Practical view on the role of the PI System in industry 4.0+ and AI for manufacturing

By Remi Duquette & Martin Davis
Your co-presenter...

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- C-level Executive
- Drives business value
- Multi-sector experience

→ Defining your Industry 4.0 Strategy
• Helping you define your Industry 4.0 Strategy
• Practical experience driving Industry 4.0 and Operational Intelligence in multinational companies
• Focus on quality business outcomes resulting in customer satisfaction
Your co-presenter...

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Industrial AI | IIoT | Datacenter Clarity LC®
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• 5 spacecraft in orbit
• 100+ Datacenter Clarity LC® sites
• 5,000+ hours on AI-ML-DL
• 10,000+ hours on skates
• 1 short-track speed skating champion

→ Your industrial AI partner

https://www.mayahtt.com/expertise/artificial-intelligence/
Better Engineering for Industry 4.0

- Composites
- Product Lifecycle Management
- Simulation
- AI & Big Data Analytics
- Internet of Things
- Manufacturing Simulation
- Cloud Applications
- Custom Engineering Applications
- Optimization Services

35+ Software solutions developed & maintained
8+ Years Partnership with OSIsoft
75% Engineers & Scientists
22% PhDs
Industry 4.0 - The 4th Industrial Revolution
GDP Value of Industry 4.0 by 2030

North America: $7.1 Trillion
Germany: $0.7 Trillion
China: $1.8 Trillion
Industry 4.0 Adoption

- 99% of companies have heard of Industry 4.0
- 57% in the early stages of adoption
- 30% ONLY, report extensive adoption
Real Benefits from Industry 4.0

<table>
<thead>
<tr>
<th>Improve OEE</th>
<th>Reduce Costs</th>
<th>Quality</th>
<th>Innovate</th>
</tr>
</thead>
<tbody>
<tr>
<td>60% Achieved</td>
<td>50% Reduced</td>
<td>42% Improved</td>
<td>13% Increased</td>
</tr>
<tr>
<td>Productivity</td>
<td>Operating Costs</td>
<td>Product Quality</td>
<td>Ability to</td>
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<tr>
<td>Increases</td>
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<td>Innovate</td>
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Industry 4.0 provides opportunities to:

• Reduce unit costs
• Increase capacity with minimal investment
• Increase revenue & profitability
• Improve transparency of business performance
• Grow through increased capacity

Industry 4.0 has been proven to deliver results
What is Industry 4.0?

Put simply:

Turning real-time data from your equipment into real-time information to make decisions and improve your processes (manual or automated).
What is Industry 4.0?

- Everything connected
- Data becomes actionable information
- Real-time information to the right people
- Automated analytics
- Autonomous actions
Sensors & Dashboards on all key machine centers

Robotics and Autonomous Vehicle

Predictive Maintenance using Artificial Intelligence

Digital work instructions / Augmented Reality

Predictive Maintenance

Autonomous Factories

Personnel Safety / Collision Avoidance

Remote Monitoring and Mobile Tools

Asset Tracking & Management

OEE (Overall Equipment Efficiency) by machine center

Real-time Quality Detection

Condition-Based Maintenance (Automated)
Getting started
A typical AI adoption roadmap

Adoption Stages & Timeline

- **Readiness Assessment**
  - Business use cases
  - Data availability
  - 2~4 weeks
  - Is there business value for using AI?

- **Discovery Project**
  - Target use case
  - Data ecosystem audit
  - Techniques
  - Correlations
  - Cause & effect
  - 3~6 months
  - What can we learn from the data?

- **Enablement Project**
  - Validation
  - Operational deployment
  - Data strategies
  - Extended scope
  - Industry 4.0 roadmap update
  - Systematically capturing savings

- **Corporate Strategy**
  - Cross BU strategies
  - Inter department
  - Enable workflows
  - Use case roadmap
  - Data roadmap
  - Industry 4.0 updated implementation

AI as a culture
Getting started – Establish YOUR AI Roadmap

A typical AI adoption roadmap

<table>
<thead>
<tr>
<th>Use Cases</th>
<th>Use Case Value</th>
<th>Time to Implement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Reduce product quality issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Increase first time yield success rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Reduce end product performance variability</td>
<td></td>
<td></td>
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<tr>
<td>4 Increase energy efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Optimize machine &amp; people capacity</td>
<td></td>
<td></td>
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<tr>
<td>6 Find machine downtime root causes and run preventative maintenance</td>
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# AI-based Metal Parts Machining Cost Prediction

**Metal parts manufacturer**  |  **Build an AI model to predict metallic parts manufacturing cost**

<table>
<thead>
<tr>
<th><strong>Challenge</strong></th>
<th><strong>Solution</strong></th>
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</table>
| • Custom parts manufacturer  
• Current quoting process: MS Excel sheet with 100’s rules  
• Time consuming, error prone | • Large library of historical parts, multiple features & costs  
• Extract CAD features to classify parts  
• Build a neural network to predict cost |

<table>
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<tr>
<th><strong>Benefits</strong></th>
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</table>
| • Accelerate quoting process  
• Improve reliability of quotes |
AI-based Metal Parts Machining

Underlying structure of AI automation

Unattended automation

Open/Import the part

Clamping / fixturing

Find machining features

Create feature process

Validation / verification

Post process

Auto-align the part

Create setups

Position in vise or fixture

Check if part fully machined

Generate G-code

Generate Shop Docs

Machining Knowledge Library

Auto-align the part

Select or generate a blank

Create setups

Position in vise or fixture

Clash detection

Check if part fully machined

The success rate is dependent on the quality of the library

Workflow fully automated
Manufacturing Quality – AI Use Case Example
Reduce product QA rejection & variability

