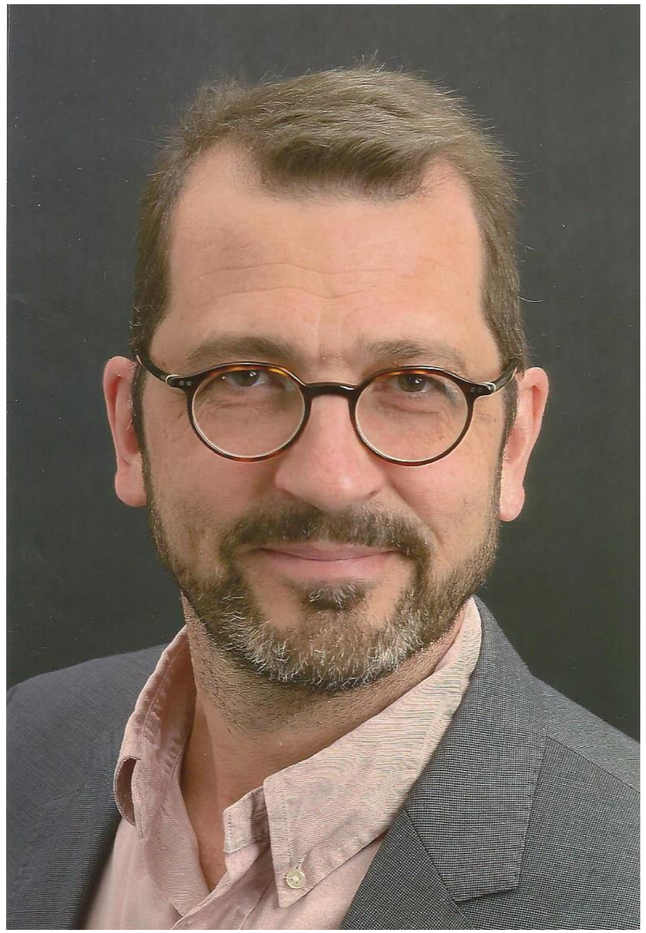
Creating a Digital Twin Based on Forge and Industry Standards

Reiner Meyer-Roessl

Autodesk, Global BizDev Process Plant

Gerardo Santillán

Customer Manager, Semantum



About the speaker

Reiner Meyer-Roessl, Dipl.-Ing.

Reiner Meyer-Roessl is the Global Business Development manager for the Process Plant Industry in Autodesk. He is responsible for strategic partnerships and projects. He is working in various data exchange industry initiatives like DEXPI, CFIHOS or CII/Fiatech.

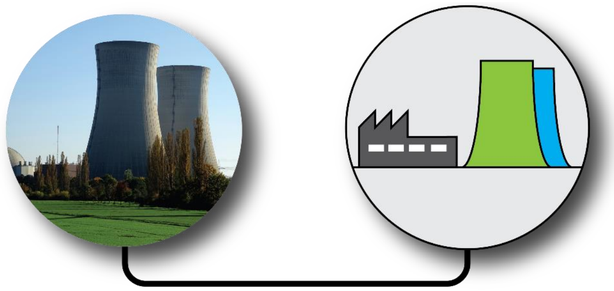
Reiner is holding an University degree in Technical Physics of the Technical University of Vienna and an Engineering degree as precision engineer; he is also an educated professional Systemic Consultant and Coach.

About the speaker

Gerardo Santillán, PhD

Customer Manager at Semantum Oy. Semantum is a software development company specialized on engineering automation and on the development of simulation-based Digital Twins for production plants.

Gerardo has over five years of experience on the application of process simulation and engineering automation techniques for rapid and efficient development of Digital Twins.



- Digital Twin
- Implementation Challenges
- Forge based Digital Twin
- DEXPI
- Model broker
- Customer examples
- Q&A

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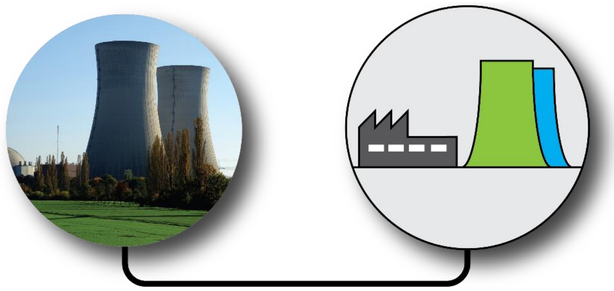
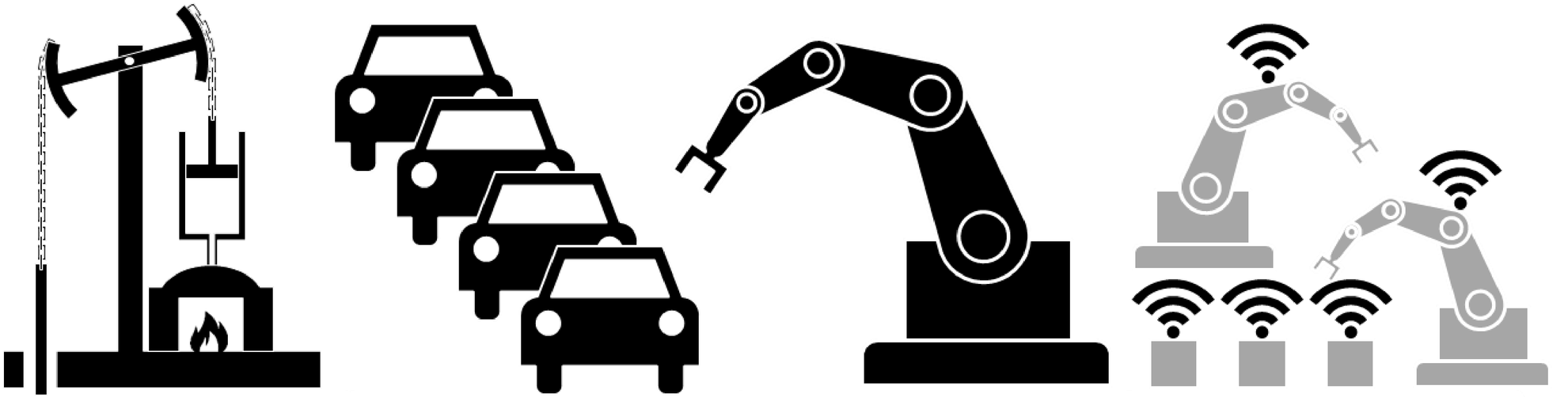


Evolution of Industry



1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

Image Credits: *Christoph Roser at AllAboutLean.com*

Digital Twin trending

Google Trends | Compare

Sign in

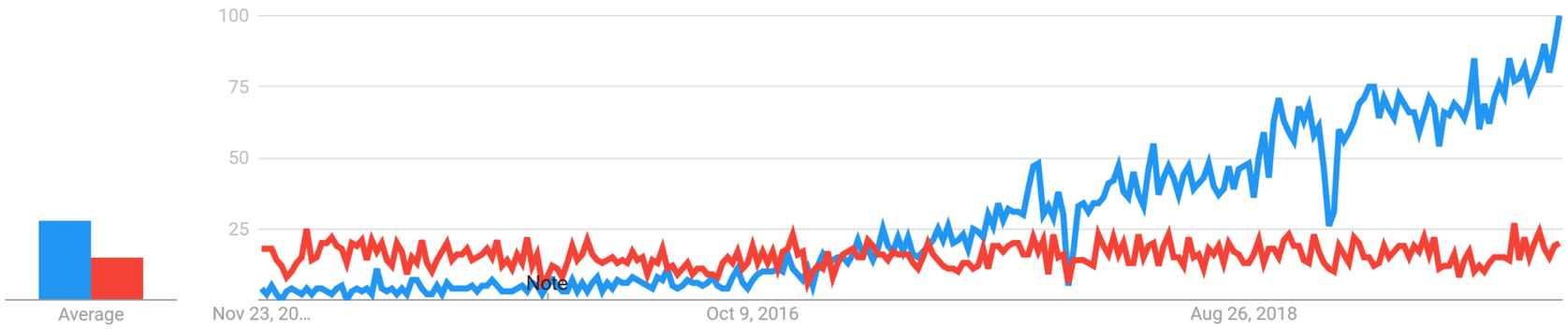
"digital twin"
Search term

automatization
Search term

+ Add comparison

Worldwide | Past 5 years | All categories | Web Search

Interest over time

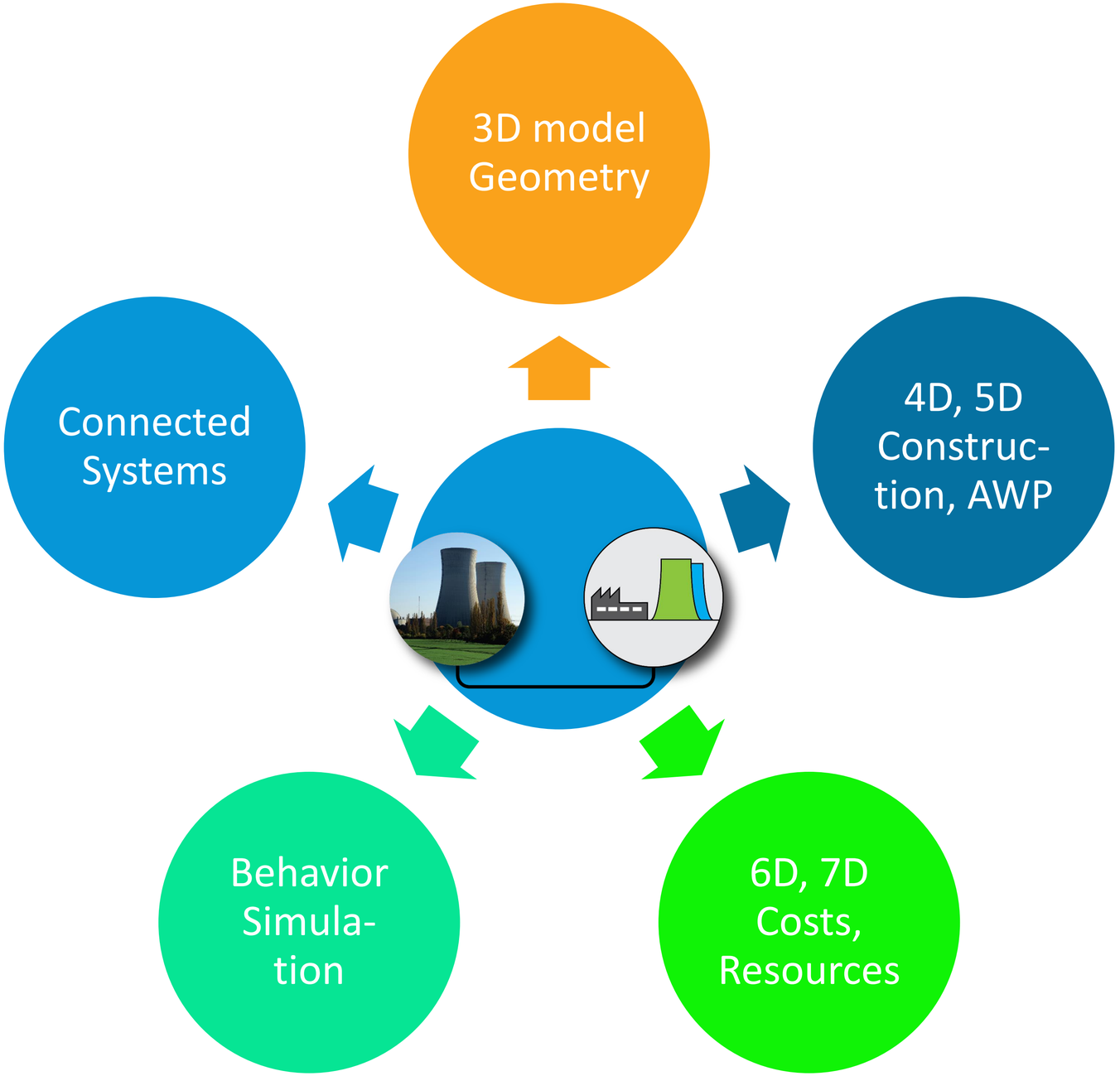



TWINS

DIGITAL TWINS?

AND YOUR DIGITAL TWIN?

answergarden.ch/1060131

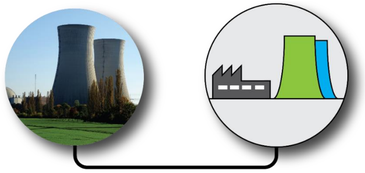

3D model
Geometry
Connected
Systems
4D, 5D
Construc-
tion, AWP
Behavior
Simula-
tion
6D, 7D
Costs,
Resources

Evolution of CAE tools - Evolution of the Digital Twin

ERA OF DOCUMENTATION
Introduction of CAD tools

ERA OF OPTIMIZATION
Digitals Models

ERA OF CONNECTION
Connected workflows
across the project lifecycle



BIM

Building **I**nformation **M**odeling

BIM

Building an **I**nformation **M**odel

CONCEPT OVERVIEW
DIGITAL TWIN

An up to date, digital representation of an object, or system *with operational awareness*

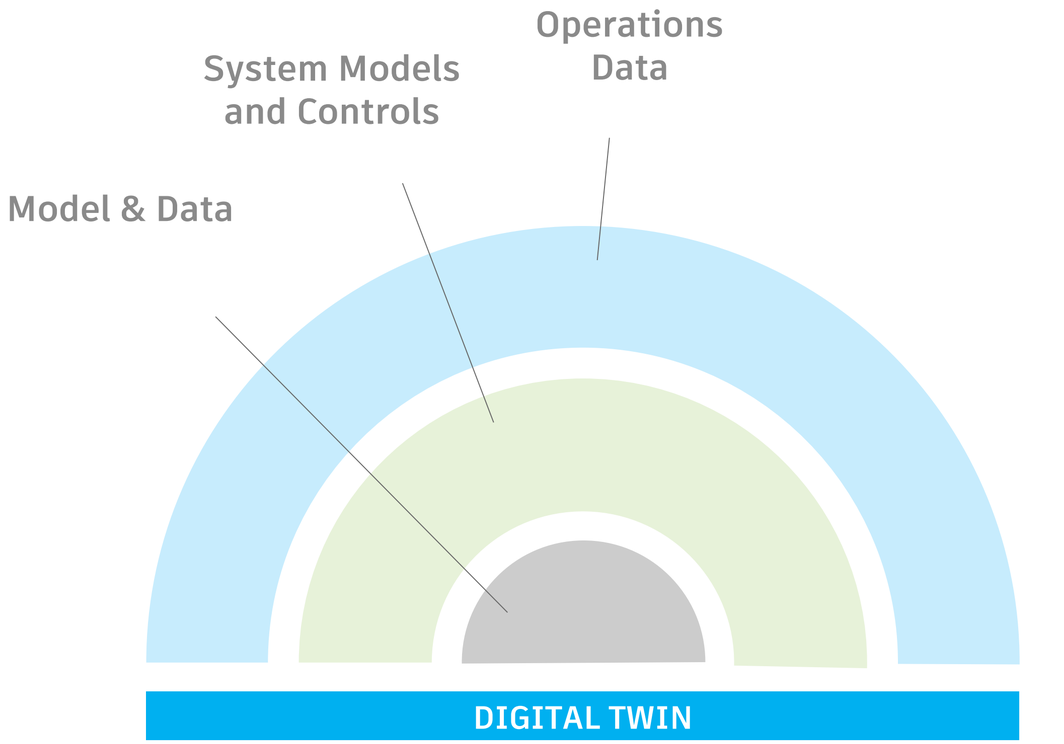
Digital Twins are enabled by:

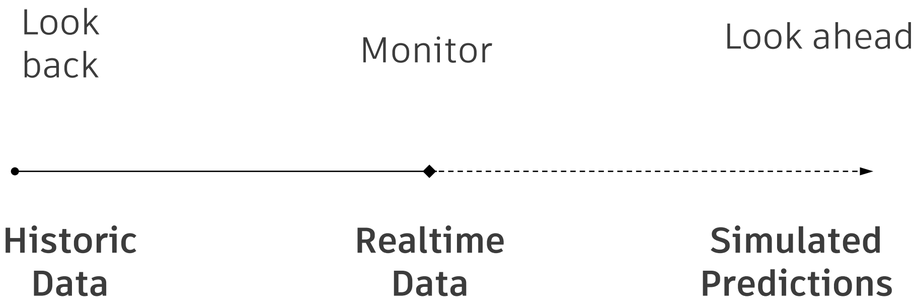
- **3D models** data
- ***Relevant*** **asset data (properties, service data,…)**
- **Models and simulation**
- **Connected, real world data from sensors and control systems (e.g. IoT)**

Used for monitoring, diagnostics, prognostics, optimization,…

Can use the past to predict the future (with ML/AI,…)

As a “living digital simulation” a digital twin can learn from real data and improve over time





AnswerGarden

What do YOU want to do with YOUR Digital Twin?

Type your answer here...

Submit

20 characters remaining

save time, eff. improve efficiency

provide value for cl

architecture

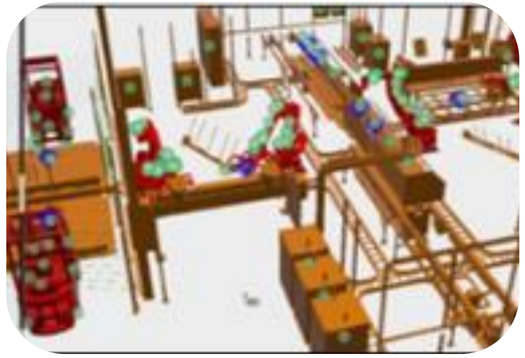
maintanance safety

iot devices

Digital Twin – of what?

Equipment

Building



Factory

Plant

Campus

City

Digital Twin – Process Industry

Equipment

Building

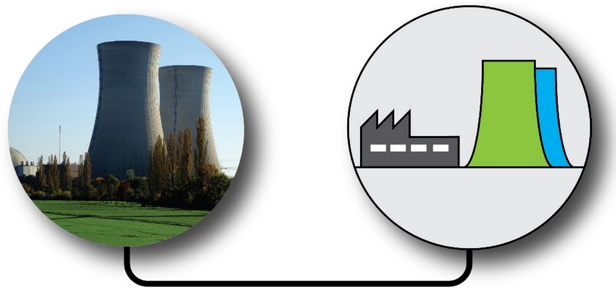
Factory

Plant

Campus

City

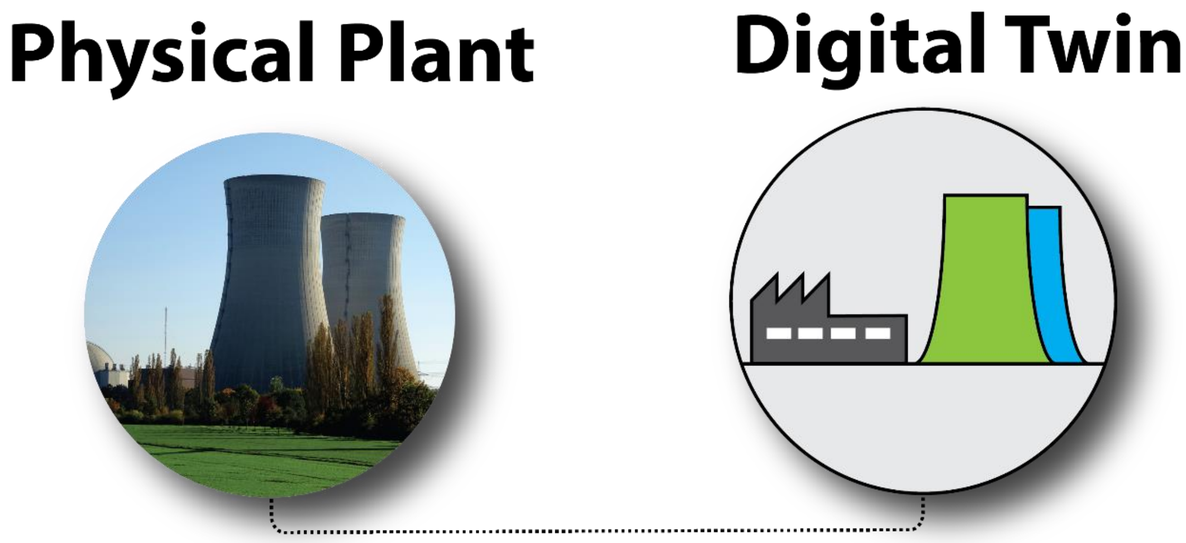
- Digital Twin
- Implementation Challenges
- Forge based Digital Twin
- DEXPI
- Model broker
- Customer examples
- Q&A



Digital Twin in Process Industry

A digital replica of a plant, which contains information of the:

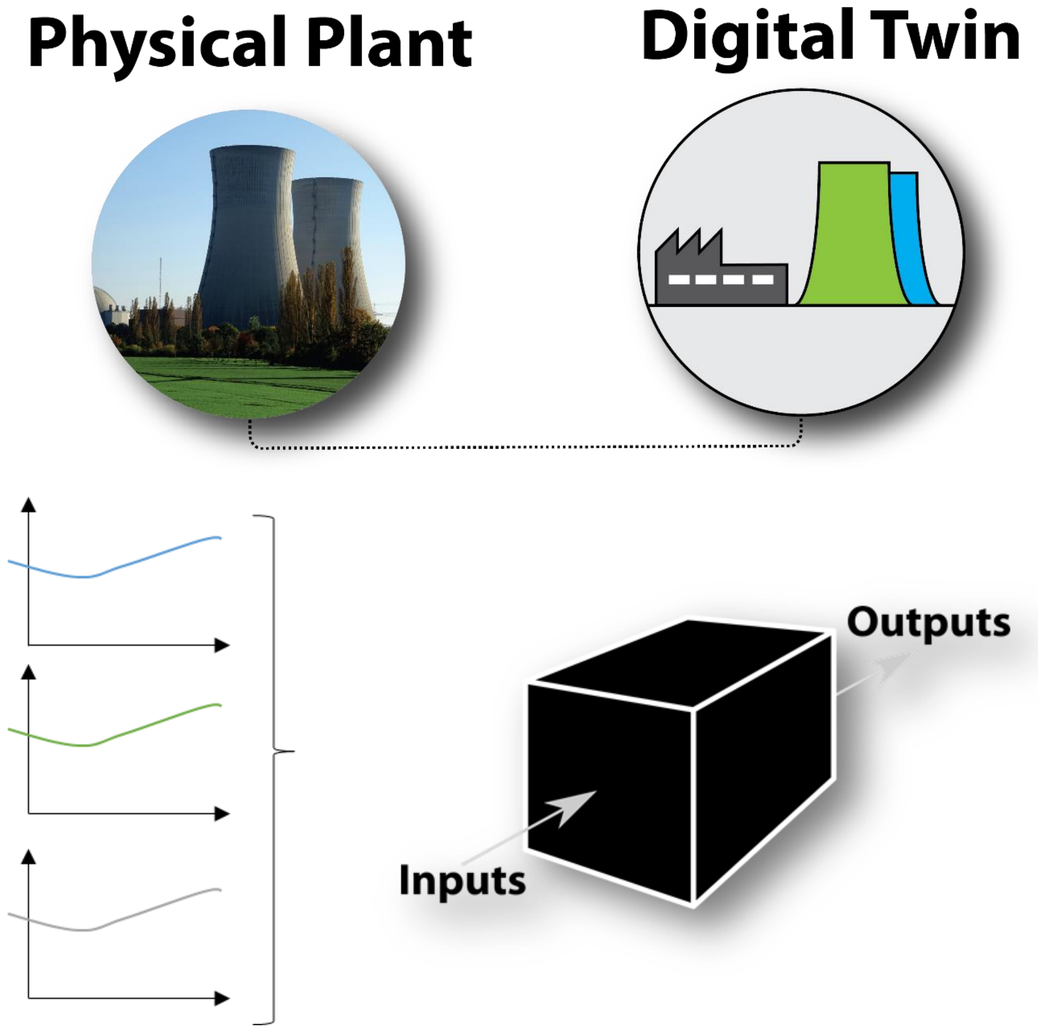
- Structure
- Dynamics of how the devices or processes operate



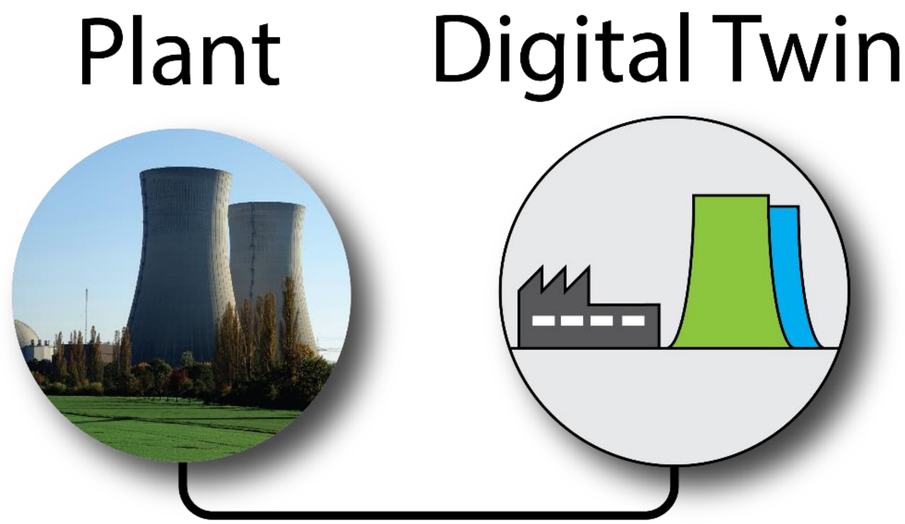
Digital Twin

A digital replica of a plant, which contains information of the:

- Dynamics, which can be **partially** obtained from data-driven methods
- E.g. machine learning, data analytics, AI.



