Final Report

MxD 19-04-04 Digital Twins for Process Manufacturing

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PROBLEM STATEMENT

How would you visualize sensor data with the best User Interface/User Experience design to get a seamless experience in continuous manufacturing?

PAIN POINTS

- Need to vet digital solutions in manufacturing settings, but manufacturers are often limited by constraints of business environments to experiment with the full-array of sensors, commercial offerings, and architectures
- Need for process manufacturing-specific testbed at MxD for validation and side-by-side comparison with discrete
- Need education about end-to-end process for “How To” achieve digital twins benefits: how to collect, aggregate, analyze sensor data to build a digital twin
- Specific problem: **demonstration is needed to prove how digital twins can digitally enable operators in the field to make more educated decisions based on data and enhanced communication with leadership and other operators**

KEY OBJECTIVES

OBJECTIVES

- Development and implementation of a framework for gathering and analyzing all the data from a process manufacturing line necessary to improve visibility and control. This framework is a key first step in being able to implement proof-of-concepts for ‘mobile worker’, cybersecurity, predictive maintenance, and other digital twin use cases.
- Demonstration of a proof-of-concept ‘mobile worker’ solution.
- Primary end users:
  - **Plant managers** will have access to dashboard tools summarizing KPIs as well as active orders and processes
  - **Process operators** will have the capability to take the HMI with them into the field not only to supervise the process, but also interact with the active control system
  - **Maintenance Technicians** will consult a real-time digital twin before executing maintenance requests
- The testbed serves as an ideal dynamic lab for experimentation with many digital twin use cases in the future.

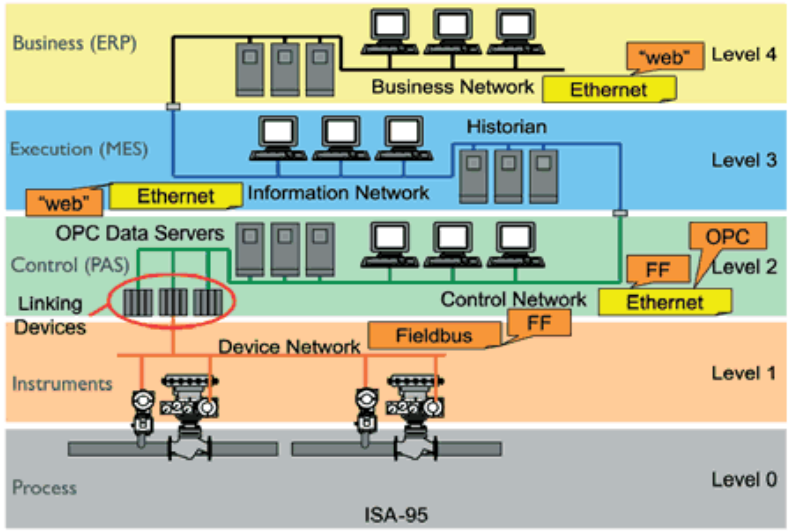
PLANNED BENEFITS

- **Deployable**: Create a platform for generation of deployable outcomes for MxD members
- **Collaboration**: Create a platform that enables collaborative learning and sharing among MxD members specifically through deployment of MxD project outcomes
- **Cost Effectiveness**: Lower the cost of digital transformation by reducing disruption to production facilities and using a shared resource
- **Risk Management**: Minimize the overall risk for process industry and extend application of proven digital technologies beyond discrete manufacturing
- **Innovation**: Broaden innovation scope by engaging solution/service providers and end-users at the early stages of technology development and evaluation
- **Advancement in System Integration**: Accelerate screening, piloting, and adoption of digital tools/technologies (sensors, cybersecurity, data analytics, 3D printing, etc.)
- **Best Practices**: Jointly address operational and regulatory requirements of process industries, e.g. safety requirements, process optimization, and process disruption, and share best practices
- **Workforce Development**: Provide training for the workers of the “future” factory

PLANNED BENEFITS

ORIGINAL STATE

- Early discussion on the current technical baseline (for example Dow's existing testbeds) and pain points
- Discuss existing technology and current "day in the life" of current user groups
- Overview of existing Siemens Process Automation World skid



FUTURE STATE

- The future state of the Digital Twin for Process Manufacturing showcase will be an **interactive**, **educational**, **knowledge sharing** and **training testbed**. It will provide a framework for **collecting, processing and analyzing data** from process manufacturing, enabling digital twins. It will be a foundation for future skids, test grounds for new solutions and new digital twins, and an area that demonstrates how today meets tomorrow for the **Process Industry**. The visitor to MxD facilities will **touch, see and feel** new technologies, and experience the art of what is possible for the Process Industries.
- The testbed will include key Industry 4.0 drivers and technologies, including Augmented Reality, IIoT, Big Data to recognize the needs of **Smart Enabled Mobile Operators, operators and cybersecurity specialists**. It will show digital transformation by **integrating** automation, software, and cutting-edge technologies.
- It will include solutions that are existing and currently available today, with data interacting **across the ISA 95 Model with vertical integrations**. These solutions can stand alone or work interactively. Siemens already offers a portfolio of solutions that comprises the core elements of the Digital Enterprise. With the scalable solutions, companies in the process industries can invest in Industry 4.0 and Digital Twin solutions for product, process and equipment, to become completely and comprehensively digitalized across the entire value chain.

FUTURE STATE CONTINUED

- The final state of this project is a functional process system, showing the real world, with software representing its Digital Twin. This will be a hands on demo that will allow users from all areas across the lifecycle (EPC, Owners, Designers, Manufacturing and Plant Maintenance and Facilities) can see and learn about the art of the possible in the Process Industry
- The key benefits of a system like this are:
  - Visibility of physical and virtual models in an environment that is easily accessed
  - Impact is seen in flexibility, speed, accuracy. With the ability to model and predict outcomes and access to the right data at the right time, the user will see quality and time improvements in their tasks.
- “Day in the life” of a user
  - The user will have a role, as defined above. As an example , a mobile worker in the field technician role needs to do a block and bleed on the testbed, or pump maintenance. That user needs easy, accurate, fast access to information that applies to his/her role. The system will make the information available, allow the user to do his/her task and immerse the mobile worker in an AR/VR environment.
  - If the user has a different role, for example, s/he is doing a quality test, s/he still need the same easy, accurate, fast access to information, but job is to take a sample of product and test it, store that information and manage it for tracing. You will see how s/he interacts with the system and software.

USE CASE SCENARIOS

PRIMARY USE CASE

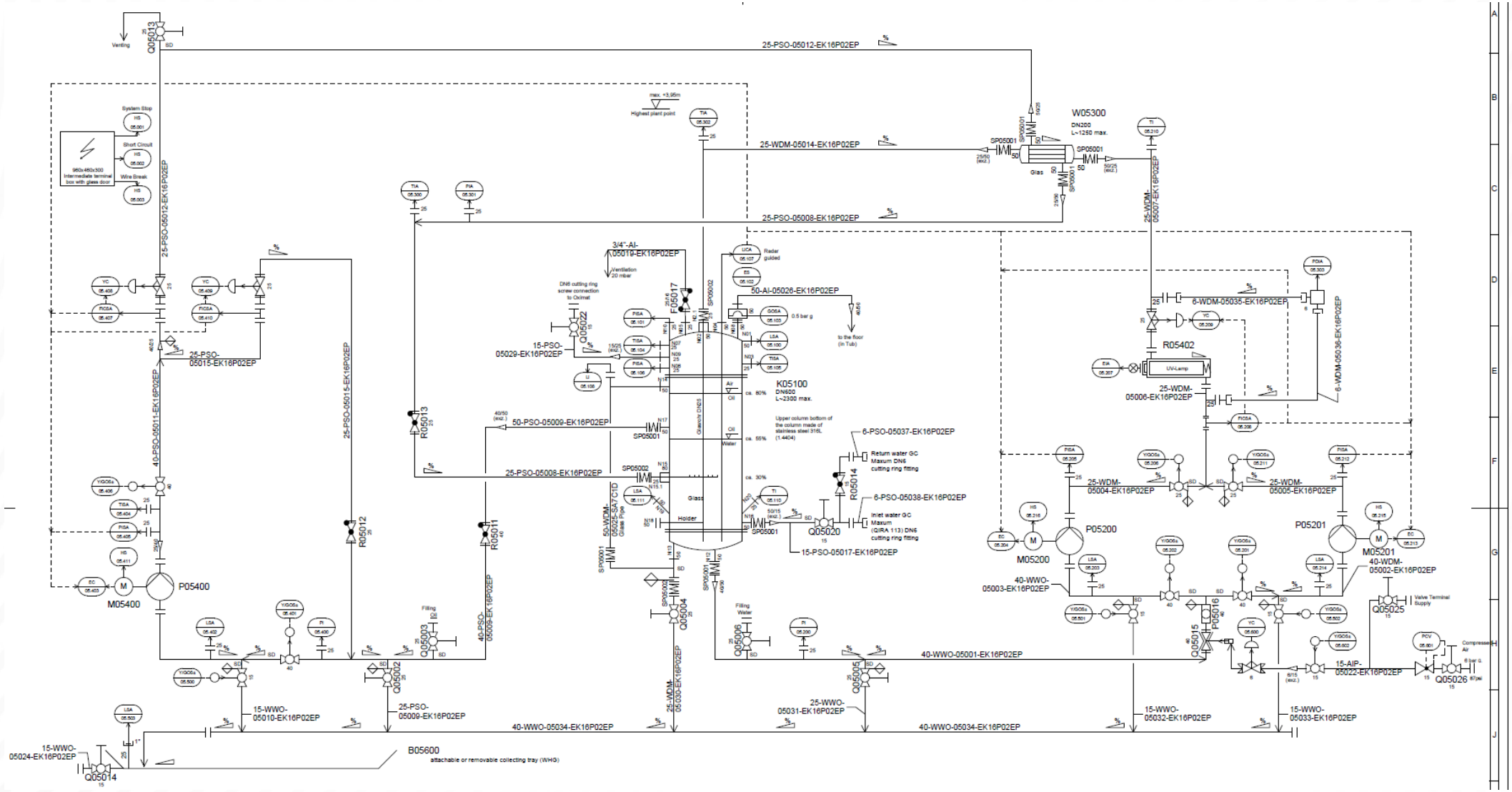
As a **'mobile worker' operator**, I want to **receive all my tasks on a mobile device** and **access all data** (EH&S, process data, ERP information, documentation, procedures, alerts) needed to **perform my task directly in the field** so that **I can update data immediately to communicate status to my team and leadership.**

