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

By Remi Duquette & Martin Davis

Maya HTT

DUNELM Associates

Your co-presenter…

Martin Davis

Managing Partner
DUNELM Associates Ltd
Martin.Davis@DUNELMAssociates.com

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

→ ***Defining your Industry 4.0 Strategy***

DUNELM Associates

Our Process

- Helping you define your Industry 4.0 Strategy
- Practical experience driving Industry 4.0 and Operational Intelligence in multi-national companies
- Focus on quality business outcomes resulting in customer satisfaction

Your co-presenter…

Remi Duquette

Vice-President
Emerging Solutions
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.mayatt.com/expertise/artificial-intelligence/

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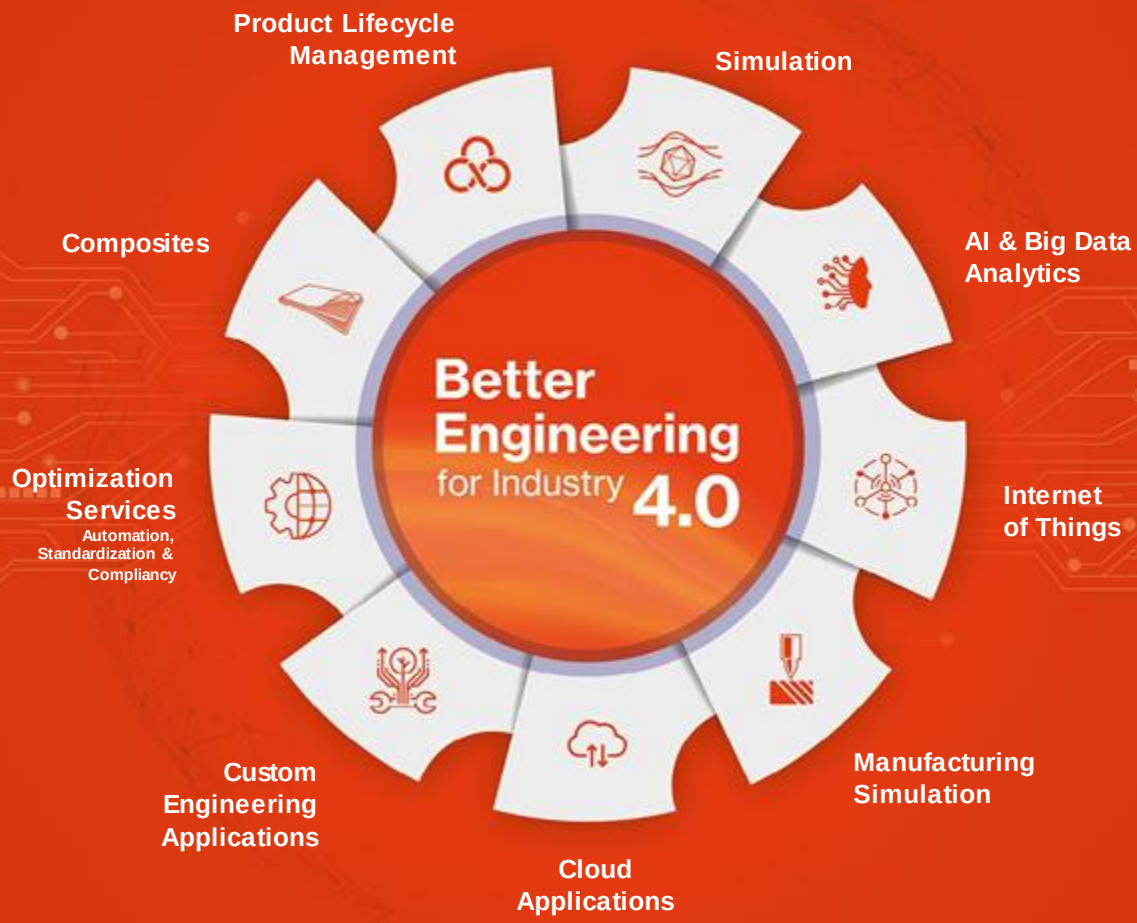
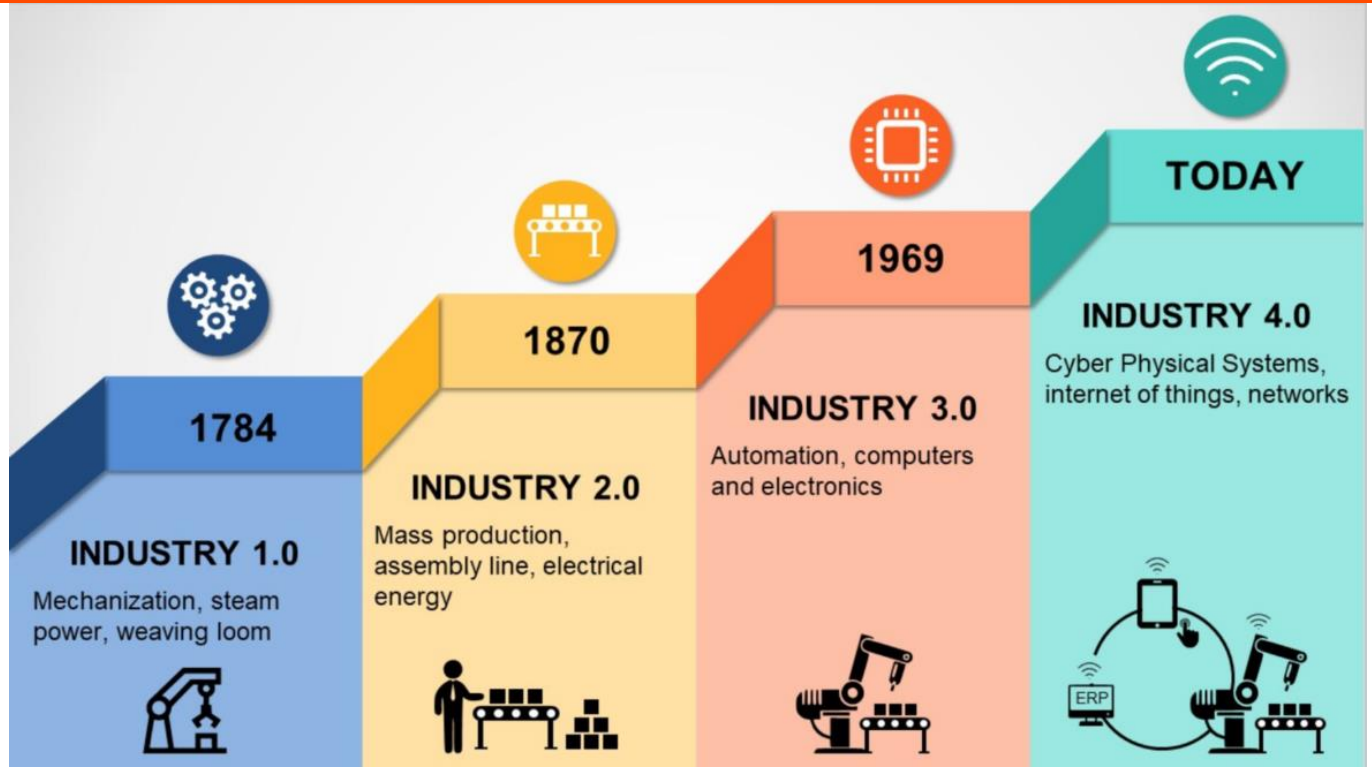
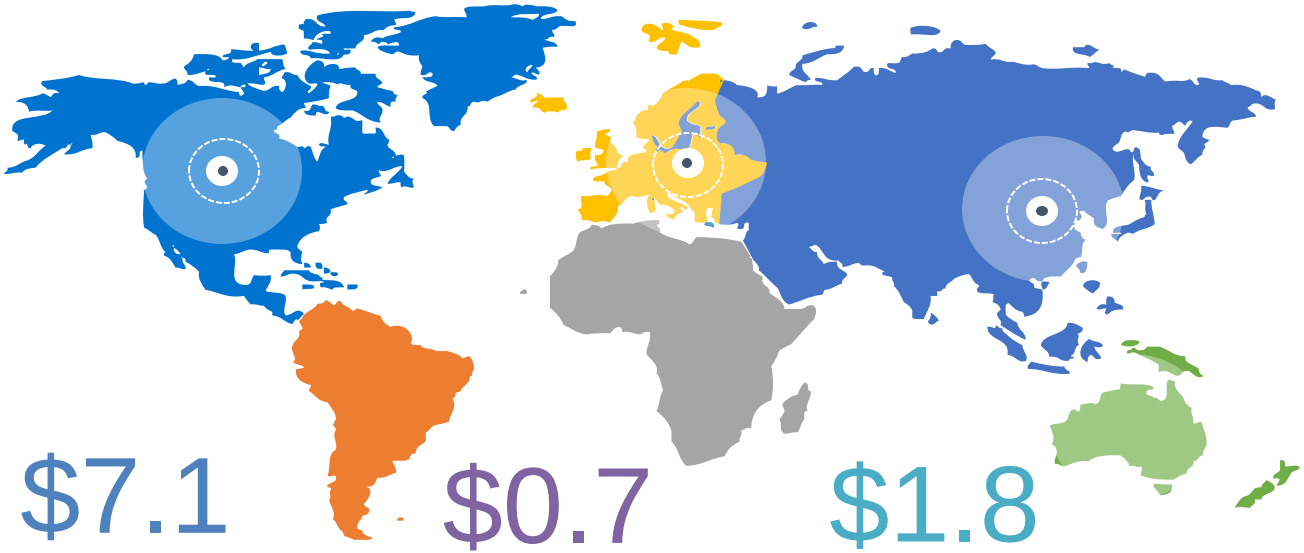