Digital Twin

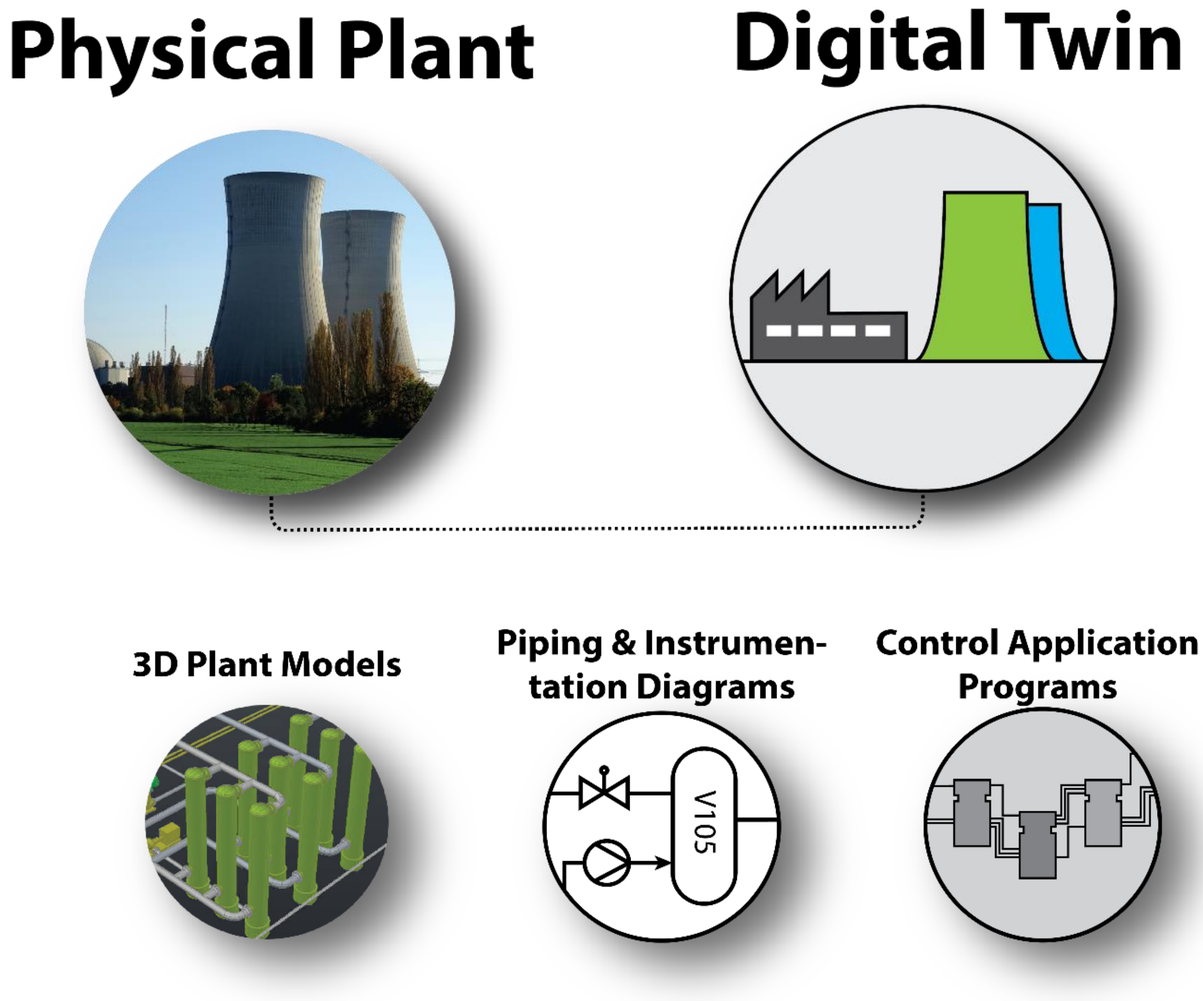


Simulation Model of the Plant

Digital Twin in Process Industry

A digital replica of a plant, which contains information of the:

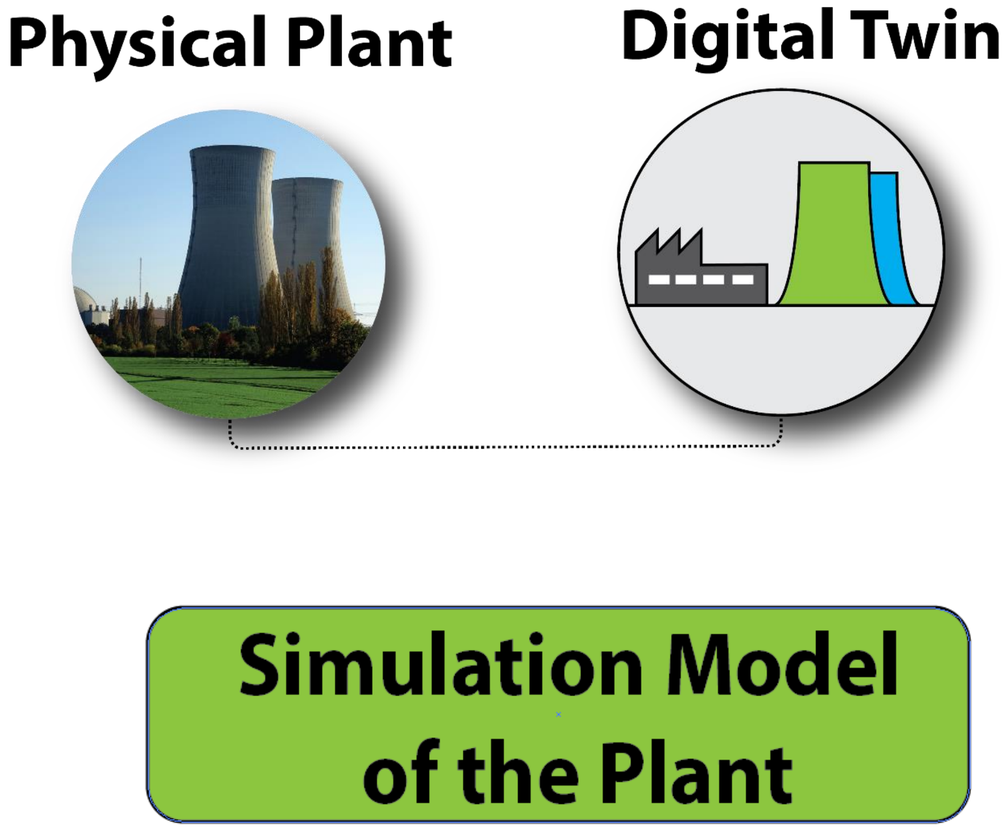
- Structure



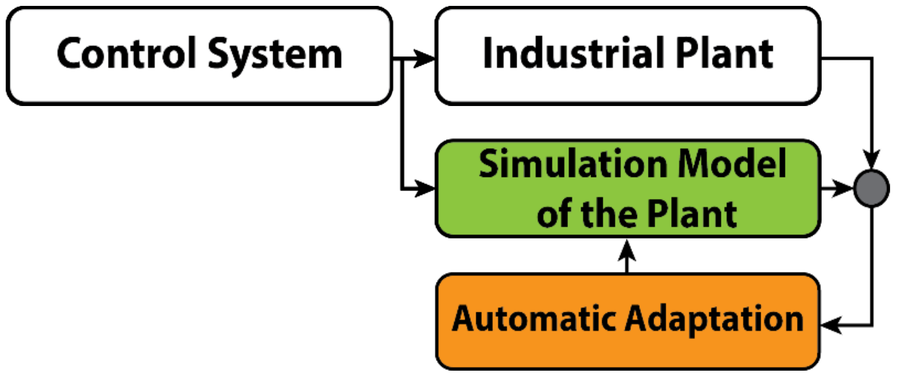
Digital Twin

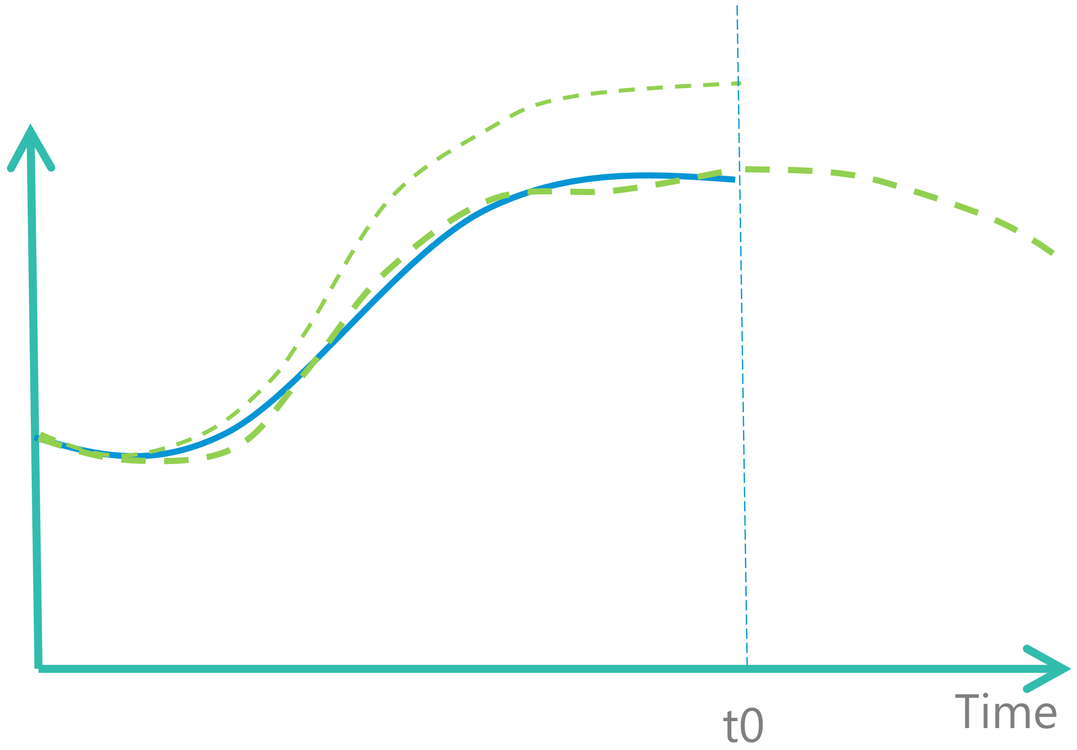
A digital replica of a plant, which contains information of the:

- Dynamics, which can be simulated using first-principles simulation models of the plant

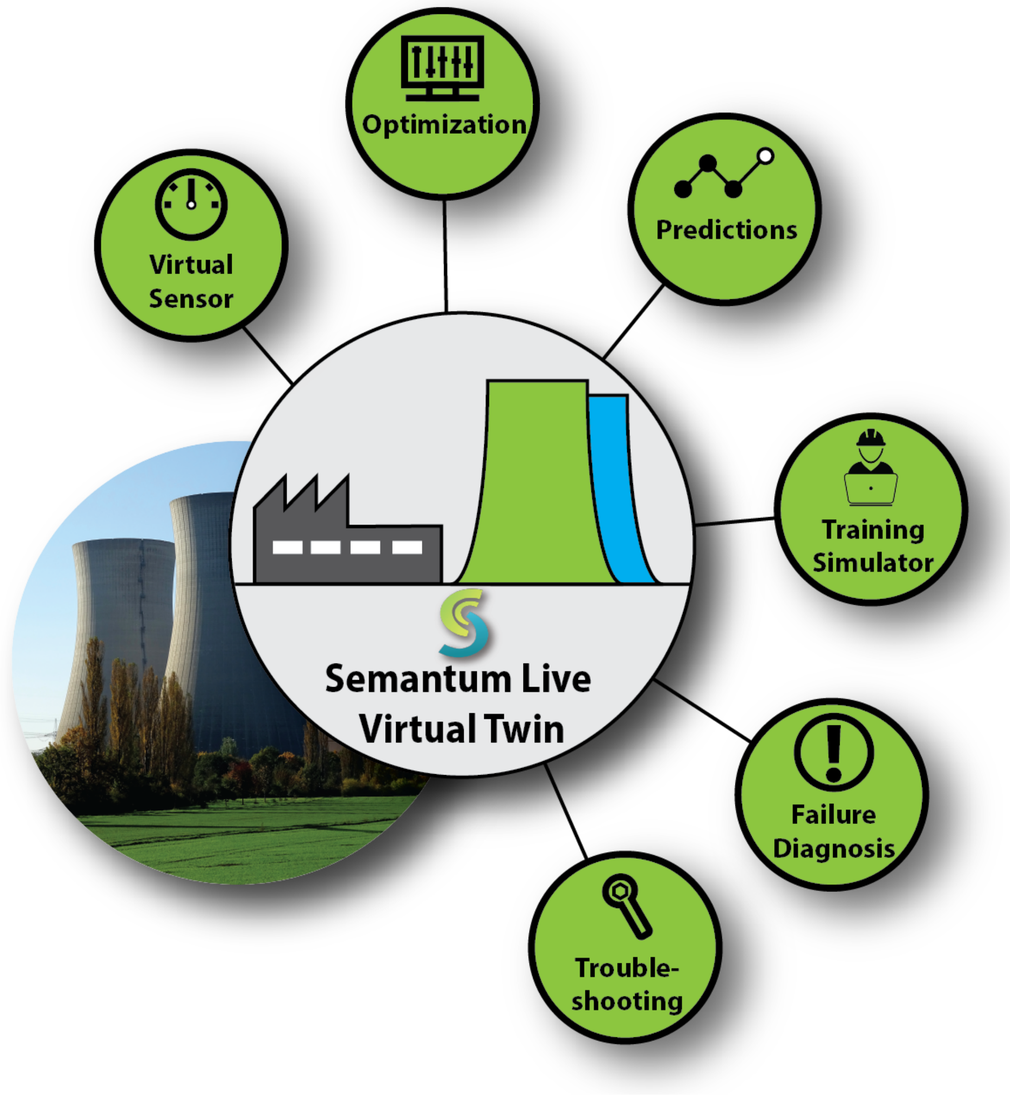


Simulation-based Digital Twin

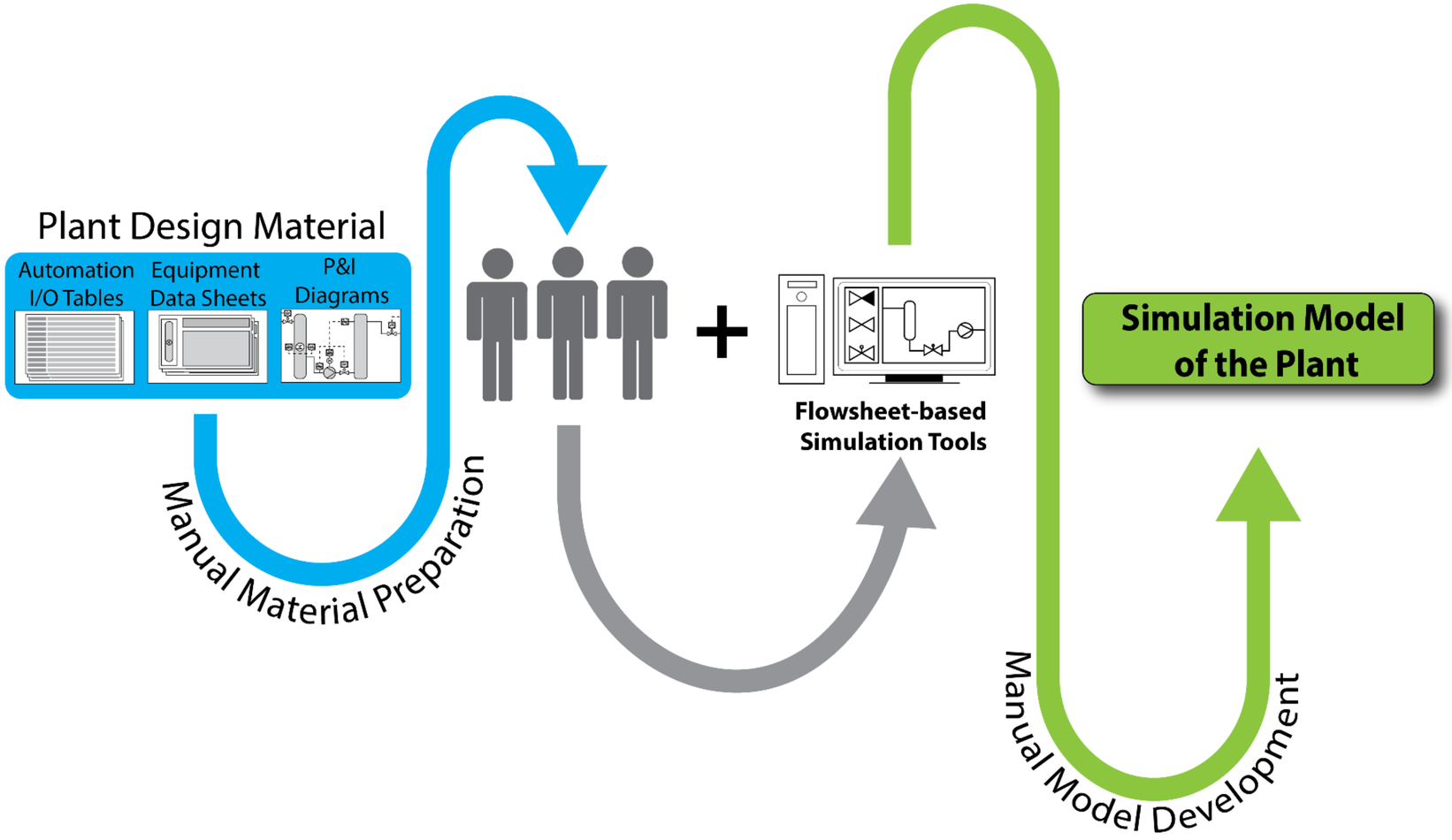


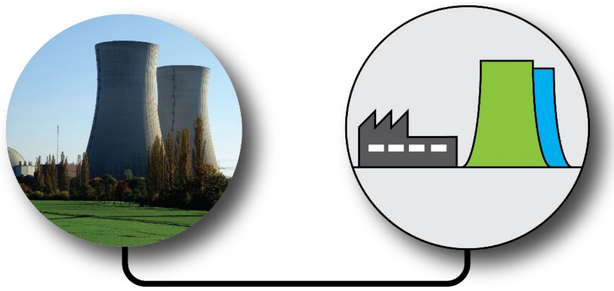


Simulation-based Digital Twin: Applications

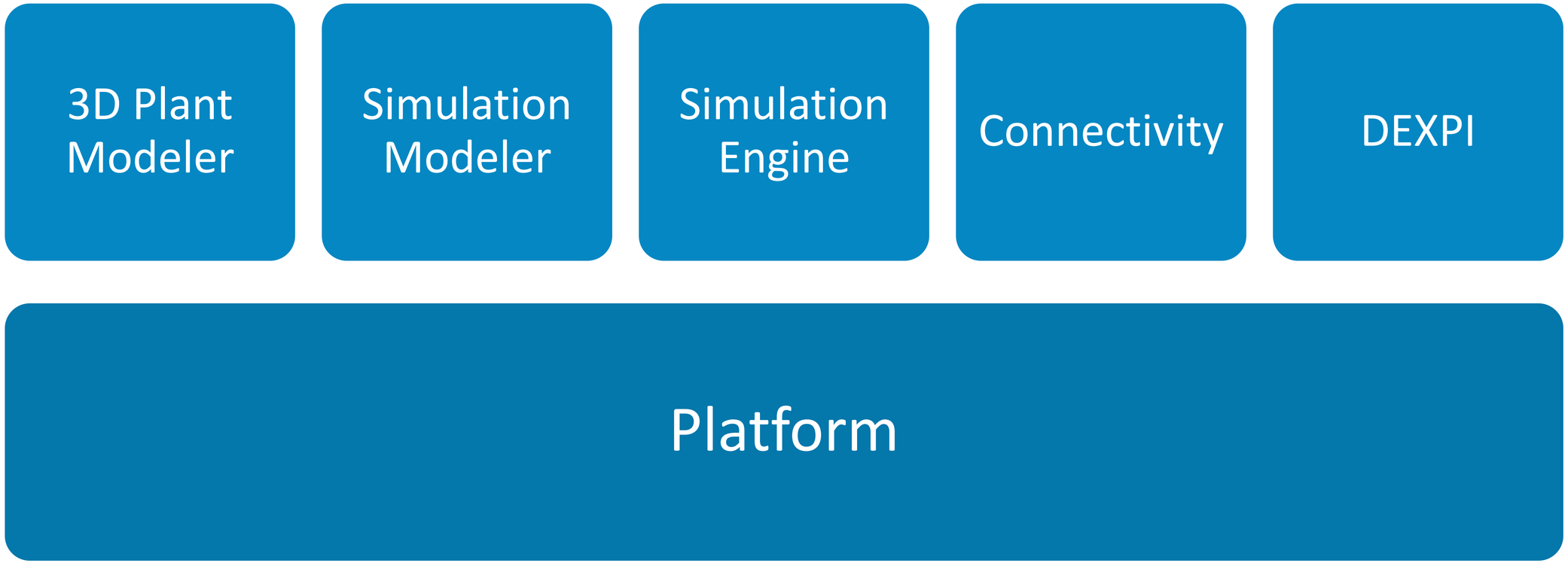


Model development in process industry

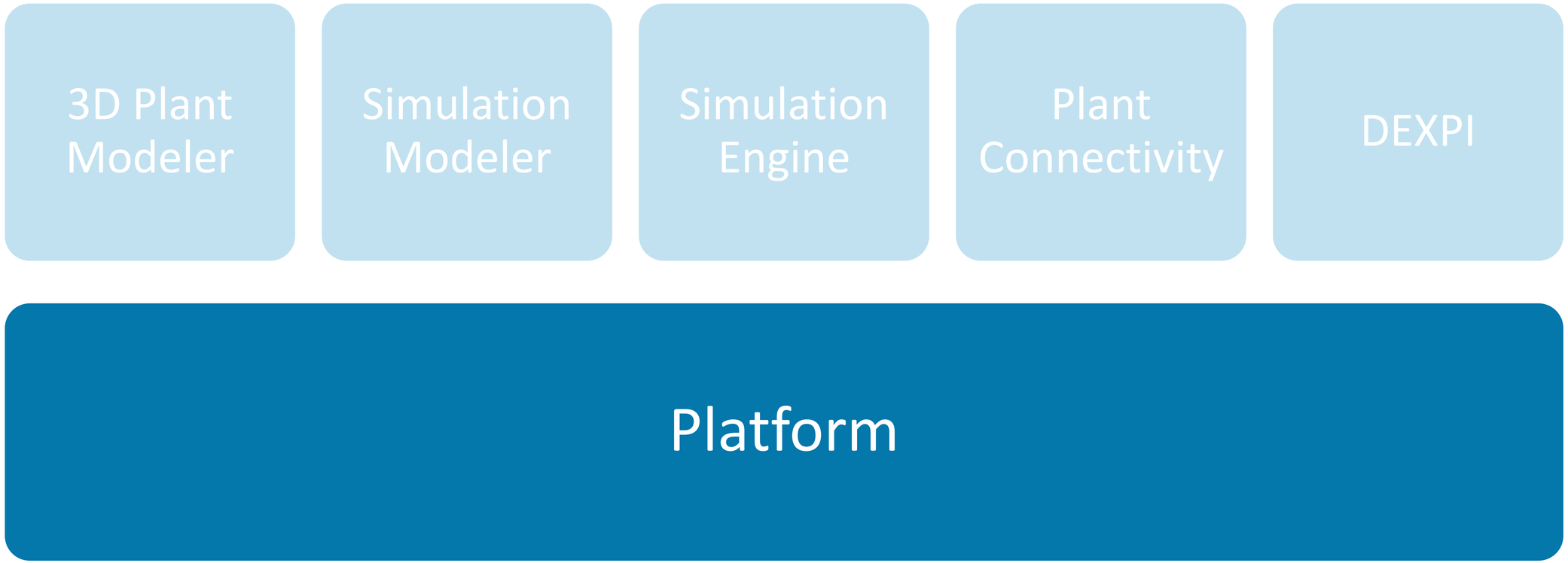




- Digital Twin
- Implementation Challenges
- Forge based Digital Twin
- DEXPI
- Model broker
- Customer examples
- Q&A