STEP 1
BUSINESS NEEDS & USE CASES

STEP 2
DATA PRE-PROCESSING

STEP 3
AI CREATION & OPTIMIZATION

STEP 4
AI PROBATION & SME VALIDATION

STEP 5
AI BUSINESS RESULTS

Total Industrial AI Project Duration: ~3-6 months

Correlation Mapping
• Analysis of top correlations within the identified ~50 features
• 9 correlation sets (18 features) identified to study for causation

Causation Analysis
• In collaboration with the customer SME, identify high likelihood of causation
• Individual or multi-feature pattern identified to reduce rejection rate

Example of a single feature pass/fail graph
Example of 2 features correlation pattern

AI Training
1) Trained ~130 DNNs
2) Optimized 2 best deep neural network candidates

AI training validation results
• Pass: 99.52% accurate
• Fail/rejection prediction: 77.82% accurate

AI feature sensitivity analysis
• ~50 out of 1000+ features with higher influence on outcome prediction

Conclusions
• Early manufacturing stage failure prediction possible with applied AI
• Removal of bad materials and unnecessary production time and rework time = ~$400k / year in savings
• Gained insight to guide production regarding sensitive settings and operations
• Established tighter production thresholds at key manufacturing stages and machine parameters to reduce rejection rates
• Cleaned up systematic erroneous data entry

Business
Identify AI target project:
❖ Need to reduce manufactured products QA rejection rate
❖ Need higher consistency in battery performance variability

Data Sources Access
1) PI System (4+ years)
2) SQL (4+ years)
3) Proprietary ERP DB (4+ years)

Data Manipulations
1) PI Asset Framework structure validation and data augmentation with SQL flags
2) PI Event Frame creation by combining SQL-based manufacturing start/end flags and PI System tags
3) Data mapping, SQL queries, cleanup, normalization, stats…

STEP 1
BUSINESS NEEDS & USE CASES

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STEP 5
AI BUSINESS RESULTS

Manufacturing Quality – AI Use Case Example
Reduce product QA rejection & variability
7 Elements leading to success in AI for manufacturing

✓ Business use cases – identified source of value
✓ Data infrastructure in place
✓ Data quantity in support of business case
✓ Data quality and operational bias
✓ AI model and data pipeline to operational AI model
✓ AI integration and process
✓ Open culture and change management
Data cleaning is 60% of AI project costs
LIGHTHOUSE project
Outlier detection powered by OCS

Raw Data with Unlabeled Events

What does an anomaly look like?
AI Solution: Outlier Detection App

Better information
Better dashboards
Better decisions
Better service
Outlier Detection
Maya’s Outlier Detection Application powered by PI AF

Real-time AI
PI Integrator for Business Analytics
PI AF
PI Data Archive(s)

Business Analysis
Continuous Improvement
Root Cause Analysis
Troubleshooting
Predictive Maintenance
Demand Forecast
AI

PI Data Archive(s)
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PI Integrator for Business Analytics
Real-time AI

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Maya HTT

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The New Way
Maya’s Outlier Detection Application powered by OCS
What’s Next?

Bring AI models to the edge with OSIsoft Edge Data Store (EDS)
What’s Next?
No-Code | Low-code Apps powered by OCS

“We need it now!”
We need to take new ideas and products to market quickly
We need to streamline and automate our operations
We need to digitalize our customer experience

“We have an 18-month backlog!”
I’m not able to respond fast enough to new business requirements
My existing systems are not flexible enough
I need to stay in control
What’s Next?
No-Code | Low-code Apps powered by OCS
What’s Next?

No-Code | Low-code Apps powered by OCS

- **Low-code development**: Build cloud-native applications 10x faster with 70% less resources

- **Multi-experience**: Applications for any channel, any device, online and offline, smart and connected

- **Unlock and extend your data and systems**: Integrate data and logic from Teamcenter, MindSphere, ERP, CRM and more

- **Enable the Digital Twin**: Deep integration with Siemens portfolio to build applications that enable the most robust Digital Twin

- **Multi-cloud**: 1-Click deploy to any public or private cloud, as well as on-premises and edge
What’s Next

Digital twin across a product’s lifecycle

- Product Digital Twin
- Production Digital Twin
- Production Performance Digital Twin
- Asset Performance Digital Twin

Product Design Optimization
Process Optimization

Virtual product
Virtual production
Real production
Real product

verification
validation
commission
ideal delivery
specification
What’s Next: Digital Twin

Smart Rover ... in Real-Time

Digital Twin Rover ... as simulated

https://www.mayahtt.com/expertise/artificial-intelligence
Industry 4.0

Corporate Strategy

• Smart / Digital Factory
• Operational Intelligence
• Lean/6-Sigma approaches
• Automation
• Trained and empowered digital workers

Industrial Internet

Enabling Technologies

• Everything connected (devices/machines/people)
• IIoT devices
• Existing operational data
• Analytics (incl. Big Data)
• Cloud computing
• AI/ML

Competitive Advantage

Improved Performance

• Increased revenue & profitability
• Increased visibility
• Improved OEE
• Reduced downtime
Operational Excellence, built on Operational Intelligence, powered by OSIsoft PI
Contact us for an Industry 4.0 or Are you AI-Ready Audit and Workshop…

- Remi Duquette
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  - Maya HTT Ltd
  - remi.duquette@mayahtt.com
  - Are you AI ready?

- Martin Davis
  - Managing Partner
  - DUNELM Associates Limited
  - Martin.Davis@DunelmAssociates.com

Check out my Industry 4.0 Blog
https://industry40iiot.com
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Navigate to this session in mobile agenda for survey

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