Bridging the Digital & Physical Worlds: IoT & Model-Based Approaches in Manufacturing

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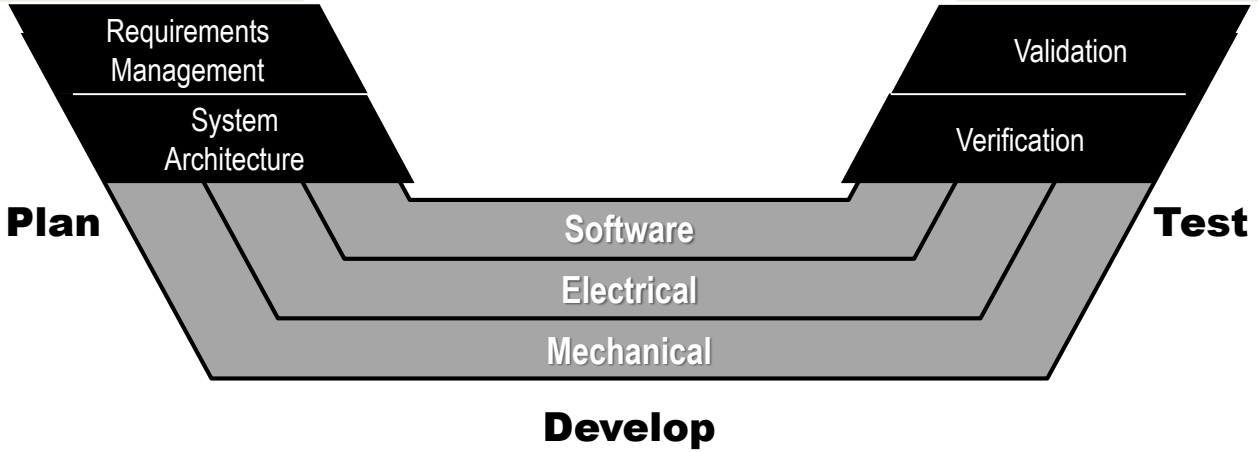
PTC Engineering Fellow, MBSE Specialist

December, 2017

Standard Systems Engineering "V"

Customer requirements, business initiatives / strategy, concept development

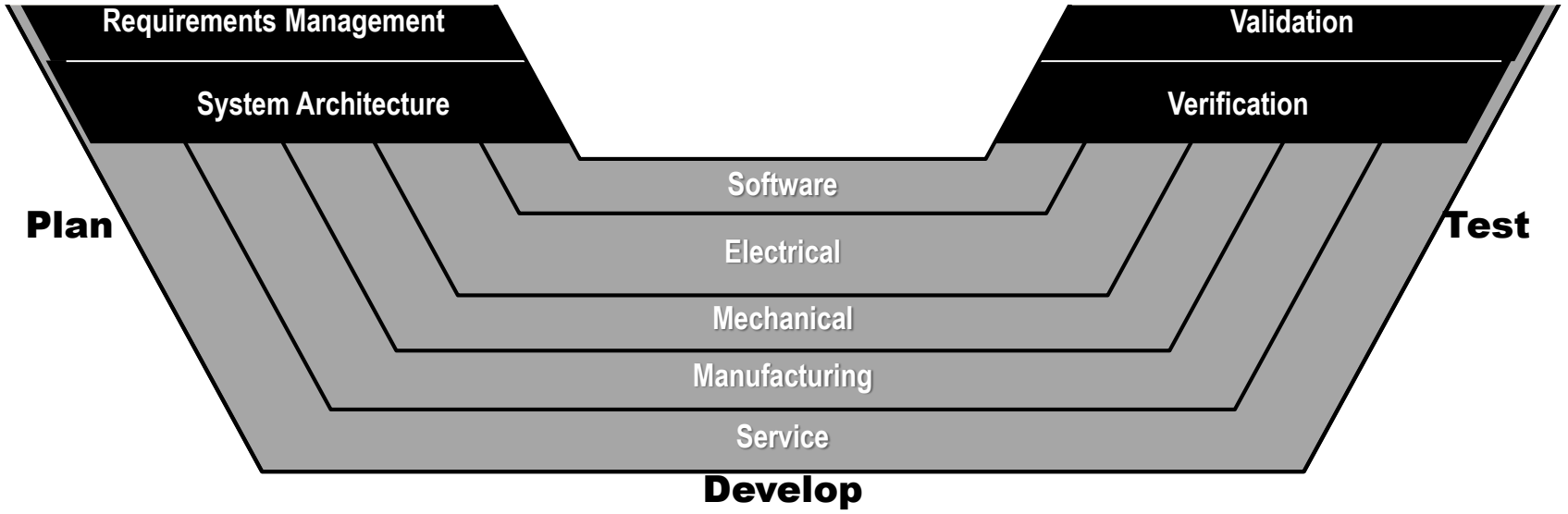
Manufacturing / Service planning, execution; after-market activities