During operator rounds I want to **capture findings directly in the field** and **create workorders** for the maintenance department. I want to **view the process in the field directly** and **validate the process steps live** beside my other tasks. I want to use **augmented reality technology** in order to create a **seamless experience by seeing all needed information (e.g. sensor data) when I am looking at the equipment.**

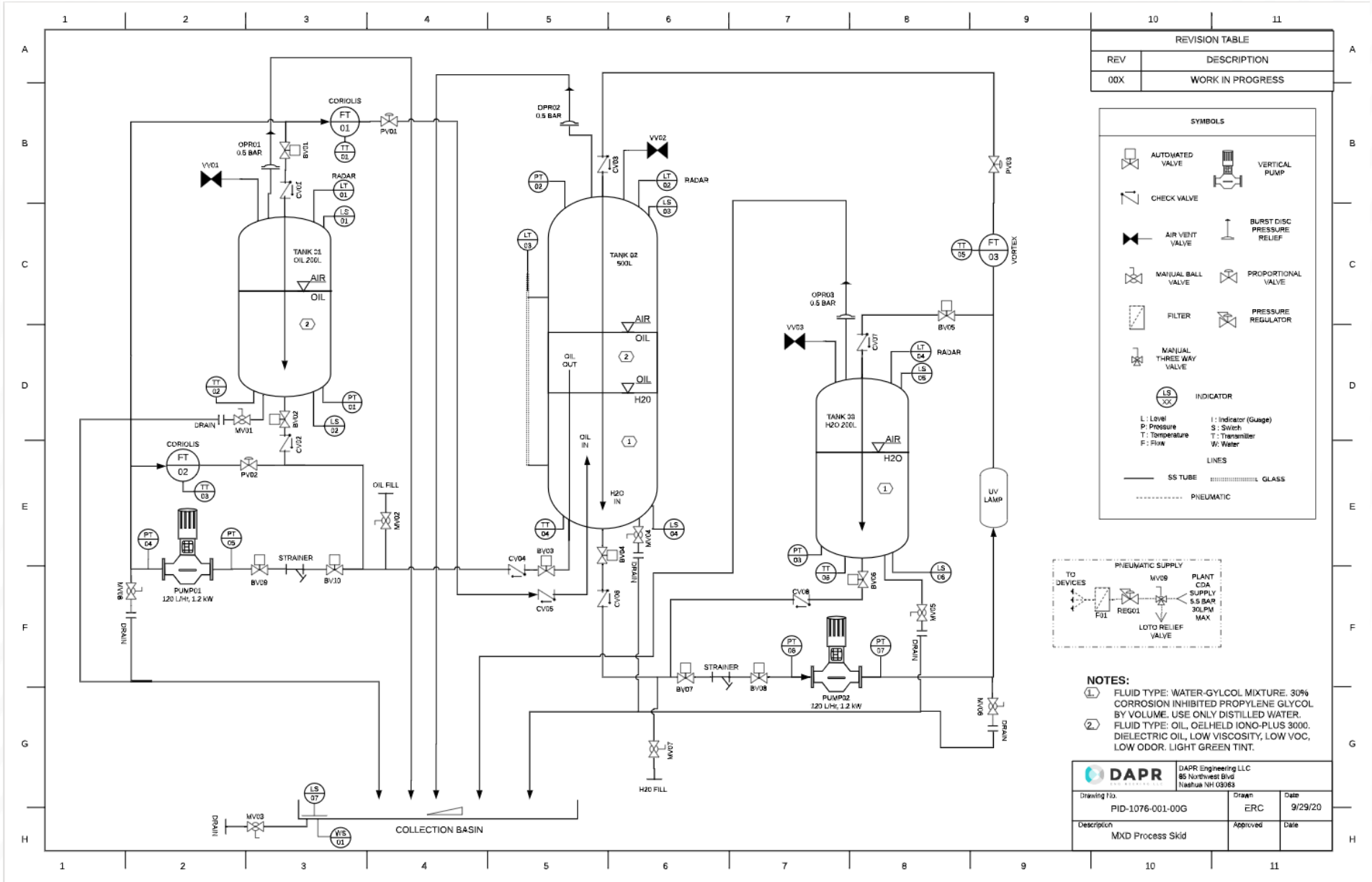
Technical Approach

- **Specifications** – DMC/Siemens team will work with MxD staff to define the detailed scope of implementation for the demonstration skid and the software stack for initial deployment.
- **System Design** – The full hardware design will be finalized and approved by DMC, Siemens and MxD.
- **Fabrication/Offline Development** – The skid will be fabricated, and DMC/Siemens will begin offline development of the various components of the system.
- **Factory Acceptance Testing** – A checklist of requirements and test plan will be generated to confirm operation of the PCS neo control system. The system will be tested for full functionality against the documented procedures prior to delivery to MxD facility.
- Field Commissioning – The skid will be installed at the MxD facility and final integration of the full software/hardware stack will be completed.
- Site Acceptance Testing – The full system will be tested at MxD against a test plan mutually agreed upon by DMC, Siemens, and MxD.
- Training & Support – A training plan, consisting of up to 3 days will be agreed on between DMC and MxD. The goal is to provide knowledge on how to operate and support the showcase.

PROCESS AUTOMATION WORLD SKID P&ID



MxD SKID P&ID



MxD Process Demonstration Skid During Fabrication

Project Status and Challenges

- Status
  - Hardware is fully operational
  - Development is complete and operational
- Challenges
  - Modern CAD design relies on models from component vendors. These have varying degrees of detail and are generally shells for “fitment”.
  - Digital twin functionality requires a higher level of detail than is normally generated for projects in several areas (design fidelity, physical placement, etc.)
  - Each of the software elements I’m about to show on the next slides would be an entire project in and of itself. Some of these would be multimillion dollar efforts making it difficult to realize this kind of tight integration in the real world.
  - Augmented Reality technology is still very immature and the industry is still evolving.

