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Process Simulation – Areas of Innovation

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- Improved Engineering Workflows
- Integration of Models with Artificial Intelligence
- Cloud
- Sustainability

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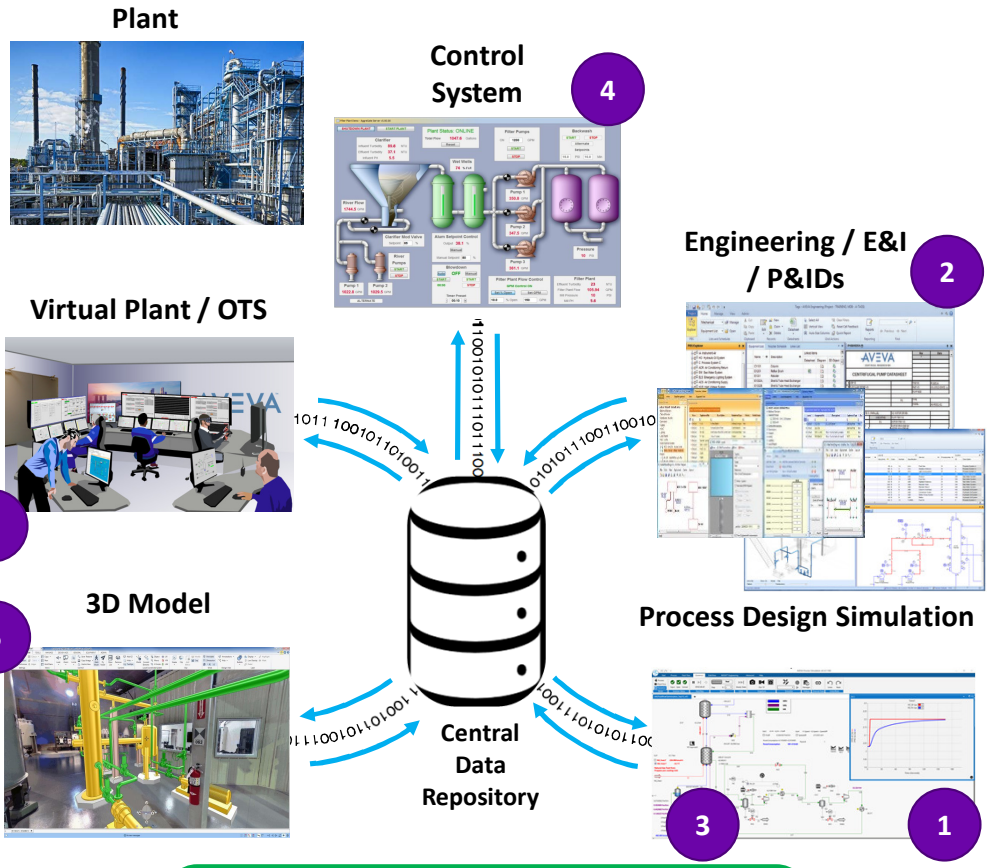
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Unified Engineering
- Simulation Driven Engineering

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Unified Engineering – From Project Concept to Handover



Data Centricity across Simulation Tools and AVEVA Engineering

FEED

The first step in the journey is the simulation of the process where we define the required plant design. 1

Detail Design

The design then evolves in all engineering disciplines including process, piping, civil, mechanical, instrumentation and electrical. 2

The design is validated using the process simulation in design, rating and dynamic modes 3

Construction

Control system is generated starting from data stored in the central repository, then connected to the process simulation and validated offline. 4

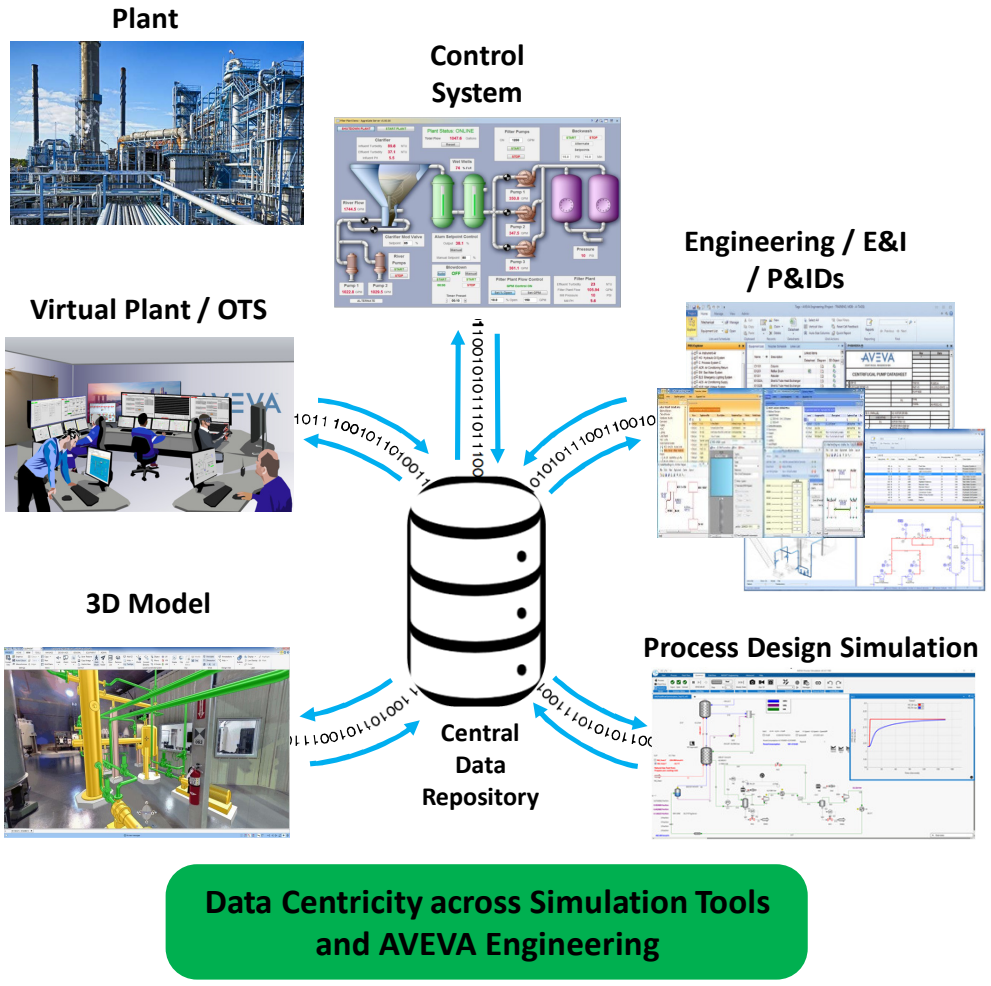
In parallel there will be fabrication, installation, and construction of the plant facility.