Extended Systems Engineering "V"

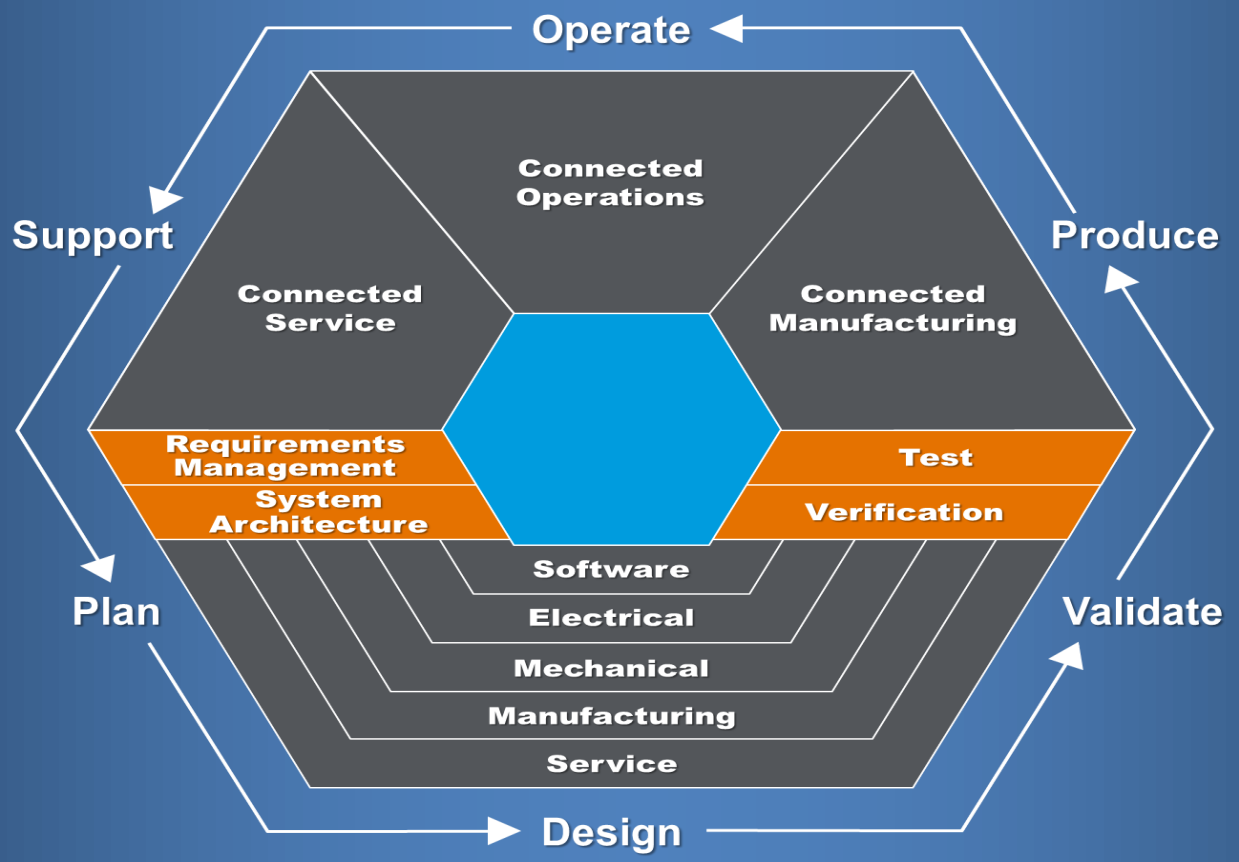
Customer requirements, business initiatives / strategy, concept development