Technical Solution Stack

Figure 1 Technical Solution Functional View

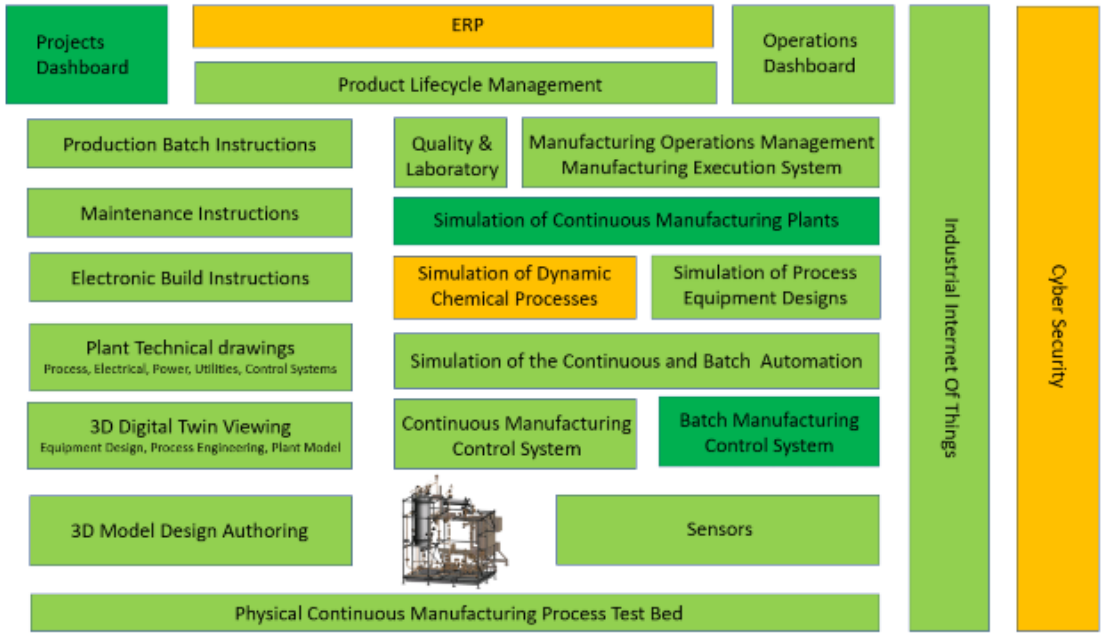
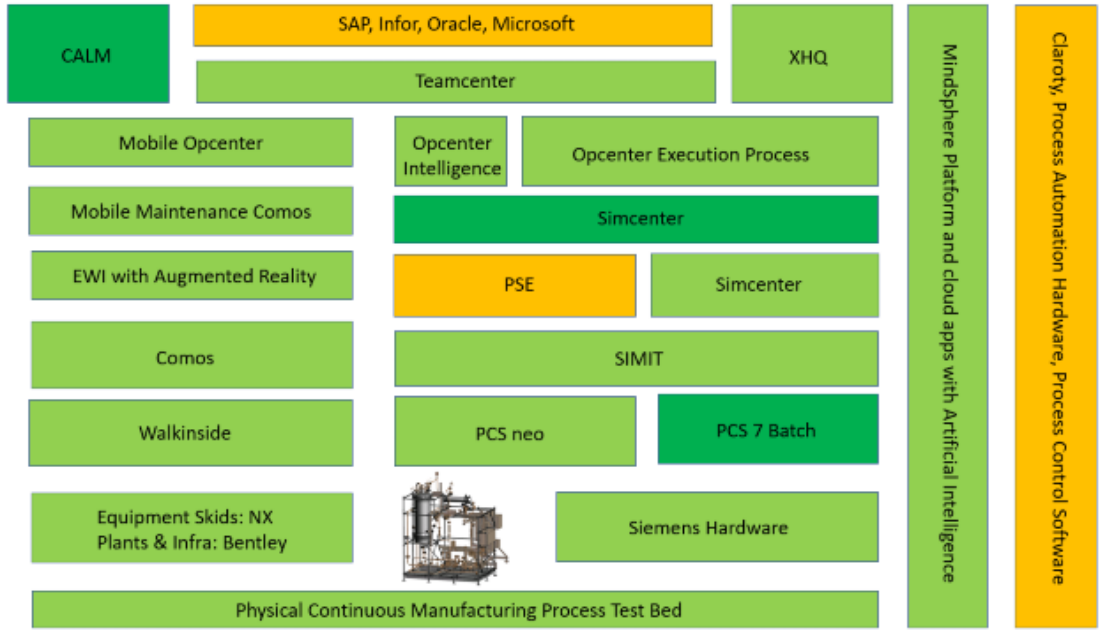
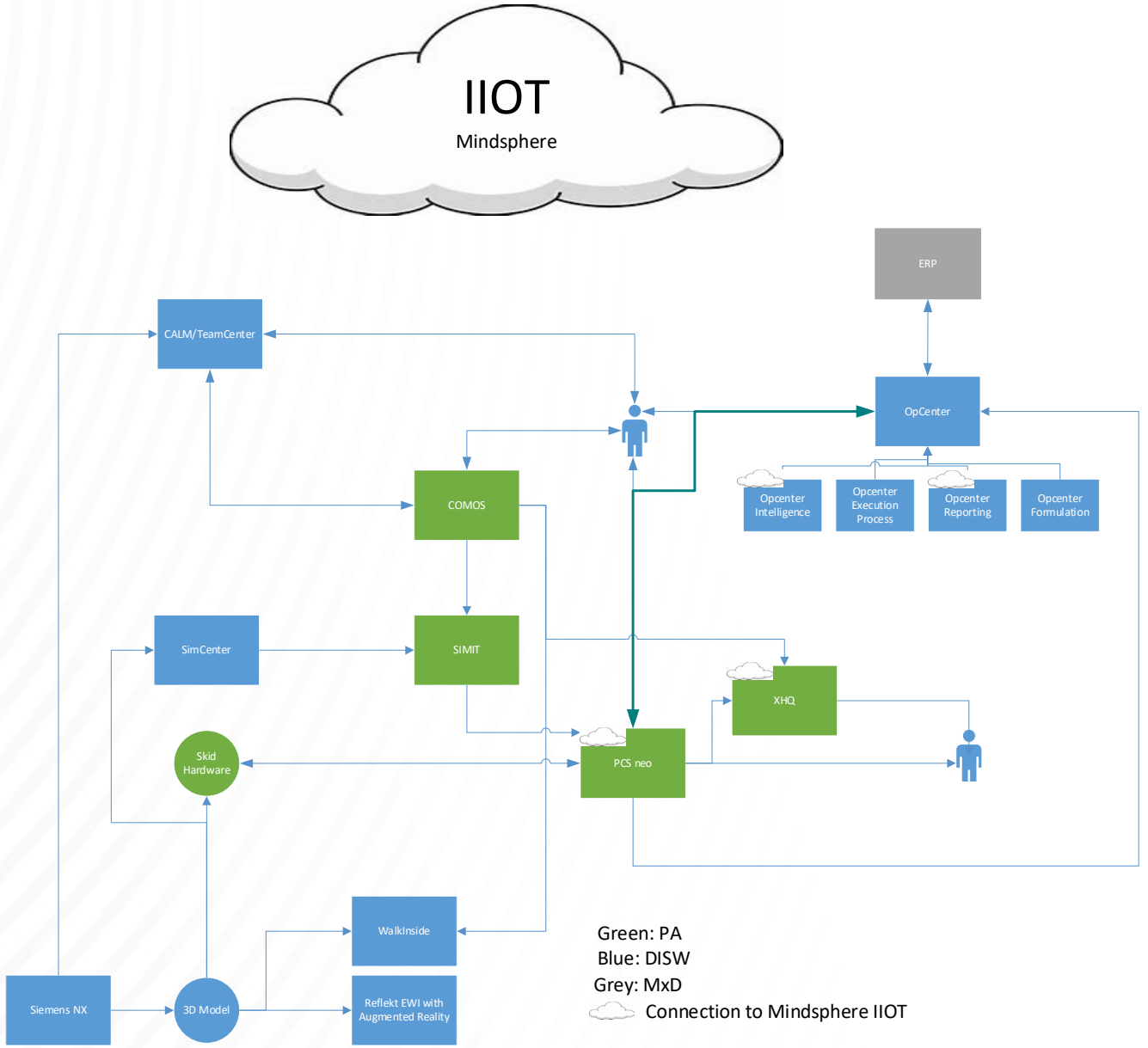
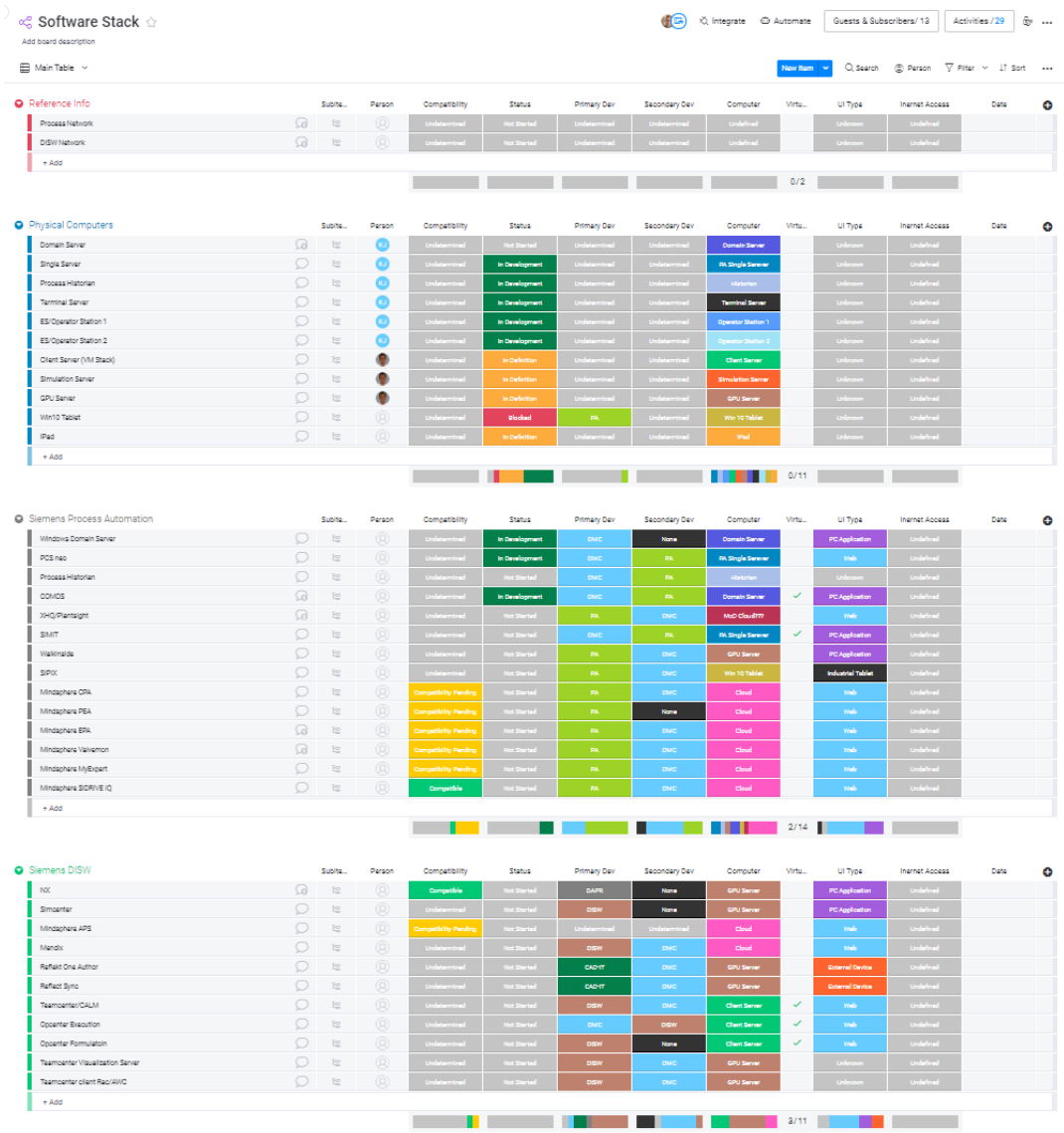