3D Plant Modeler
Simulation Modeler
Simulation Engine
Connectivity
DEXPI
Platform

Components of the Digital Twin



Evolution of development interfaces

ERA OF DOCUMENTATION
Introduction of CAD tools

ERA OF OPTIMIZATION
Digitals Models

ERA OF CONNECTION
Connected workflows
across the project lifecycle

AutoLisp
Object ARX
Visual LISP

Managed .NET
VBA
ActiveX

AUTODESK® FORGE

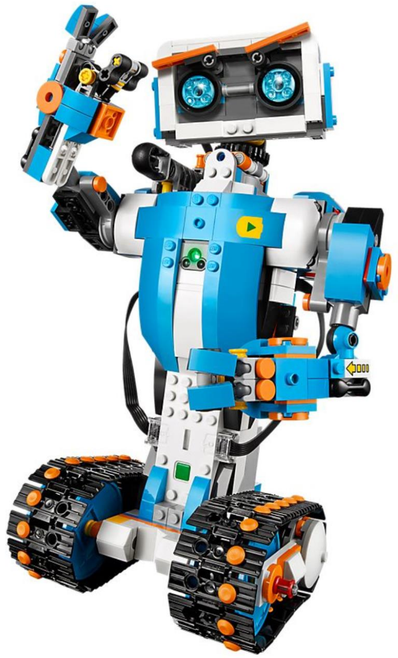

DESIGN
PRE-CONSTRUCTION
FIELD EXECUTION
HANDOVER & OPERATIONS
Authoring
Collaboration
Detailing
Clash Detection
Constructability
Coordination
Quality / Safety
Progress Tracking
Work Coordination
Commissioning
Handover
Maintenance
ANALYTICS & INSIGHT
PROJECT DATA
AUTODESK FORGE

Technology.

Forge takes components from Autodesk’s powerful library of software and delivers them as cloud-based building blocks for companies to create their own new solutions.

Integrate.

Use these services to extend products or to create entirely new solutions within your existing infrastructure. We provide the blocks, you build the solution.



AUTODESK® FORGE

3D Plant Modeler

Simulation Modeler

Simulation Engine

Connectivity

DEXPI

AUTODESK® **FORGE**

3D Plant Modeler

Simulation Modeler

Simulation Engine

Connectivity

DEXPI

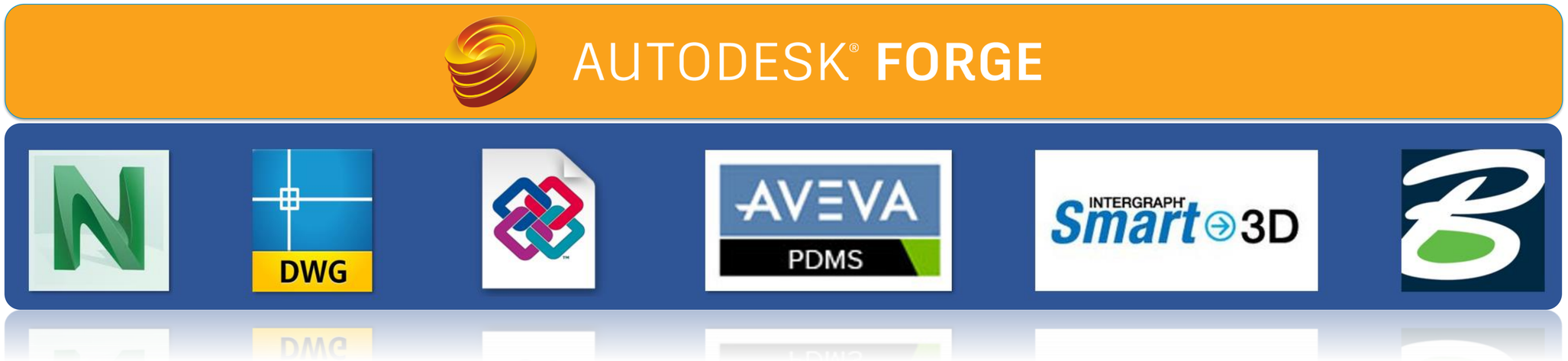
AUTODESK® **FORGE**

3D Plant Modeler

AUTOCAD PLANT 3D

AutoCAD Plant 3D™

An industry-specific toolset for plant design and engineering to create P&IDs and integrate them into a 3D plant design model.



AutoCAD Plant 3D

Simulation Modeler

Simulation Engine

Connectivity

DEXPI

AUTODESK® **FORGE**

AutoCAD Plant 3D

Simulation Modeler

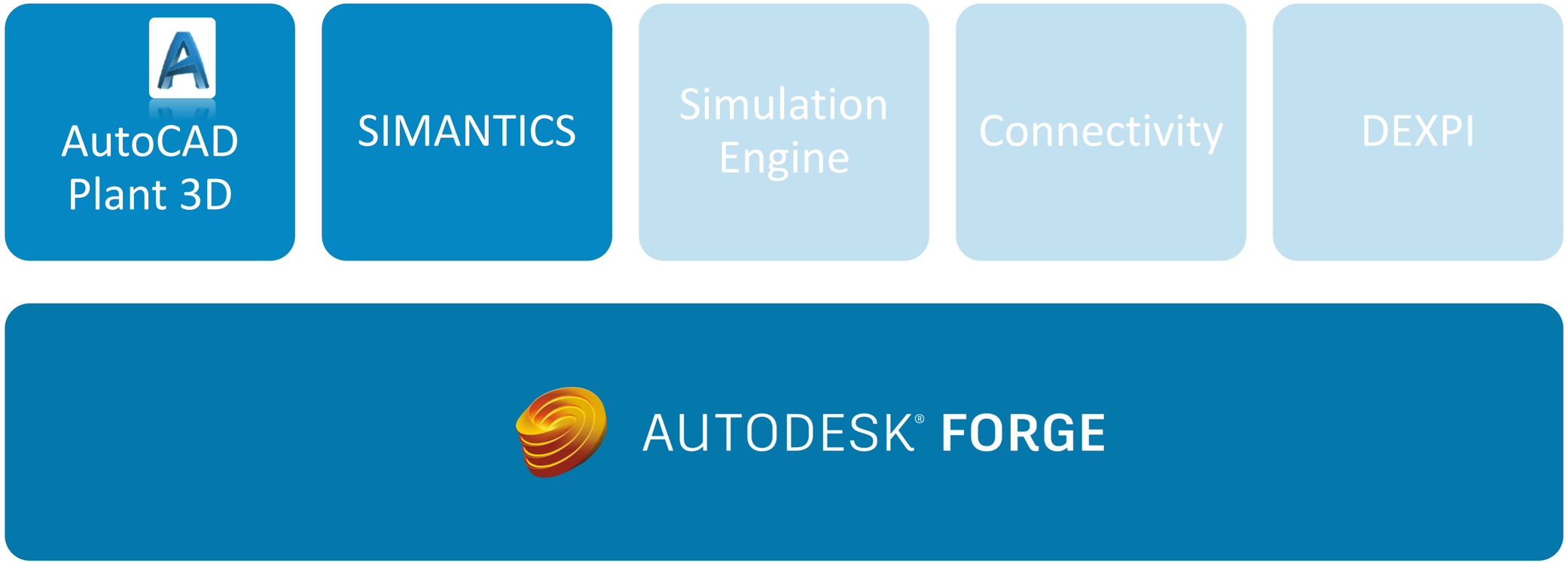
Simulation Engine

Connectivity

DEXPI

AUTODESK® **FORGE**

Simulation Modeler: SIMANTICS (open source)



AutoCAD Plant 3D

SIMANTICS

Simulation Engine

Connectivity

DEXPI

AUTODESK® **FORGE**

Simulation Engine: Apros 6

AutoCAD Plant 3D

SIMANTICS (open source)

Apros 6

Connectivity

DEXPI

AUTODESK® **FORGE**

AutoCAD Plant 3D

SIMANTICS

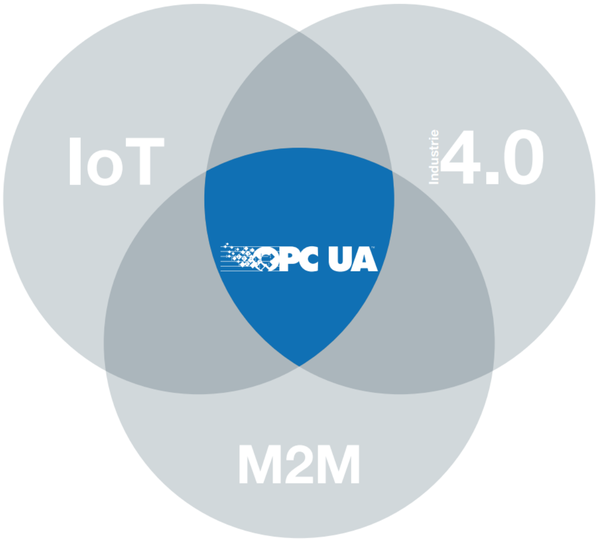
Apros 6

Connectivity

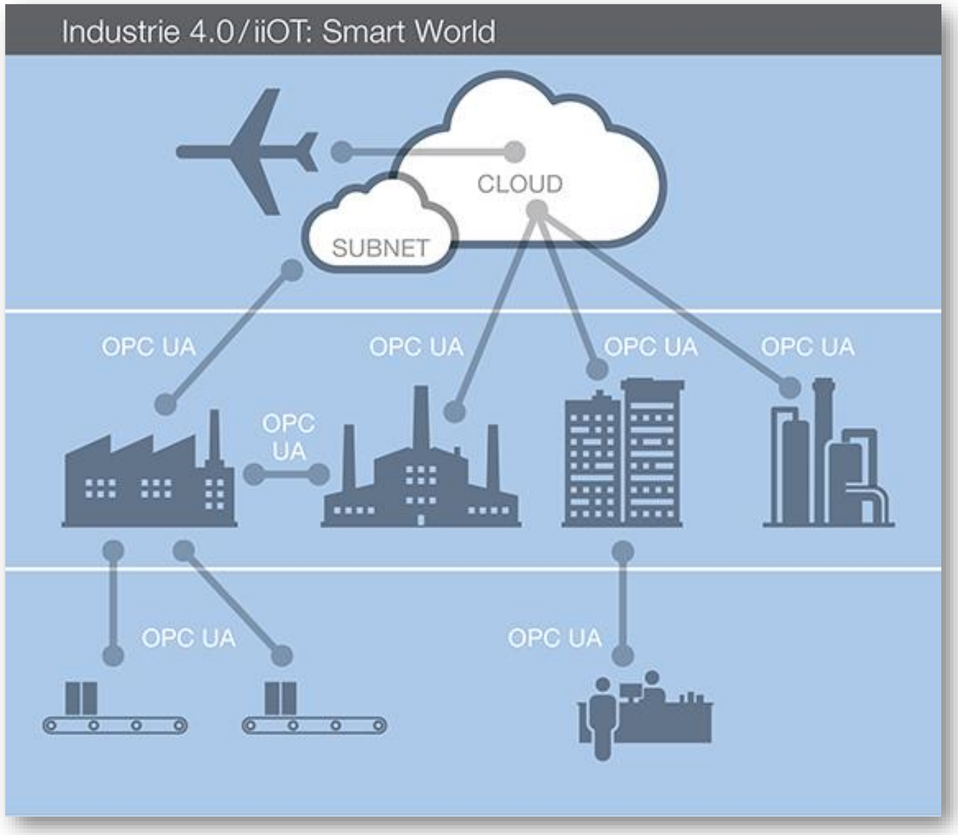
DEXPI

AUTODESK® **FORGE**

OPC Unified Architecture



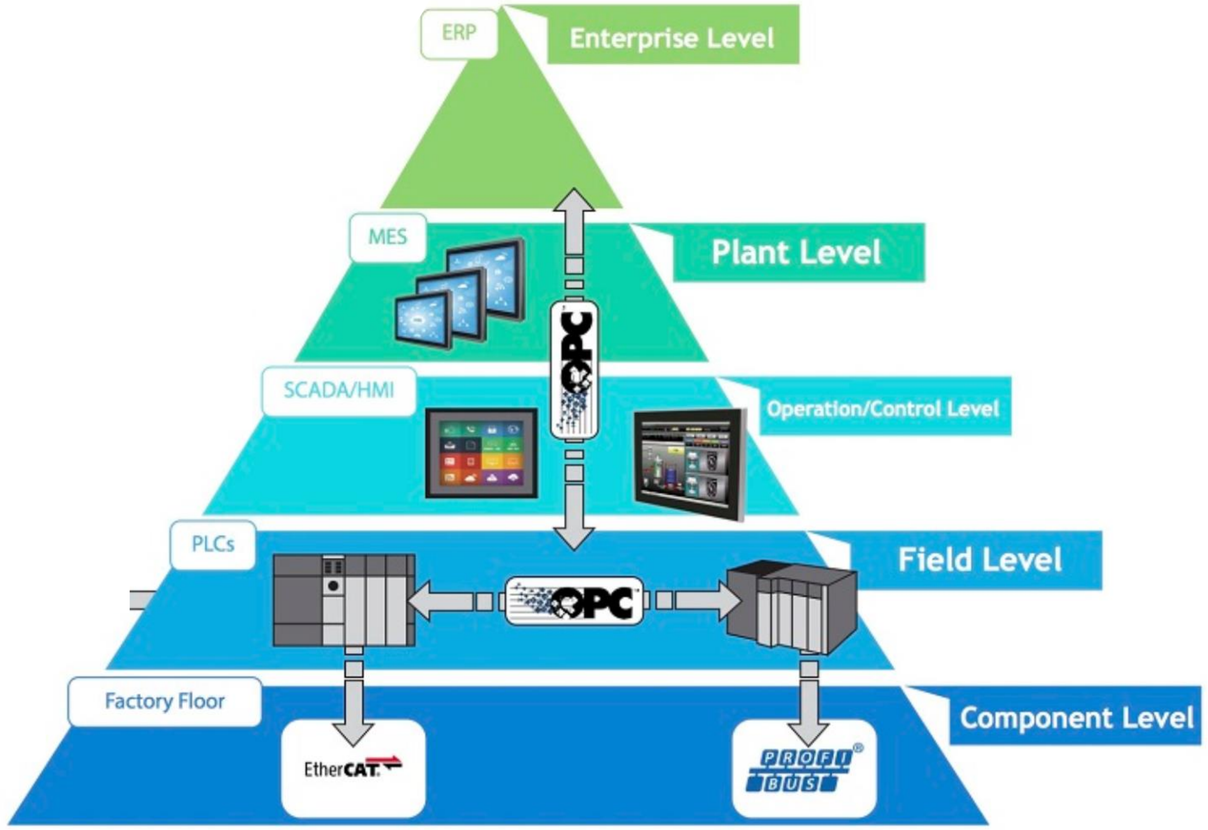
- Seamless and non-disruptive integration of heterogeneous data sources.
- Secure data exchange that includes encryption, authentication and auditing
- More than just a communication protocol. It offers specifications for other functions, e.g.:
  - Data modelling
  - Historical access
- Enables creation and adoption of new industrial services



OPC Unified Architecture

Information exchange for industrial communication

- Platform independent, scalable and internet compatible
- Information modelling capabilities
- Standardized as IEC 62541
- Server/client architecture
- Based on latest security standards



OPC FOUNDATION

Enabling technologies

AutoCAD Plant 3D

SIMANTICS (open source)

Apros 6

OPC UA (open source)

DEXPI

AUTODESK® **FORGE**

Enabling technologies

AutoCAD Plant 3D

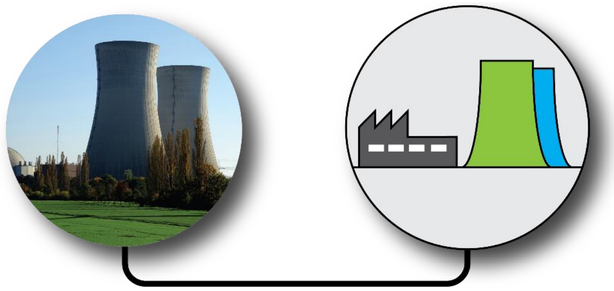
SIMANTICS (open source)

Apros 6

OPC UA (open source)

DEXPI

AUTODESK® **FORGE**



- Digital Twin
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What and who is DEXPI?

DEXPI – A Successful Team

DEXPI Data Exchange in the Process Industry

DATA EXCHANGE IN THE PROCESS INDUSTRY

Owner / Operators

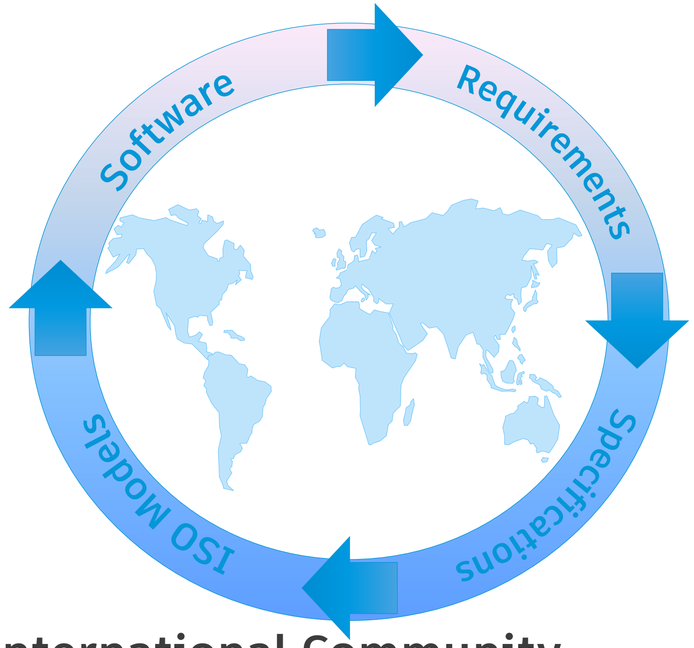
- BASF
- Bayer
- Covestro
- Equinor
- EVONIK
- Merck

EPC

- Air Liquide

Software Vendors

- Autodesk
- Aucotec
- Aveva
- Bilfinger
- Hexagon
- PTC
- Semantum
- Siemens
- X-Visual
- eVision



Research Organizations

- AixCAPE e.V.
- VTT of Finland
- TU Berlin
- RWTH Aachen University
- Tecgraf/PUC Rio

International Community

- ISO TC 184 SC4
- CII / FIATECH
- OPC Foundation
- CFIHOS
- DECHEMA / NAMUR / DKE / VDMA
- SSG

DEXPI Hackathons

Two times a year

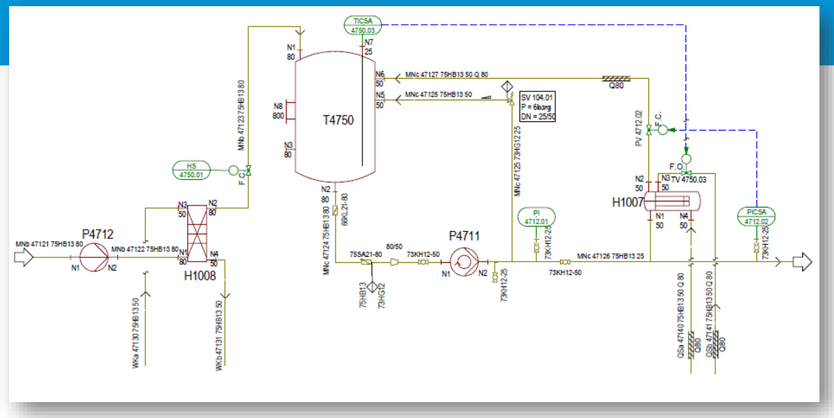
DEXPI Mission

DEXPI Data Exchange in the Process Industry

What we do

We work to create an **open**, neutral and reliable **data exchange standard** for the **process industry** to establish a future-proof **digitalized collaboration.**