35+	Software solutions developed & maintained
8+ Years	Partnership with OSIsoft
75%	Engineers & Scientists
22%	PhDs

Industry 4.0 - The 4th Industrial Revolution



GDP Value of Industry 4.0 by 2030



$7.1 Trillion
North America

$0.7 Trillion
Germany

$1.8 Trillion
China

Industry 4.0 Adoption

99% of companies have heard of Industry 4.0

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57% in the early stages of adoption

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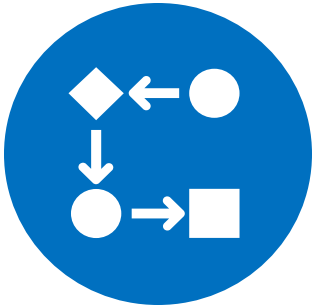
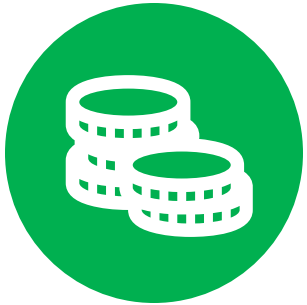
30% ONLY, report extensive adoption

Real Benefits from Industry 4.0

Improve OEE	Reduce Costs	Quality	Innovate
60% Achieved Productivity Increases	**50%** Reduced Operating Costs	**42%** Improved Product Quality	**13%** Increased Ability to Innovate

Bottom Line Impact

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

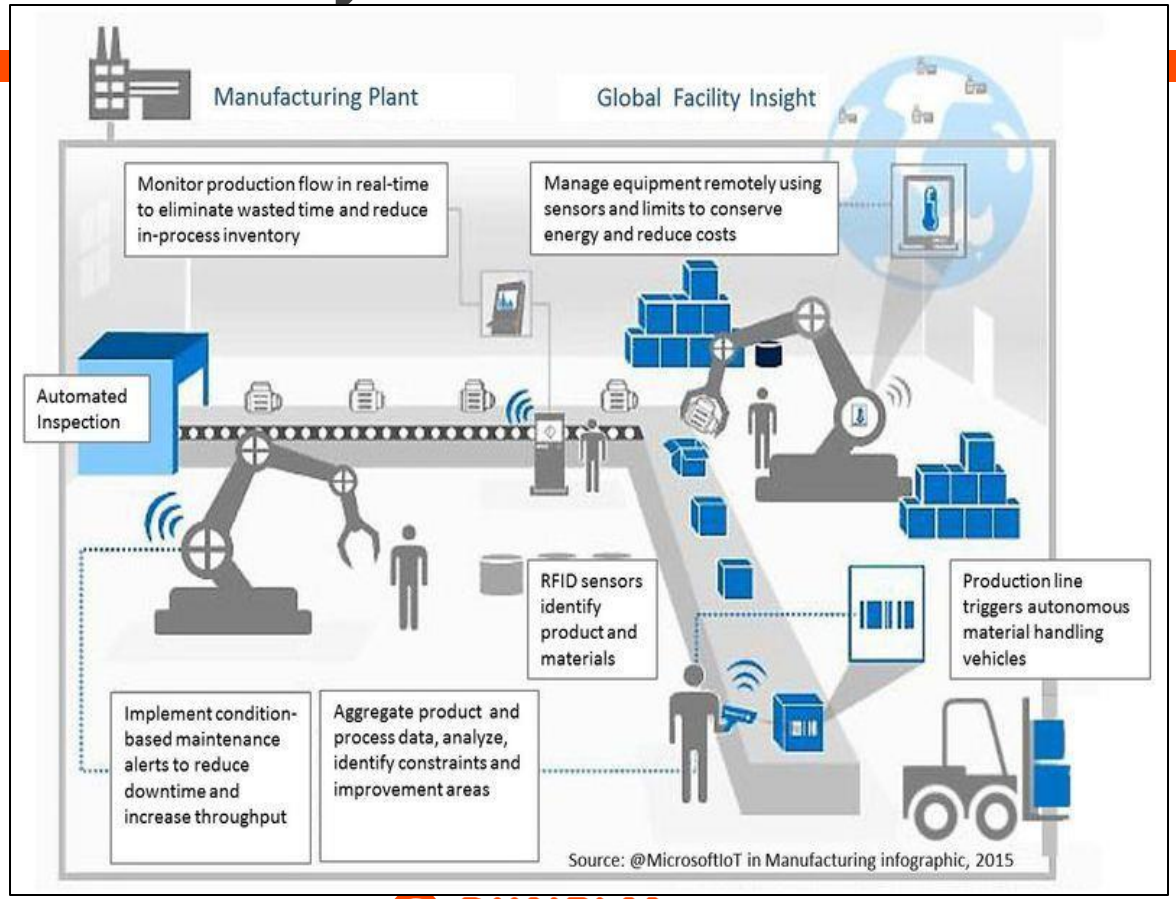
What is Industry 4.0?