Figure 2 Technical Solution Product View

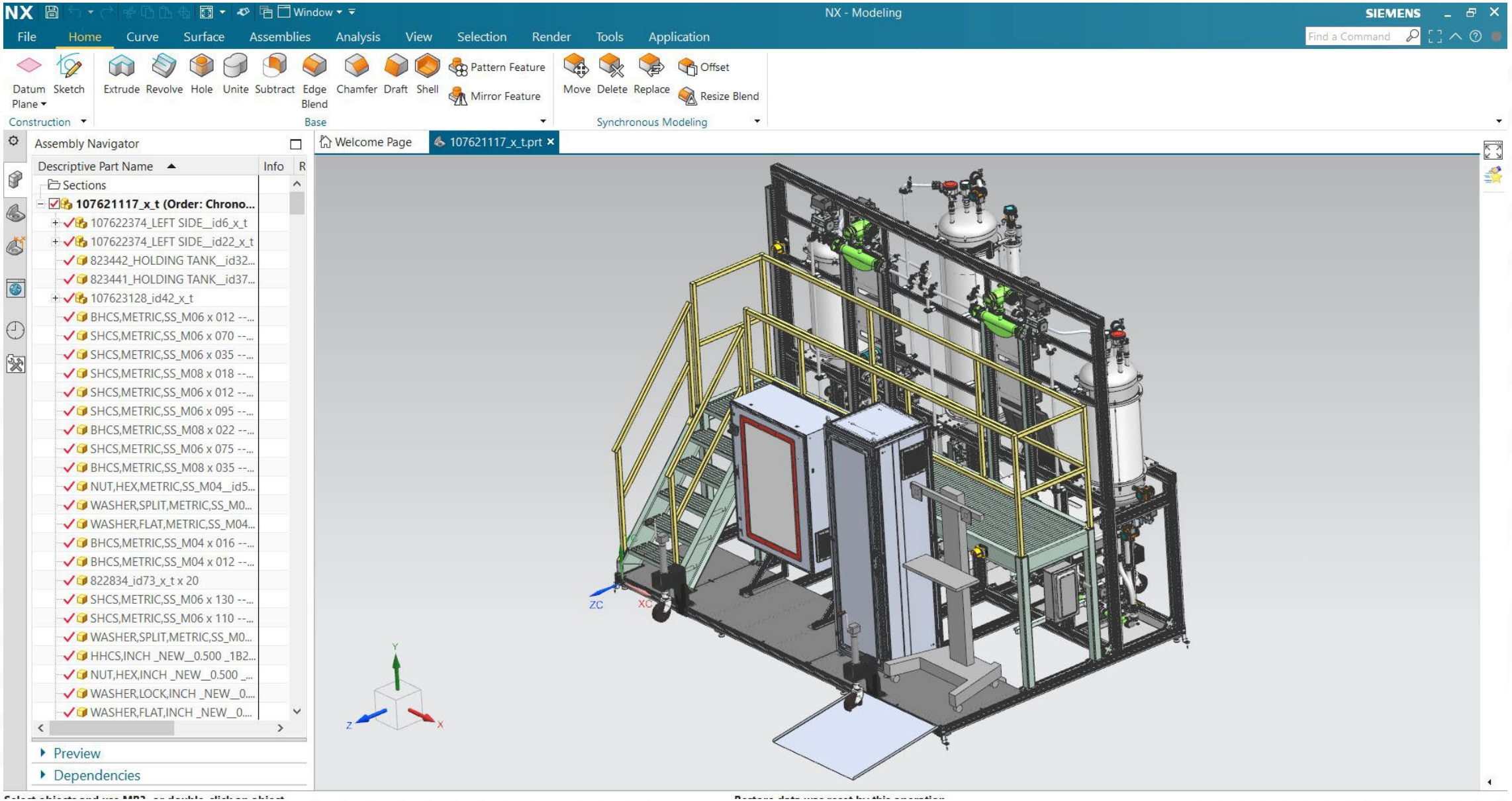


SIEMENS SOFTWARE OVERVIEW





Siemens NX Model

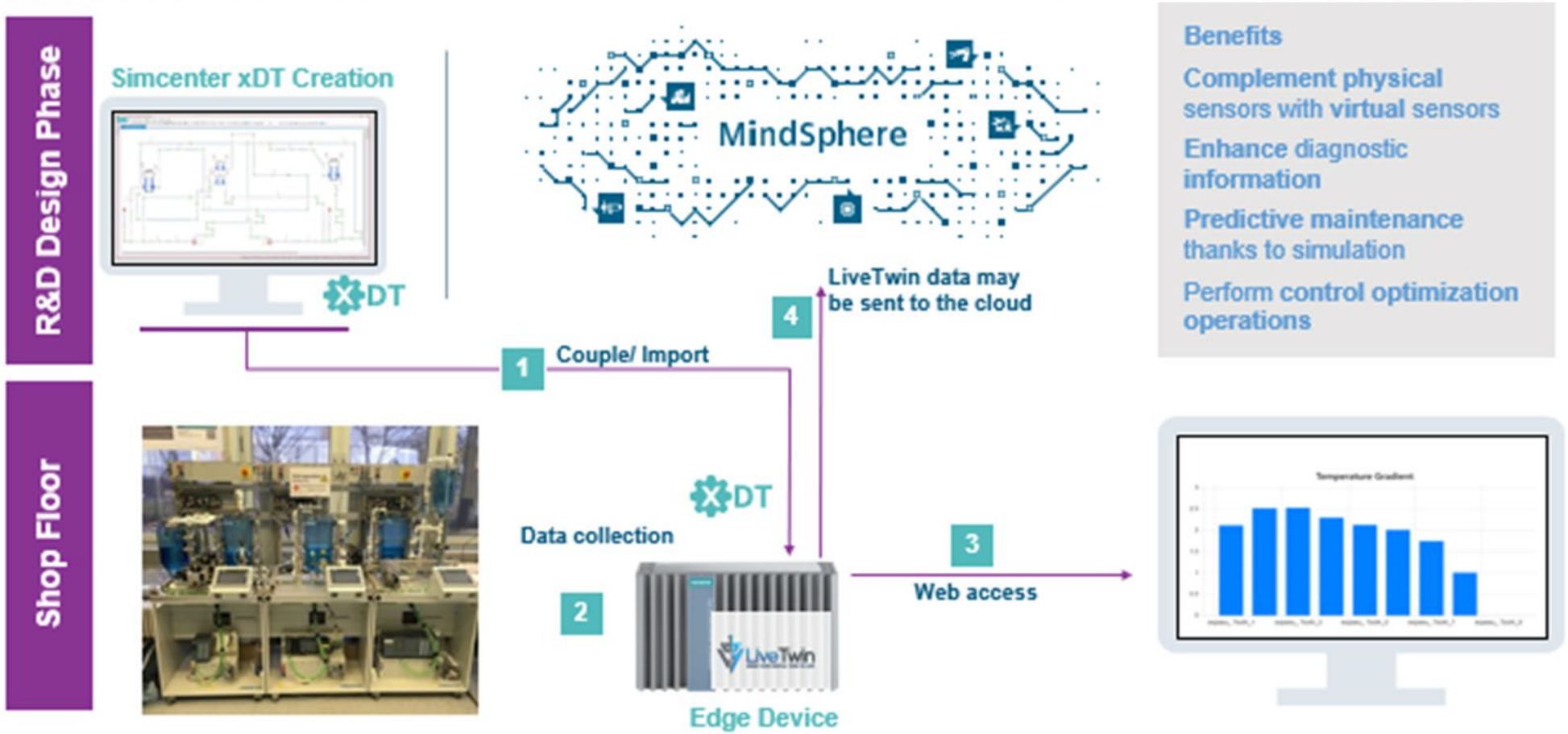


Siemens NX CAD

- Full featured CAD system