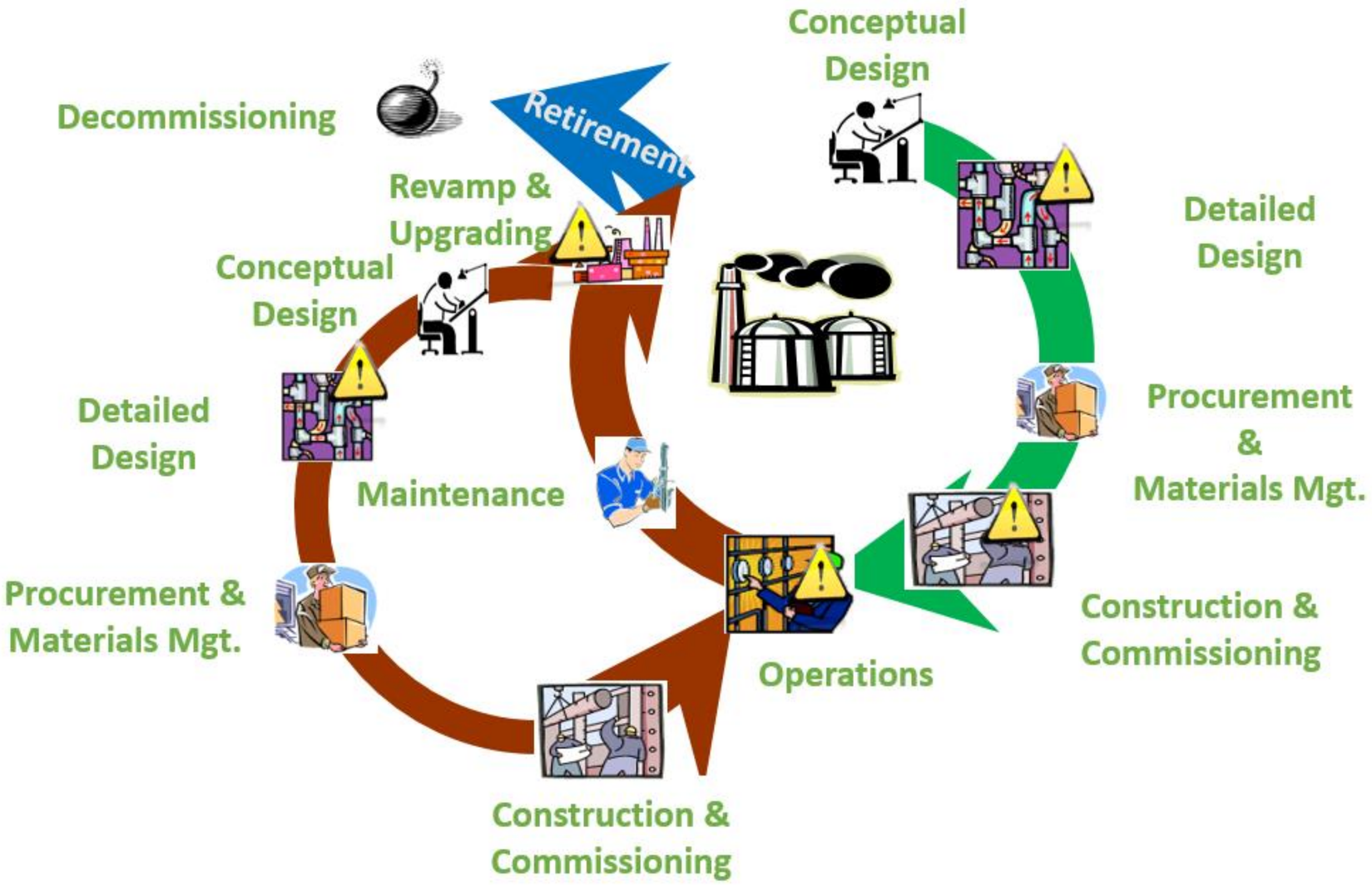
… and we started with the P&ID



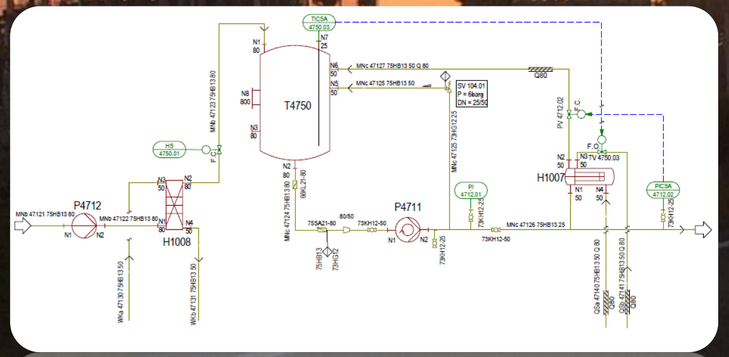
What Problem is DEXPI trying to solve?

Data Exchange in Plant Life Cycle

DEXPI Data Exchange in the Process Industry

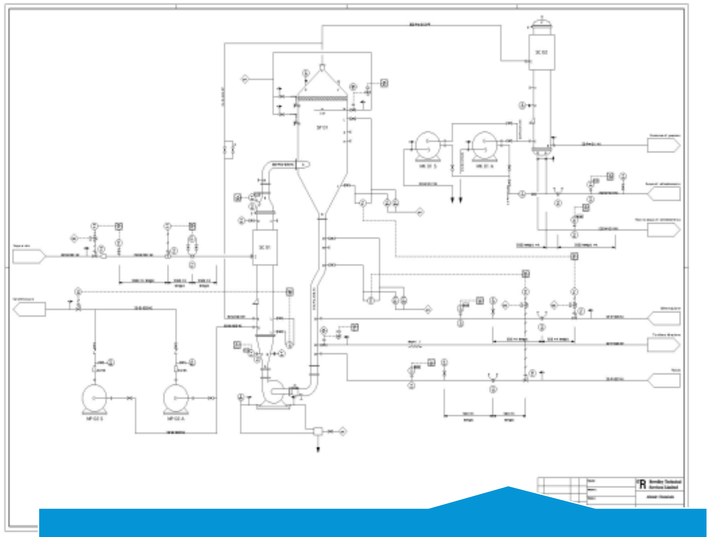


One of more important documents in a process plant…



P&ID Information

DEXPI Data Exchange in the Process Industry

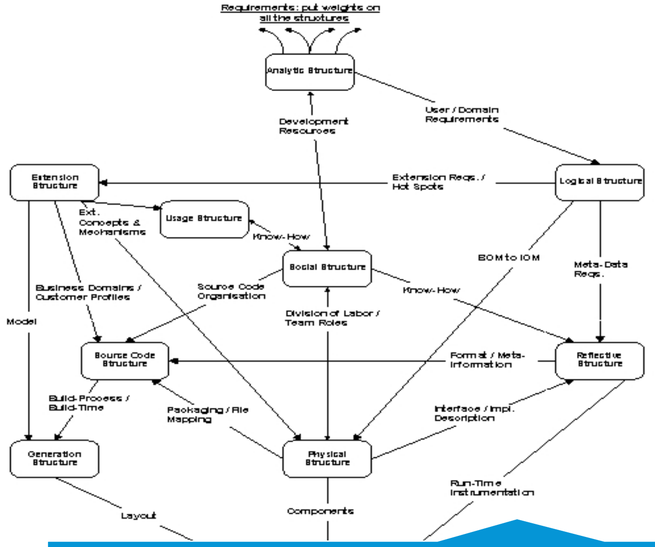


Graphics

Stückliste zur Schubstange Zeichnung Nr. . .

Zeichen	Gegenstand	Stück-zahl	Material	Bemerkungen
A	Schubstange	1	Siemens-Martin-Stahl	Im Gabelende Keilnut.
B	Verschlußstück	1	" " "	
C	Bolzen	2	Schmiedeeisen	Mit $^3/_4$″-Gewinde und je zwei Muttern O und N nebst Sicherung M.
D	Lagerschalenhälfte	2	Bronze	Neues Modell, ausgießen mit Lagermetall.
E	Zwischenlagen	2	Messing	
F	Kreuzkopfbolzen	1	Stahl	Mit $^3/_4$″-Gewinde und Keilnut.
G	Scheibe	1	Schmiedeeisen	
H	Mutter	1	"	$^3/_4$″-Gewinde.
J	Keil	1	Stahl	
K	Scheibe	1	Schmiedeeisen	
L	Kopfschrauben	4	"	$^5/_{16}$″-Gewinde.
M	Sicherungsschraube	2	Stahl	
N	Mutter	2	Schmiedeeisen	S. a. C
O				
P				

Lists



Structures

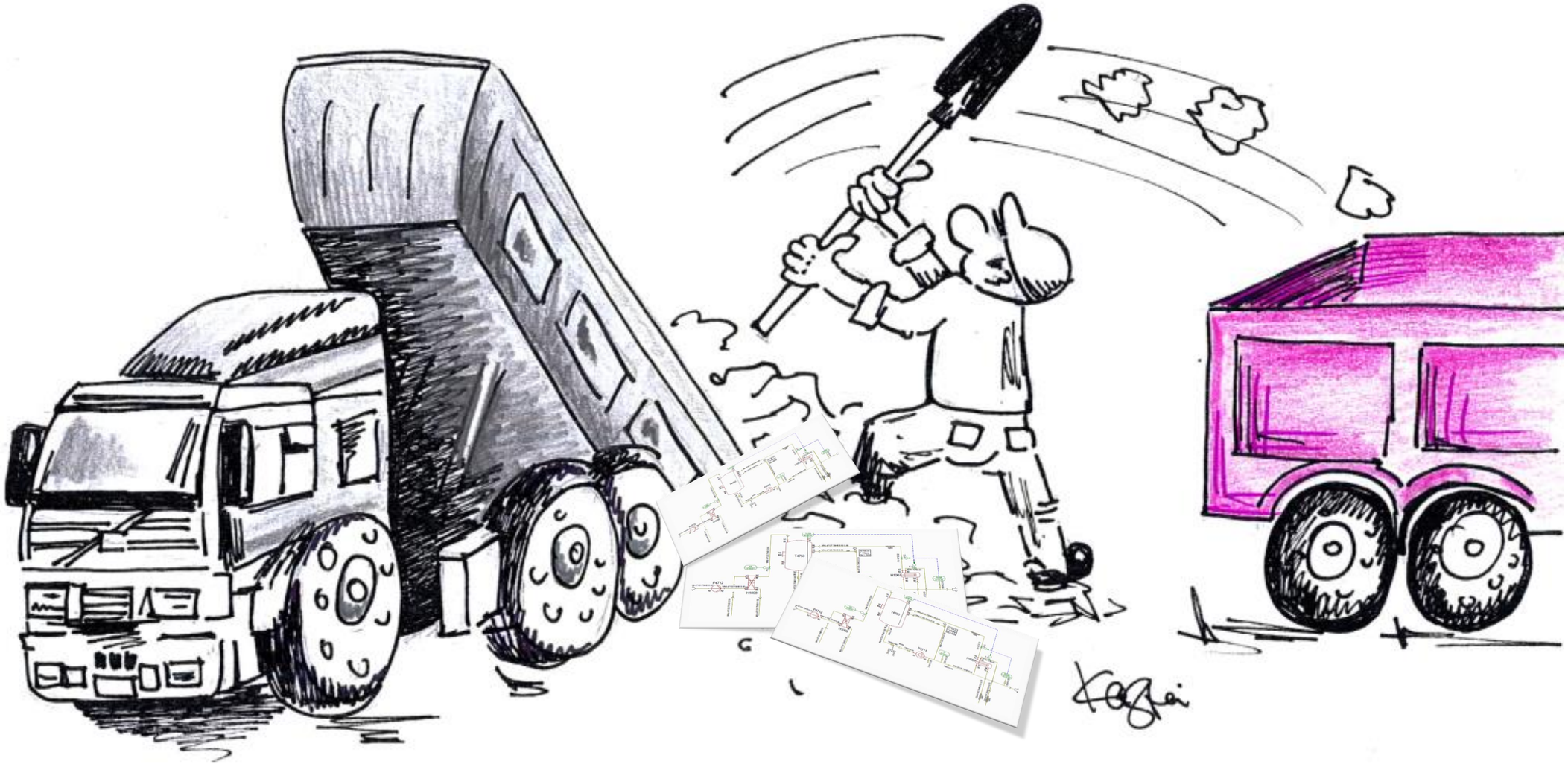
P&ID information transferred as…

DEXPI Data Exchange in the Process Industry

Paper	DWG, DGN	PDF, DWF	XLS
			

NO standard for P€ID exchange

DEXPI Data Exchange in the Process Industry



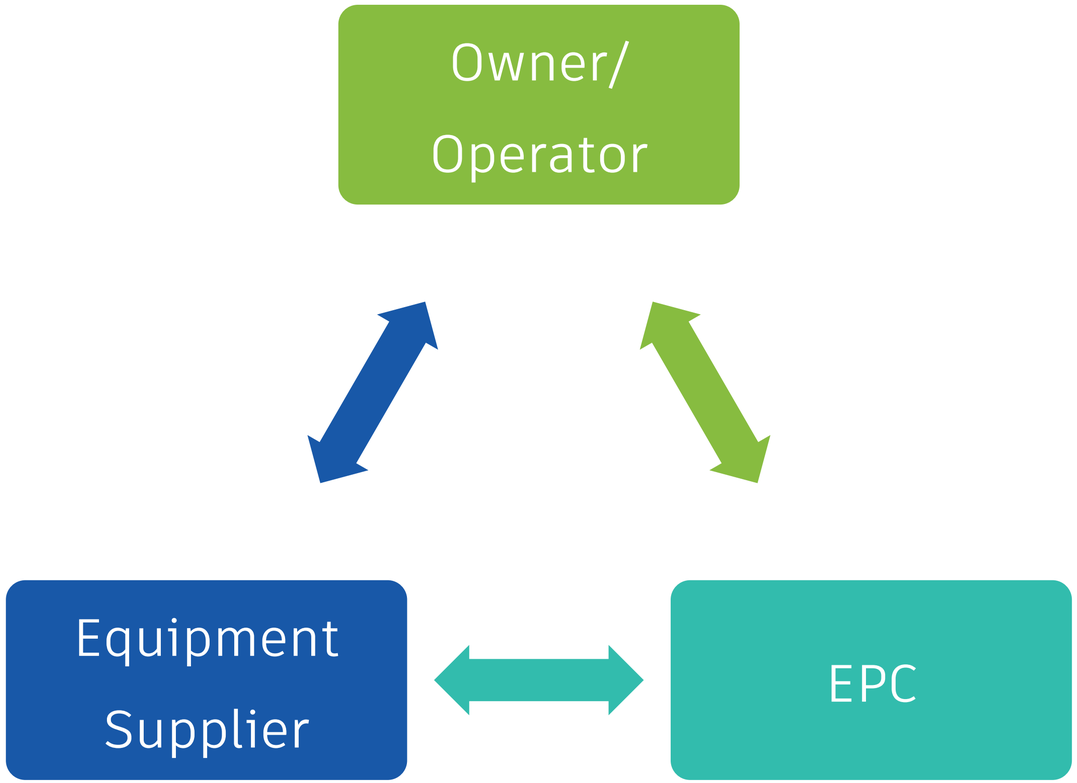
DEXPI workflows

DEXPI Data Exchange in the Process Industry

These (data exchange) workflows are supported through the DEXPI standard

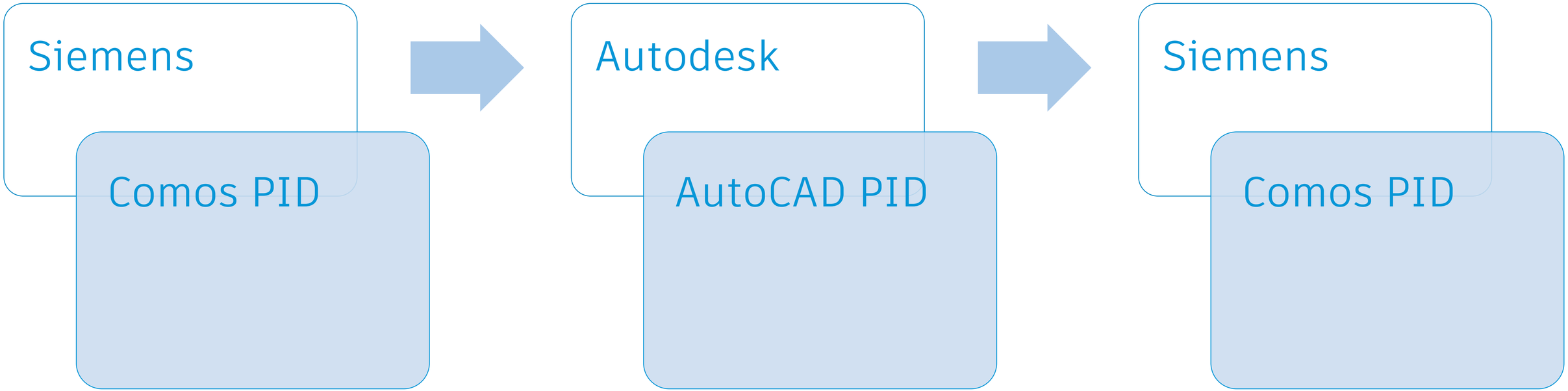
- PID data exchange between CAE systems / Data handover of semantic PID's:
  - From EPC to O/O
  - From EPC to equipment supplier
  - From O/O to contractor
  - From O/O to equipment supplier
  - Inside a company between different departments

Exchange Data, not documents



Handover between PID tools

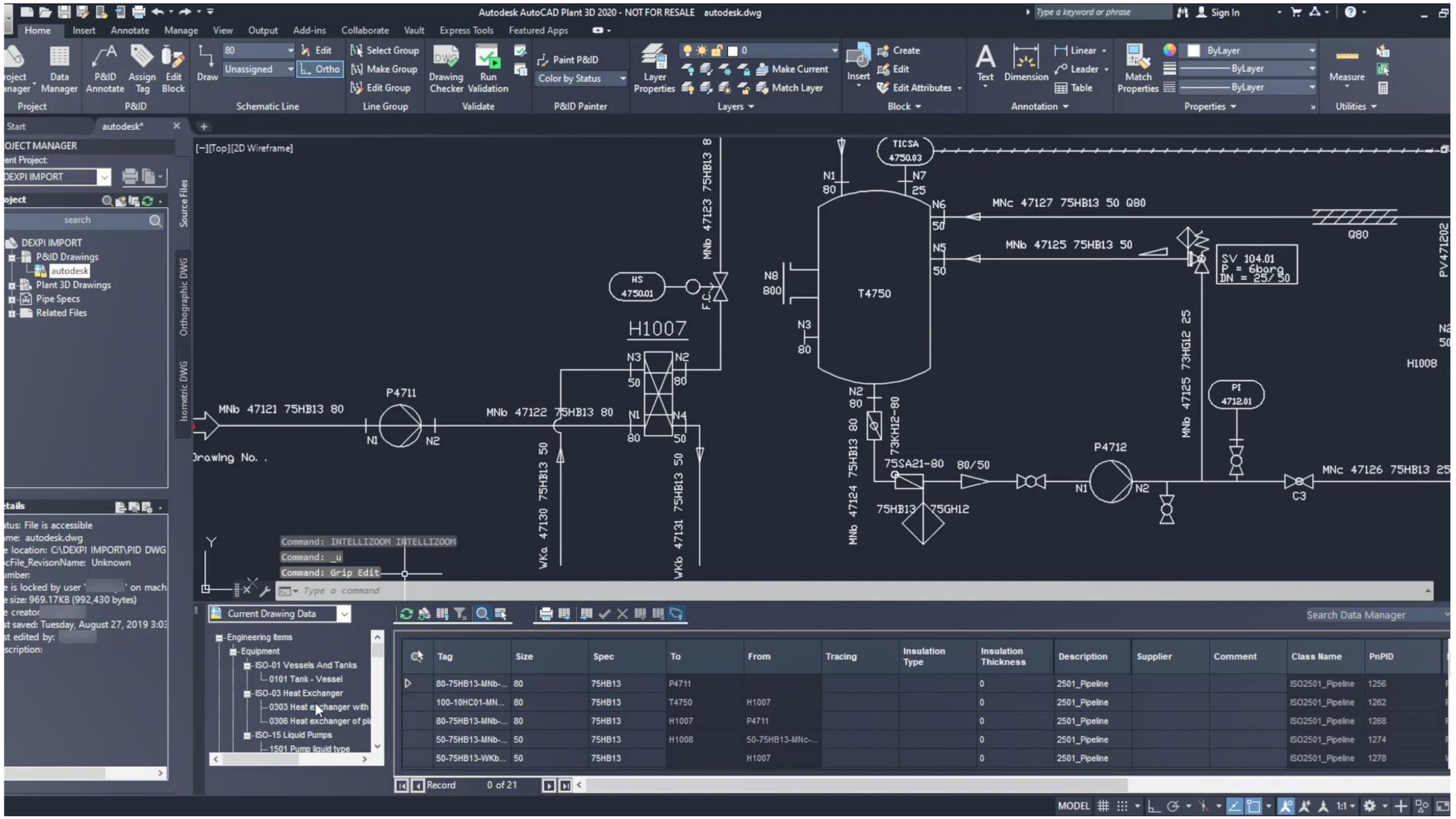
DEXPI Data Exchange in the Process Industry



Managing Data, not documents

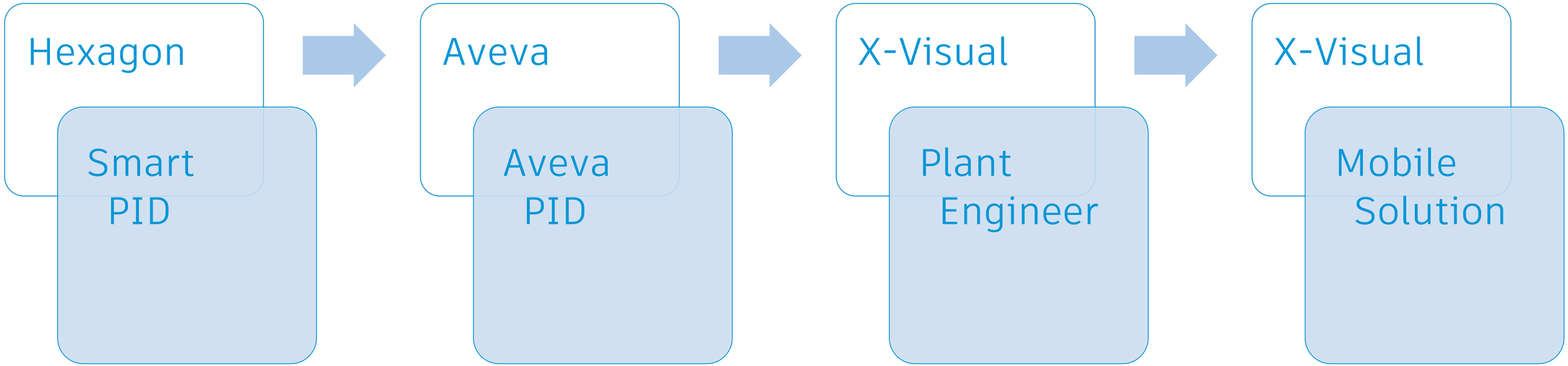
DEXPI Data Exchange in the Process Industry

Transfer of a semantic PID between different software vendors (Siemens, Autodesk)



Handover between PID tools

DEXPI Data Exchange in the Process Industry



DEXPI workflows

DEXPI Data Exchange in the Process Industry

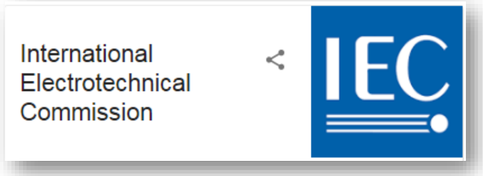
These (data exchange) workflows are supported through the DEXPI standard

Re-use PID information for other disciplines

Instrumentation systems	Process simulation	AR/VR	IoT and control systems	3D piping systems	Mobile solutions	Safety and work permit systems	ERP, Data Management (Plant topology)
							

DEXPI status and roadmap

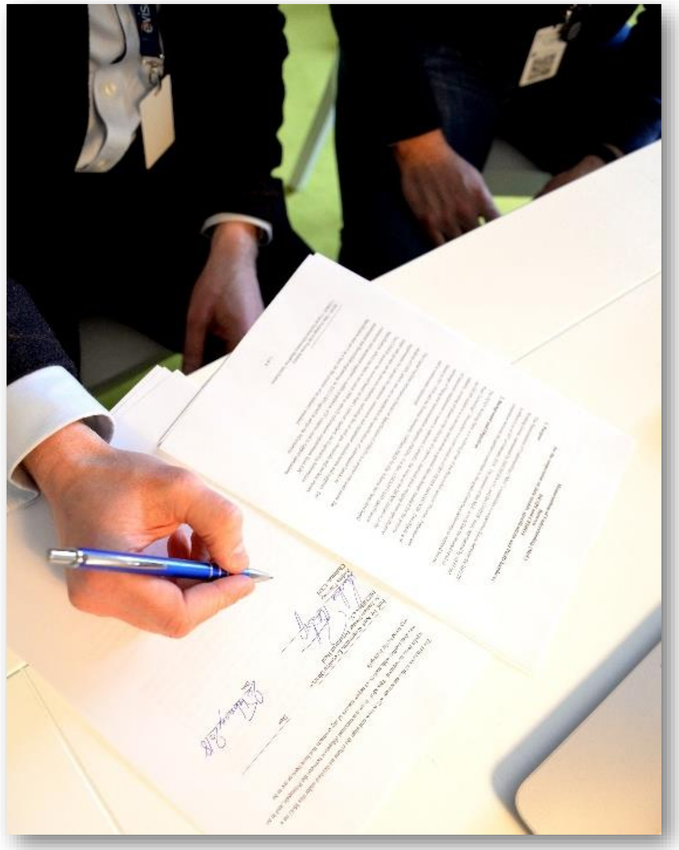
DEXPI‘s Influence and cooperation



DEXPI & CFiHOS

DEXPI Data Exchange in the Process Industry

Working closer together: MoU signed and content harmonization takes place.