Manufacturing / Service planning, execution; after-market activities



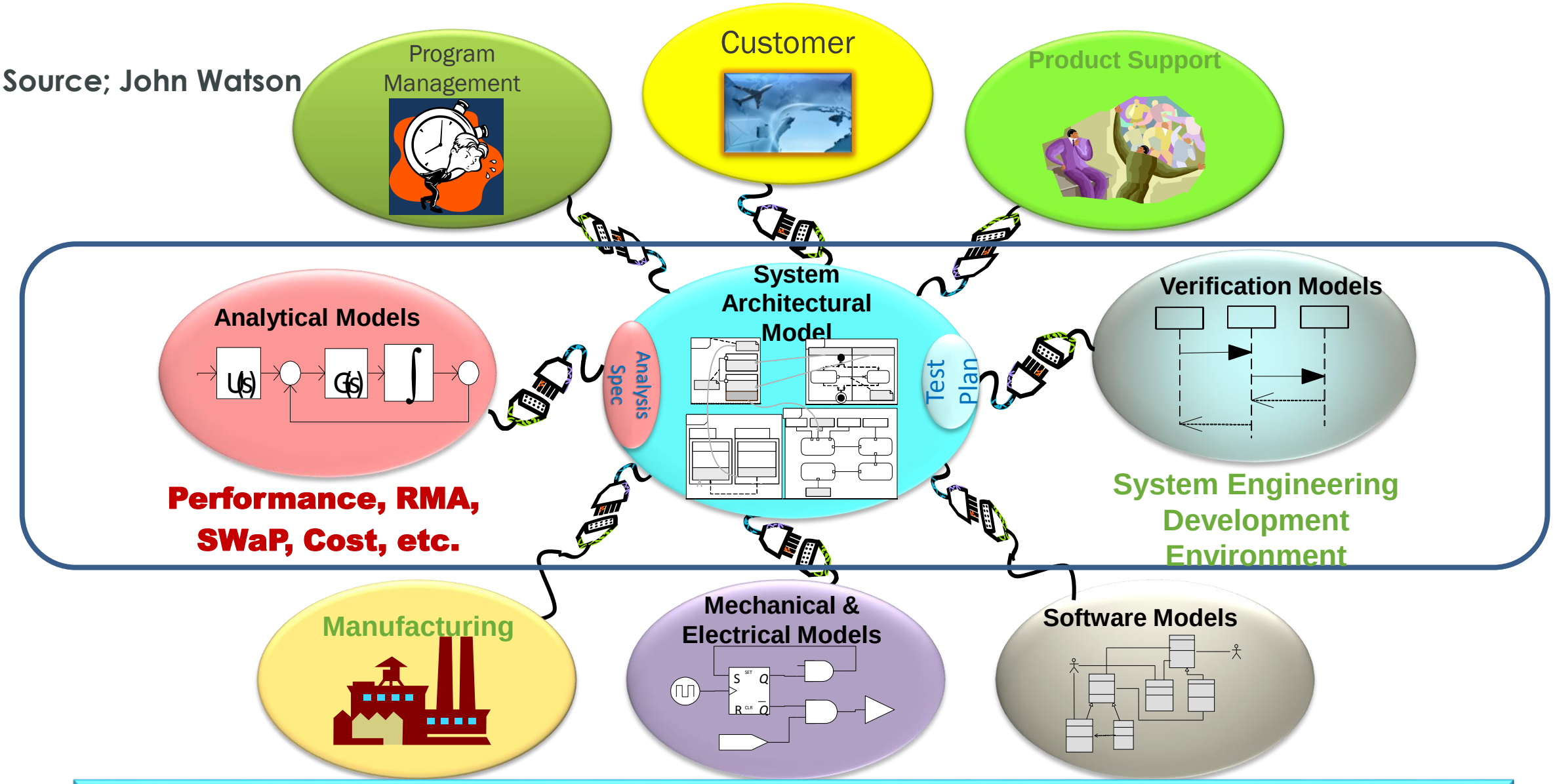
Closed Loop Systems Engineering

A **holistic**, **multi-disciplinary** and collaborative approach to designing and maintaining **complex** systems throughout the systems lifecycle.