Commissioning

The process simulation connected to the control system and the OTS and optionally the XR can be used to prepare staff to be ready on day one 5

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Unified Engineering – From Project Concept to Handover



Data Centricity across Simulation Tools and AVEVA Engineering

FEED

Detail Design

Construction

Commissioning

- Shared environment with data at its core
- All applications work with the same shared data
- Everyone contributes to data maturity
- Information is passed from tool-to-tool seamlessly
- There is one single source of truth
- Errors are minimized
- Improved collaboration between disciplines
- Teams can see the engineering progress
- Continual and seamless handover of information into operations

"High FEED maturity and accuracy results in 24 percent lower project costs overrun"

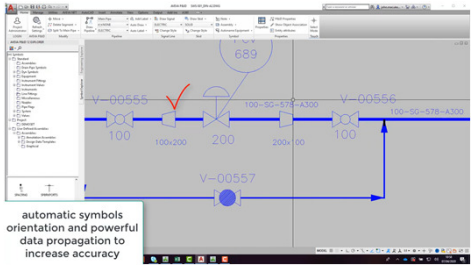
CII Report - Assessing the Maturity and Accuracy of Front-End Engineering and Design, April 2018

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Import Intelligent P&IDs into AVEVA Dynamic Simulation

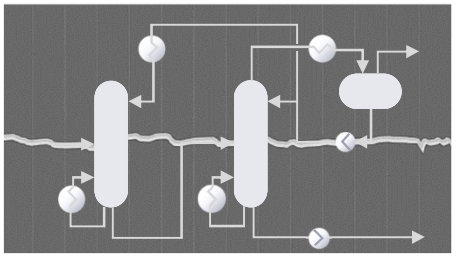
Intelligent P&IDs



DEXPI export



Dynamic Simulation



- Export intelligent P&ID's and engineering data into **DEXPI** (standard for Data Exchange in Process Industry)
- DEXPI standard is supported by all major vendors of intelligent P&ID's.
- The DEXPI file is then automatically converted into an equivalent dynamic simulation with all selected process lines and equipment. It is also possible to transfer engineering data.
- This can save up to **50% in the time** to develop a dynamic simulation and ensures the **correct transfer of design data**

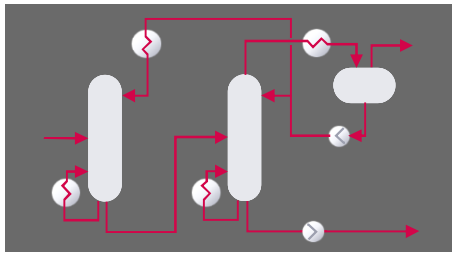
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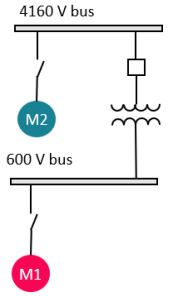
Integrated Process and Electrical Digital Twin

Breaking down interdisciplinary barriers to get the correct design, first time

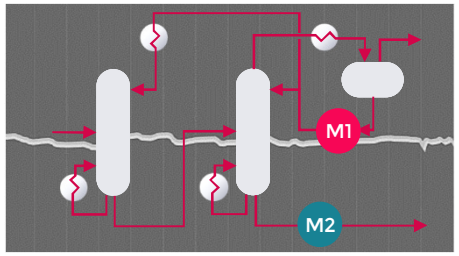
Process Simulation



Electrical Simulation



Process & Electrical Simulation



- Combine both process and electrical dynamic simulations using AVEVA Dynamic Simulation and Schneider Electric's Electrical Modeling platform ETAP.
- During FEED, a highly accurate dynamic process model can provide the process energy consumption requirements. When connected to a design quality electrical model, the engineer can optimize the E-House by quickly iterating on many potential configurations.
- Co-simulation can reduce the time for an energy management study and validate the study results quickly, with demonstratable dynamic results.