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



Practical Examples of Industry 4.0?

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)

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Are you AI-ready?

AI Project Exploration Road-mapping

Engineering
- Quality
- Change management
- Systems level model
- Root cause analysis
- Surrogate models
- Optimization

Manufacturing
- Product Quality issues
- Rejections rates
- First time yield
- Total yield
- OEE
- Product performance specification issues
- Env. Factors and regulations
- Supplier issues
- Downtime
- Root cause of failures
- Energy efficiency

Operations
- Downtime
- Incidents
- Logistics and scheduling
- Asset health
- Telemetry data quality
- Fleet optimization
- Performance analysis
- Root cause of failures
- Energy efficiency

Marketing
- Sales data
- Product features analysis
- Customer sentiment analysis
- Chat-bot directed campaigns

Sales
- Performance correlations
- Price history
- NLP on standard PO forms
- Raw material cost forecasting
- Demand forecasting
- Recommendation tools

Customer Experience
- Warranty issues
- Returns
- Performance issues
- Operational feedback
- Product support
- After sales services support

Getting started

A typical AI adoption roadmap

AI maturity

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

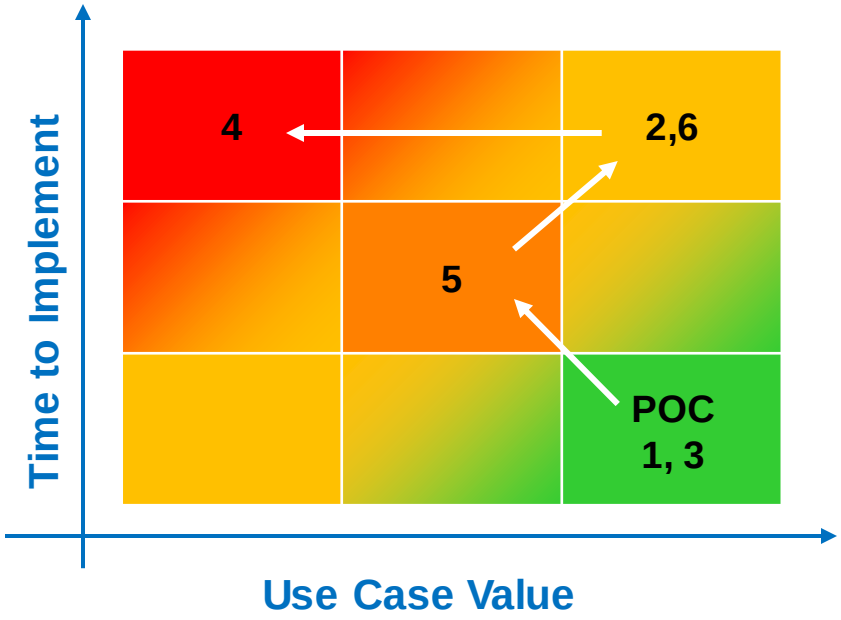
AI as a culture

Adoption Stages & Timeline

Getting started – Establish YOUR AI Roadmap

A typical AI adoption roadmap

Use Cases	
1	Reduce product quality issues
2	Increase first time yield success rate
3	Reduce end product performance variability
4	Increase energy efficiency
5	Optimize machine & people capacity
6	Find machine downtime root causes and run preventative maintenance



AI-based Metal Parts Machining Cost Prediction

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

Challenge

- Custom parts manufacturer
- Current quoting process : MS Excel sheet with 100's rules
- Time consuming, error prone

Solution

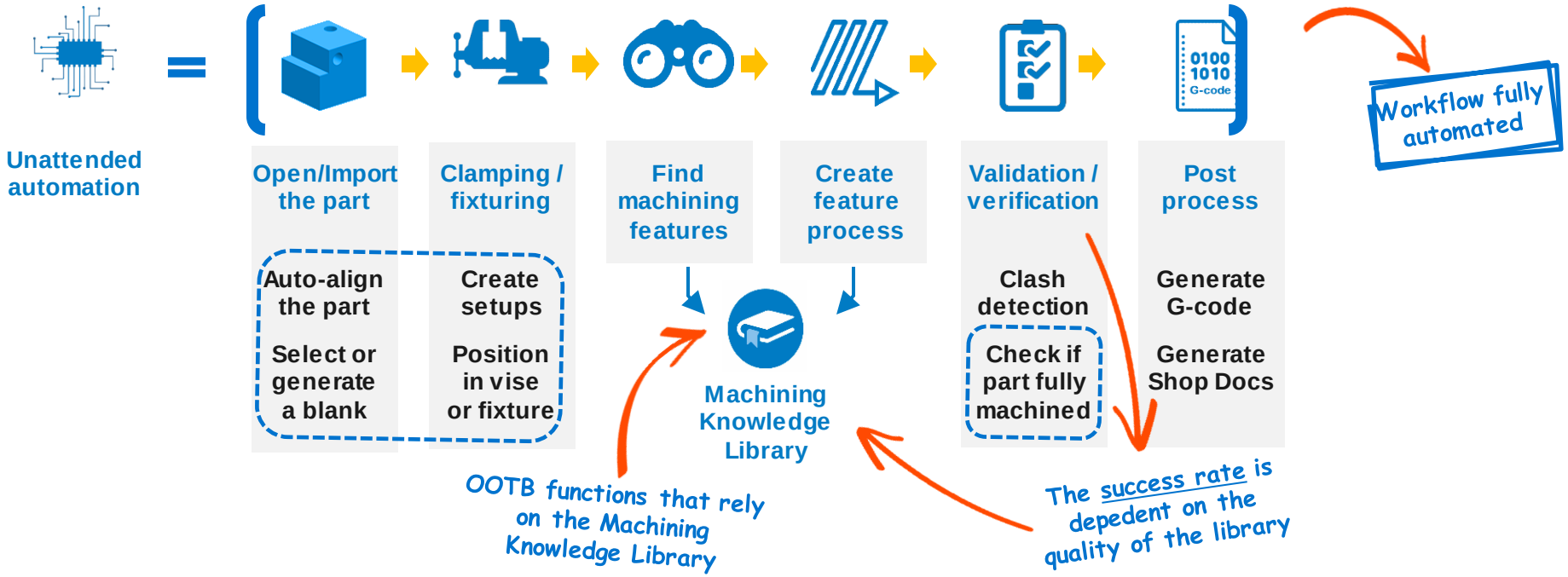
- Large library of historical parts, multiple features & costs
- Extract CAD features to classify parts
- Build a neural network to predict cost