2019 Implementation Status

DEXPI Data Exchange in the Process Industry

CAE Vendor	Product	DEXPI Interface
AUCOTEC	Engineering Base 2020	Export only
AUTODESK	AutoCAD P&ID 2020	Import & Export
AVEVA	Aveva PID	Import & Export
HEXAGON	Smart PID 2009, 2014, 2014 R1	Export only
SIEMENS	Comos PID	Import & Export
VISUAL	Plant Engineer 2019	Import & Export

External Testing Body Established

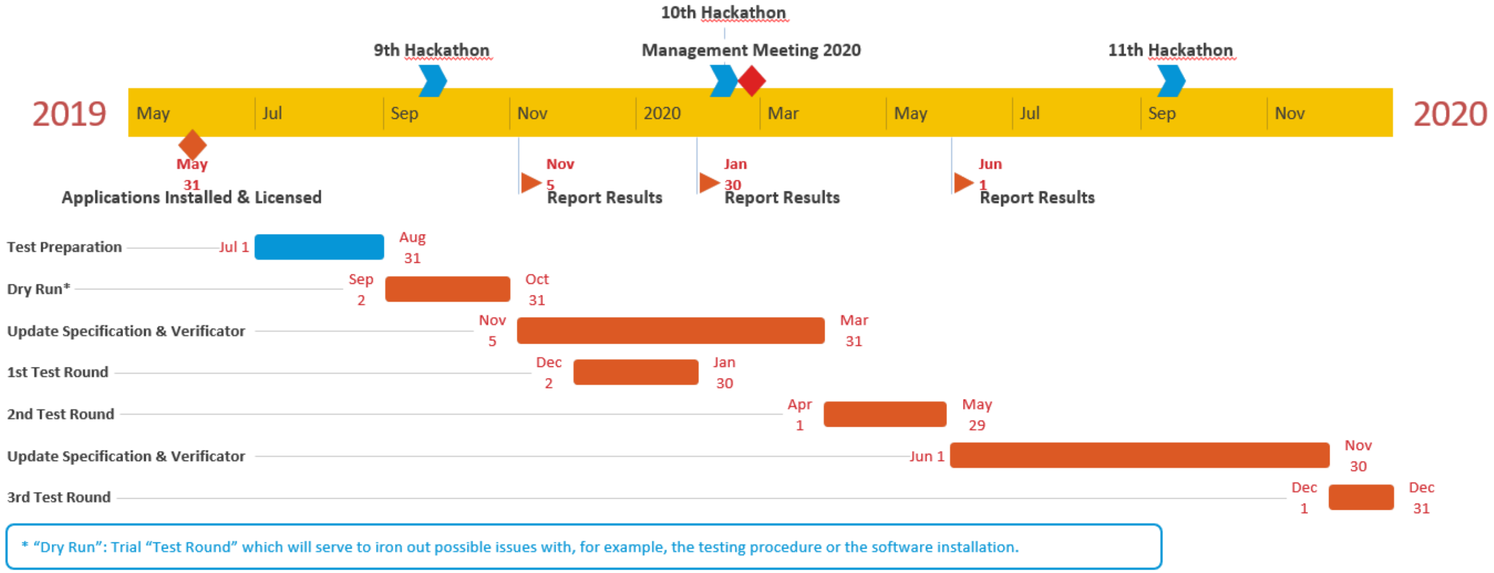
DEXPI Data Exchange in the Process Industry

- Independent Test Organization (plants & bytes)
- Founded for that reason
- Funded by Owners / Operators
- SW vendors provide
  - Software + DEXPI Interface
  - Training
- Timeline agreed with DEXPI group

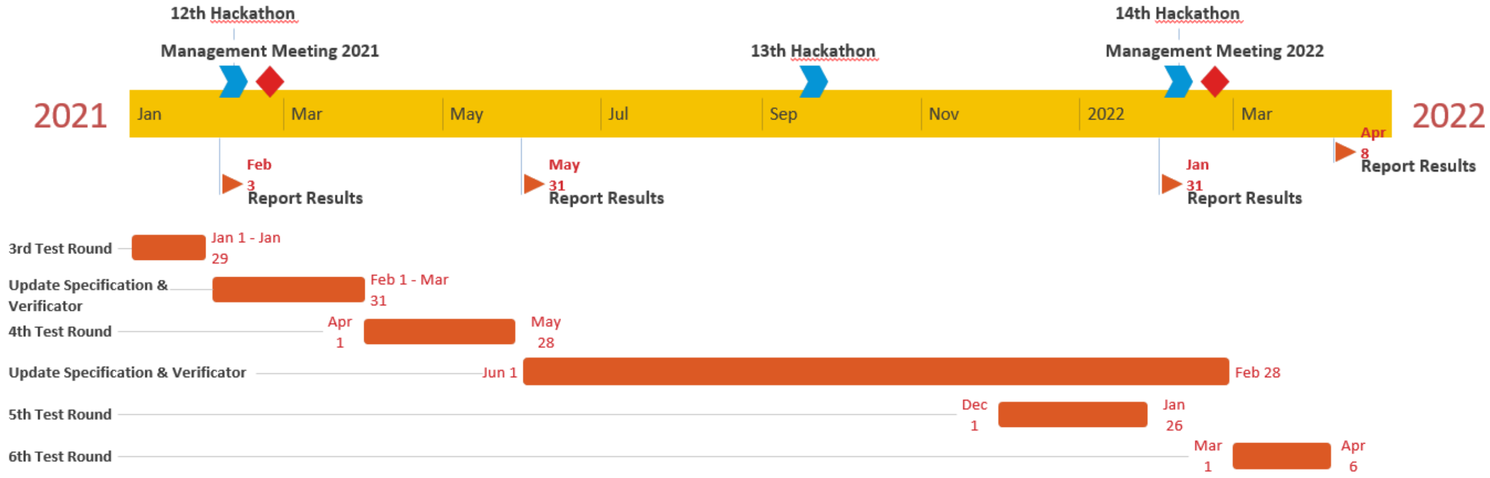
Testing and development timeline

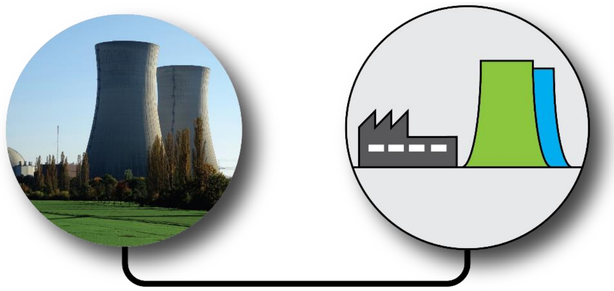
DEXPI Data Exchange in the Process Industry

How we proceed in 2019 and beyond



* "Dry Run": Trial "Test Round" which will serve to iron out possible issues with, for example, the testing procedure or the software installation.





- Digital Twin
- Implementation Challenges
- Forge based Digital Twin
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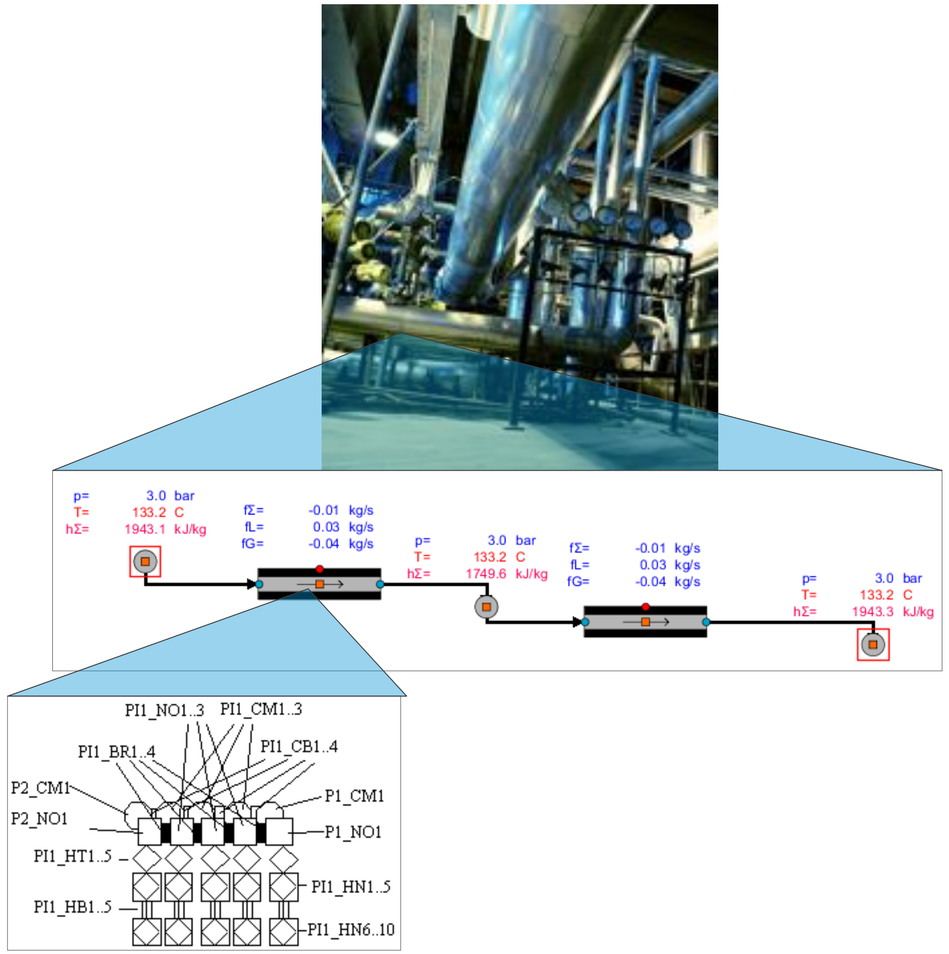
- Model broker
- Customer examples
- Q&A

Model Broker for Apros®

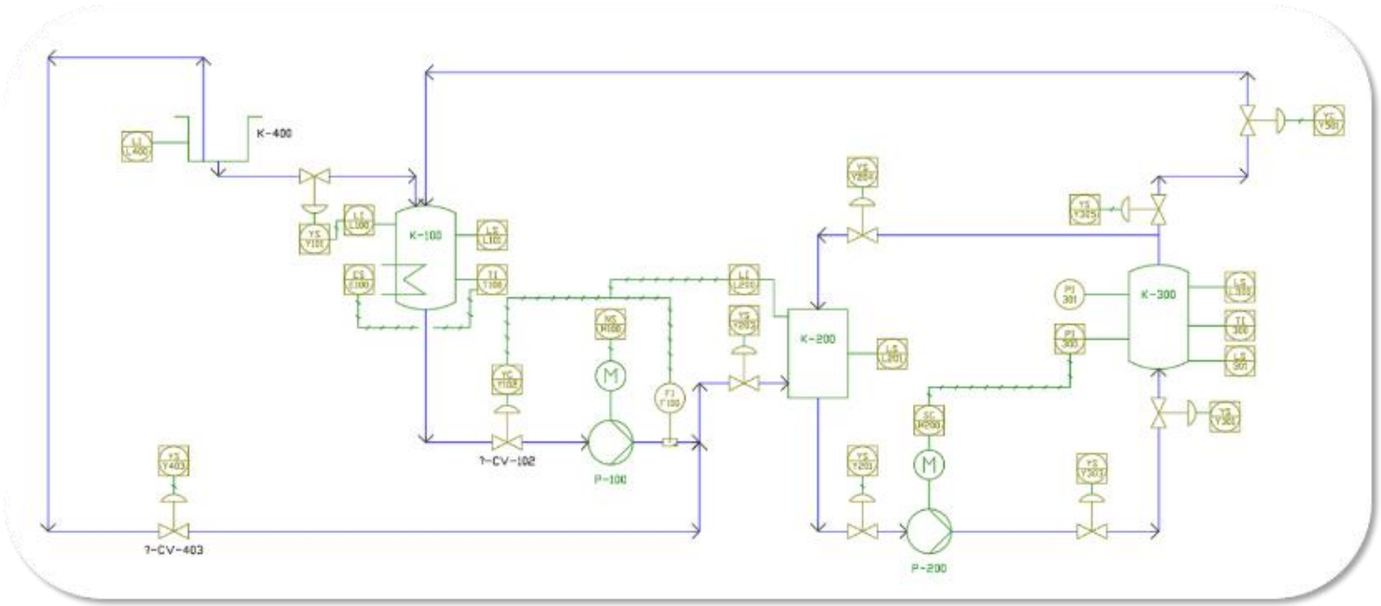
Apros®: high-fidelity simulation for thermal-hydraulic processes

- Apros® (www.Apros.fi) is a software tool for modelling and dynamic simulation of industrial thermal-hydraulic processes,
  - Including automation and electrical systems
- Widely used for modeling and simulation of power plants, their subsystems, control applications and equipment
  - Combined and heating PP
  - Concentrated solar power
  - Nuclear
  - District heating and cooling networks
  - Pulp and paper mills

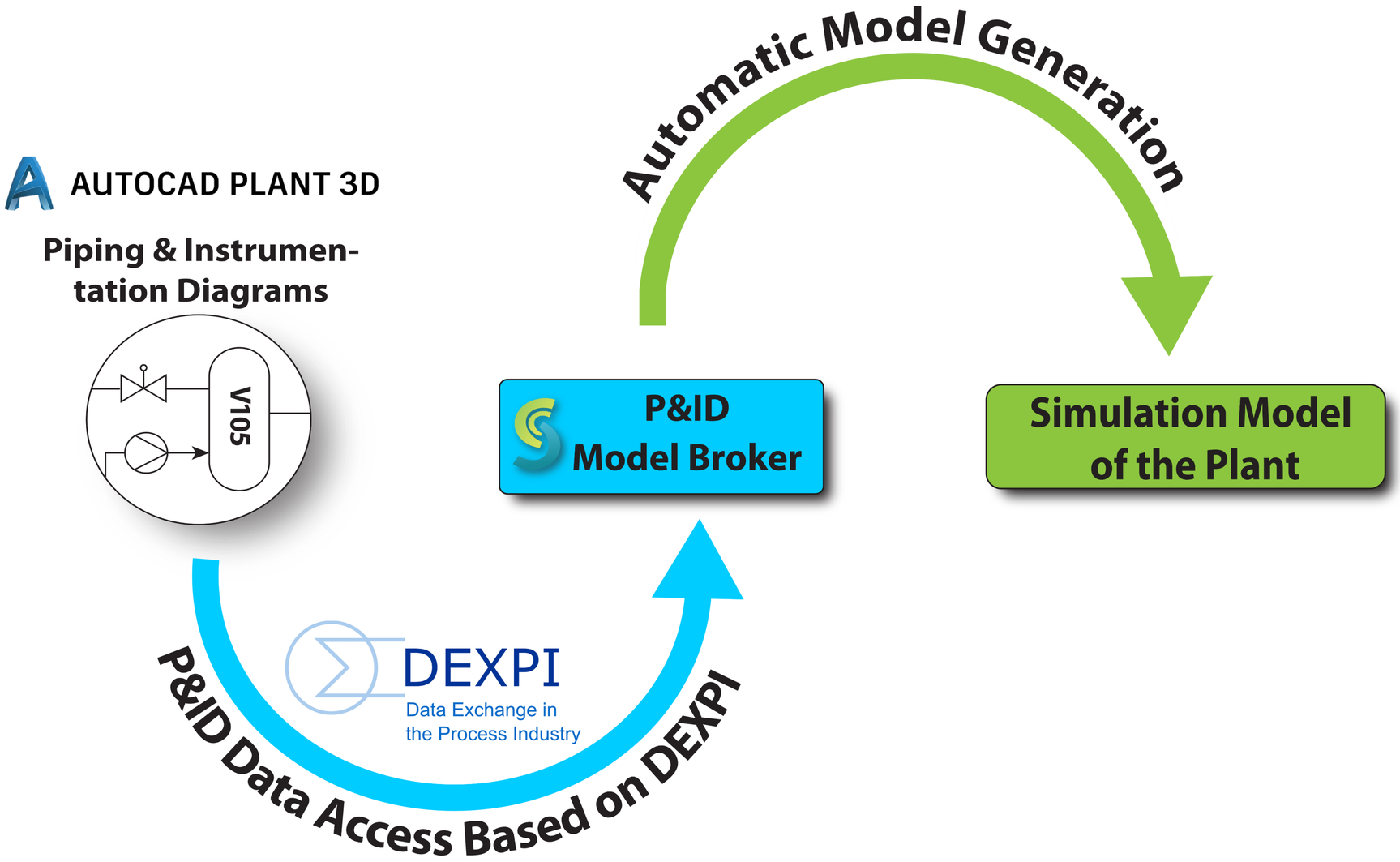


Model development in process industry

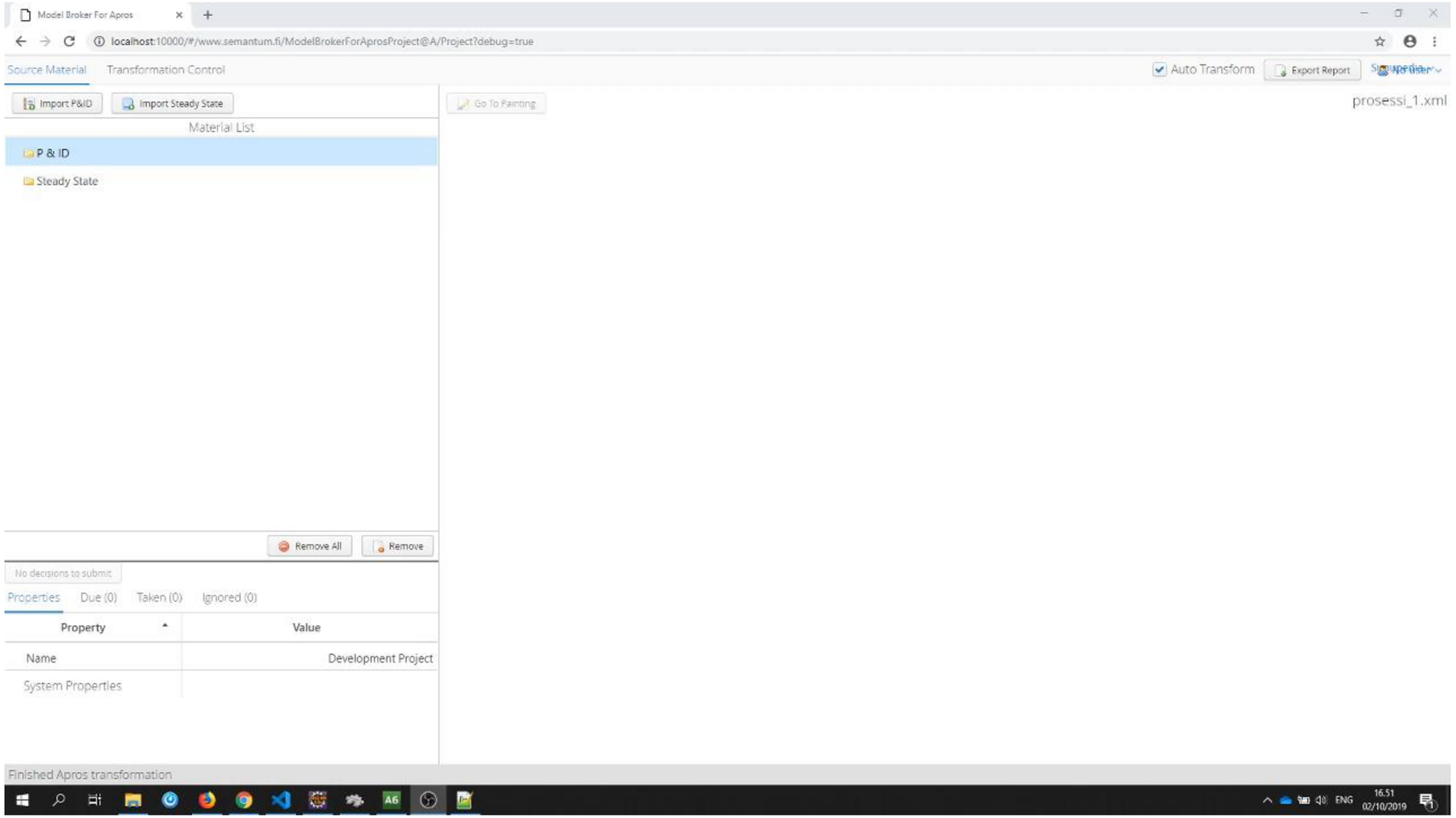
Automatic model generation of a lab process