- Highly integrated into Siemens stack

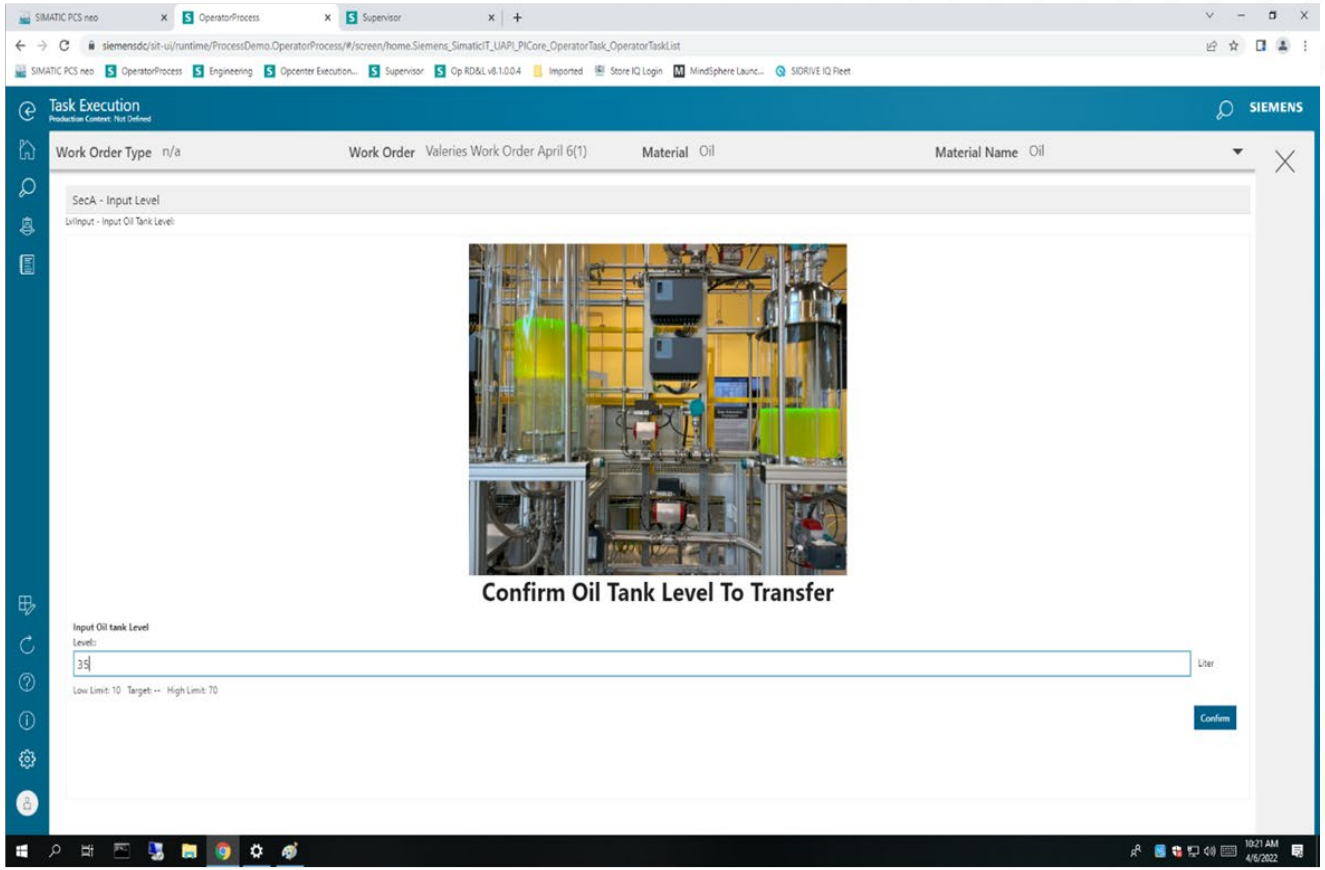
Installation at MxD

Simcenter Flomaster Virtual Sensing



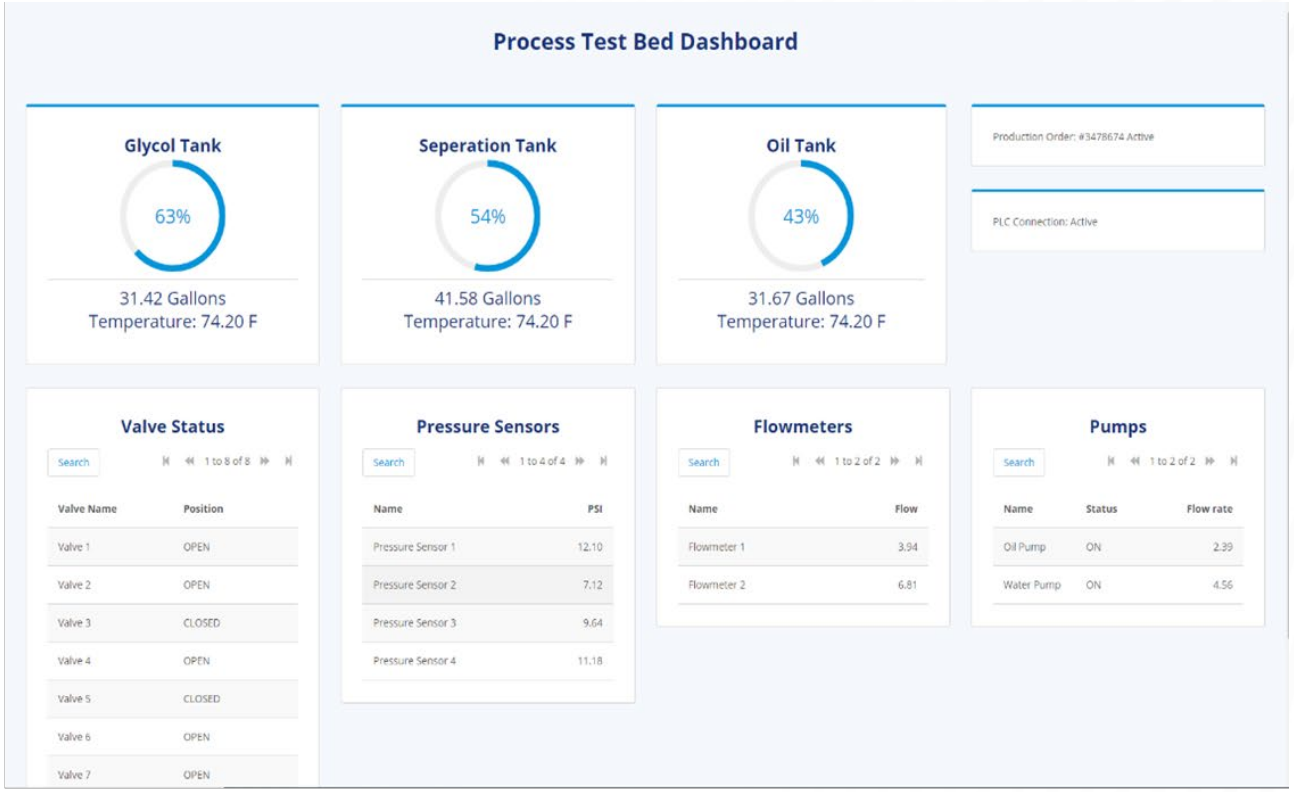
Opcenter Manufacturing Operations Management