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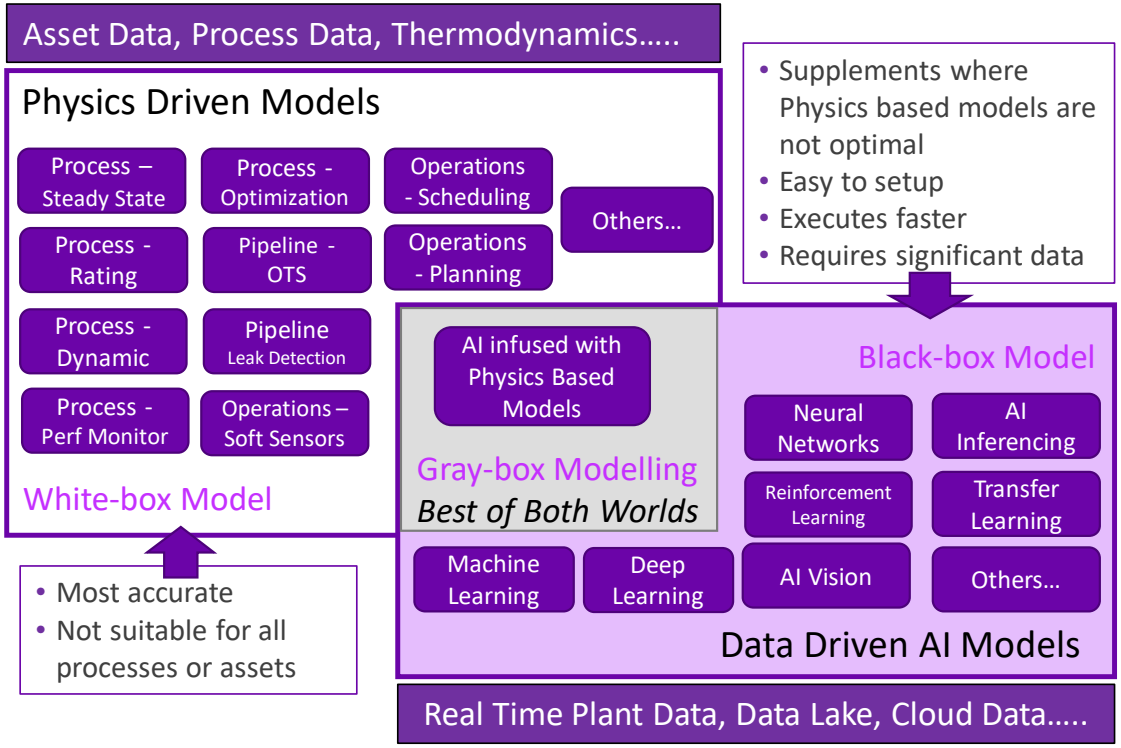
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First Principles Simulation Integrated with Artificial Intelligence

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Models & Use Cases

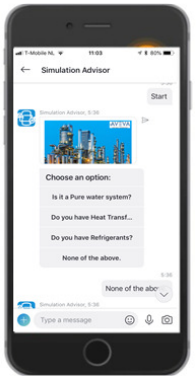


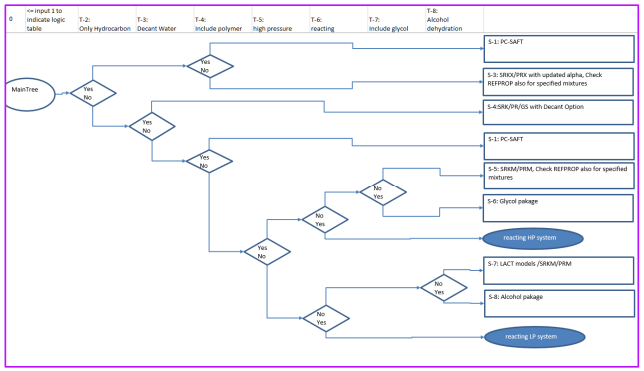
White Box	What design has the lowest environmental impact?
	Is my heat exchanger correctly sized?
	Is my plant stable and controllable?
	How do I know when I have a leak in my pipeline?
	What crude is best for my refinery?
	Can you optimize my process to identify new levels of untapped productivity?
	How do I get my operators ready for operations on day one?
Gray-Box	Can I model a new process that only has first principles models for some of the assets?
	How do I reinforce learning after the formal training is over?
	Can you learn from past behavior to recommend optimal schedules?
Black Box	How do you calculate key Asset KPIs when first principles algorithms don't accurately model the asset?
	How do you keep a digital twin live for a brownfield operation?
	Can sections of my plant be run autonomously?
	Can you predict performance using AI cognitive capabilities such as machine learning, deep learning, and computer vision?