Benefits

- Accelerate quoting process
- Improve reliability of quotes

AI-based Metal Parts Machining

Underlying structure of AI automation



Manufacturing Quality – AI Use Case Example

Reduce product QA rejection & variability

STE 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

Manufacturing Quality – AI Use Case Example

Reduce product QA rejection & variability

Business

Identify AI target project:

- Need to reduce manufactured products QA rejection rate
- Need higher consistency in battery performance variability

10 Manufacturing stages

~20,000 PI tags over 4+ years

S1 > S2 > S3 > S4 > S5 > … > S10

S1-1 > S1-2

- High rejection rate
- High cost of re-work

STEP 2
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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…

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Reduce product QA rejection & variability

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DATA PRE-PROCESSING

AI Training

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

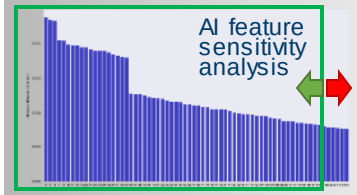
AI training validation results

- Pass : 99.52% accurate
- Fail/rejection prediction: 77.82% accurate

Prediction accuracy: 99.52%

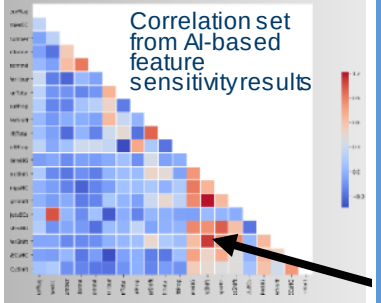
AI feature sensitivity analysis

- ~50 out of 1000+ features with higher influence on outcome prediction

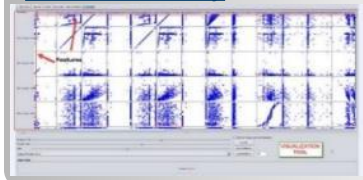


Correlation Mapping

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



Correlation Array



STEP 4
AI PROBATION & SME VALIDATION

STEP 5
AI BUSINESS RESULTS

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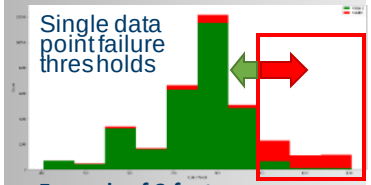
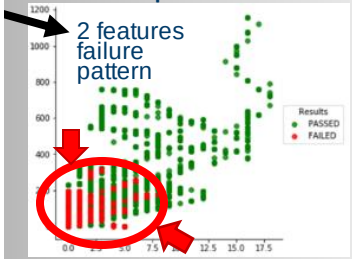
Causation Analysis

- 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



STEP 5
AI BUSINESS RESULTS

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Conclusions

- Early manufacturing stage failure prediction possible with applied AI
- Removal of bad materials and unnecessary production time and re-work 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 rejections rates
- Cleaned up systematic erroneous data entry

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AI BUSINESS RESULTS

Total Industrial AI Project Duration : ~3-6 months

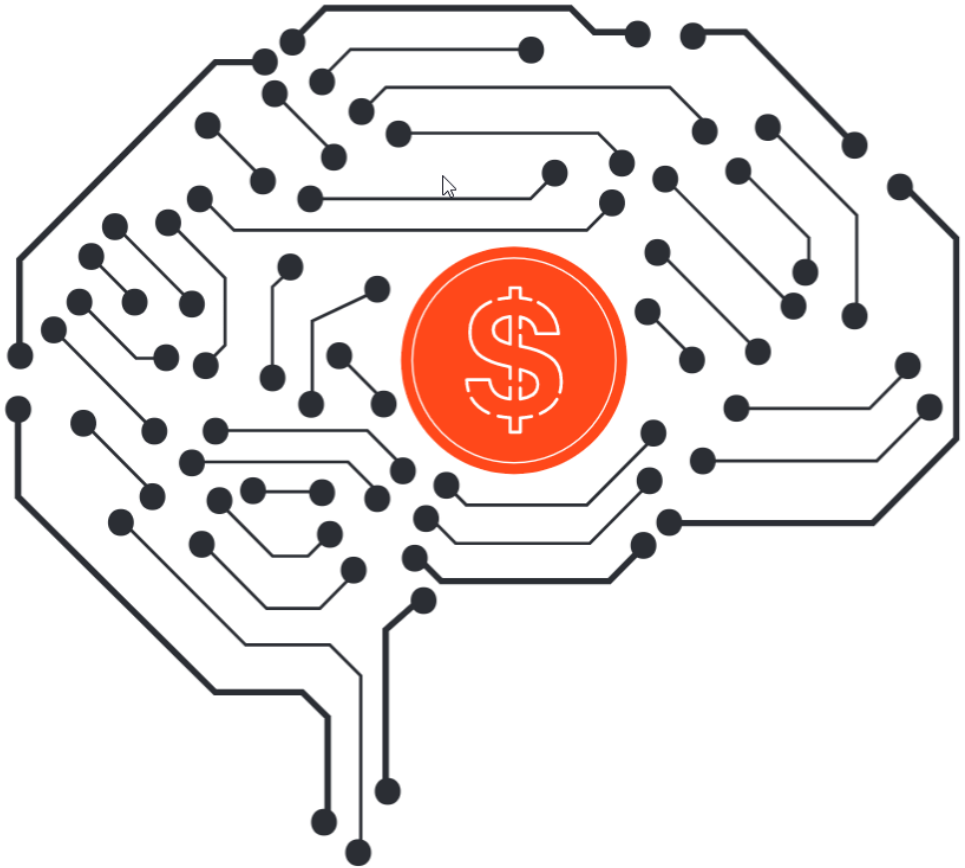
7 Elements leading to success in AI for manufacturing

- ✓ 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?

