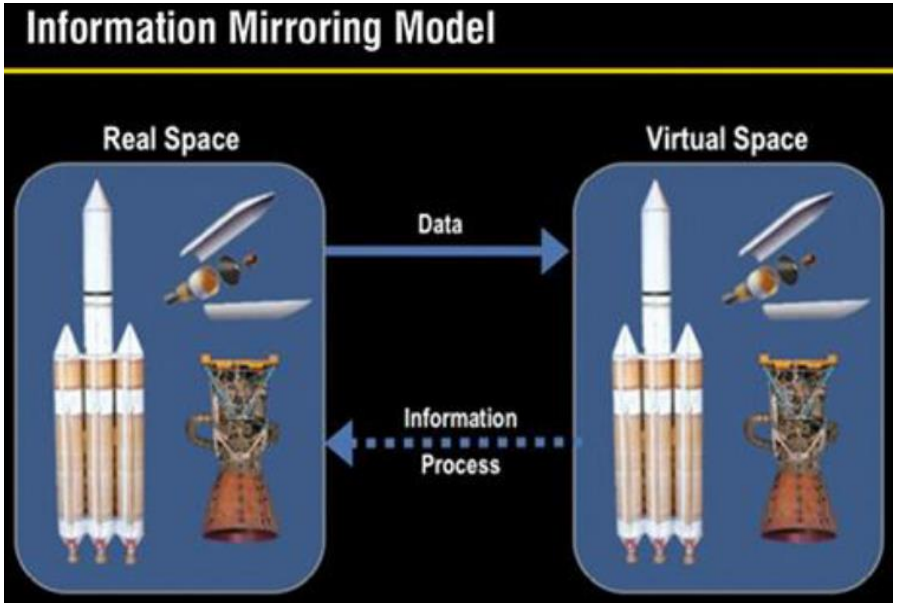


Image Source: Mirrored Spaces (M. Grieves, 2002)

"The ultimate vision for the digital twin is to create, test and build our equipment in a virtual environment…"
"…the digital twin contains all the information that we could have by inspecting the physical build."
– John Vickers, NASA

Ethylene Middle East Technology Conference
EMET CONFERENCE

What is Digital Twin?

A digital replica of a product or system, maintained as a virtual equivalent throughout the lifespan of the physical product.

Source: MIT Europe conference, Vienna

A dynamic software model that employs sensors and other forms of data to analyse its state, respond to changes, and improve operations.

- Donna Rhodes, MIT

Image Source: AVEVA, Building the digital asset

Definitions (M. Grieves, 2002)

- **Digital Twin Prototype** is information necessary to describe and produce a physical version that duplicates the virtual version.
- **Digital Twin Instance** describes a specific corresponding physical product, remaining linked to it throughout its lifespan.
- **Digital Twin Aggregate** is an aggregation of all DTIs for a set of products.

Purposes of Digital Twins

- Actionable – determines behavior
- Informative – provides useful and instructive information
- Predictive – predicts outcomes
- Analytic – analyzes outcomes
- Diagnostic – identifies faults
- Interrogative