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Use of AI for Advising Thermo Method and Data

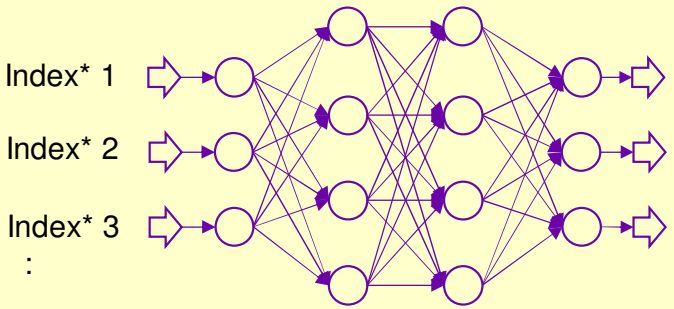




Partial Update of Decision Tree Using Machine-learning

In input parameters
(demands, scalable)

Output parameters
(simulation configurations, scalable)



*Example of index: “robustness required”, performance (speed), outcome of other decision trees, accuracy for specific systems….
**Recommendation could be thermo sets, databanks, configurations for unit operations, and their combinations.

(A patent was submitted)

Objectives

- Make suggestions to customers on thermo configurations such as methods and data

Solution

- Use of autonomous SNS tools (like BOTs) which enable users to have “structured conversation” with an expert system based on “decision tree” using popular platforms like smart phones
- Human interventions are recorded in data storage. Machine-learning is applied to improve the decision tree
- Helps for education/training (joyful contents)

Plan

- Phase-1:Suggest methods and data sets based on a fixed decision tree and data availability maps.
- Phase-2:(Long term) Diagnosis simulation file. Machine-learning to autonomously improve the decision learning from human interventions

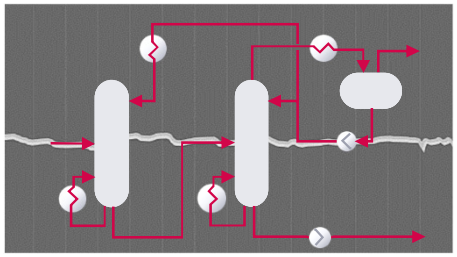
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Operator Advisor for Dynamic Transients

First Principles Model used to Train AI model for identifying optimal operating procedures

Dynamic Simulation



Artificial Intelligence

Online Advisor



- AVEVA dynamic simulator is used to train an artificial intelligence agent to identify the optimal trajectory between two operating conditions.
- The AI agent tries thousands of different operations using parallel sessions of the simulator on the Cloud to identify the one which can be completed in less time, with less alarms and with lower emissions.
- PRiSM TRANSIENT model trained as a surrogate on the best run will give an operator a real-time view of when their actual actions deviate from the best possible.
- This could translate into higher production, safer operations, and lower environment impact.

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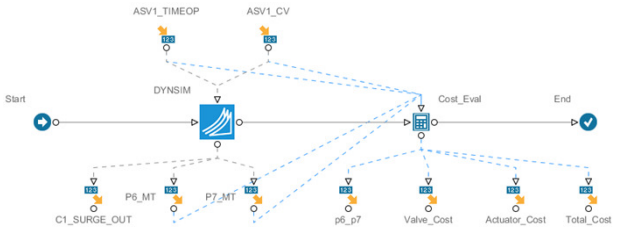
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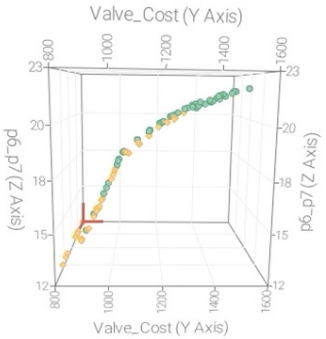
Optimum Design – Combining Rigorous Models with AI

First Principles Model and AI used to evaluate optimum process design

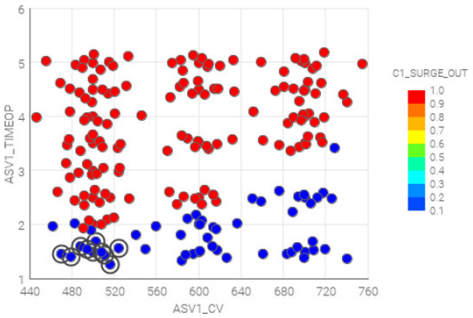
Automated Workflow



Powerful Visualization



Robust and reliable design



- Process engineer can automate the parametric optimization of the design combining AVEVA process simulation with ESTECO ModeFRONTIER in the same workflow
- Use the AVEVA high-fidelity models to train AI surrogates for running multiple simulations in parallel to accelerate the engineering process
- The solution includes several state-of-the-art optimization algorithms and visualization tools to find the optimal design
- The resulting robust and reliable design reduces the CapEx and OpEx cost