LIGHTHOUSE project

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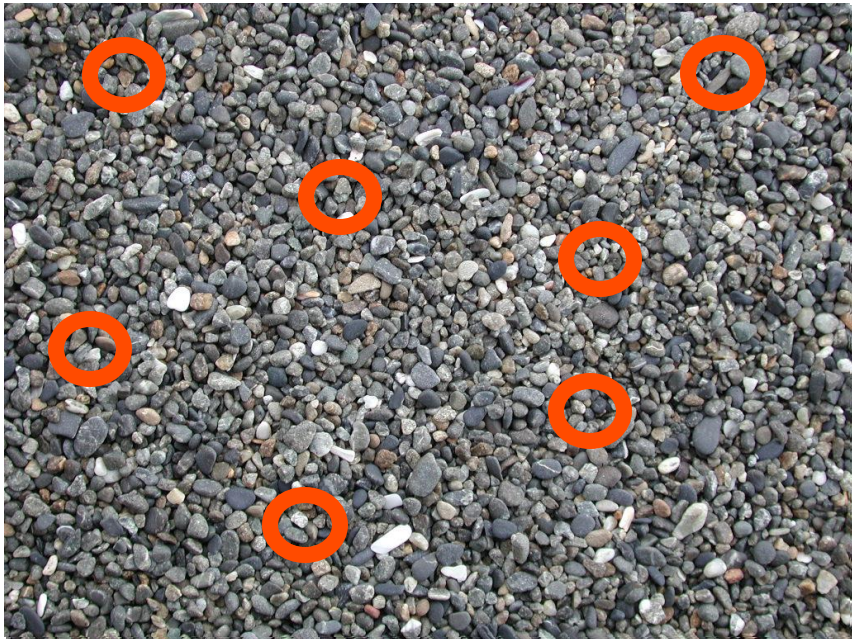


Raw Data with Unlabeled Events

What does an anomaly look like?

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

Business Analytics

PI AF

PI Data Archive(s)

Business Analysis

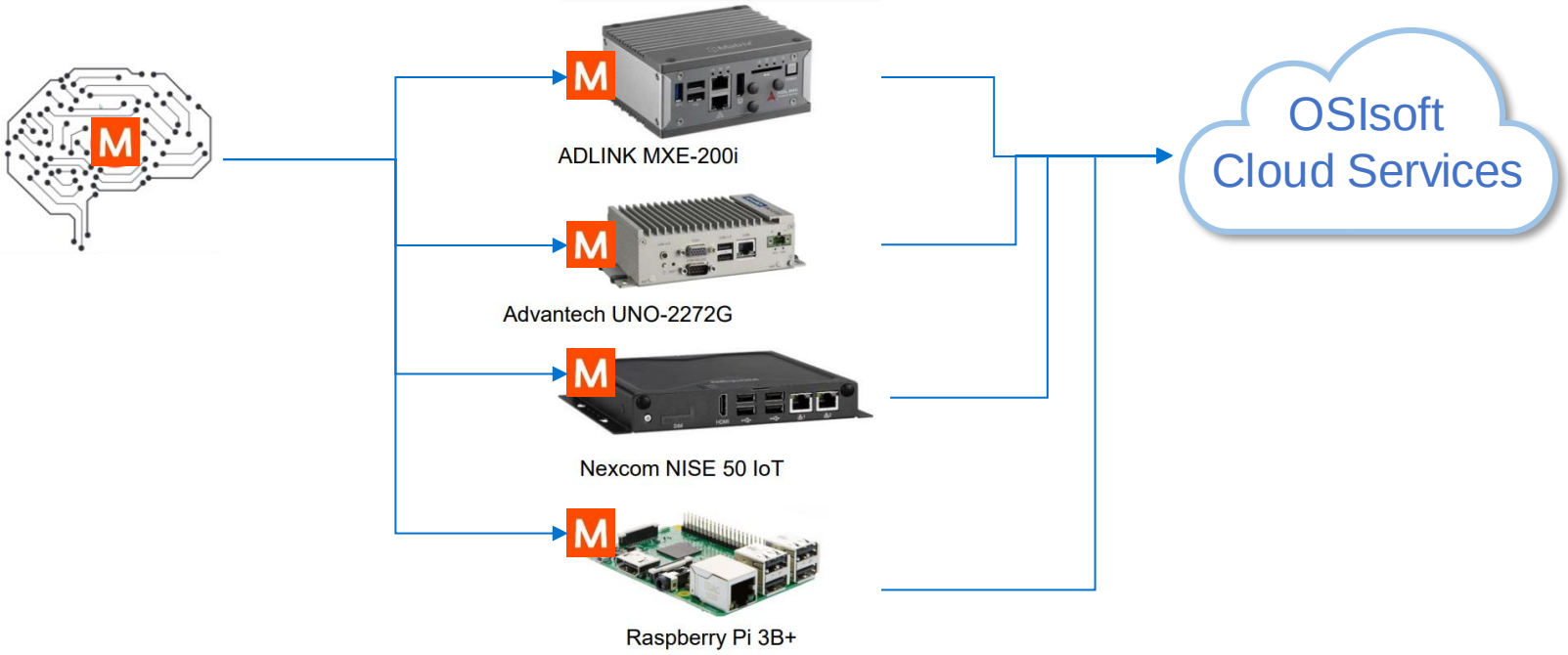
- Continuous Improvement
- Root Cause Analysis
- Troubleshooting
- …

AI

- Predictive Maintenance
- Demand Forecast
- …

What's Next?

Bring AI models to the edge with OSIsoft Edge Data Store (EDS)



What's Next?