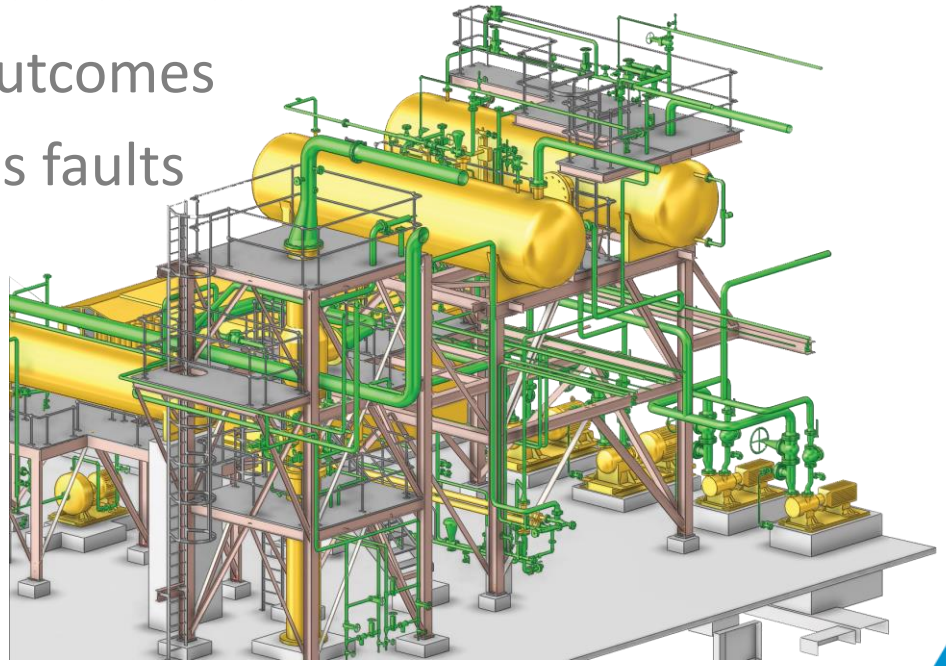


Image Source: AVEVA Engineering 3D

Ethylene Middle East Technology Conference
EMET CONFERENCE

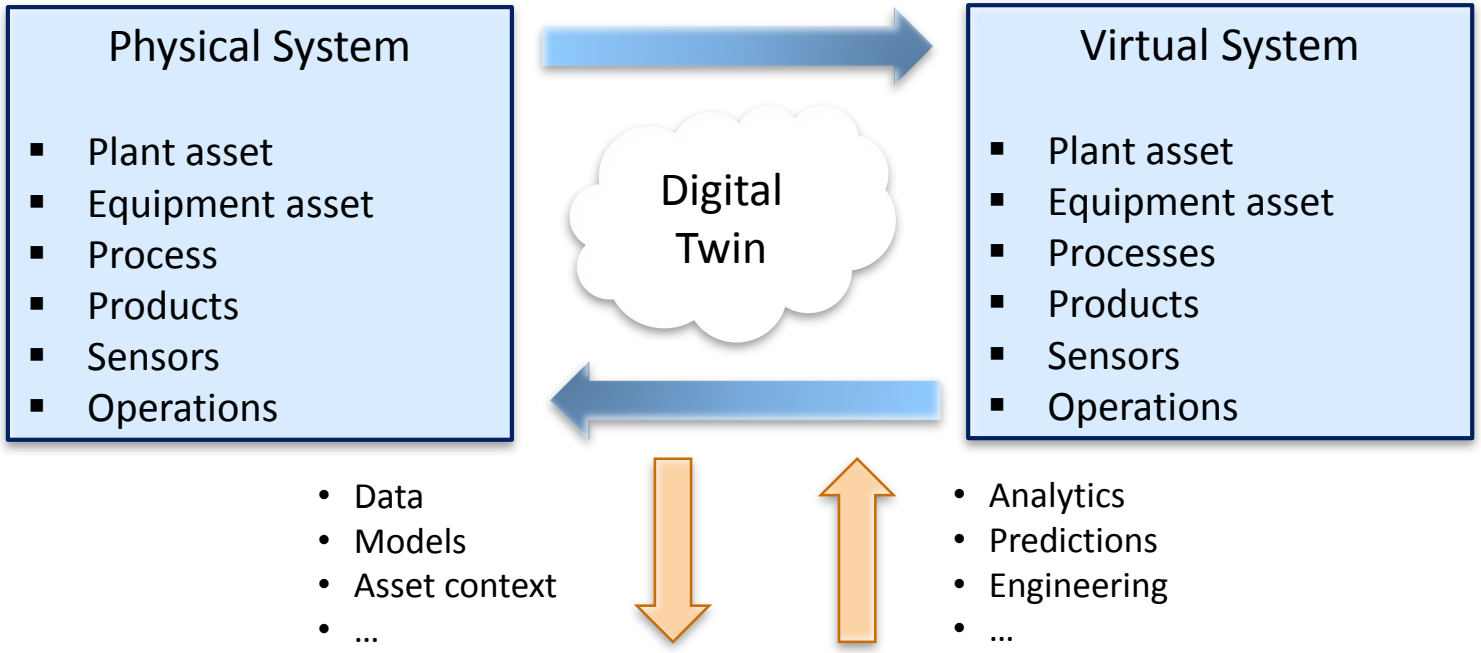
Challenges

- Business Challenges:
  - Models' valuation.
  - Intellectual property strategy.
  - Changes to traditional business model.
- Technical Challenges:
  - Model complexity and scaling.
  - Interoperability standards and connectivity.
  - Difficulty migrating legacy products into the digital space.
  - Security of information across systems
- Operational Challenges:
  - Interpretation and acceptance of models as primary source of truth.
  - Adoption of models as part of work process.
- Organizational Challenges:
  - Limited training and knowledge digitalizing legacy products.
  - Limited skills and experience in current work force for digitalization.
  - Organizational structure not well adapting to new digital framework.

