Digital Transformation at Covestro
Utilizing PI to improve operations and increase OEE

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Speakers

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Covestro
World-leading chemical manufacturer of high-tech materials

✓ 17.200 employees  ✓ Total revenue of €12.4 bn  ✓ 30 production sites worldwide

**POLYURETHANES**
€5.8 bn  47%
Your car seats  Your house  Your sofa

**POLYCARBONATES**
€3.5 bn  28%
Your smartphone  Performance cars  Medical products

**COATINGS, ADHESIVES & SPECIALTIES**
€2.4 bn  19%
Car coating  Robust floors  Your sports outfit
Digital@Covestro: 3 Dimensions

**Digital Operations**
Leverage data and break data silos to improve safety and increase efficiency
- Collect and structure production data
- Visualize, analyze & predict
- Global impact on production, R&D, commercial and strategic decision making

**Customer Experience**
Support dynamic customer decisions across multiple digital touchpoints
- Customer contact through various media
- Social media, WeChat, websites

**Business Models**
Use digital technologies to enhance customer benefits
- ONLINE MARKETPLACE: Buy and sell chemicals
- ALIBABA FLAGSHIP STORE: Sell to smaller customers as well
- TECHNICAL CUSTOMER SERVICES: Predict product properties
Agenda

• Business Challenge
• Vision and Priorities
• Central PI Server
• Sensor and Data Health
• A/F Library, Template Definition
• Asset Health
• Scalability
• Conclusion
Business Challenge: Data Hurricane!

Using digitalization to improve OEE

Goal: Reduce unplanned outages by 50%+

- Improved Safety and Environment
- Improved Energy Efficiency
- Increased Revenue
- Reduced Maintenance Spending
Vision and Priorities

We would like to provide the right information at the right time so our people can make fast and informed decisions.

- **Data Health:**
  - sensor health,
  - accurate and digitalized documentation

- **Asset Health**
  - At a glance visualization
  - anomaly detection,
  - prescriptive input available to SME

- **Unit Process Monitoring:**
  - Include asset and quality information for predictive unit performance

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Sensors

Assets

Production

Emerson Pressure Transmitter
In progress: Central PI System

Each regional PI server will feed into the global server for data analytics and ease of sharing information.

Local → Regional
We will clean data and standardize tag names.
Integration of Online Process Models

Leverage the process modeling know-how

- Benefits from new integration concept
- Easier deployment and maintenance
- Easy supplement of missing sensors for KPI calculations in asset templates

- Early detection of deviations: Indication for sensor failure or process upset
- Validated model offers additional process insights

Comparison of online dynamic model with installed sensors.
Sensor Malfunction: Offset /Freezing /Fouling
-- Redundant Safety Sensor Diagnostics --

• RSD algorithm successfully detects
  • Offset malfunction
  • Freezing malfunction
  • Fouling malfunction

• RSD reporting
  • Robust reporting of malfunctions over a month and over a day
  • Prevent false alarms
  • If a malfunction occurs, a clear step is reported

Redundant Sensor Diagnostics –
Active on all redundant safety sensors installed globally.
Under Investigation: Can APERIO automatically tell us which redundant sensor is bad?

Aperio is a scalable platform that ensures IIoT sensor data integrity and protects against data manipulation.

How it works:

1. IIoT sensors generate signals that respond to physical laws
2. Aperio translates these signals into mathematical & data models
3. Aperio learns the fingerprint of every sensor individually and creates groups of correlated signals
4. Aperio identifies events on individual sensors and identifies if correlation between sensors changes
5. Aperio ensures the authenticity and integrity of operational data
Sensor Diagnostics Pilot with Element: Outstanding first results!

Data Integrity Report Card

<table>
<thead>
<tr>
<th>Template</th>
<th>Average Attribute Coverage (%)</th>
<th>Asset ID Count</th>
<th>Attribute Count</th>
<th>Total Mapped Tag Count</th>
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<tbody>
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<td>0</td>
<td>2</td>
<td>0</td>
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</tbody>
</table>

List of problem tags

List Bad Transmitters

Null Tags: 1,998 Total
Intermittent Tags: 7 Total
Static Tags: 1,824 Total
Move & Structure: FLoc Asset Hierarchy (AKZ Corp Standard)

- Definition of **asset hierarchy** based on FLoc

![FLoc Hierarchy Diagram]

- Elements in this hierarchy are based on templates

  → Examples of typical templates include Pumps, HEx, Distillation Columns, Reactors, etc.
Move & Structure: Internal References

- Definition of **internal references** among tag and asset hierarchies
  
  ✓ Tag AF hierarchy
  ✓ Template attributes
  ✓ Asset AF hierarchy

“Data Source“

Data + Context + Calculations

“Data Consumer“
**Monitor: AF Template Development**

**Measured process variables for WA100:**
- Flowrates, Temperatures, Pressures

**Calculated KPI’s for WA100:**
- Heat transfer coefficient “U”

\[
U = f(\Delta T_{\text{hot}}, \Delta T_{\text{cold}}, F)
\]
- A decrease over time indicates fouling
- Actionable information to plan next cleaning activity
- Send notifications via Event Frames, if threshold is reached.