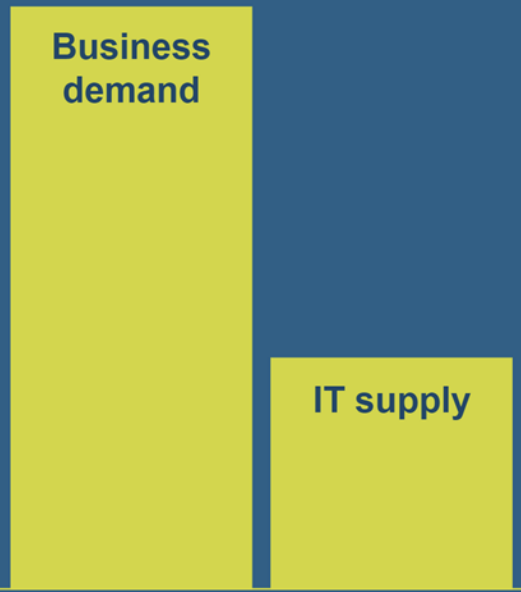
No-Code | Low-code Apps powered by OCS

"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!"

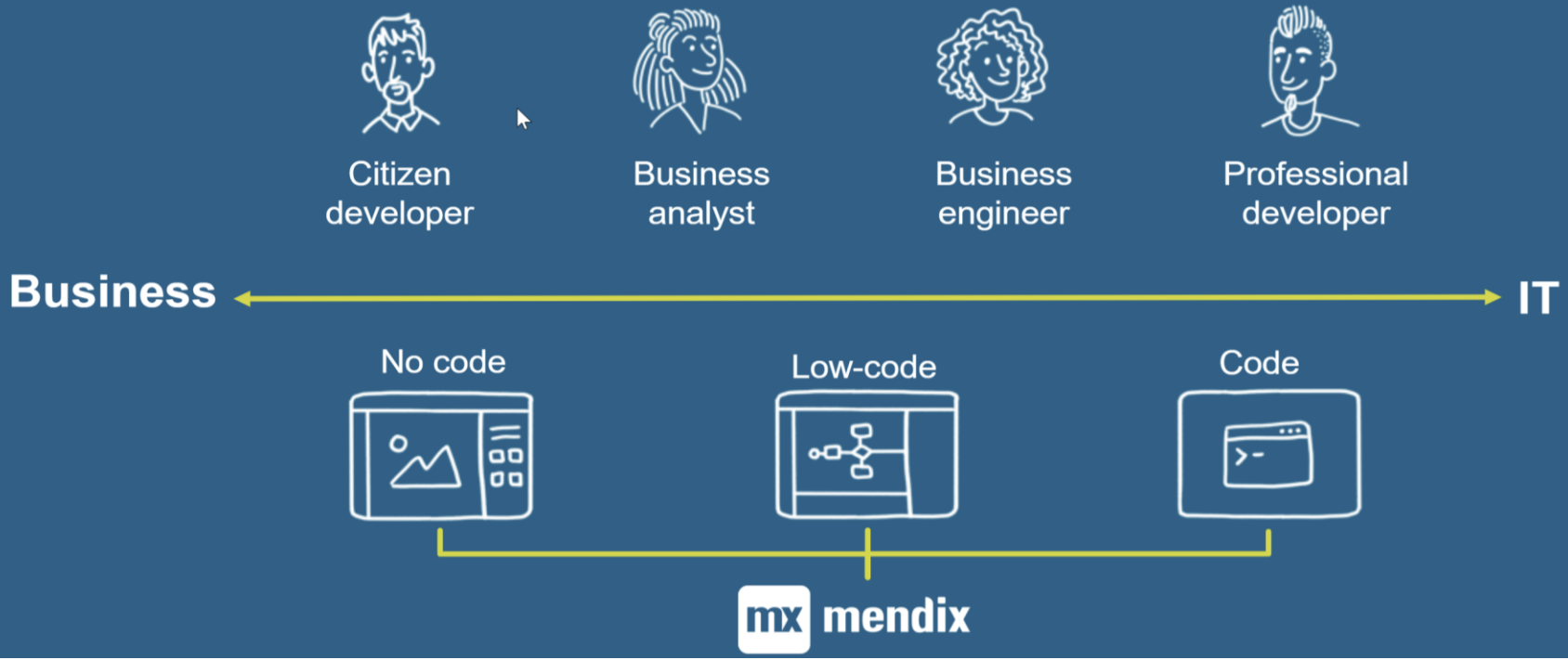
I'm not able to respond fast enough to new business requirements

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

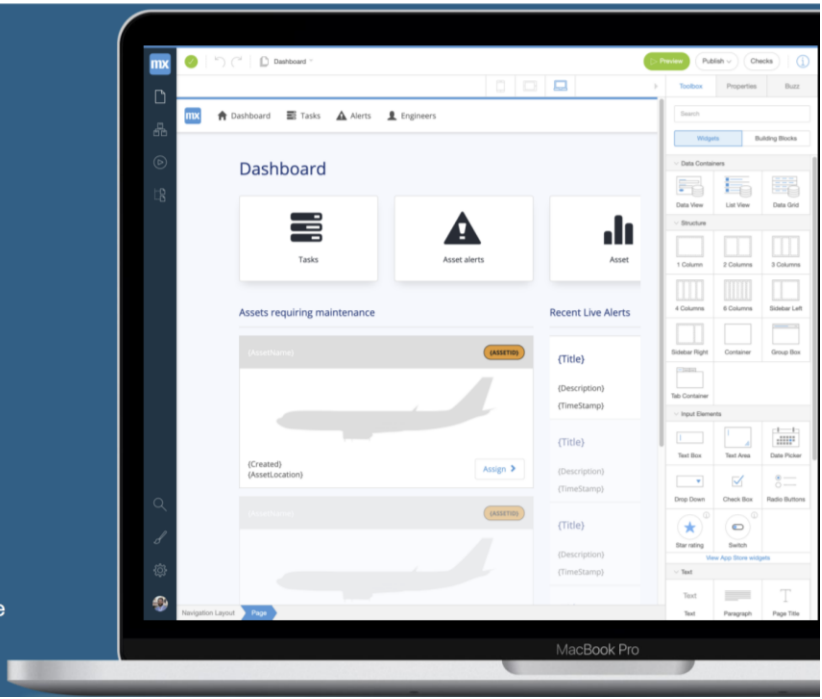
Low-code development
Build cloud-native applications 10x faster with 70% less resources