Ethylene Middle East Technology Conference
EMET CONFERENCE

Digital Twin in Industry 4.0

High-level representation of Digital Twin in Industry 4.0

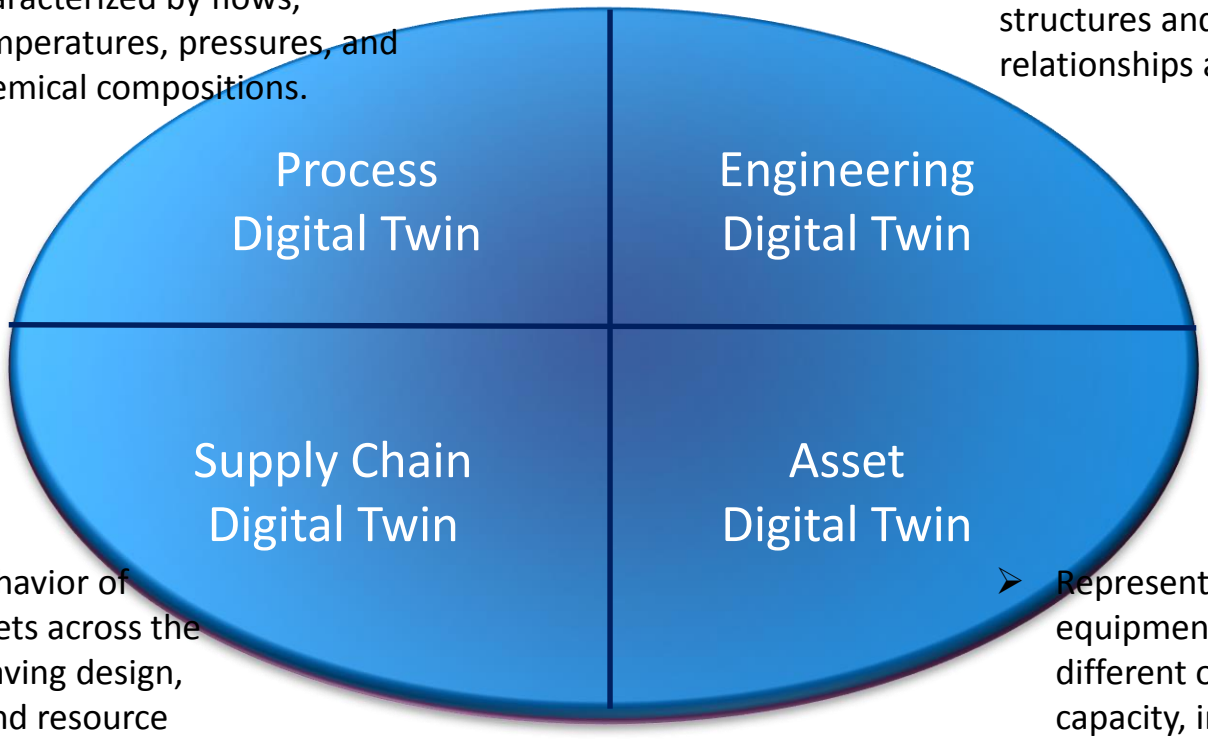


Ethylene Middle East Technology Conference
EMET CONFERENCE

Digital Twins in Industrial Operations

- Represents behavior of phased materials across unit operations, characterized by flows, temperatures, pressures, and chemical compositions.

- Represents physical shapes, locations, equipment identifiers, connectivity, hierarchical structures and their contextual relationships and associations.

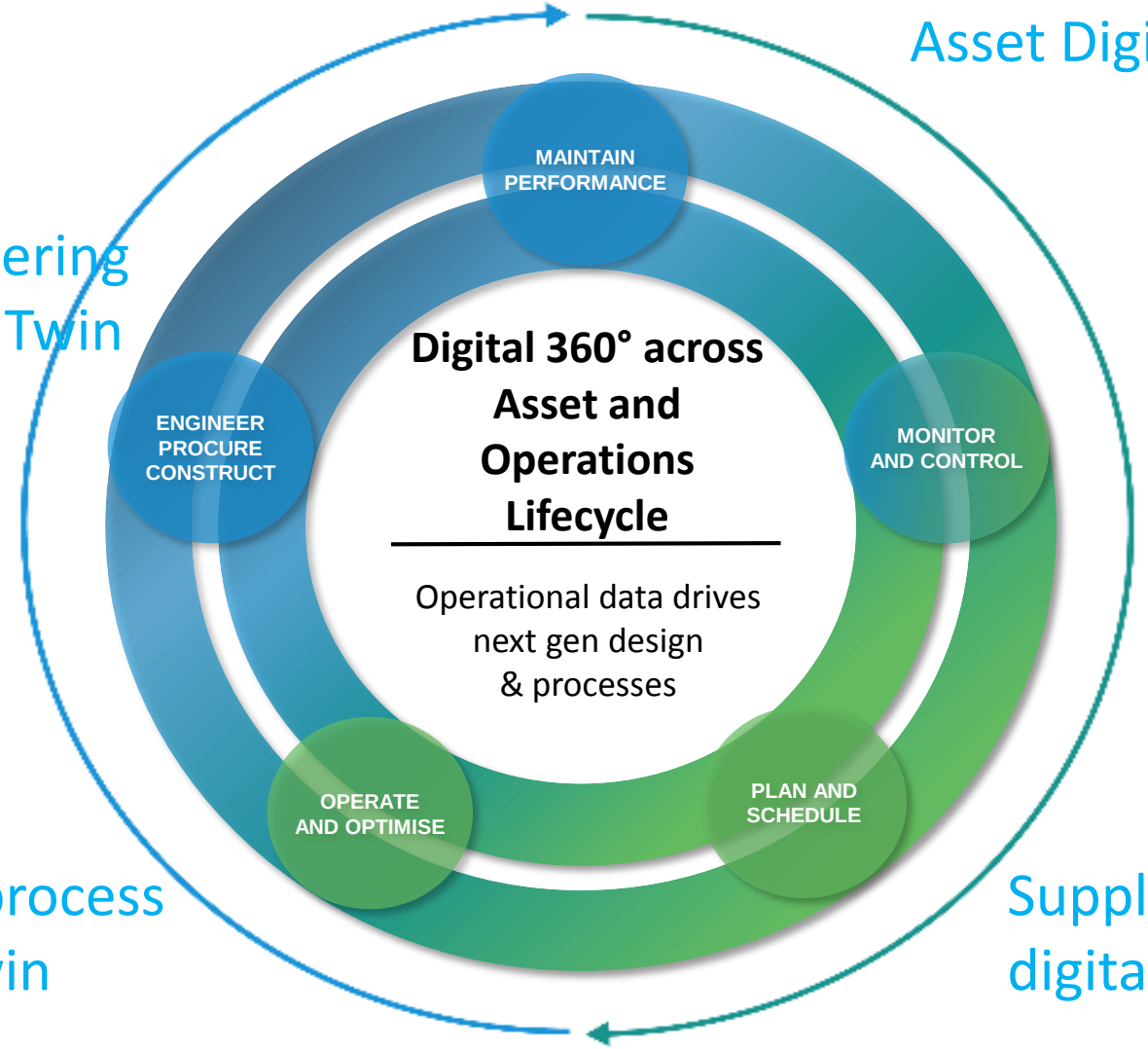


- Represents behavior of connected assets across the value chain, having design, operational, and resource constraints / limitations.