- Vertical/Horizontal Integration
- Workorder Orchestration
- Integrated Quality
- Production Reporting
- Genealogy
- Manufacturing Intelligence

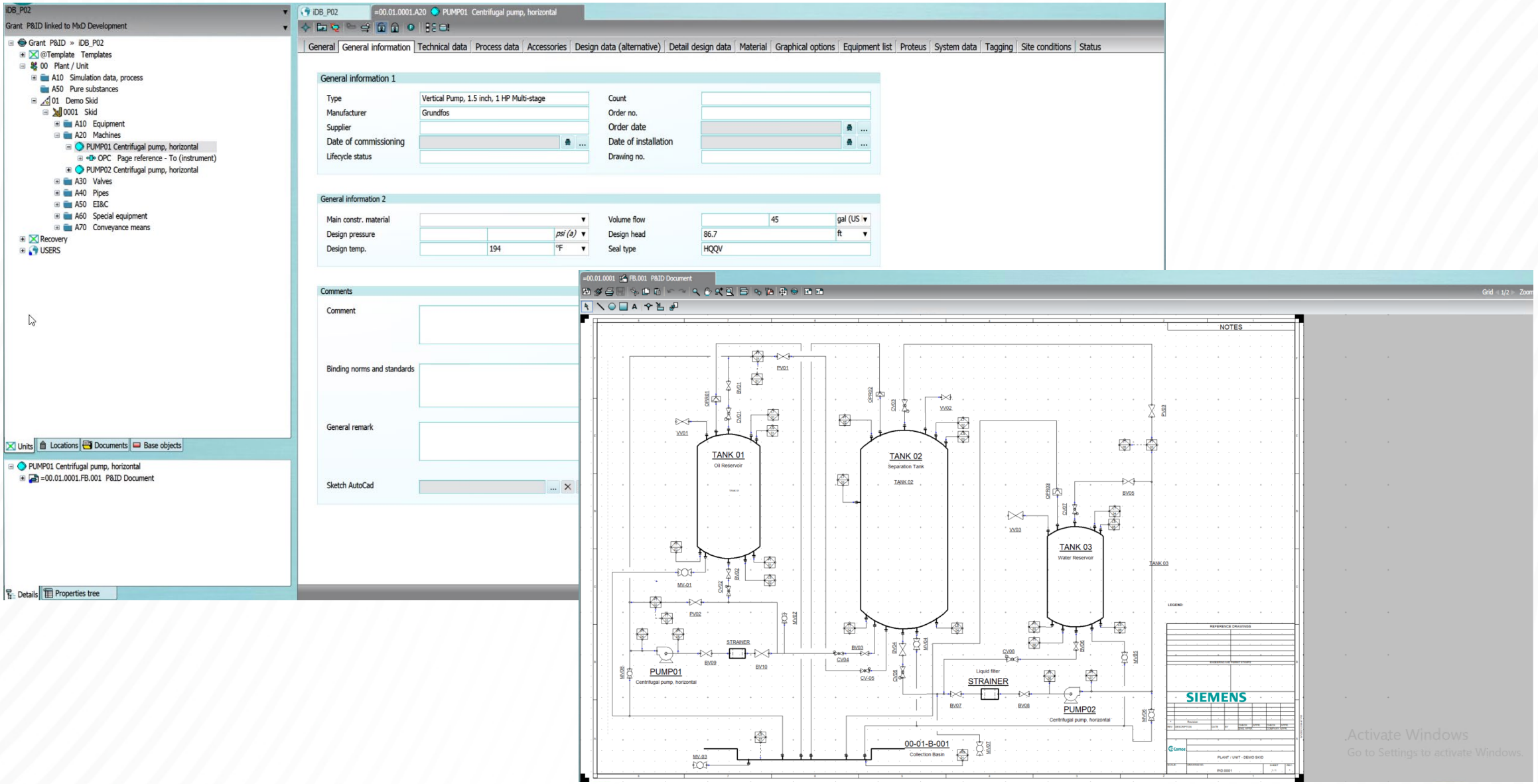


IIOT Mindsphere/Mendix

- Correlation between IT/OT/ET
- Value to disparate data
- Easy Adoption
- Insight
- Connectivity to systems
- Support many roles needing mobile capabilities