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

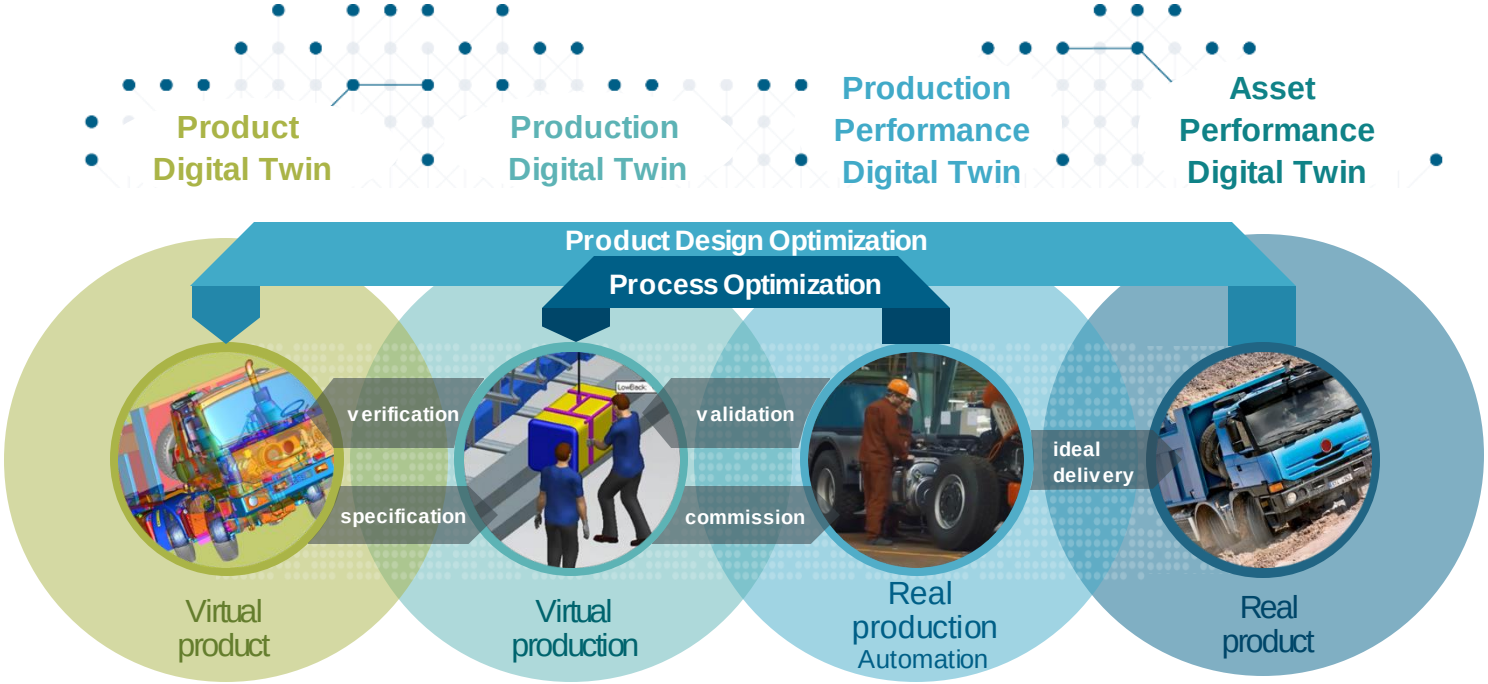
Enable the Digital Twin
Deep integration with Siemens portfolio to build applications that enable the most robust Digital Twin

Multi-cloud
1-Click deploy to any public or private cloud, as well as on-premises and edge