- Represents behavior of equipment characterized by different operating modes, capacity, integrity status, actual and/or predictive state.

Ethylene Middle East Technology Conference
EMET CONFERENCE

Continuously Adding Value



Ethylene Middle East Technology Conference
EMET CONFERENCE

Engineering Digital Twin

The Digital Asset

A rigorously detailed replica of the structures and equipment mechanicals with a rich set of context links to associated 2-D diagrams and 1-D documents and sheets.

- For “design” – integrated asset modeling, multi-user collaboration.
- For “control” – asset maintenance, incident management, lock out/tag out.
- For “performance” – construction / retrofit progress, visual context.

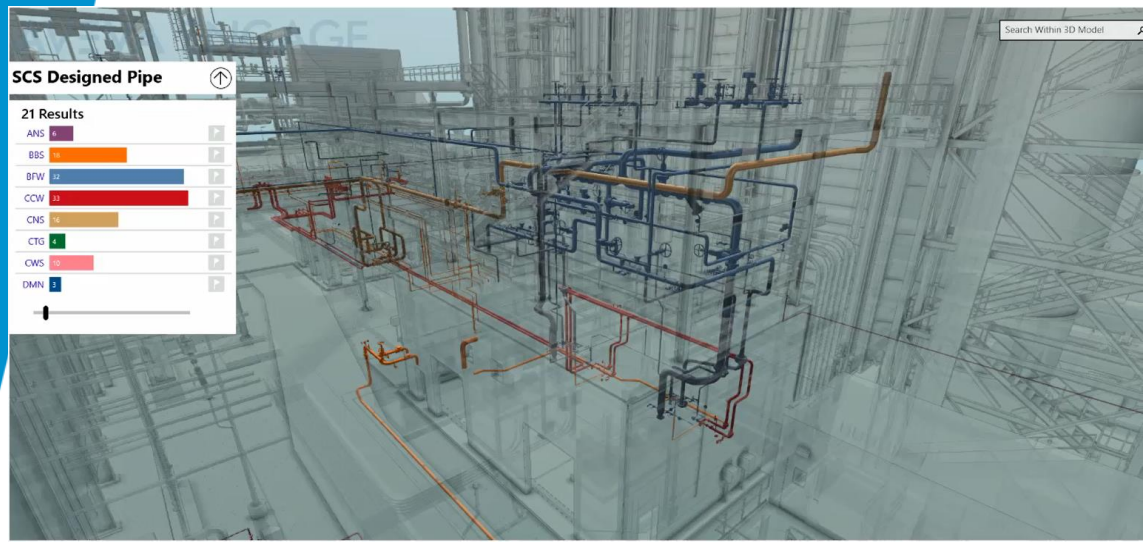


Image Source: AVEVA Engineering Model

Asset Digital Twin

Asset Digital Behavior

A heuristic replica of expected behaviors used to predict and identify imminent equipment failures.

- For “design” – equipment behavior modeling.
- For “control” – equipment monitoring of status, availability, remaining useful life.
- For “performance” – equipment predictions, integrity status.