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Cloud Hosted Solutions

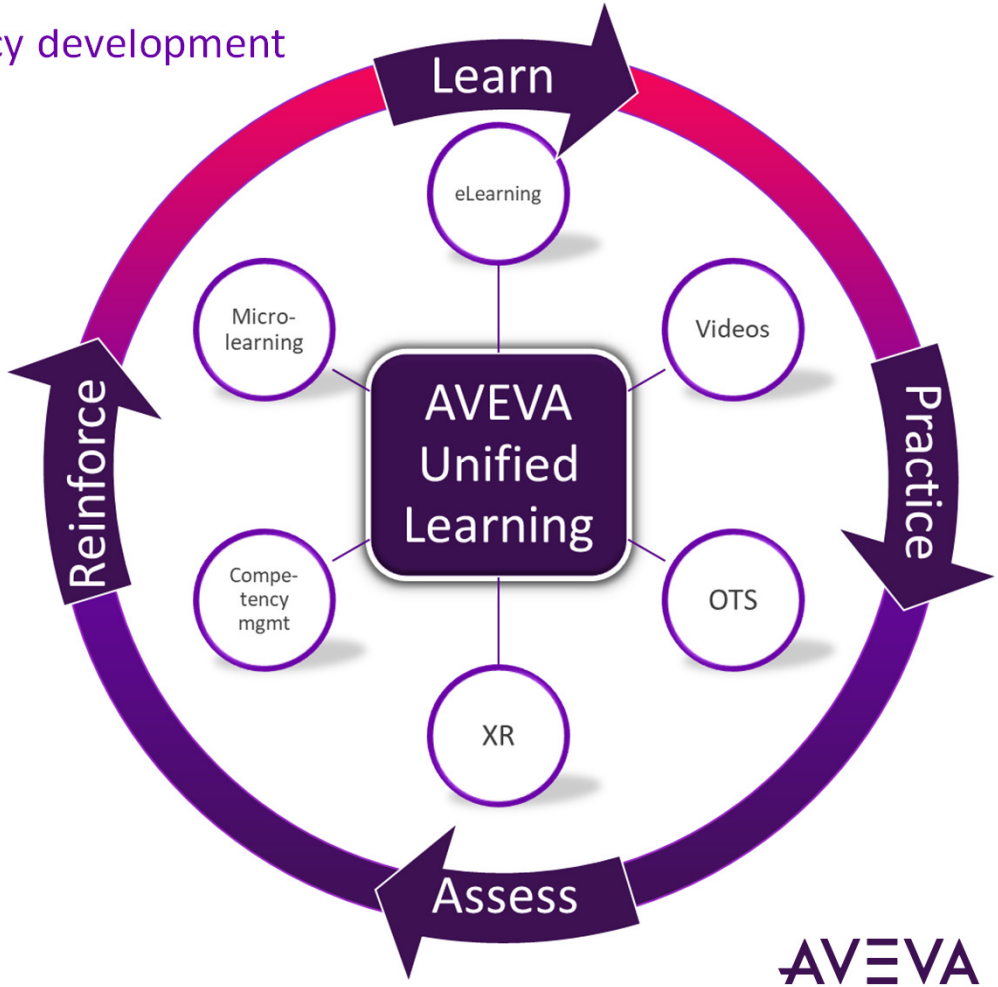
— Simulation as a Service, On-Line Performance Monitoring & Predictive Analytics

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Cloud Hosted AVEVA™ Unified Learning

Central hub for industrial training and competency development

- Remove barriers to accessibility and availability
- Reduce hardware, IT and travel cost
- Shorten time to competence
- Boost global team's collaboration
- Empower remote working
- Pay as you go



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AVEVA Connect – First Principles Informed Predictive Analytics

Assett Anomaly Detection with Simulation and Predictive Analytics Online

Objective

- Allow owners to monitor equipment (primarily rotating) using ML and Simulation to show performance and predict asset ano and potential failure.

Solution

- AVEVA Process Simulaltion facilitates the development of first principle equipment performance models
- Equation oriented-data reconciliation available when needed.
- Real time scheduler software, Data Cleansing, PRiSIM connection

Status

- Prototype and video available



AVEVA Process Simulation Compressor model to predict isentropic efficiency and adiabatic head linked to AVEVA Predictive Analytics (Video Available)

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AVEVA Connect – Online Performance Monitoring

Live Process Monitors

Objective

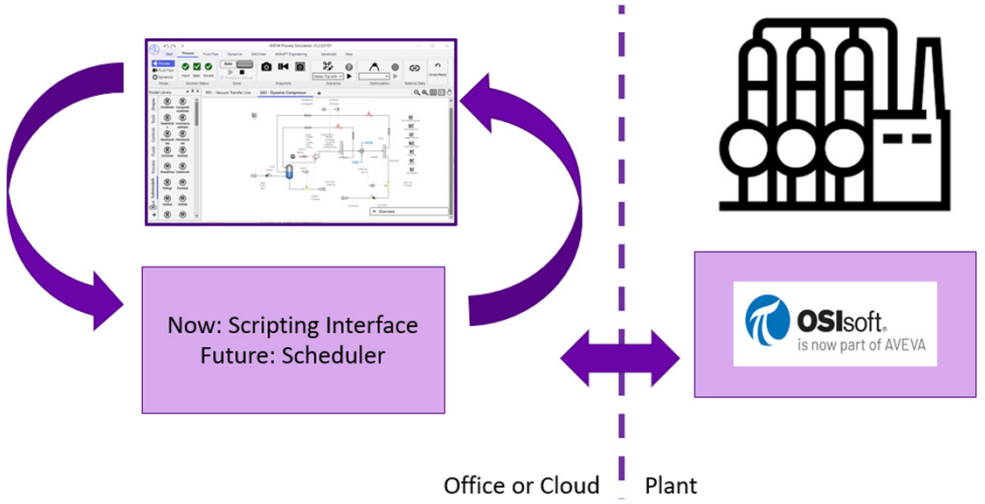
- Allow owners to monitor their plant efficiency and bottlenecks (eg flooding) through a historian using reconciled simulations.