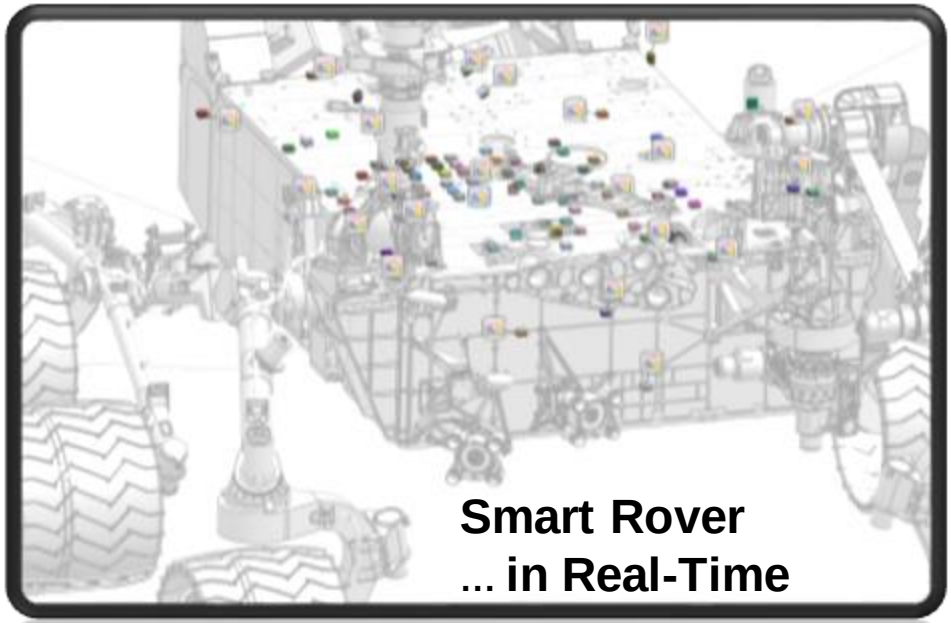


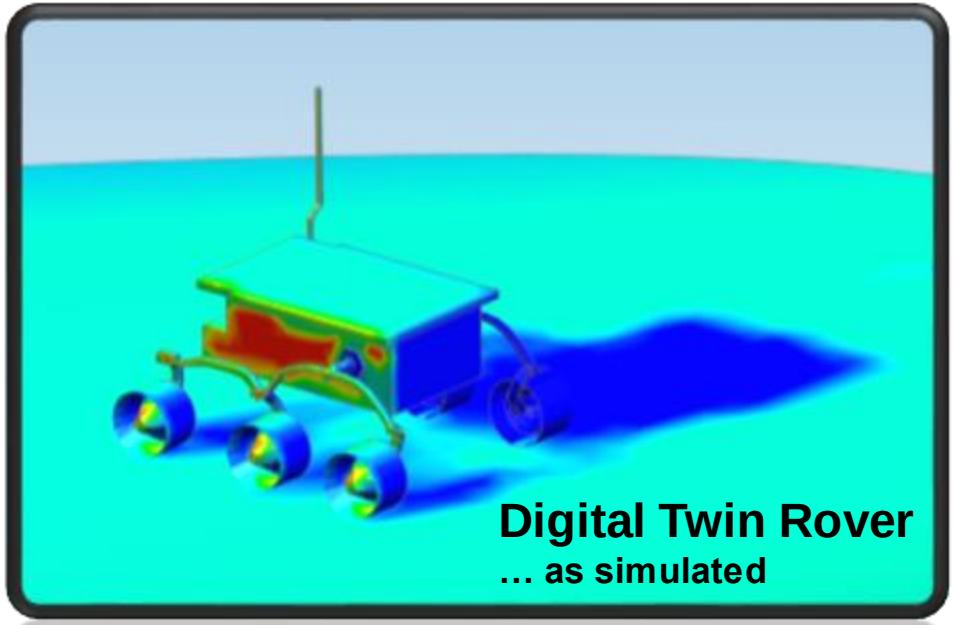
What's Next

Digital twin across a product's lifecycle



What's Next: Digital Twin





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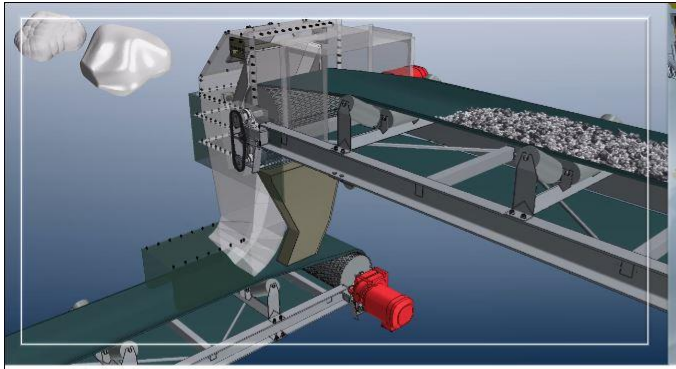

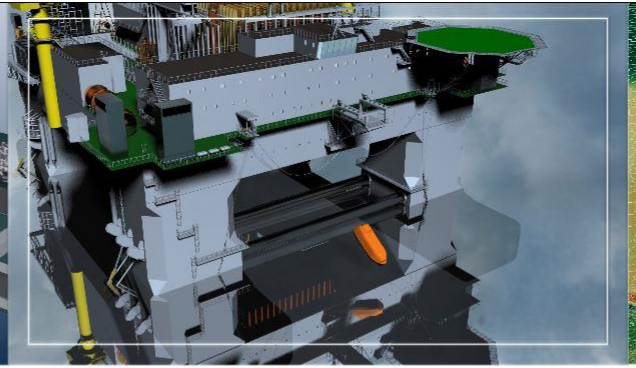

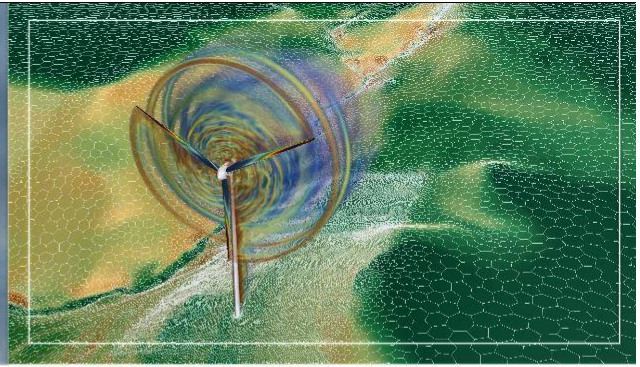

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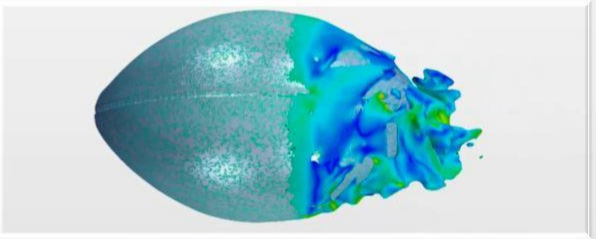
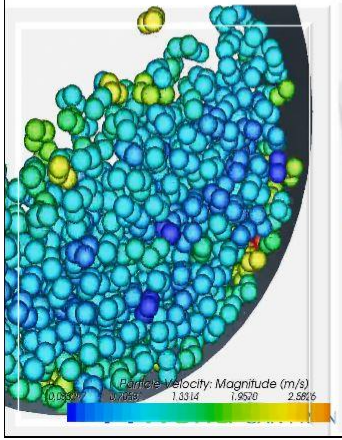
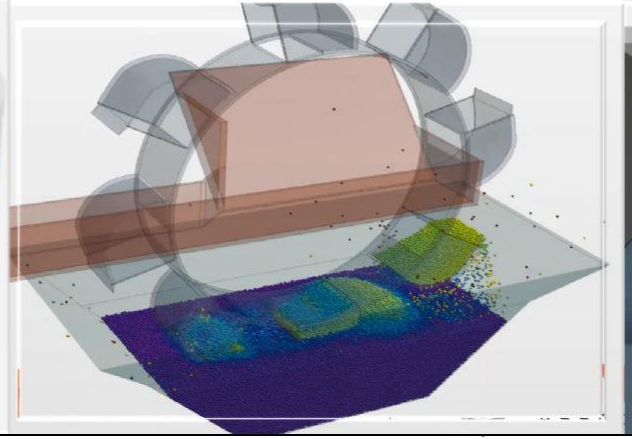
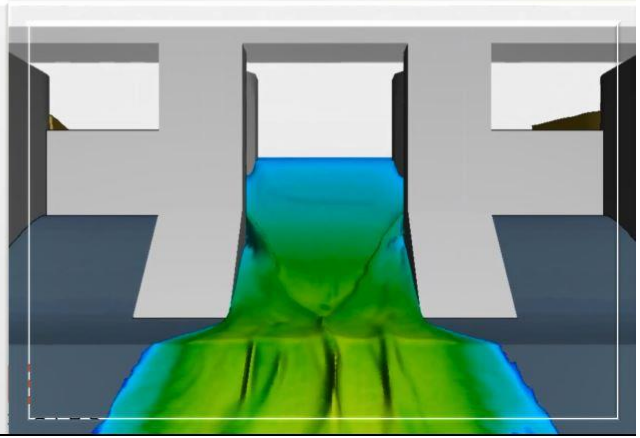
Better thinking
Better future®









Industry 4.0

Corporate Strategy

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

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Industrial Internet

Enabling Technologies

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

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Competitive Advantage

Improved Performance

- Increased revenue & profitability
- Increased visibility
- Improved OEE
- Reduced downtime

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Industry 4.0

+

Industrial Internet

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Competitive Advantage

Operational Excellence, built on Operational Intelligence, powered by

OSIsoft.

Contact us for an Industry 4.0 or Are you AI-Ready Audit and Workshop…

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

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

Questions?

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TANK
TAPADH LEAT
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ESKERRIK ASKO
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GRACIAS
HVALA
ХВАЛА ВАМ
THANKYOU
TEŞEKKÜR EDERIM
ТИ БЛАГОДАРАМ
DANK JE
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GRATIAS TIBI
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ありがとうございました
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PAXMAT САГА
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MATUR NUWUN
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СИПОС