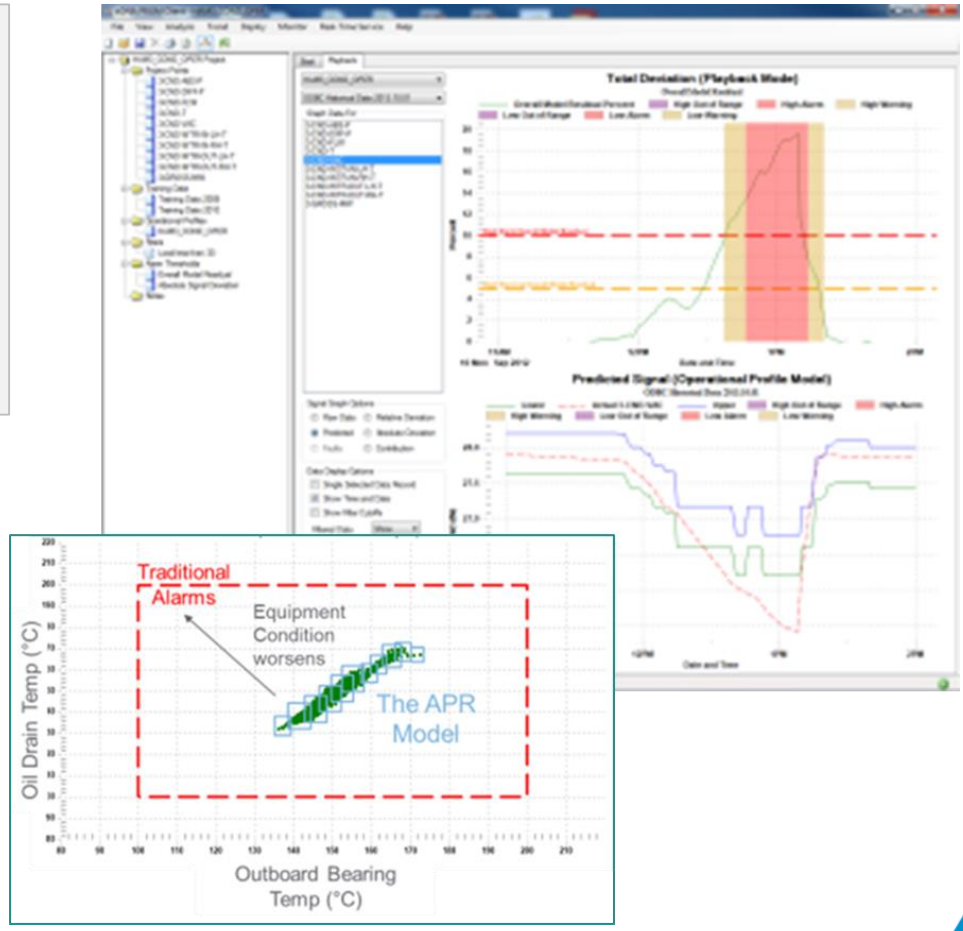


Image Source: AVEVA Asset Performance

Process Digital Twin

The Digital Process

A rigorously detailed replica of process and fluid behaviors except imminent failures.

- For “design” – plant / process design.
- For “control” – process simulation at varying conditions, real-time optimization.
- For “performance” – energy efficiency, furnace coking & yield predictions.

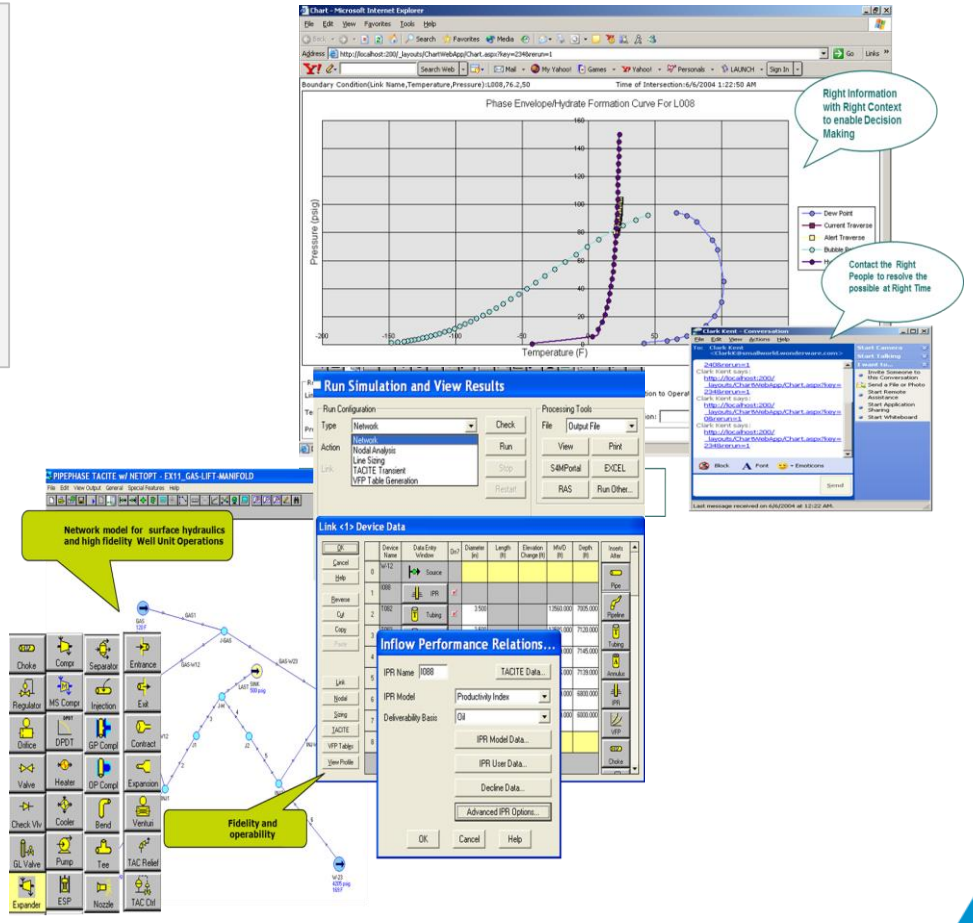


Image Source: AVEVA Process Simulation Model

Ethylene Middle East Technology Conference
EMET CONFERENCE

Supply Chain Digital Twin

Digital Supply/Demand

An detailed replica of supply & demand flows across the value chain for optimal operations.

- For “design” – planning & scheduling process.
- For “control” – optimized plan, feasible schedule, feedstock selection for optimum yield and costs.
- For “performance” – unit conversion, yield, deviation from plan.