Solution

- Create simulations yourself using AVEVA Process Simlaution rather than rely on a services team.
- Read to and from data Historian such as OSI PI
- View parameters that you cannot measure (eg Colur Flooding)
- Uses APS Scripting interface with Python

Status

- Prototype testing by major chemical company in Japan



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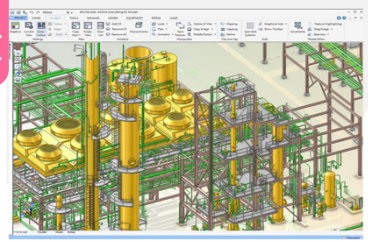
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Two Types of Digital Twin

verifies engineering design THEN replicate the operating plant

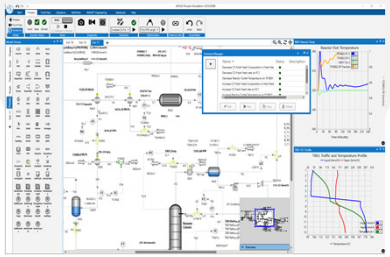
3D Engineering Data
A repository for all engineers to collaborate keeping all data in one place. Based on data not drawings.



Engineering Digital Twin

- Design verification and validation
- Global cloud collaboration
- Warnings if plant does not operate as expected
- Automated case execution

Process Simulation
Single simulation that perform all types of modeling.



Operating Digital Twin

- Troubleshoot past operations
- Provide soft sensors
- Improve future operation and efficiency
- Predict equipment degradation and failure

Live /Archived Plant Data
A repository of historical data that explains how the plant is actually operating



OSIsoft. is now part of AVEVA

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Sustainability

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Innovation: Green House Gas Calculations

Create designs and operation to minimize eCO2

Objectives

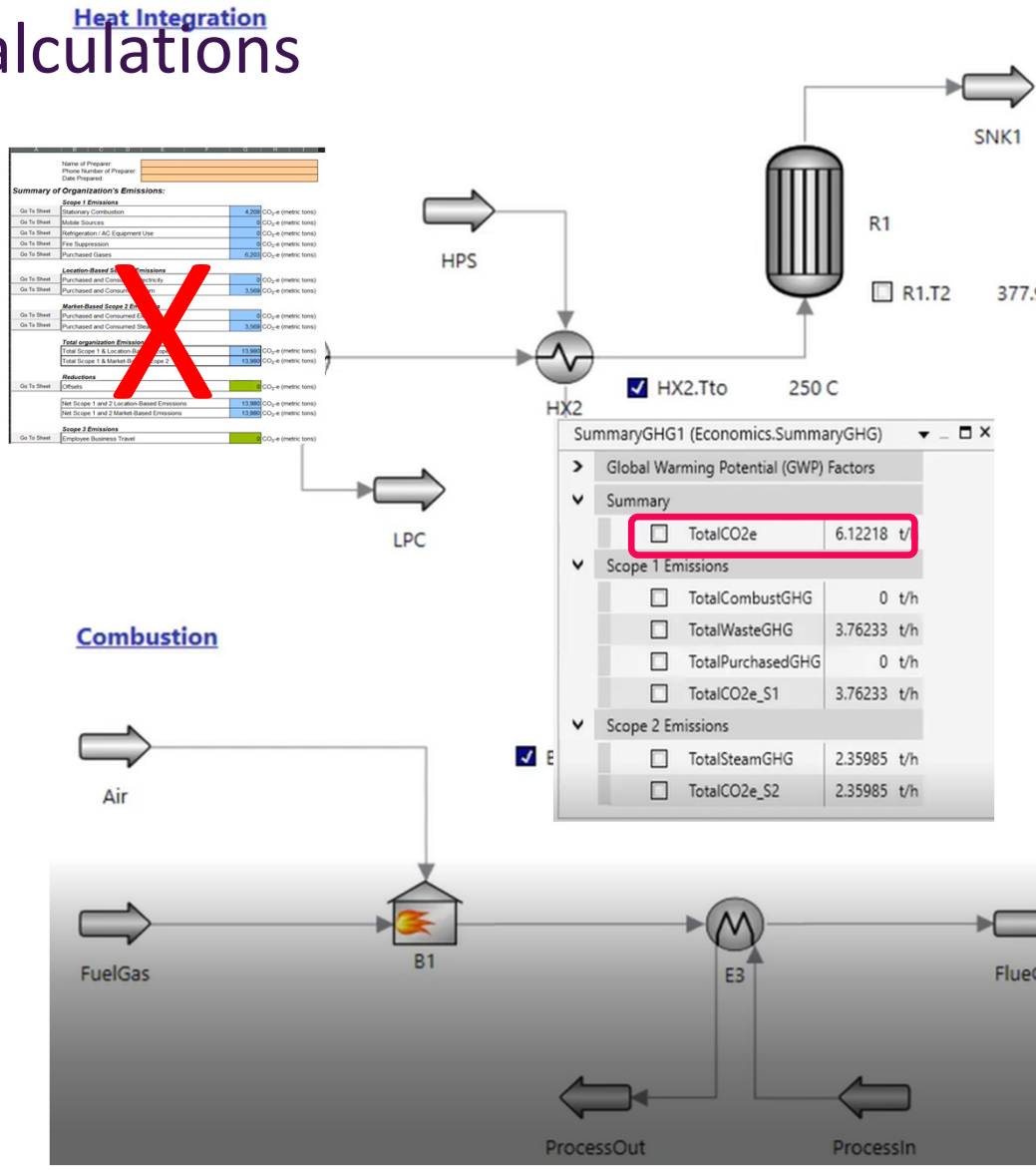
- Use design simulation to improve operations and design with government GHG emission reduction and eliminate the need for iteration from simulation to complex government spreadsheets.