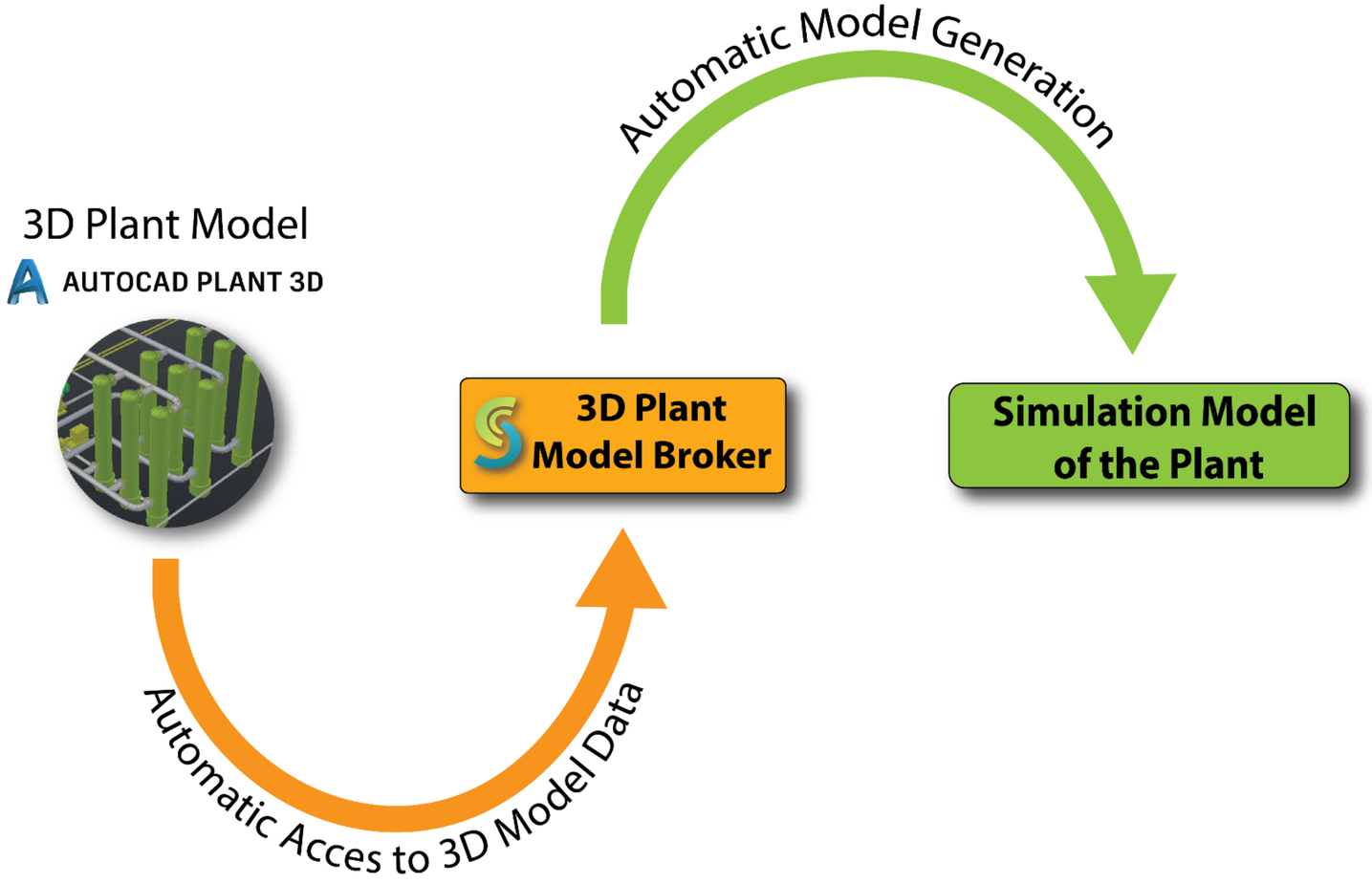
Model development in process industry



Model Broker



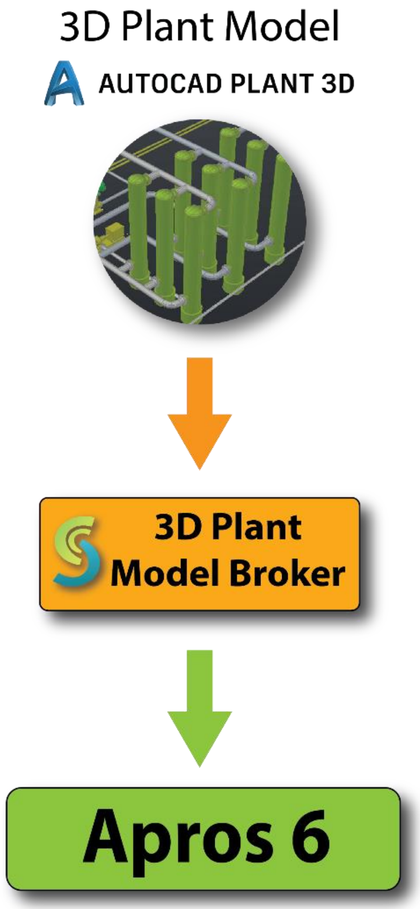
Automatic Process Simulation Model Generation from AutoCAD Plant 3D Model



3D Plant Model of the Water Heating Process

Automatic Model Generation

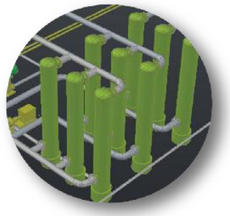
- Automatic model generation in 3D Plant Model Broker is based on Simantics Constraint Language.
- AutoCAD Plant 3D model is used to retrieve geometrical data of:
  - Equipment
  - Piping
  - Pipes, elbows and tees.
  - Points
  - Connections



Automatic model generation:
Automatic Equipment Connections

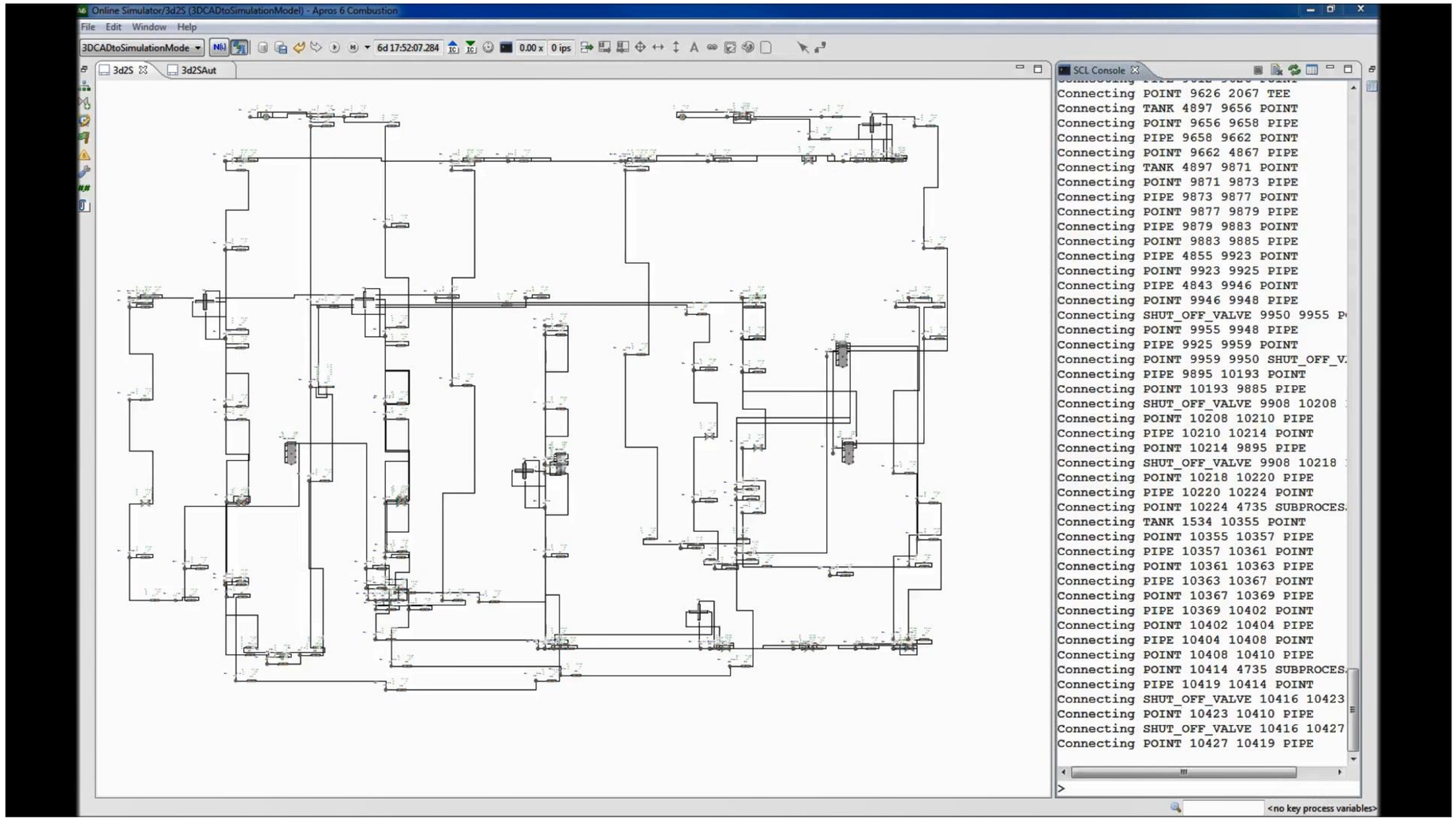
3D Plant Model

AUTOCAD PLANT 3D

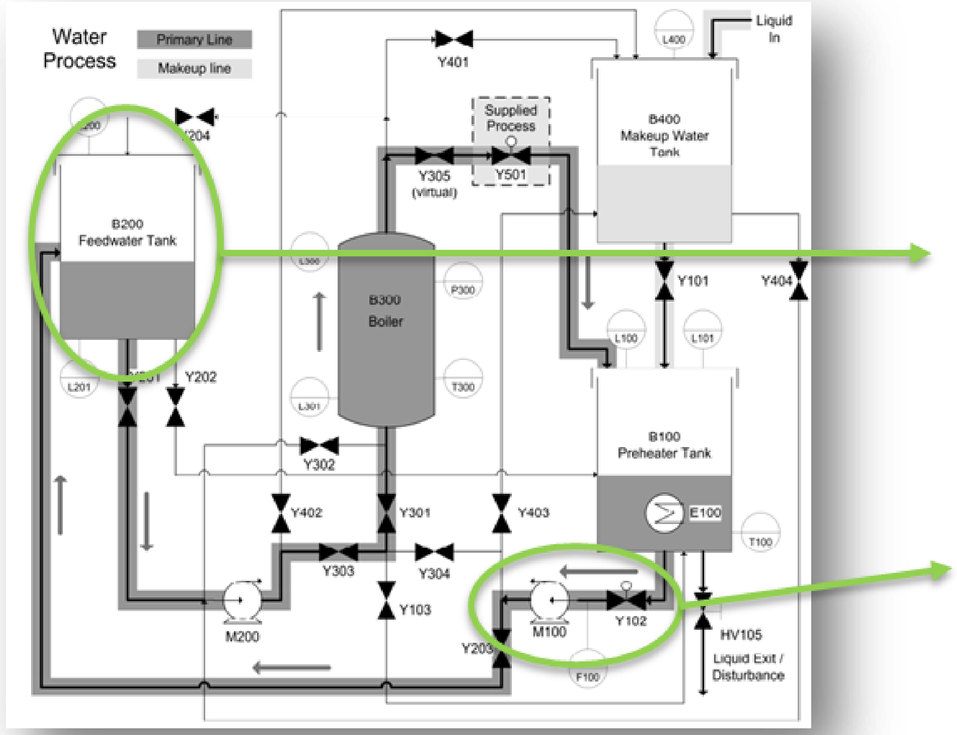


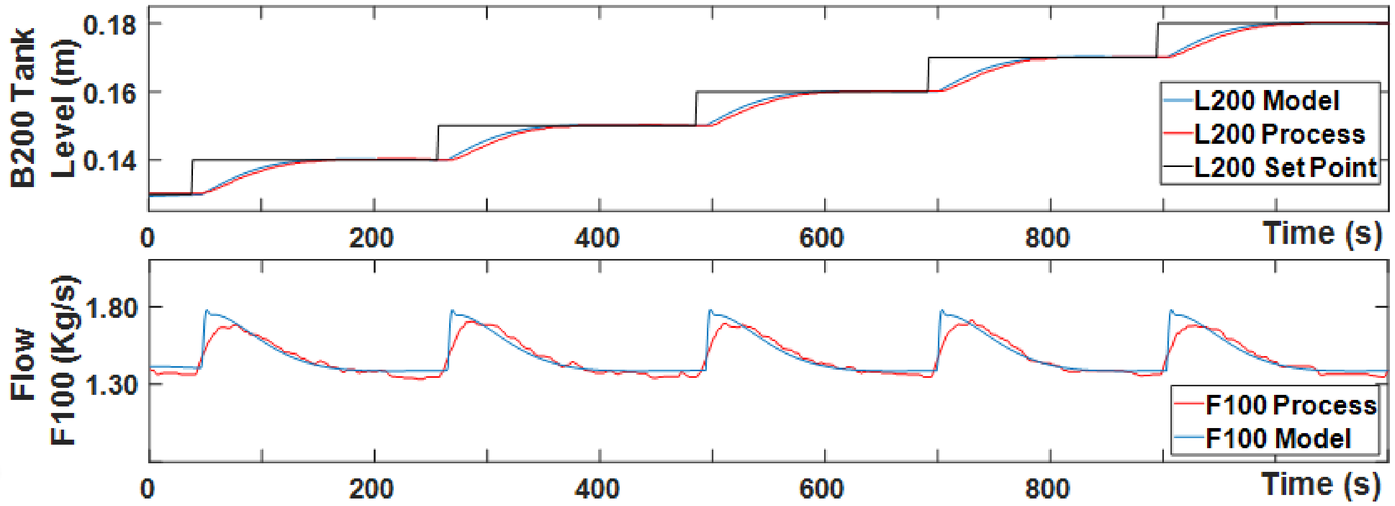
3D Plant Model Broker

Apros 6



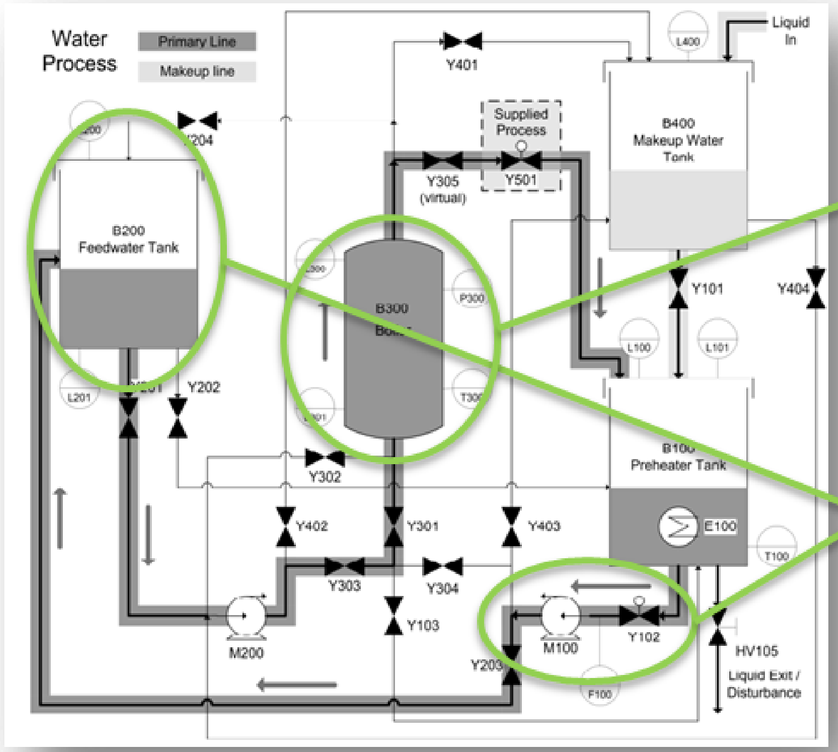
Simulation Model Results

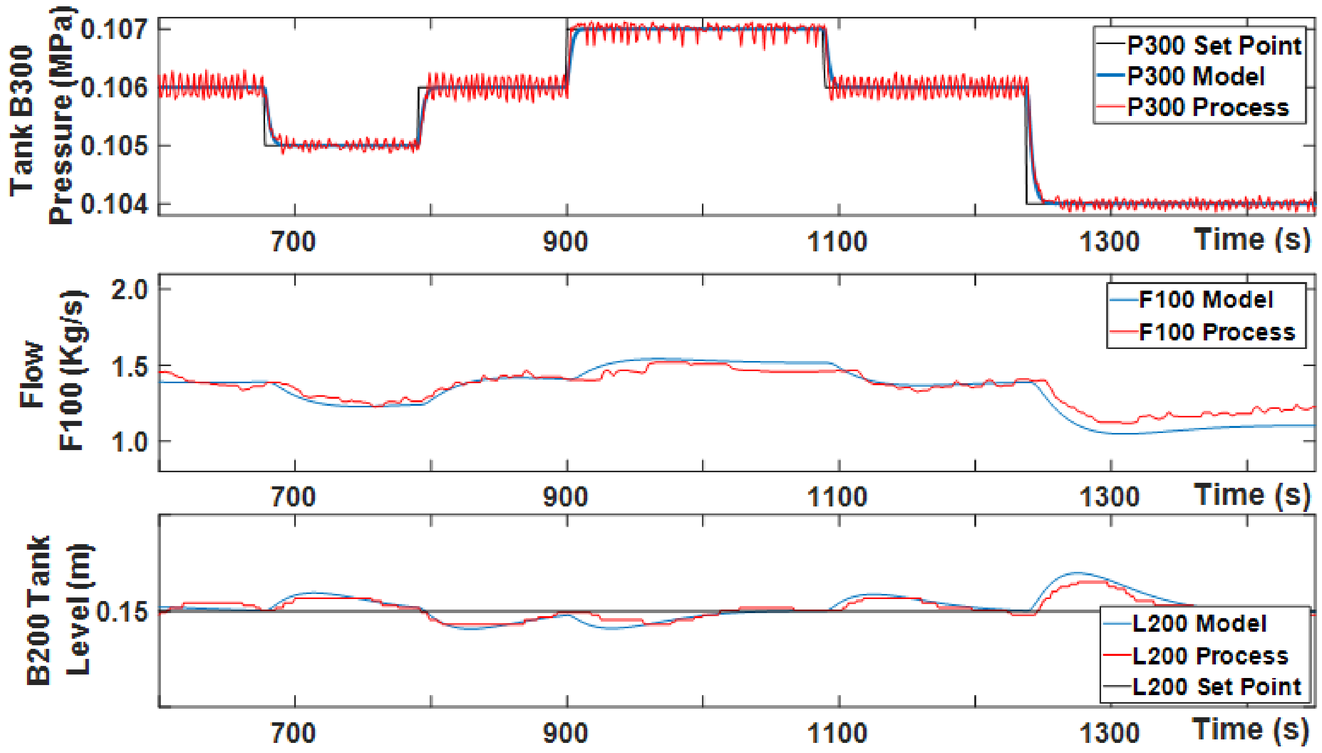




G. Santillán Martínez, S. Sierla, T. Karhela, J. Lappalainen, and V. Vyatkin, "Automatic Generation of a High-Fidelity Dynamic Thermal-hydraulic Process Simulation Model from a 3D Plant Model," *IEEE Access (Under Review)*, 2018.