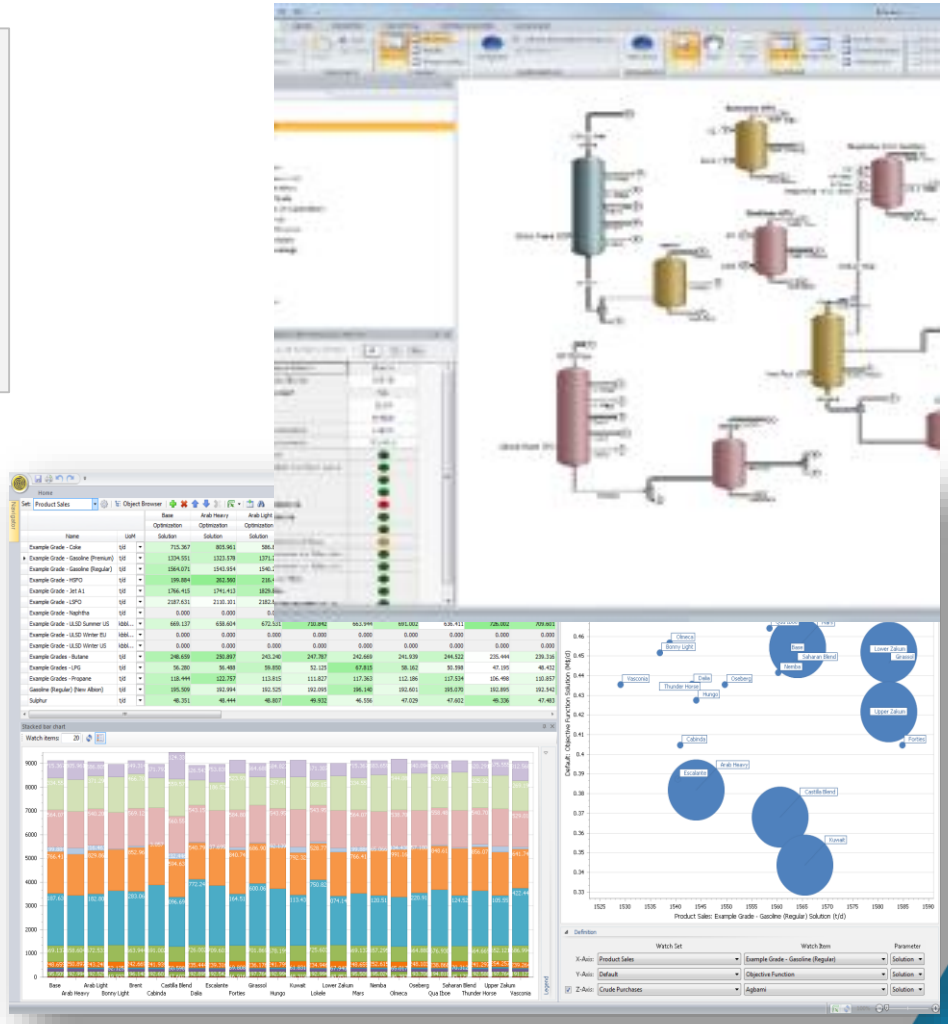


Image Source: AVEVA Unified Supply CHain

How Digital Twins are Transforming Work

Changes “when” and “where”…

- Digital twin “brings the work to the worker” for performance degradation, flow assurance problems etc.
- Teams find and view associated information, diagrams and documents within minutes, often within seconds. “Wasted work” is minimized.