Solution

- Use APS Economics Library to drag GHG calculations for combustion and utility heat onto appropriate equipment models.
- Calculate total equivalent CO_2 (CO2e) of all gasses per EPA calculations.
- Change or optimize design to minimize GHG production or overall costs accounting for GHG.
- Calculations can be modified by user for any country.

Status

- Available in version 5.3 Beta in July 2021



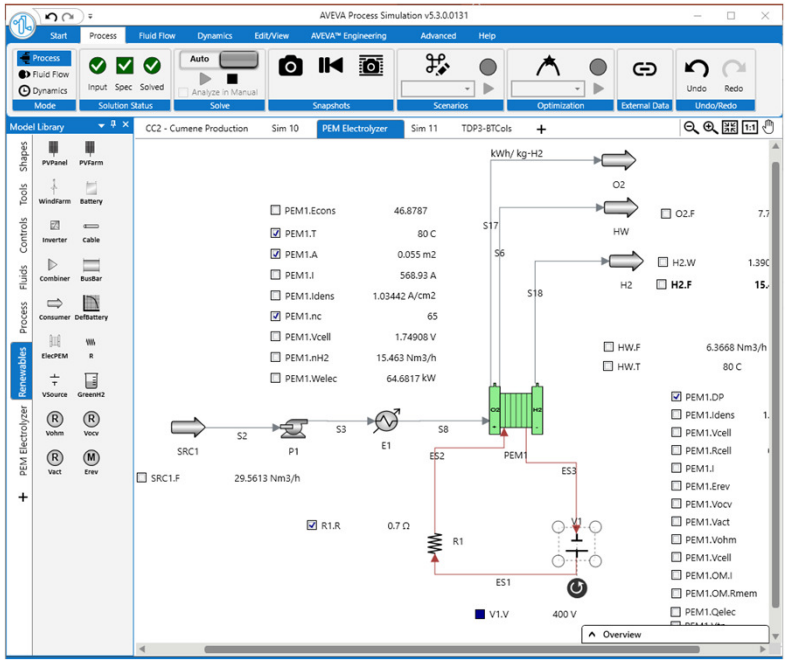
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AVEVA Process Simulator – Hydrogen Economy Simulation Platform

Most modern and contemporary simulation platform – perfect for sustainability initiatives

- Emerging Hydrogen economy simulation platform
  - Gray, Blue and Green hydrogen process modeling
- Hydrogen economy value chain –
  - production, transmission, distribution, storage onto end-use all possible in a single simulator
- Renewables model library
  - Wind Turbines, Solar Panels, Electrolyzers, Hydrogen Liquefaction, Carbon capture and storage, Power distribution and LOHC processes