**Standardized PI AF Template**
One-Stop-Shop Visualization: Navigation Cockpit

Maintenance View  Asset View  Hierarchy View  Process HMI View
One-Stop-Shop Visualization: Navigation Cockpit

✅ Asset View

✅ Hierarchy View

ProDAVis: Process Data Analysis and Visualization at Covestro
PI Vision Template – Heat Exchanger
PI Vision Template – Heat Exchanger
Seamless Integration of Self Service Analytics

Prediction

U – calculated from PI-AF

U – linear prediction in SEEQ

U – threshold before cleaning

~ 4 months to cleaning
Covestro Pump Health Monitor

Legend:
- Non-Compliance > 25 % of time
- Non-Compliance < 25 % of time
- Non-Compliance < 5 % of time

OST: Pump On-Stream Time [%]
- Period1: Last 180 Days
- Period2: Last 30 Days
- Period3: Last 7 Days
- Period4: Last 1 Day

Dual Pump Operation > 60 min in Last 30 Days
One-Stop-Shop Visualization: Asset Monitors
Digitalization = Augmented Intelligence

We want to get all information available to humans to decide on path forward.

The machines give recommendations, the humans pick and choose.
How do we make Digitalization in Operations Sustainable?

Pilot roll-out scheduled to write sustainable solution.

1. People are key to success
2. Must have adequate infrastructure and computing power.
3. Must have reasonable workflows, defined roles and responsibilities to achieve sustainability
4. Find something you like and try it out.
5. Do a proof of concept – quickly!
6. Start rolling out what works as soon as possible.
7. Engage different levels of the organization. Make them want it so they will own the solution.
Enabling One-Stop Shop at Covestro

The Journey

Today
- AF Build
- AKZ tag renaming
- Sensor Diagnostics

Work in Progress
- SAP Evergreening
- Hexagon Evergreening
- Global Asset Monitoring
- Global Process Monitoring

Meta Data Producing Systems
- OSIsoft instrumentation AF compliant with German AKZ standard
- Asset Health for:
  - Pumps
  - Carbon Filters
  - Mixed bed Exchangers
  - Anion & Cation Exchangers

Application and Consuming Analytics Systems
- Sensor Diagnostics bad PI data reporting
- Asset Health – Pumps, Heat Exchangers, Columns, Extruders, Reactors, and Reboiler
- Inconsistent Units of Measurement and Current Values Report
Industrial Asset Data Is Messy and Complex

One Pump: Hard to Process, Multifaceted Data

- Last Maintenance Date
- Outlet Temperature
- Flow Rate
- Maximum Flow Rate
- Consequence Mitigation Severity
- Last Failure Date
- Length of Last Failure
- Viscosity Rating
- Motor Speed
- Minimum Voltage
- Functional Location
- Differential Pressure
- Maximum Differential Pressure

- PI System Data
- OEM Data
- Work and Asset Management
- HazOps Data
- Design and Construction Data
- Lab Data
At Enterprise Scale, It’s Unmanageable

1,000 pumps and across 50 production sites

RESULTS IN

Virtual Blind Spots in Decision Making
Building a Global Asset Hierarchy

- Systems of record for as-designed, as-operated, as-maintained view of assets and equipment.
- With templates for assets and processes.
- Integrate and enrichen PI System data with metadata from other systems.
- Manage data integrity and governance. Keep data synced across source systems.
- Analytics by quickly spinning up new AF’s and shrinking schema planning requirements.
AssetHub
Purpose-Built for Industrial Data

Connect
Standardize
Transform
Persist
Enable

Across data silos

Features
- Spreadsheet import
- ODBC, JDBC
- XML, JSON
- MSFT SQL Server, Oracle, PostgreSQL
- SAP, Maximo, Infor
- MSFT Access
- PI WebAPI import
- Integration APIs
AssetHub
Purpose-Built for
Industrial Data

- Connect
- Standardize
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- Persist
- Enable

Across data silos

Upload Data
Directly upload data from the active worksheet to Element AssetHub. Once uploaded, the data is accessible from all pipelines within the selected organization.