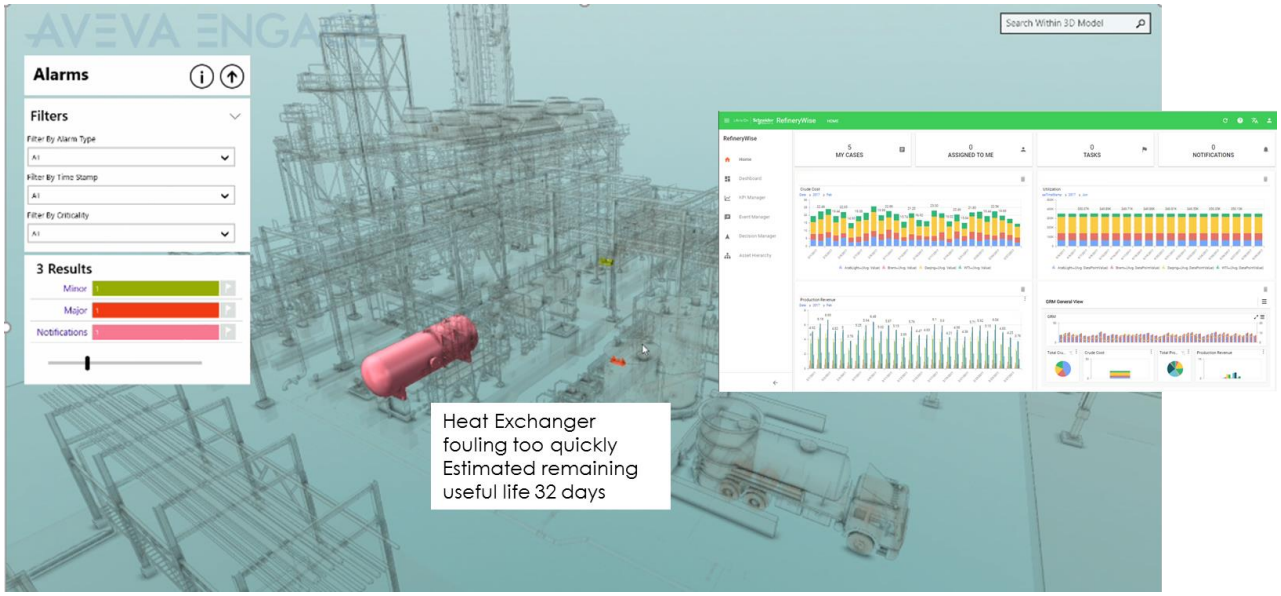


Image Source: AVEVA

How Digital Twins are Transforming Work

Changes “when”, “where”, “which”, and “how”…

- Digital twin “brings the work to the worker” for imminent equipment and/or asset failures.
- Knowledge library and sharing enabled. Decision making faster and more accurate.

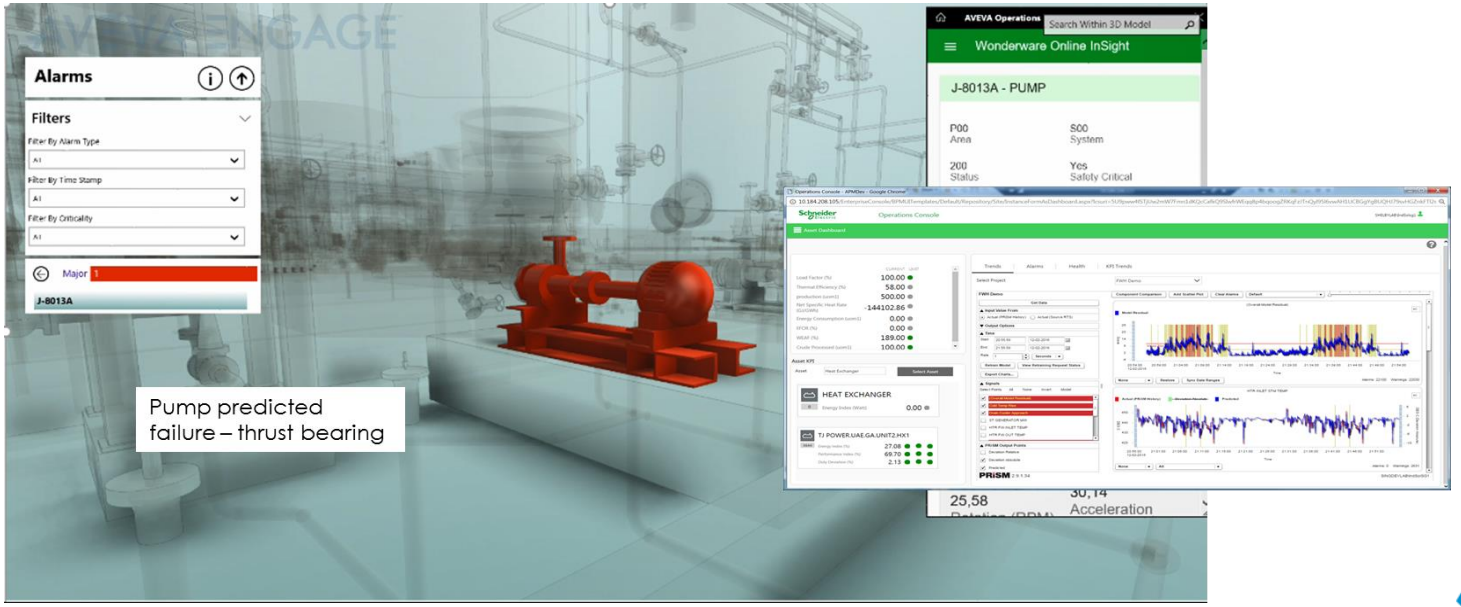


Image Source: AVEVA

Ethylene Middle East Technology Conference
EMET CONFERENCE

How Digital Twins are Transforming Work

Changes “when”, “where”, “which”, and “how”…

- Digital twin “*guides and tracks field work procedures”, including inspections*.
- *Workers annotate observations directly and supervisors notified on overdues*.