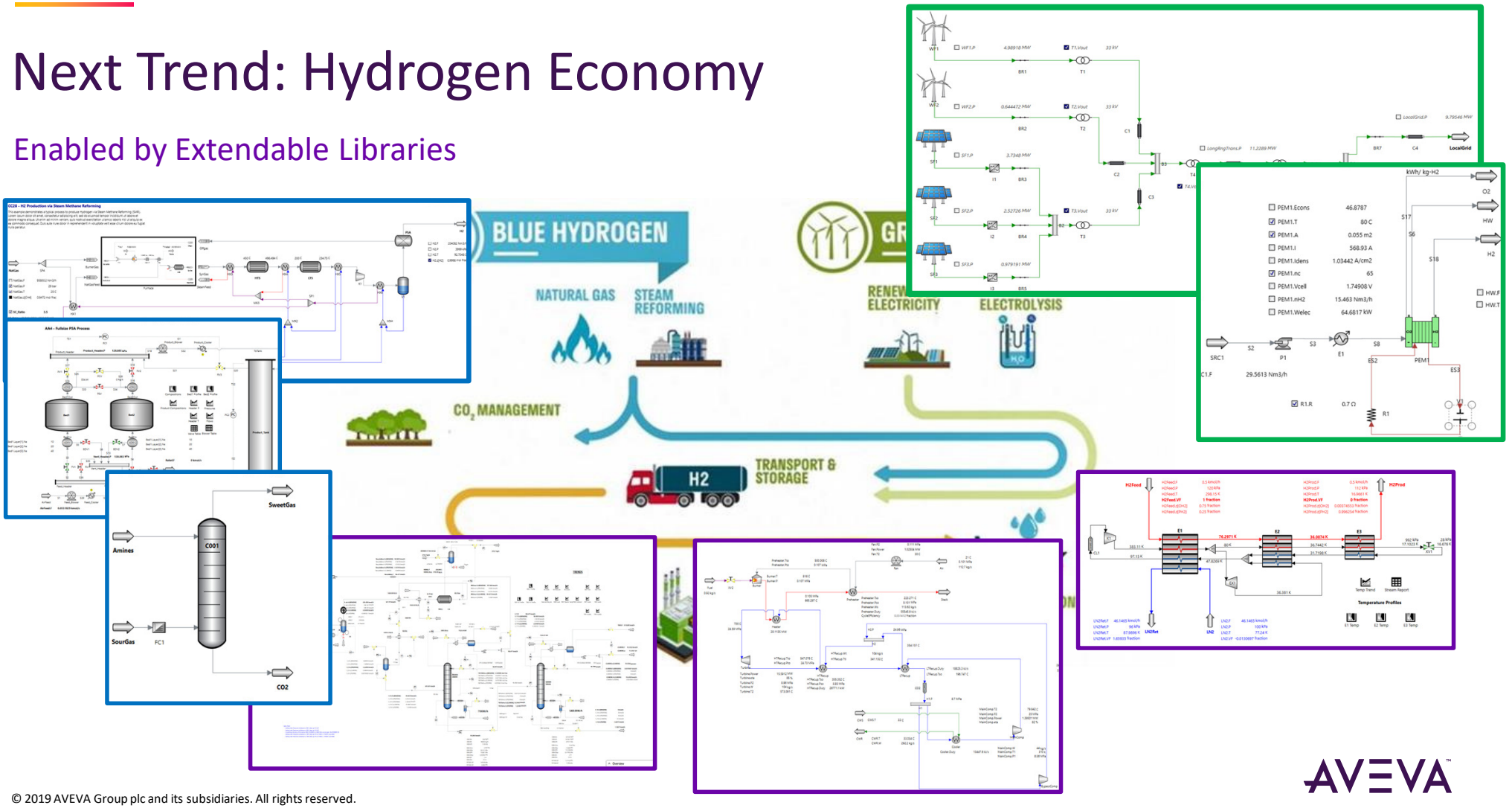
Proton Exchange Membrane Electrolyzer model

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Next Trend: Hydrogen Economy

Enabled by Extendable Libraries



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Carbon Capture Simulation

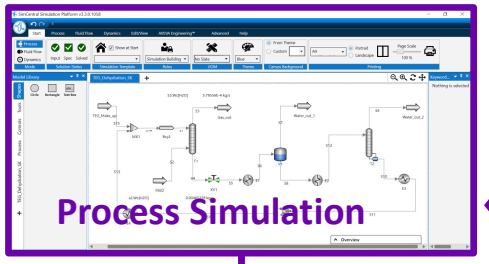
Objectives

- Support the life-cycle of carbon capture technologies using amine/hybrid solvents;
  - Research phase: Select optimal solvent. University partnerships.
  - Basic engineering: optimal design based on customers' proprietary solvents
  - Detail design: rating/sizing of equipment. Final checks of performance/ controls based on 3D data

Solution

- Equip AVEVA Process Simulation with the following features
  - Mass-transfer model considering reactions at VL boundary layer
  - Rigorous and flexible thermo model for amines
  - Data regression covering reaction parameters

- Laboratory data
- Pilot plant data
- Solvent selection (combinatorial approach)

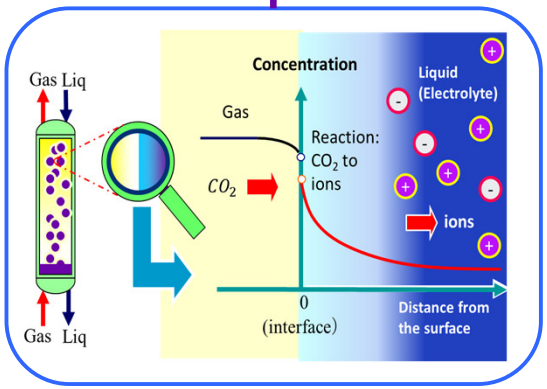


- Basic/detail design
- 3D data
- Equipment information

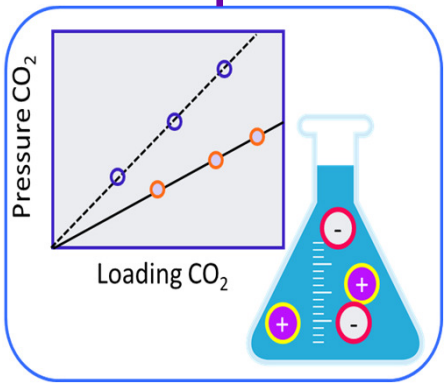


Autonomous adjustment of parameters using customers' proprietary data

Data regression covering reaction parameters



Mass-transfer model considering reactions at VL boundary layer



Rigorous and flexible thermo model for amines

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