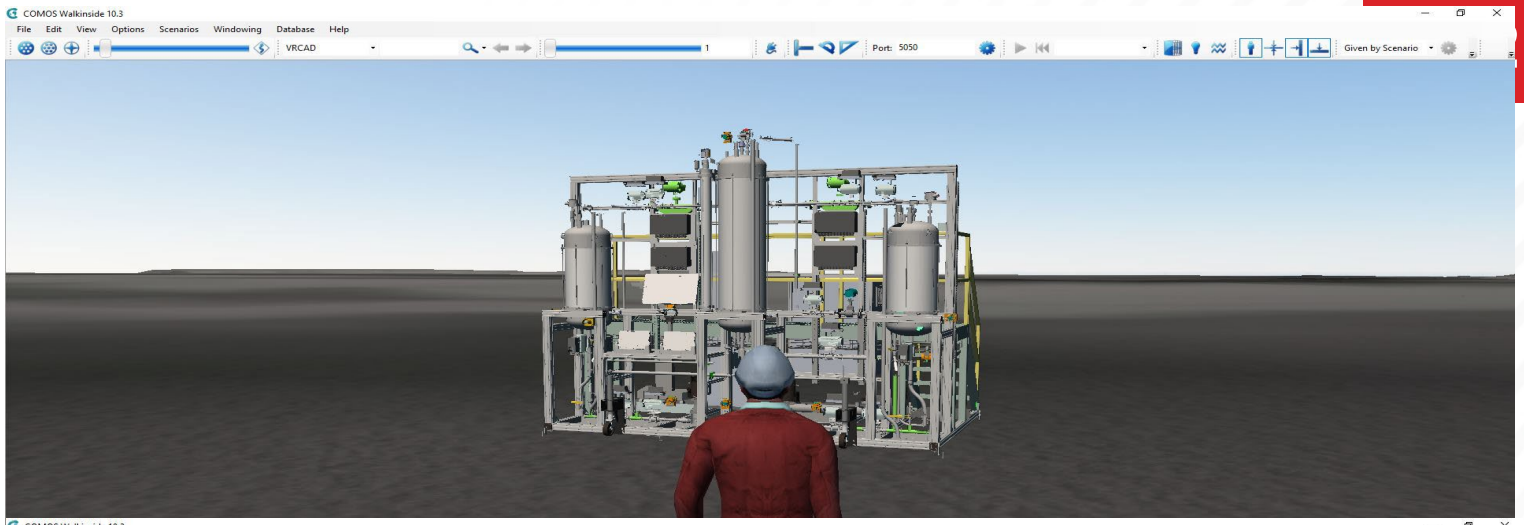


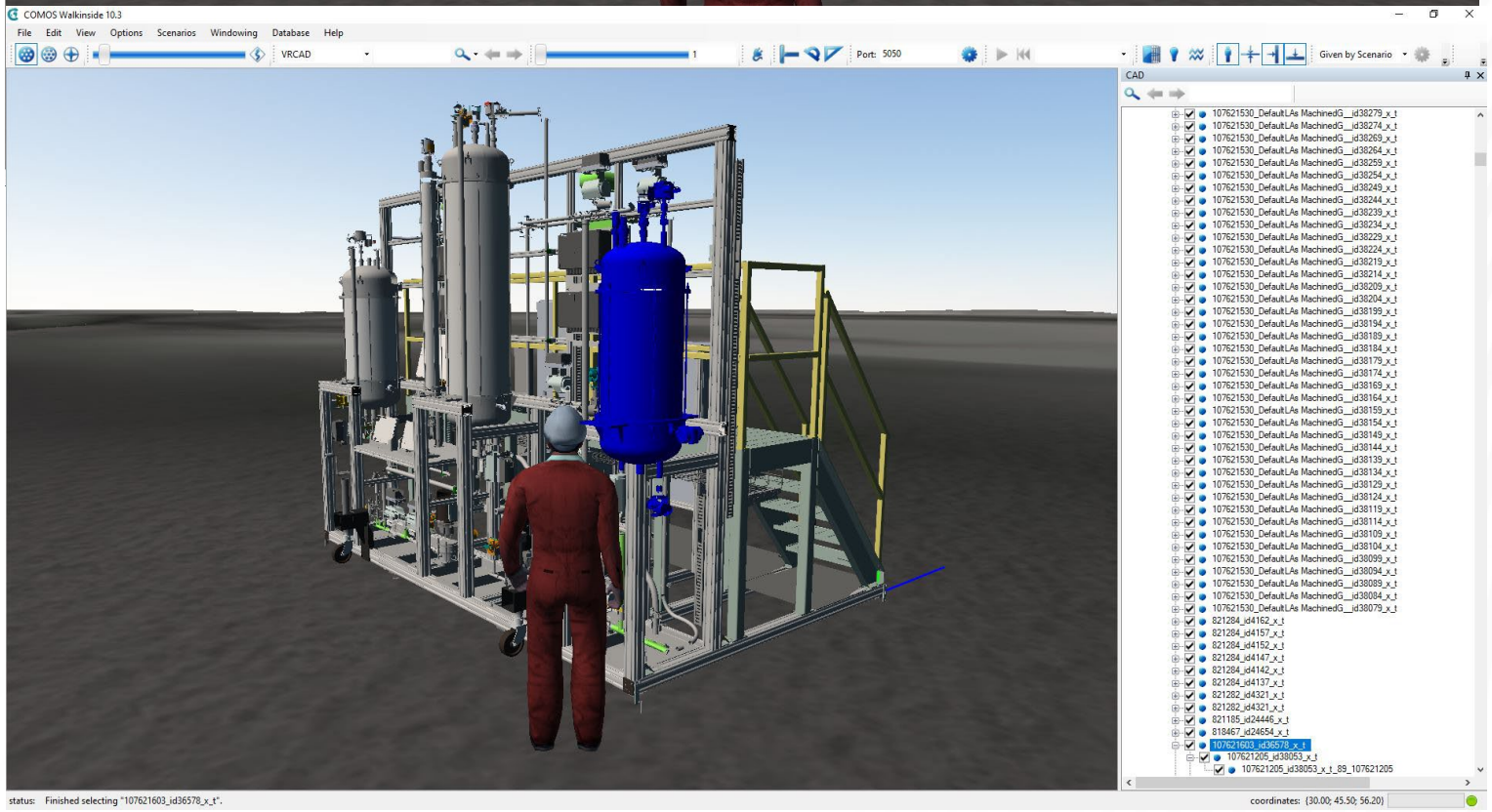
COMOS Plant Engineering Software



COMOS Walkinside

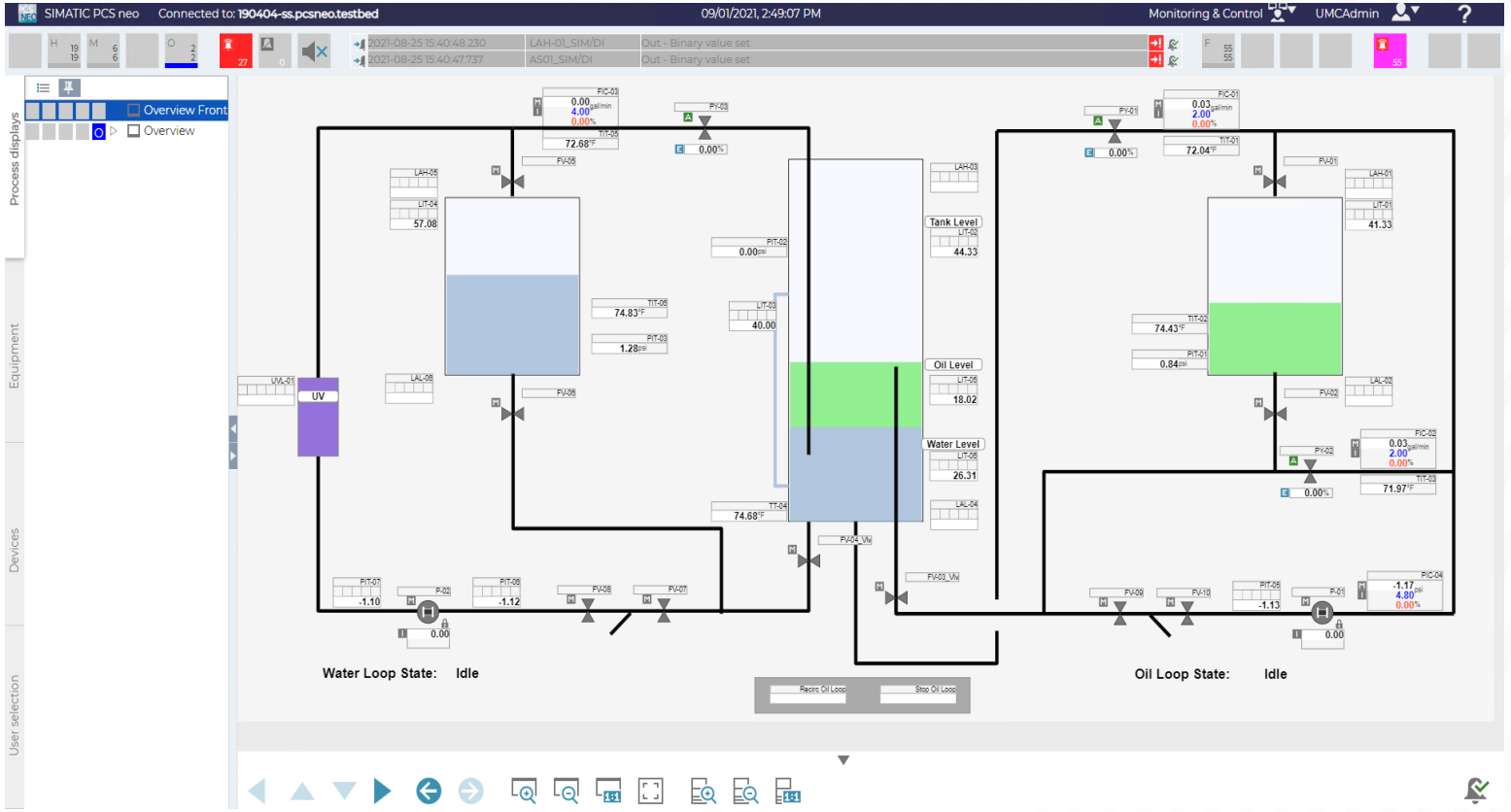
- 3D virtual skid immersion for maintenance, training, and interactivity.
- Interacts with SIMIT to allow safe training and interaction on an emulated skid.
- Works with PCS Neo to provide live skid status and information in the digital twin.
- Utilized in dashboarding apps to provide quick 3D skid reference to objects from other applications.