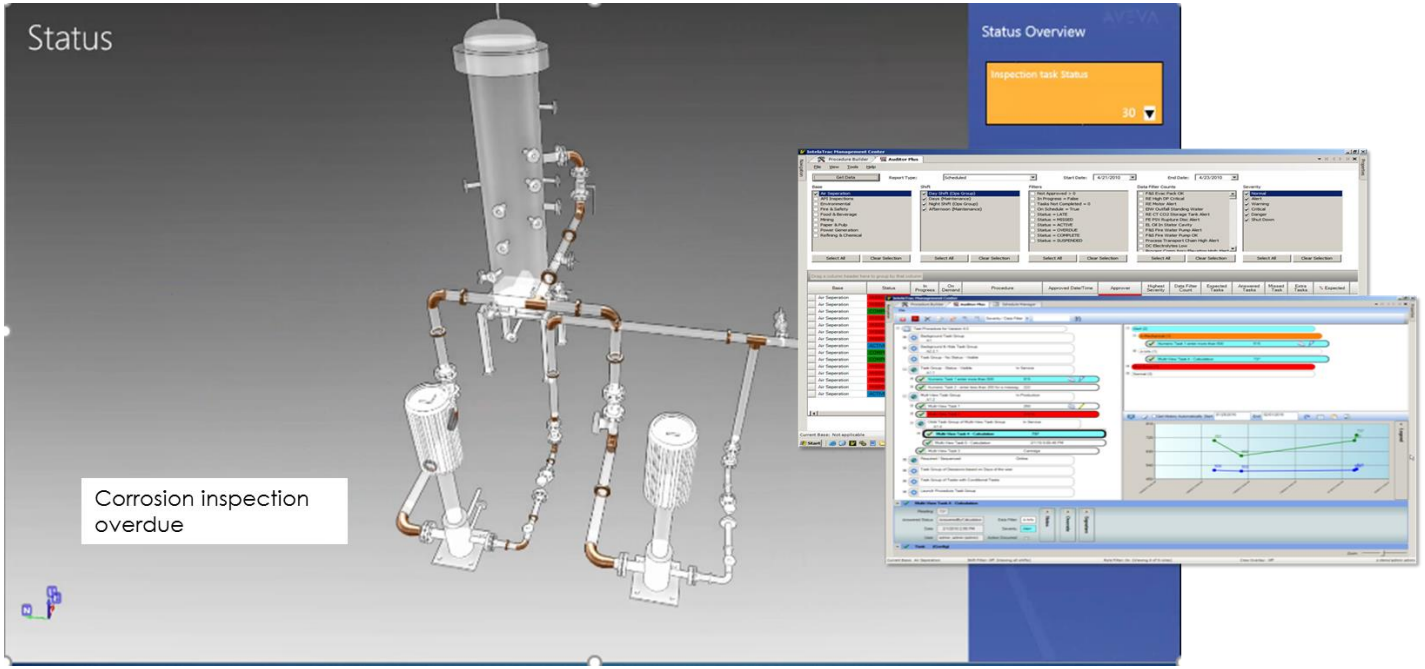


Image Source: AVEVA

Ethylene Middle East Technology Conference
EMET CONFERENCE

Digital Twin Enablers

- Wireless sensory technology
- Cloud computing & storage
- Hyperscale computing
- Data sciences and visual analytics
- 3rd party providers of digital toolsets & services
- Integrated IT infrastructure & information security
- Augmented and virtual reality

Ethylene Middle East Technology Conference
EMET CONFERENCE

The Emerging Digital Ecosystem

- Digital twin is four on Gartner's top ten strategic technology trends in 2019.
- Immersive world that blends virtual and physical worlds.
- Digital twins representation of billions of items and things.
  - From replica of large scale systems to small critical part components.
- A digital mesh involving processes, assets, people, devices, contents, and services.

> *"The future will be characterized by smart devices delivering increasingly insightful digital services everywhere."*
> – David Cearley, Gartner's Vice President Analyst


AVEVA ENGA
Search Within 3D Model
Model
Reset View
Section
Measure
Visual Query
X-Ray
Walk
Extensions
Annotate
Snap
Collection
0

Imagine a Future Where Every Item has a Digital Replica…

Image credit: ANSYS

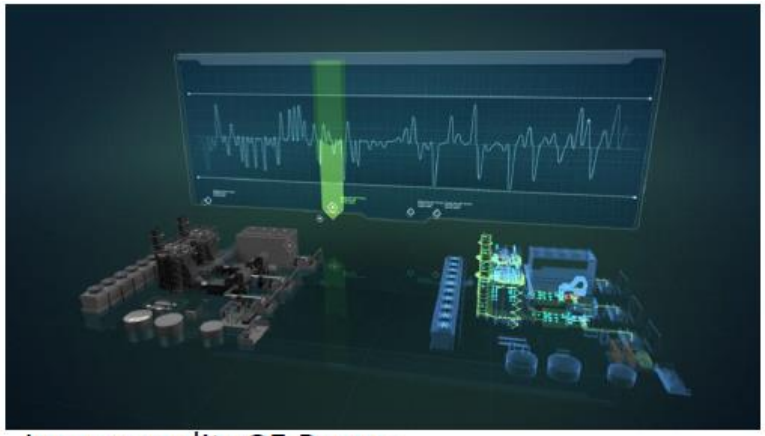


Image credit: GE Power

Image credit: GE

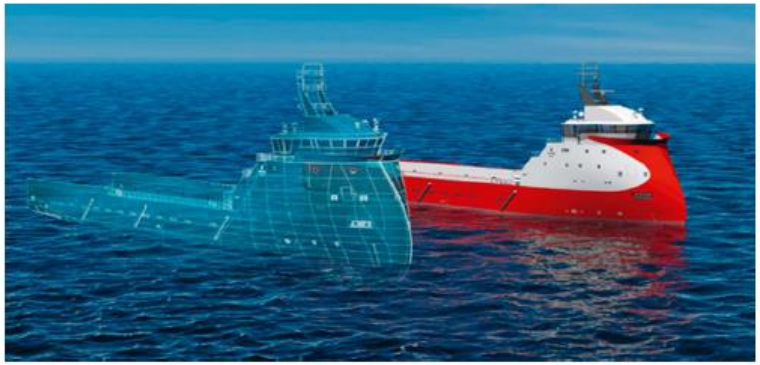


Image credit: DNV GL