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### Template Library

**Standardized class definitions**

#### Connect

- System, process, asset

#### Standardize

- Easily import and modify existing templates
- 75+ templates
- ISO/API standards
- Template Inheritance
- Child Attributes
- Enumeration Sets
- Value Types
- Data References
- Config Strings
- Attribute Categories
- Event Frame templates
Template Library
Standardized class definitions

Connect
Standardize
Transform
Persist
Enable
Asset Pipeline
Transform, cleanse, and integrate data sources

Connect
- No code / model driven development
- Orchestration and persistence

Standardize
- Encode business knowledge
- Regular Expressions
- Fuzzy Logic

Transform
- Asset standardization
Asset Pipeline
Transform, cleanse, and integrate data sources

- No code / model driven development
- Orchestration and persistence
- Encode business knowledge
- Regular Expressions
- Fuzzy Logic
- Asset standardization

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<th>Search</th>
<th>Match</th>
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<tr>
<td>Valve</td>
<td>Value</td>
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</table>
Asset Integrity Report Card
Identify model gaps to ensure trusted applications

Connect
Standardize
Transform
Persist
Enable

Data Integrity

- Missing Data
- Data Cleanup Needed

119 out of 169 are mapped to this attribute
70% of digital twins

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Sensor Diagnostics
Identify tags reporting bad data

Features
- Null, intermittent, static tags
- Asset context to prioritize and resolve data collection issues

<table>
<thead>
<tr>
<th>Null Tags</th>
<th>Intermittent Tags</th>
<th>Static Tags</th>
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<tr>
<td>28</td>
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Problem Tags

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<tr>
<th>Issue Type</th>
<th>Tag Name</th>
<th>Sensor Name</th>
<th>Description</th>
<th>Eng Units</th>
<th>Last Value</th>
<th>Corrective Days</th>
<th>Equipment Name</th>
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<td>97</td>
<td>Centrifugal Comp...</td>
<td>1</td>
<td></td>
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</tbody>
</table>
Asset-Sync
Evergreen models to stay in sync with physical asset changes

Features
- Update AF with new assets
- Remove out of service AF elements
- Ensure template and hierarchy governance
- Identify local AF changes
AF Governance
Empower sites and ensure corporate standards

Connect
Standardize
Transform
Persist
Enable

Features
- Identify / address ungoverned local changes
- Centrally manage AF models

Graphical representation of AF Governance with Baytown and Port Arthur sections.
AF Synchronization
Keep multiple AFs in sync

Connect
Standardize
Transform
Persist
Enable

Features
• Sync multiple AFs associated with same assets

Development
• Iterate model
• Validate model

Sandbox
Testing and design

Production
• End-user trusted
• Validated and tested
Asset Explorer
Rapidly create new AFs

Connect
Standardize
Transform
Persist
Enable

Unlimited use case and personas
**Benefits:**

Scale Organized Data to Infinite Use cases

**Ops Reliability**
- Reduced Downtime
- Ensure uptime of operations
- Increased visibility on asset health

**Applications**
- Cross fleet asset health
- Root cause analysis
- Heat exchanger fouling
- OEE

**Instrumentation SMEs**
- Ensure process safety

**Applications**
- Flow vs. Position Analysis
- Valve travel time report
- PHA

**Maintenance**
- Shift from calendar-based to condition or runtime-based maintenance
- Reduce time-consuming data analysis

**Applications**
- Integrated maintenance and process reports
- Track out of compliance assets
- Track maintenance spend

**Data Science**
- Unlock silos of data
- Think big, model once, go fast
- Reduce redundant work

**Applications**
- Advanced analytics
- R/Python
- Data Lake

**Build the model once and consume as use cases demand**

Central Repository for Collaborative Lifecycle Management of Asset Frameworks
Orchestrating People, Process & Technology

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>PEOPLE</th>
<th>PROCESS</th>
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<tbody>
<tr>
<td>Connect to, and import, PI tag and</td>
<td>• Industrial Operations, Automation &amp; Controls&lt;br&gt;• OSIsoft PI System and AF</td>
<td>Discovery › Implementation › Education › Customer success</td>
</tr>
<tr>
<td>asset metadata</td>
<td>• Big data modeling and analytics&lt;br&gt;• Innovation focus and culture&lt;br&gt;• People first</td>
<td>Agile, sprint-based approach generates quick wins</td>
</tr>
<tr>
<td>Define Asset Templates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Build and maintain AF models</td>
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<td></td>
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<tr>
<td>Deploy AF models and configure PI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision &amp; AF Analytics</td>
<td></td>
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</tr>
</tbody>
</table>

Agile, sprint-based approach generates quick wins
Having accurate and easy to understand data is the key to success for improving operations and maintenance in the chemical industry.