Simulation Model Results





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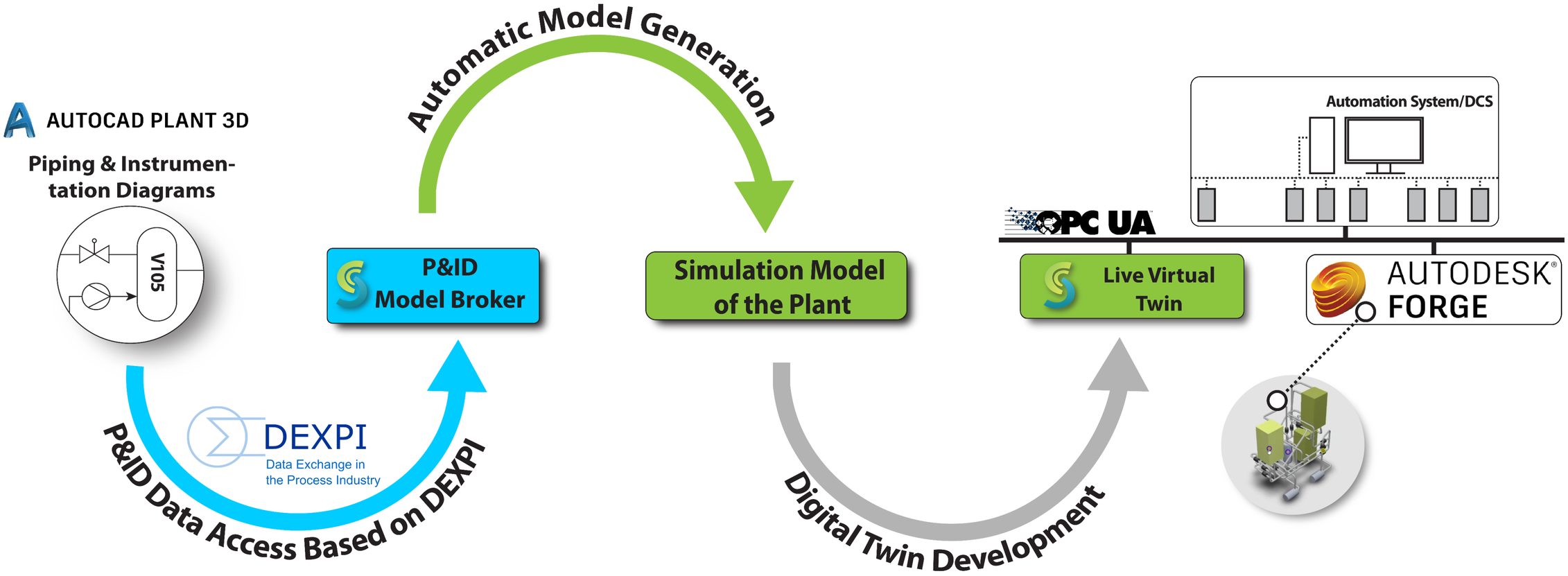
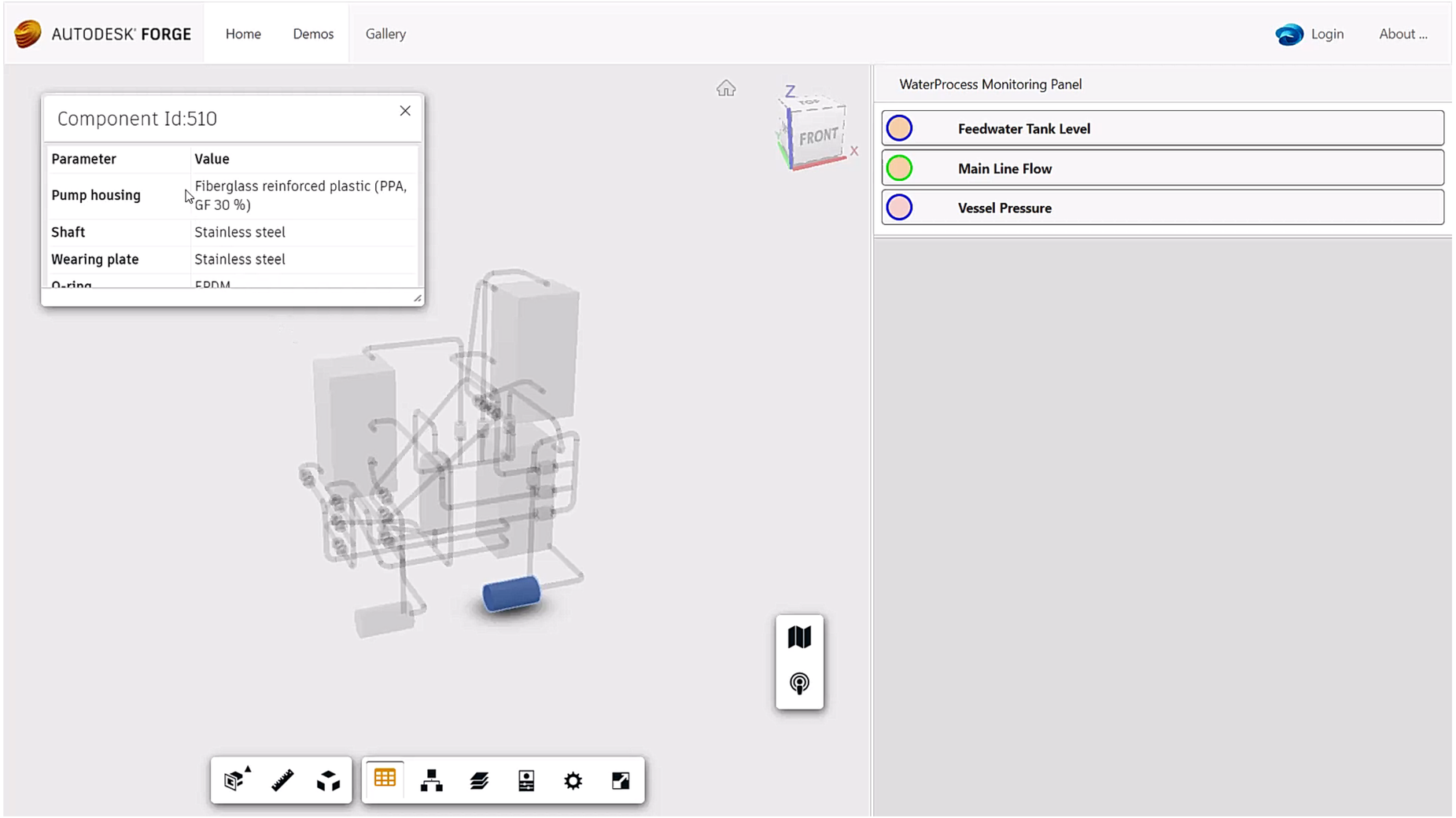
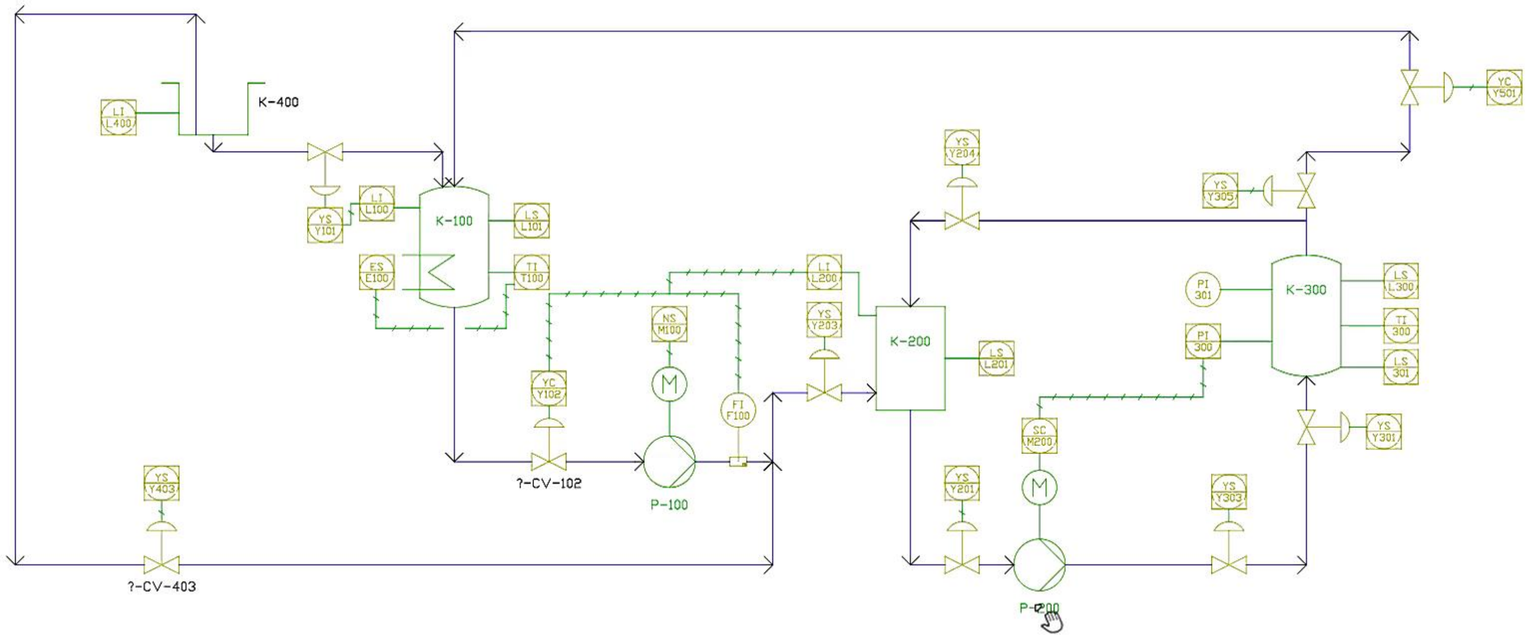
Digital Twin interface developed with Autodesk Forge



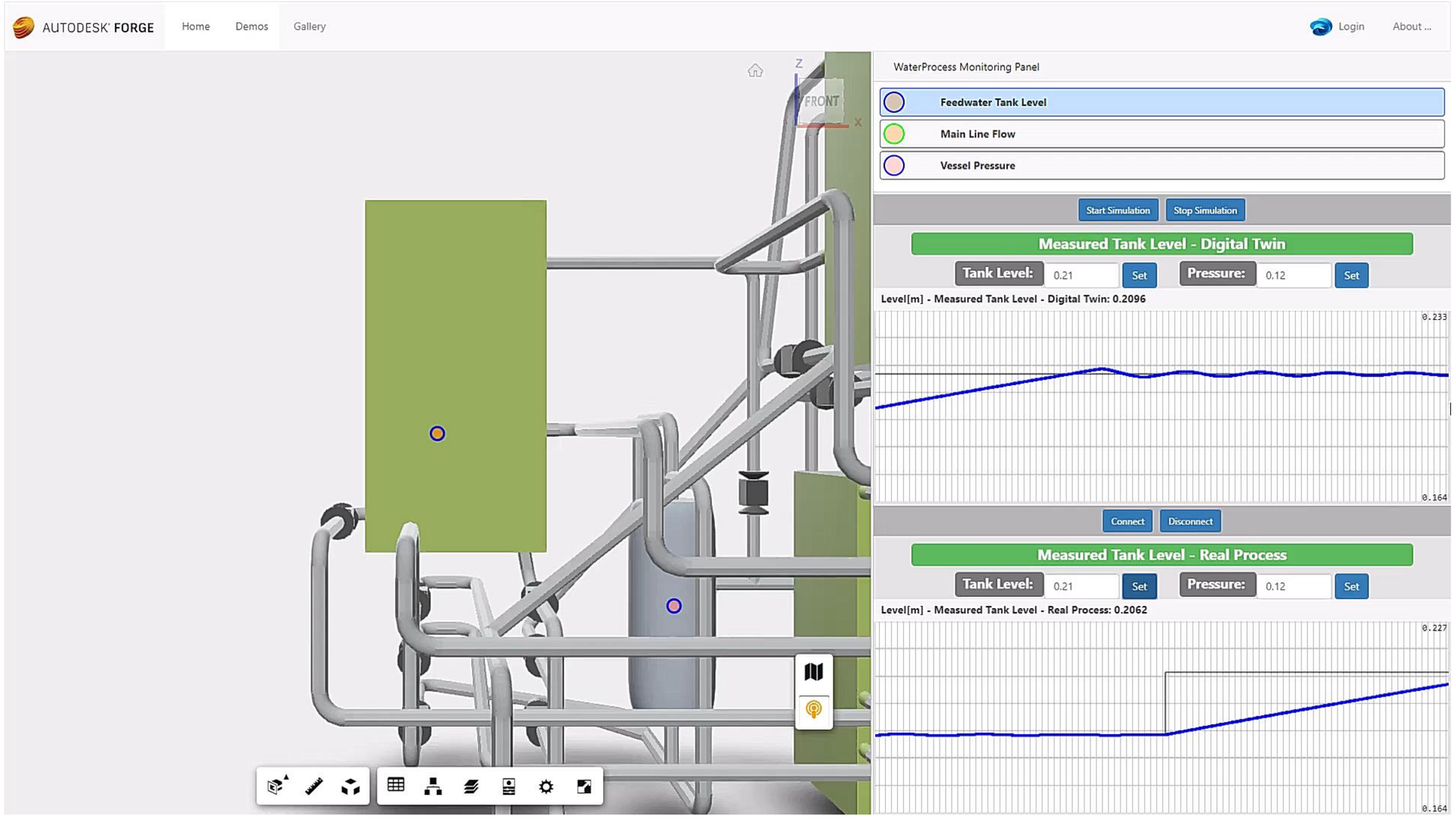
Digital Twin interface developed with Autodesk Forge



Digital Twin interface developed with Autodesk Forge



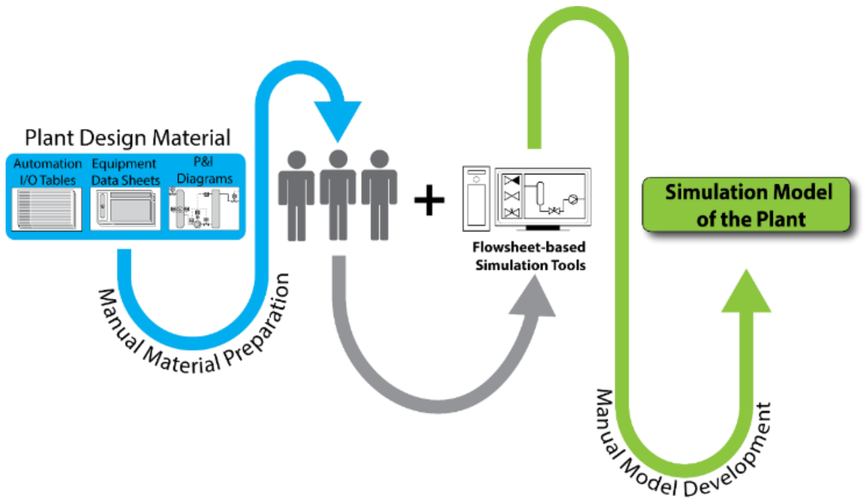
Digital Twin interface developed with Autodesk Forge



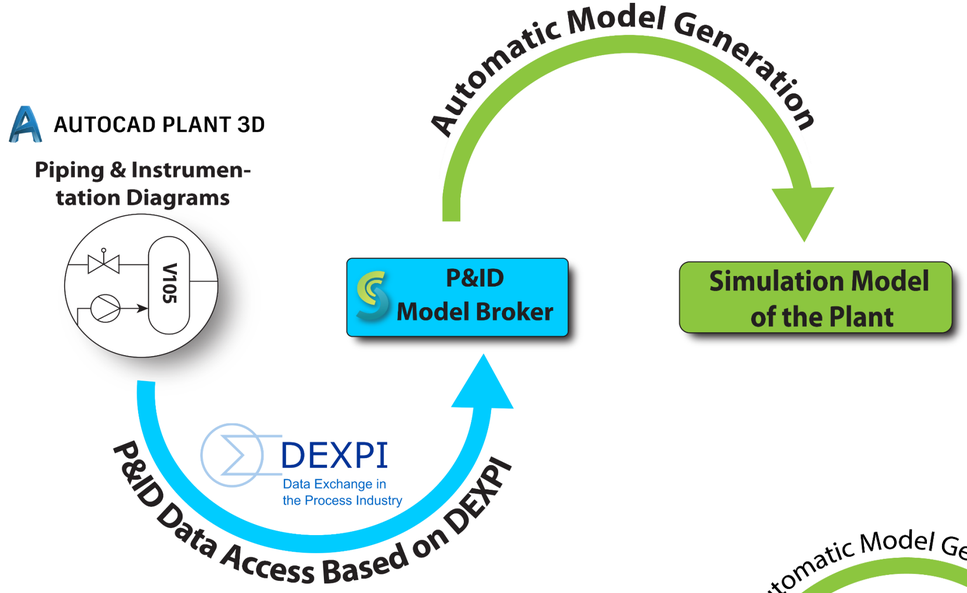
Model Broker: Benefits

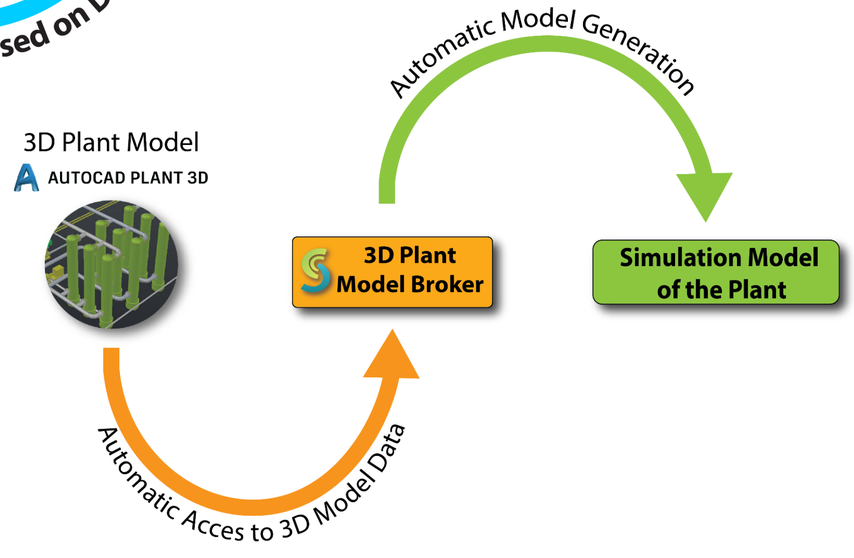
Reduction of simulation models development time and cost

Automatic model generation dramatically reduces model development and maintenance time and costs.



VS





Automatic generation based on DEXPI

Owner / Operators
- BASF
- Bayer
- Covestro
- Equinor
- Evonik
- Merck

EPC
- Air Liquide

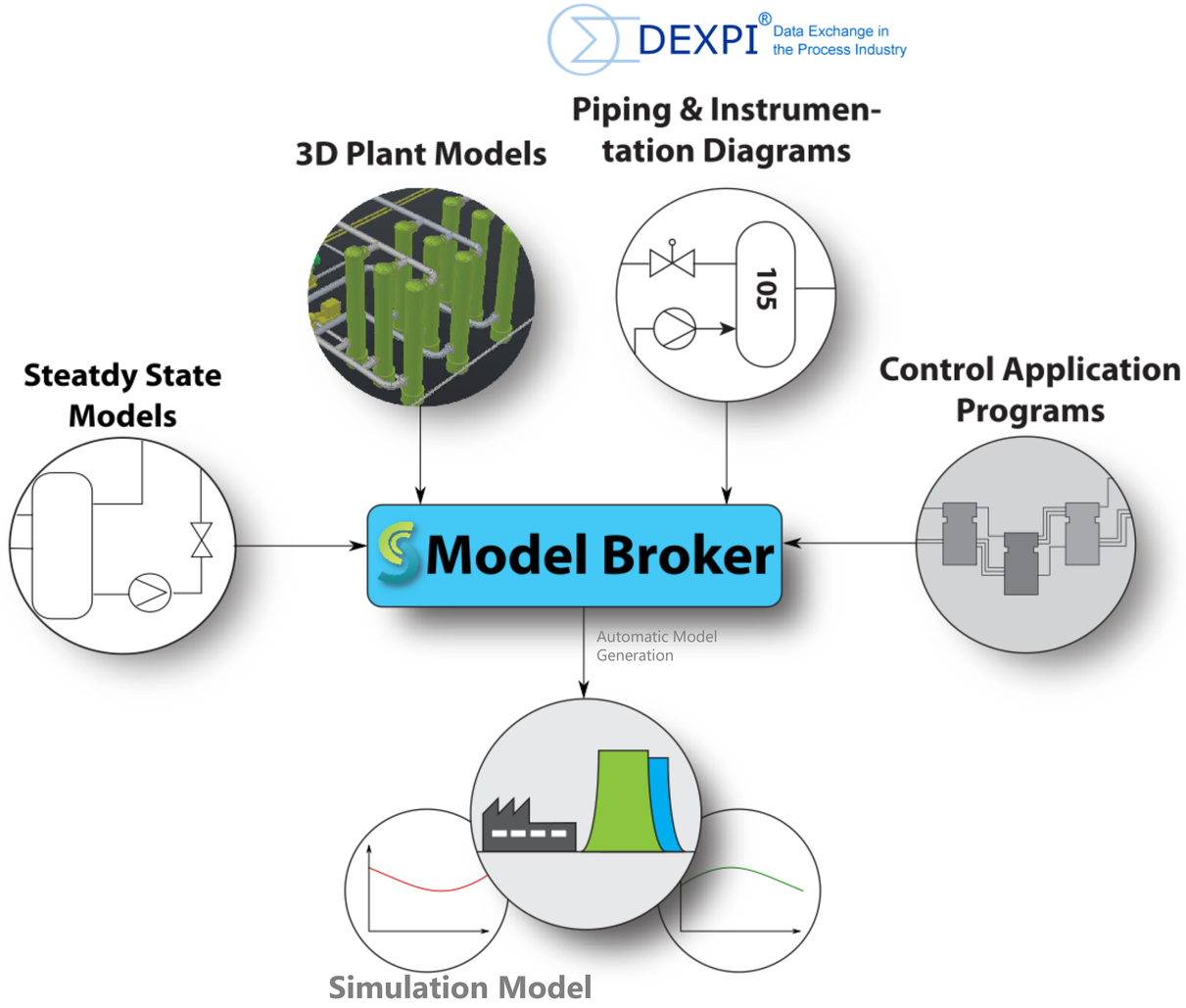
Software Vendors
- Aucotec
- Autodesk
- Aveva
- Bilfinger
- Hexagon
- Semantum
- Siemens
- X-Visual
- eVision
- PTC

Research Organizations
- AixCAPE e.V.
- VTT of Finland
- TU Berlin
- RWTH Aachen University
- Tecgraf/ PUC-Rio
- Kyungpook National University

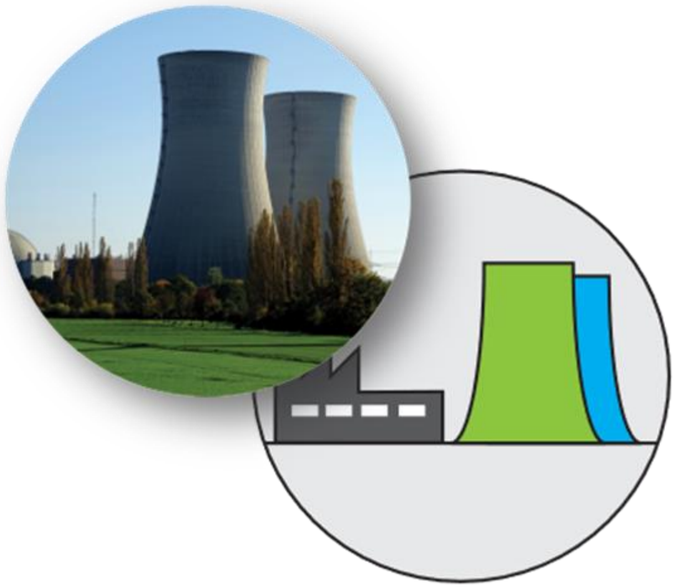
International Community
- ISO TC 184 SC4
- FIATECH / CII / POSC Caesar
- OPC Foundation
- CFIHOS
- DECHEMA / NAMUR / DKE / VDMA
- SSG

Increased fidelity

- Results of simulation models automatically generated improve when other engineering data sources are combined.



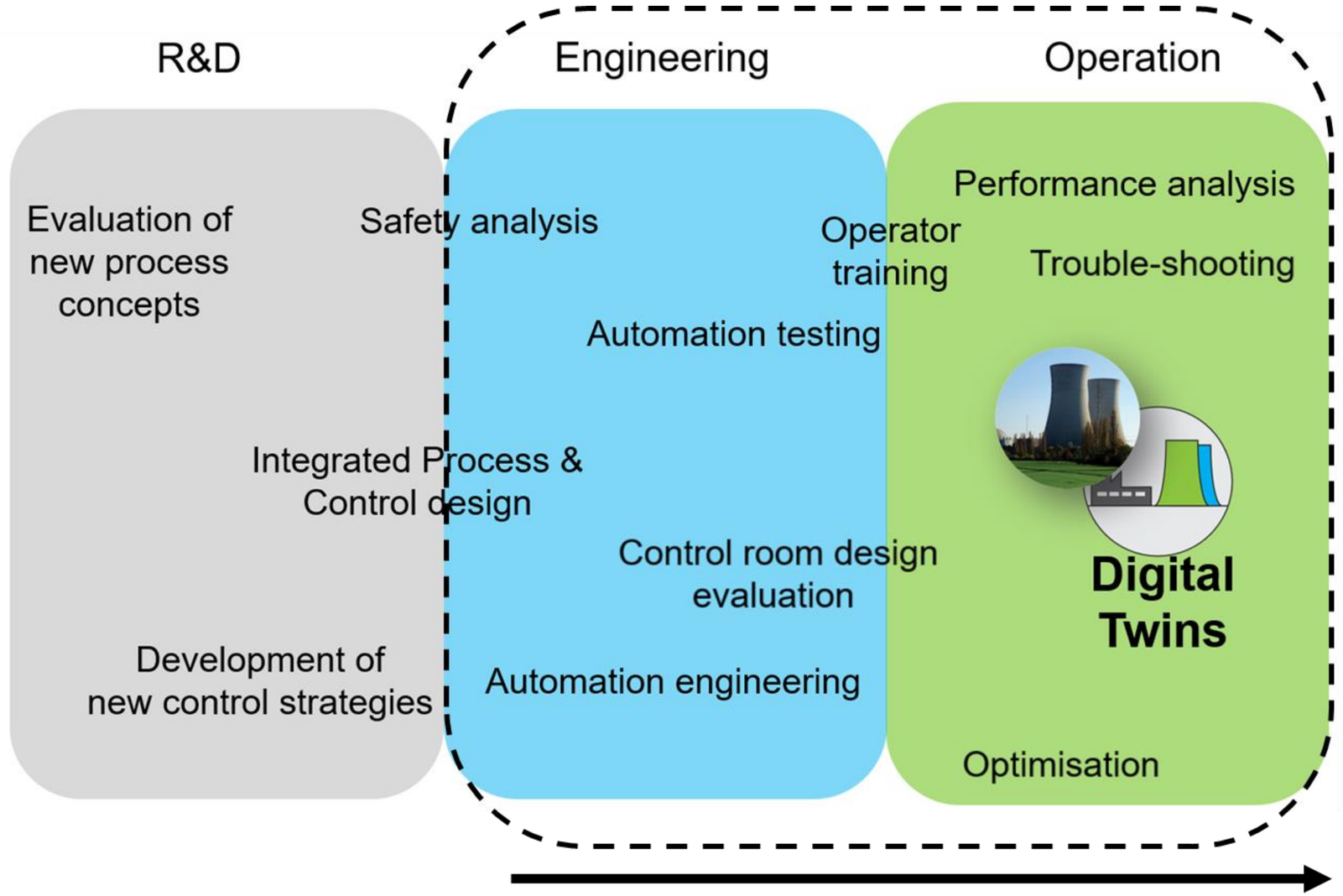
Solutions for thermal hydraulic and petrochemical industries

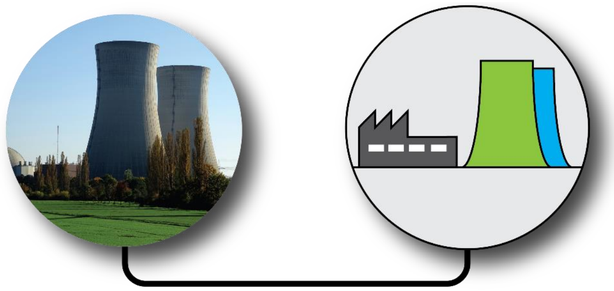


Apros® 6

Visual Modeler®

Efficient model generation





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- Customer examples
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Digitalize the Customer Experience

PRODUCT/PARTS BUYING EXPERIENCES

The Challenge

Identifying the correct product configuration or spare part to order can be error prone – leading to delays and extra cost.