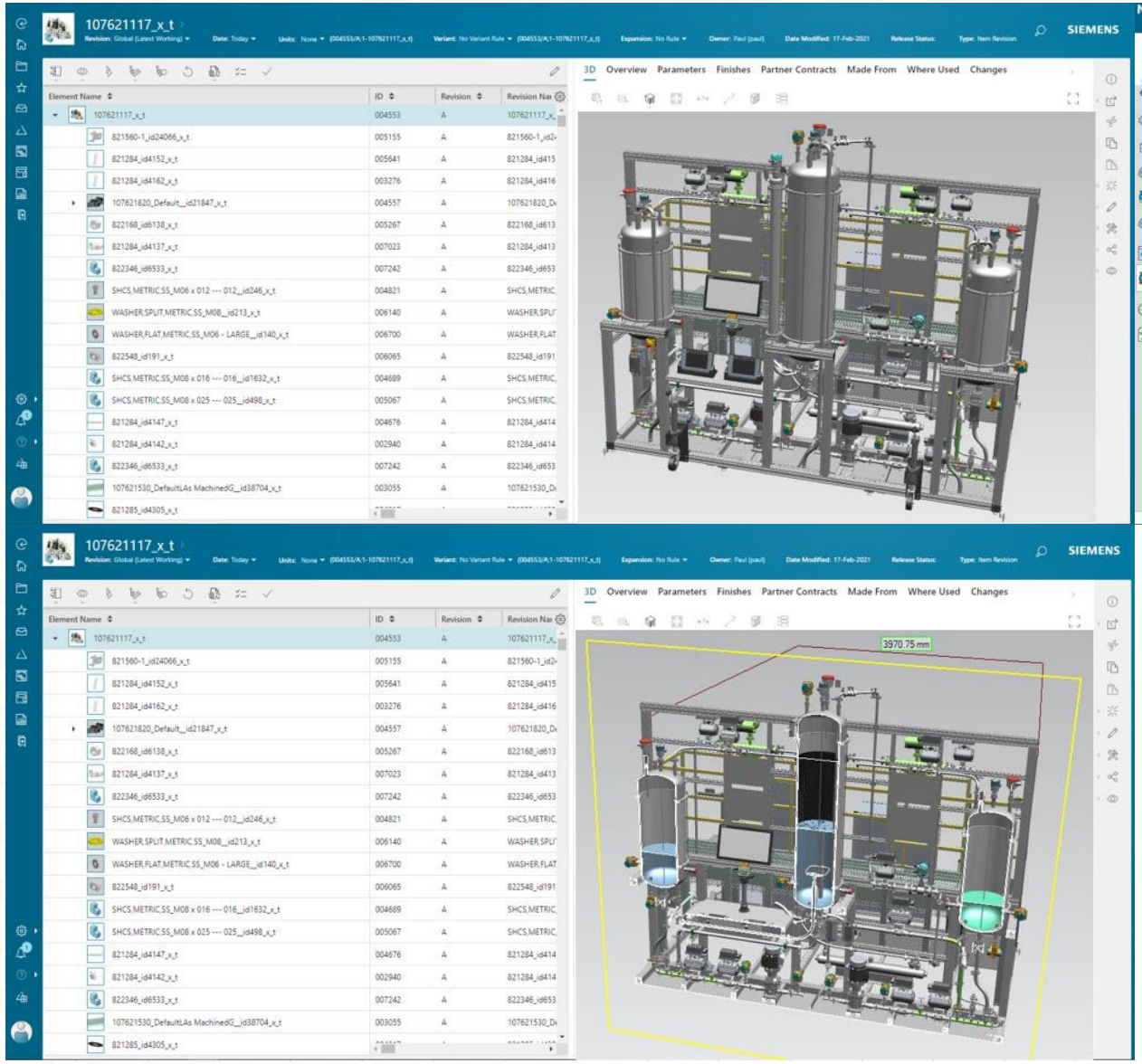


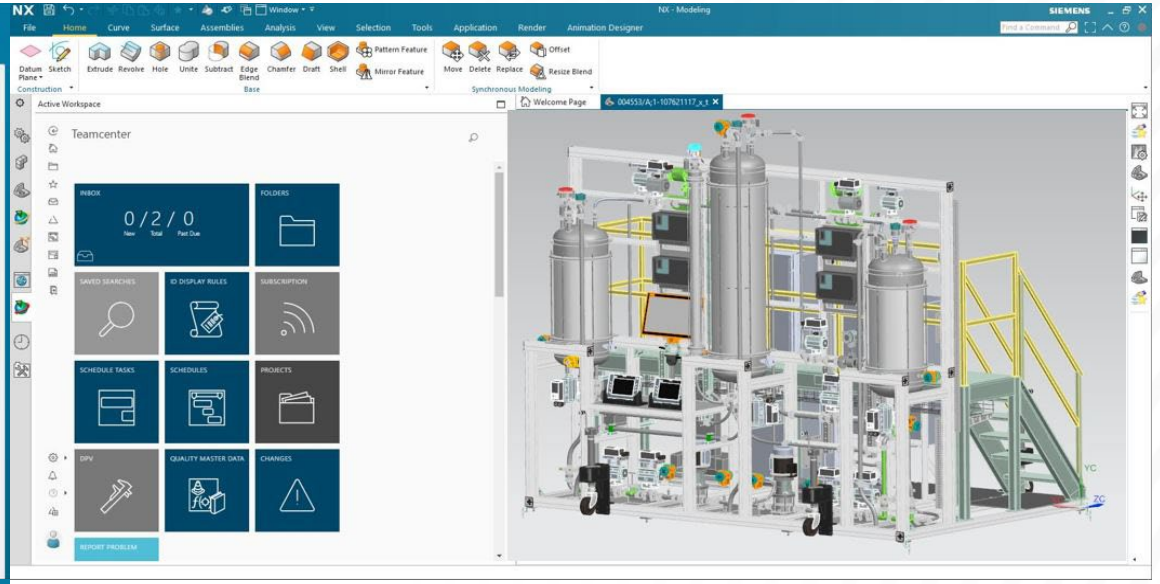
PCS neo

- Next generation process control system
- Web based client architecture allows for zero install clients with simplified licensing and maintenance.
- HTML 5 UI system allows for seamless transition between desktop and mobile clients.



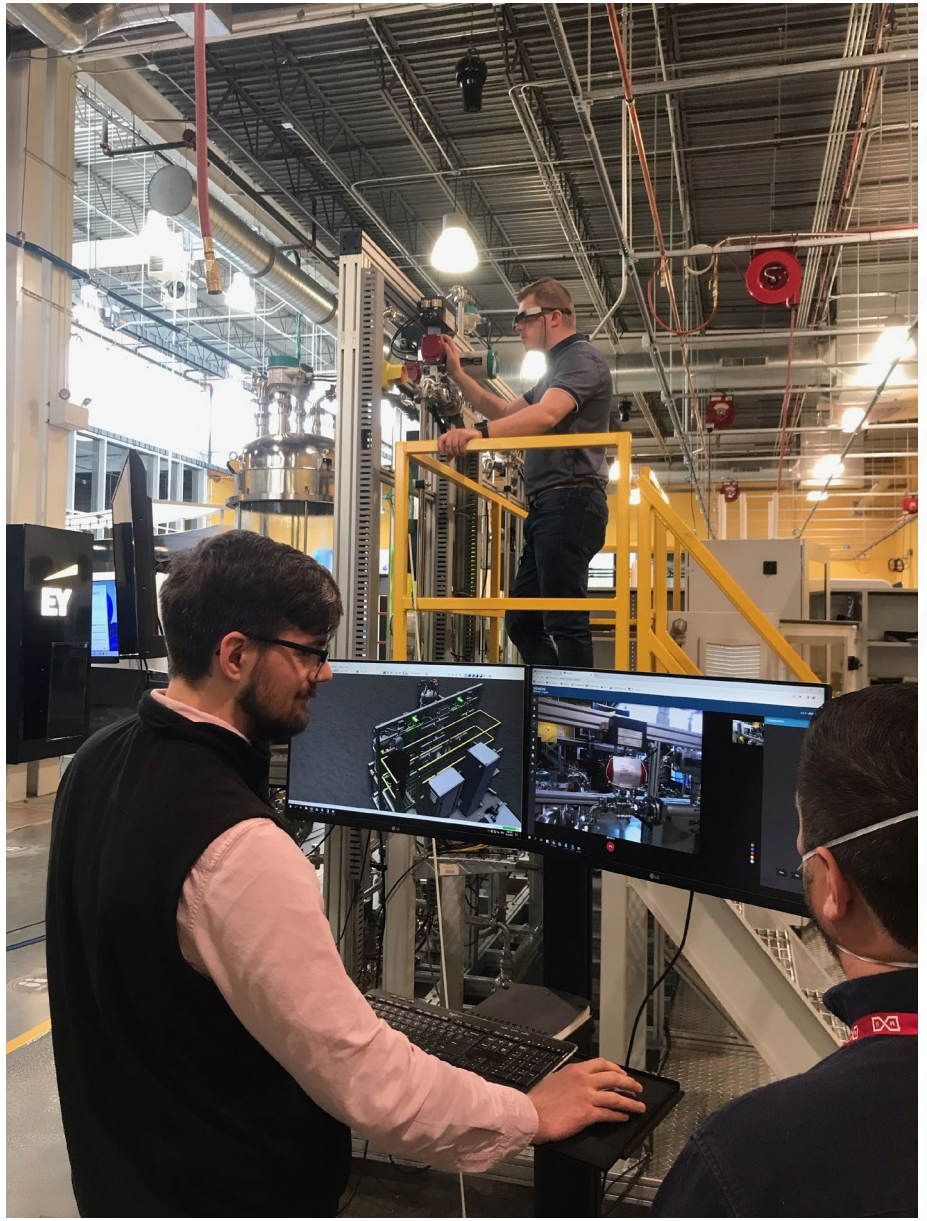
Teamcenter Product Lifecycle Management





- Tree of parts on the left allows visualization of part location in 3D model
- Tracks detailed information such as vendor, revision, and specifications for parts
- Can be integrated with COMOS P&ID and plant CAD

Training



- Skid training complete
- Siemens Process Automation mobile worker training complete
- Siemens DISW training next week

Conclusions & Next Steps

- Conclusions
  - Rapid industry advancement is beginning to allow tighter integration of entire processes with these “next generation technologies”
  - Integrating this level of software stack is extremely challenging, even in a well controlled environment like this
  - Digital twin functionality requires a dramatic increase in design and data fidelity over that normally generated for systems
- Promotion
  - This testbed provides an excellent playground of technologies for potential consumers of the technology to experience the benefits firsthand
- Next Steps
  - Use this skid as the framework to trial and implement better ways of performing these integrations and transitioning them to industry