The Solution

Use Forge to create a simple point-and-click ordering experience based on interactive 2D and 3D views of your product.

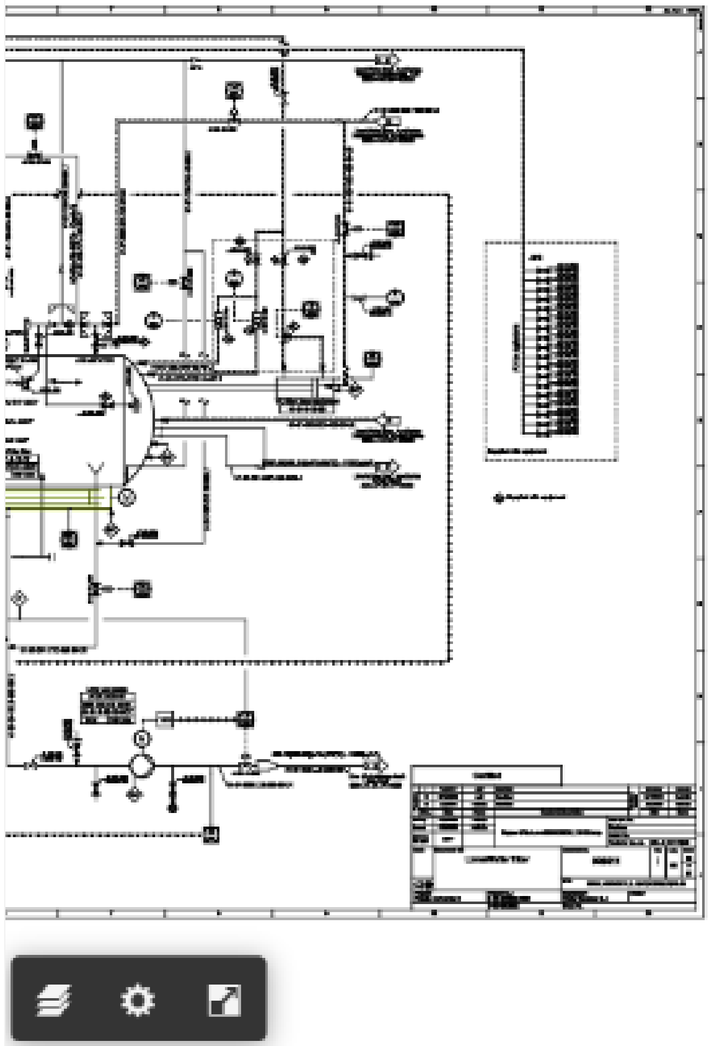
The Benefits

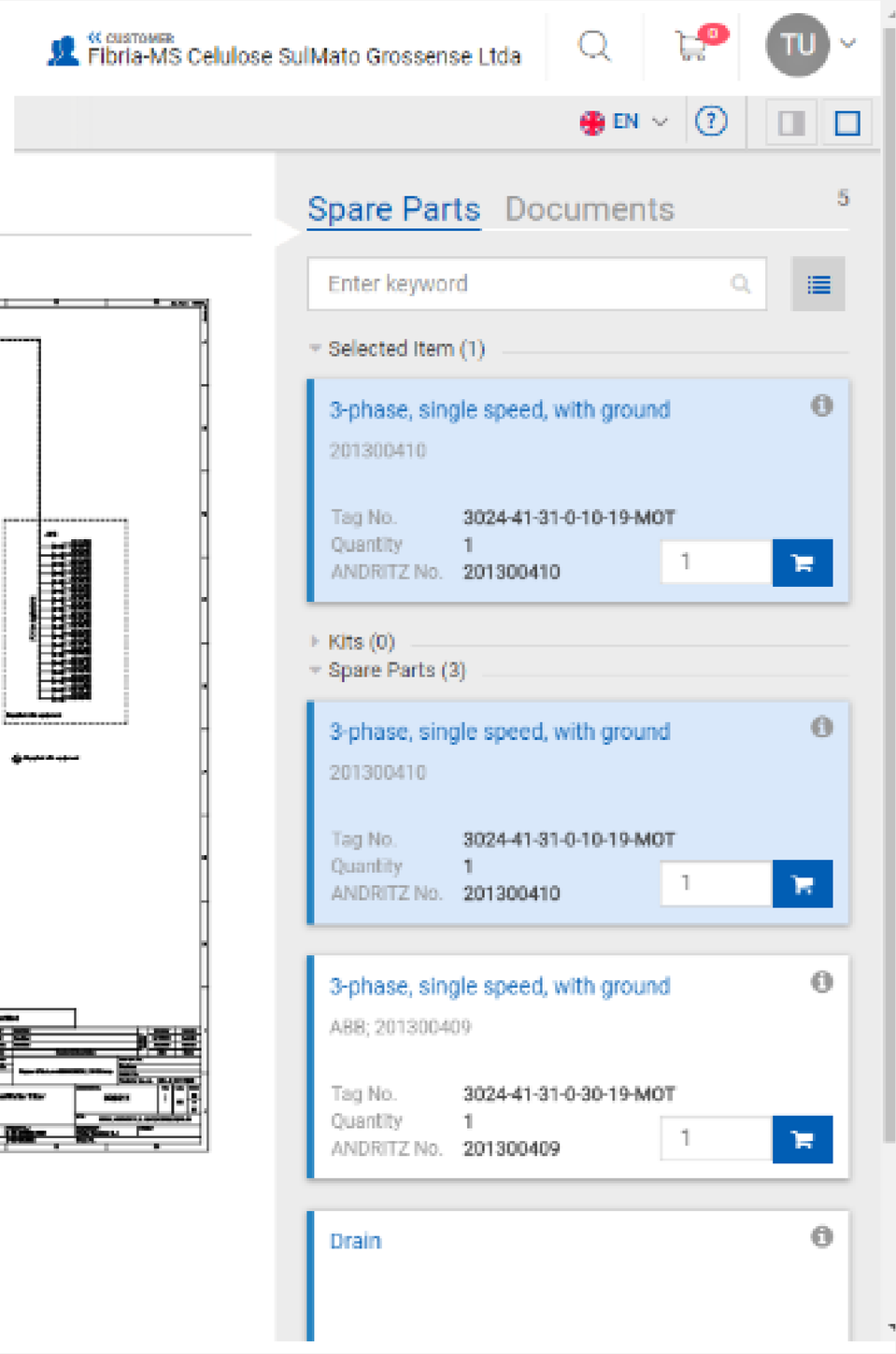
- Lower Cost
- Higher Revenue
- Faster Issue Resolution
- Scalable, Transparent Solution

Digitalize the Customer Experience

ANDRITZ

Augmenting customer experience through Digital Twin in a competitive market





Digitalize the Customer Experience

Demo

BENEFITS

Faster Issue Resolution

Andritz's customers can more quickly identify the correct parts to order – reducing downtime due to errors

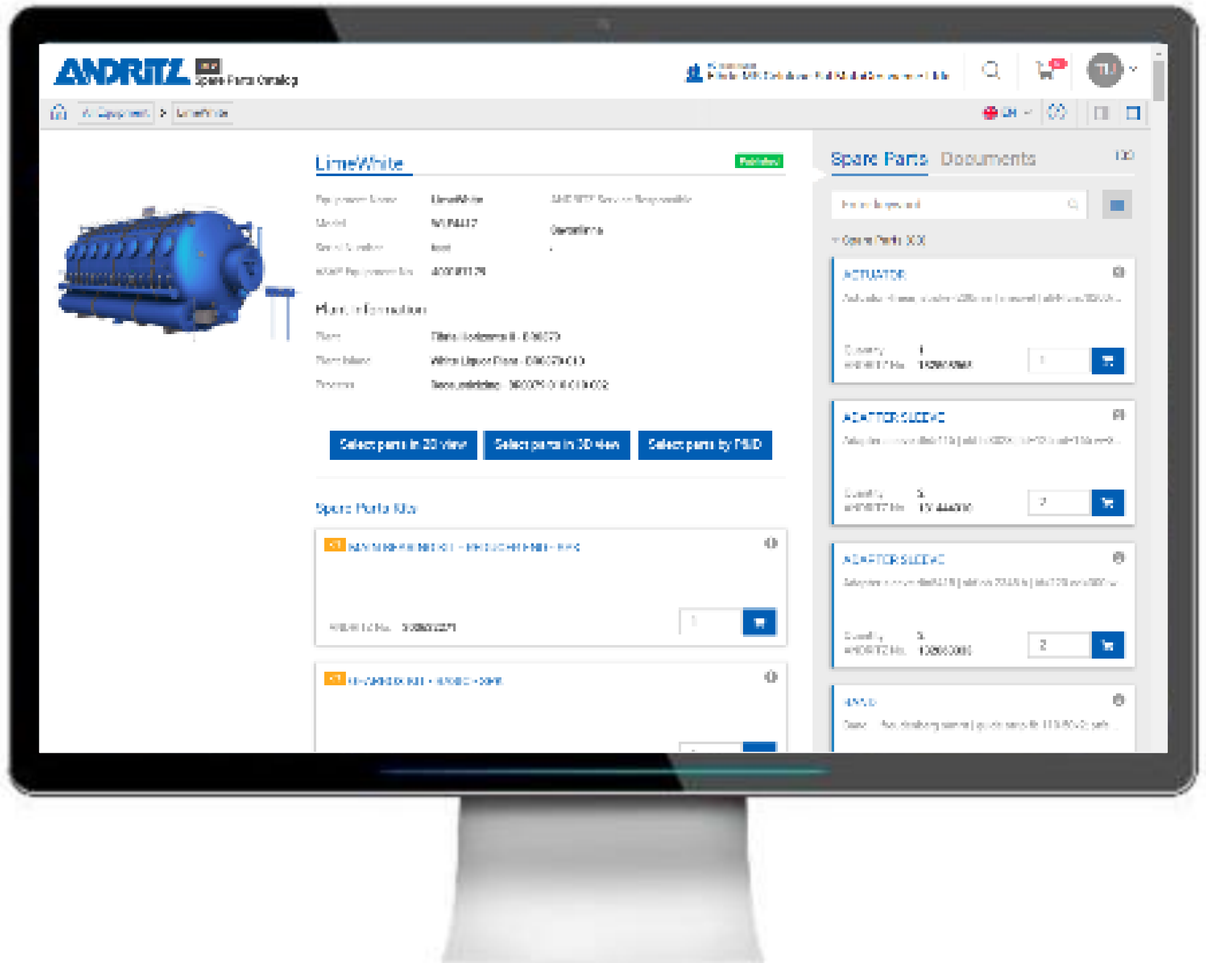
Higher Revenue

Delivering a better customer experience is protecting Andritz's spare parts business from copycat manufacturers

Scalable, Transparent Solution

Forge allowed Andritz to quickly build a robust solution that can serve the diverse needs of its many customers

- Andritz used Forge to create a web portal – creating a single place where each customer can view and select parts to order from interactive 3D models of their equipment



Viewer

Model Derivative API

Data Management API

ANDRITZ Spare Parts Catalog

Need some help?

Requests Quotations 100

Enter part name or keyword

- Submitted
- Created
- Cancelled

Welcome to your ANDRITZ Spare Parts Platform

Search by keyword, part number or equipment ID

Browse by Plants | Browse by Equipment | Advanced Search

Please select one of the buttons to start your spare part request: "Browse by Plants" provides an overview of all your plants currently included in the catalog. "Browse by equipment" allows you to see all equipment across all plants. "Advanced search" provides search functionality across all your plants and equipment.

If you have any further questions please use the help button at the top to get in touch with an ANDRITZ representative who will be happy to assist you.

Digitalize the Operations

DIGITAL TWIN FOR MONITORING

The Challenge

Modern, sensor-laden machinery generates huge quantities of operation data. It is difficult to present this data in a meaningful way – from which we can draw insights.

The Solution

Forge allows you to connect your detailed design data to all your enterprise data – including live IoT data – creating an interactive 'Digital Twin' view of your machinery thereby allowing you to monitor and control it better.

The Benefits

Lower Cost

Optimized Performance

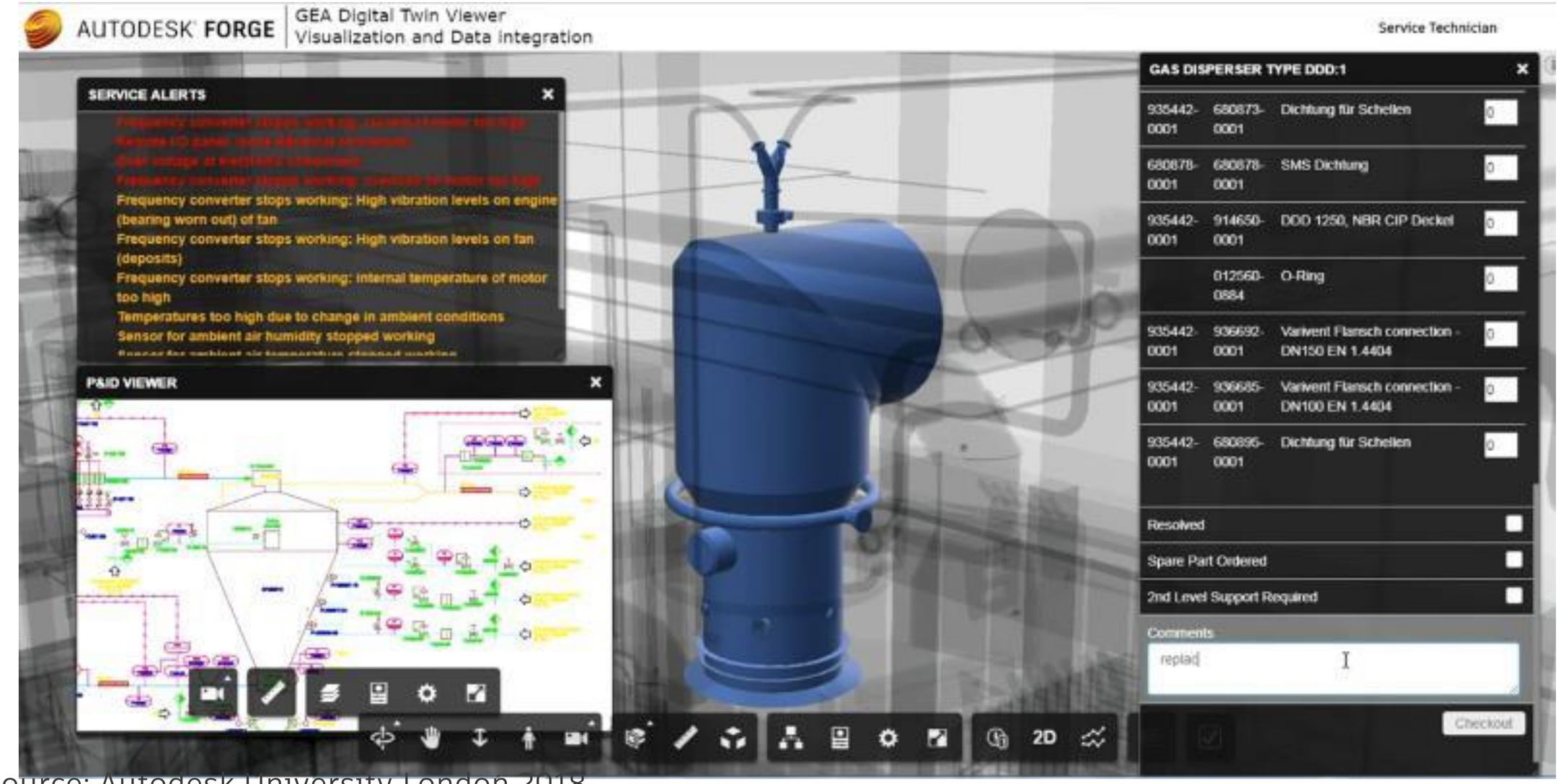
Increased Productivity

Faster Issue Resolution

Digitalize the Operations

engineering for a better world

Closing the loop from Design to Operations



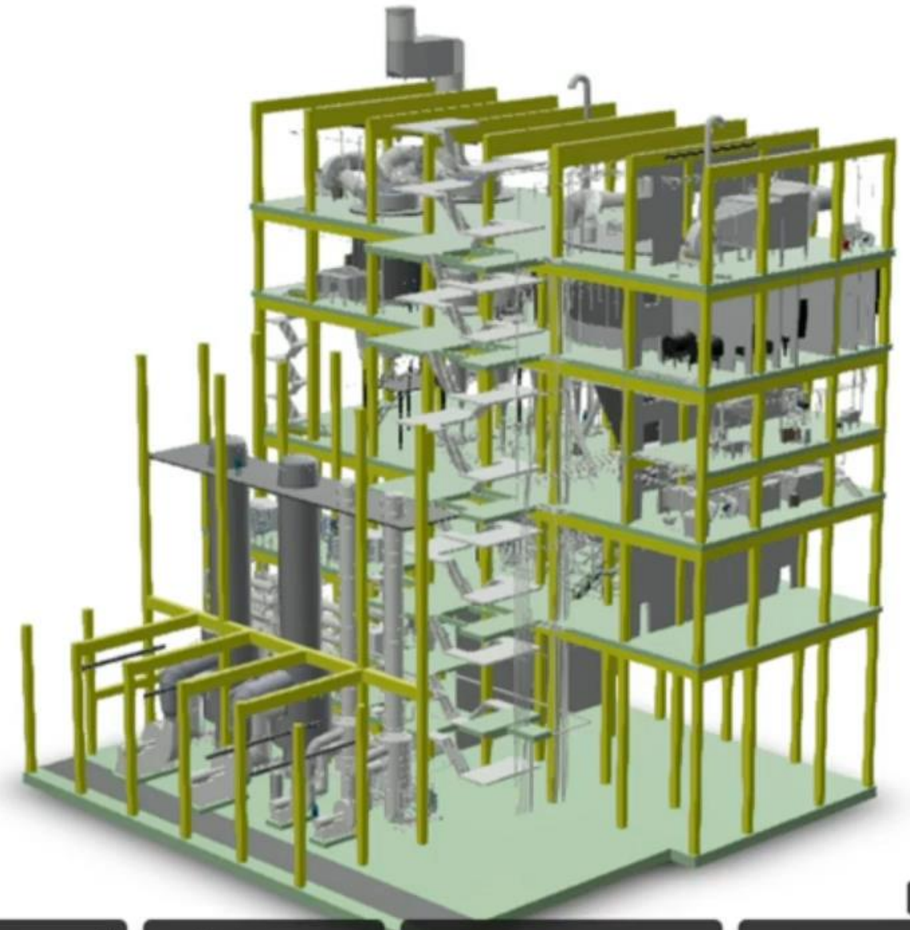
Source: Autodesk University London 2018

GEA Digital Twin Viewer

Sicher | https://geapocwebapp.azurewebsites.net

AUTODESK® FORGE | GEA Digital Twin Viewer
Visualization and Data integration

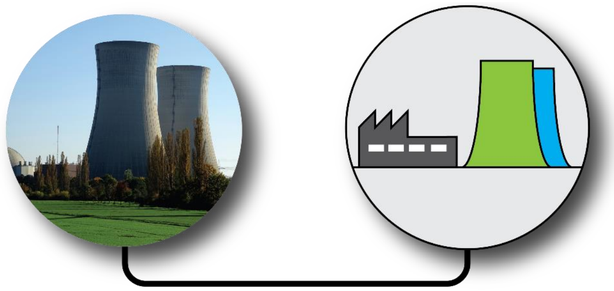
Service Technician



Chart

2D

DE 15:46 19.06.2018



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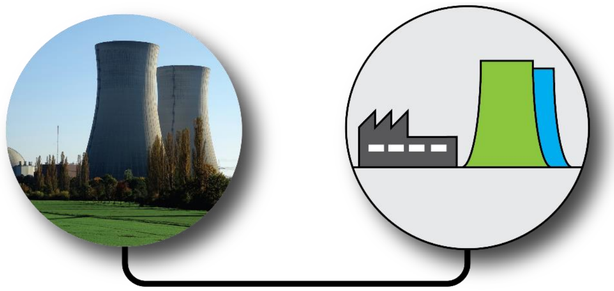

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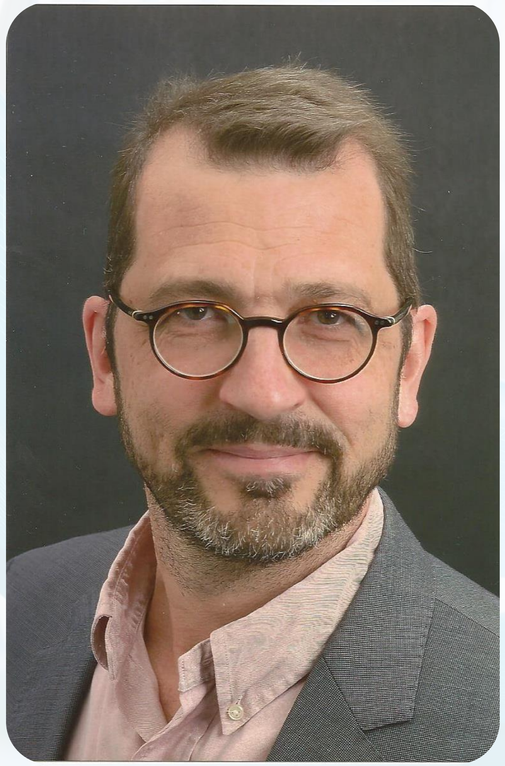
Q&A

AUTODESK®

Make anything™

Contact Information



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Global Business Development

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