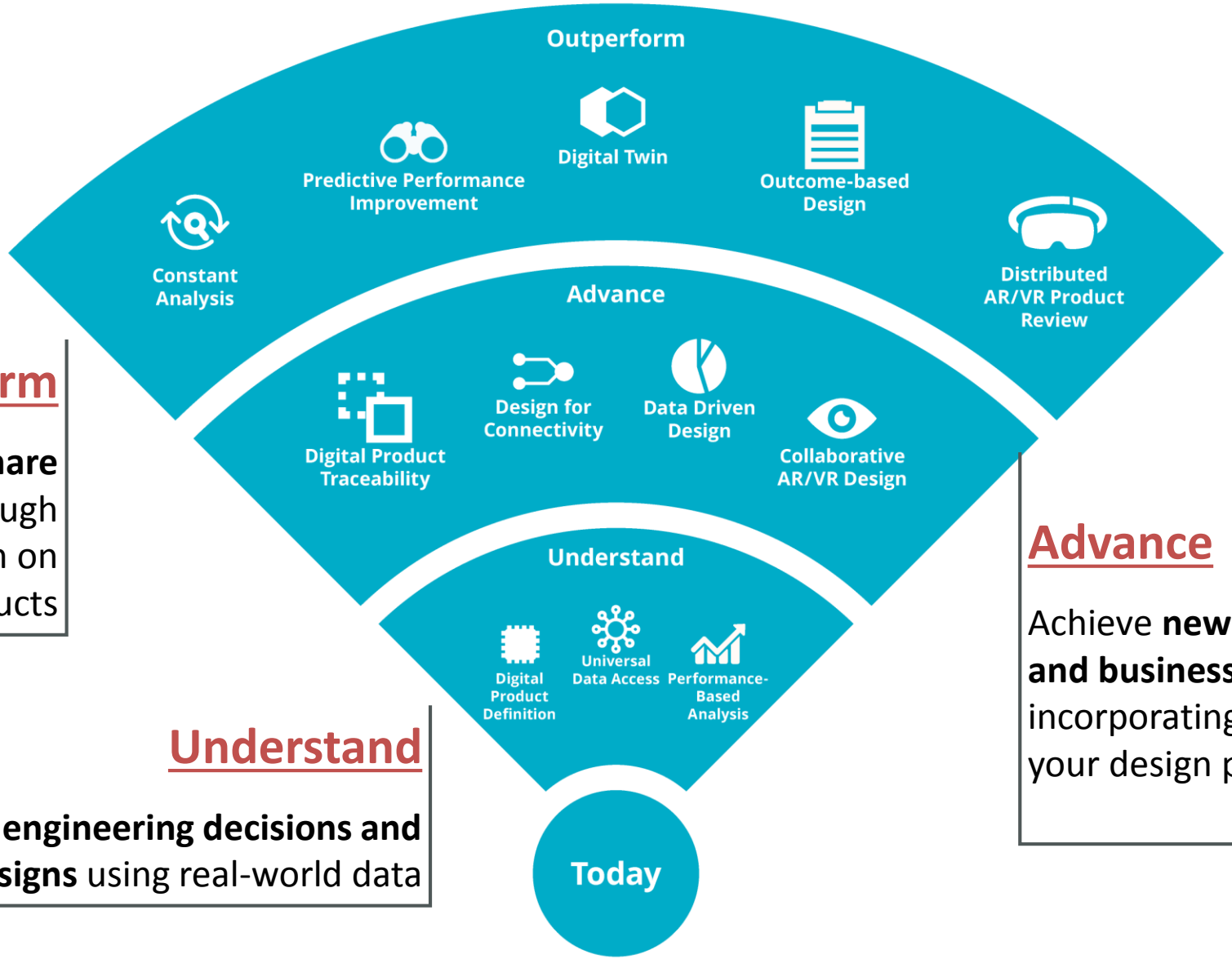
Evolving MBSE Use Cases

Source; John Watson



To measure MBSE effectiveness we need to understand the context of how it is used

Digital Engineering Journey



Outperform

Grow your market share and profitability though continuous innovation on evergreen products

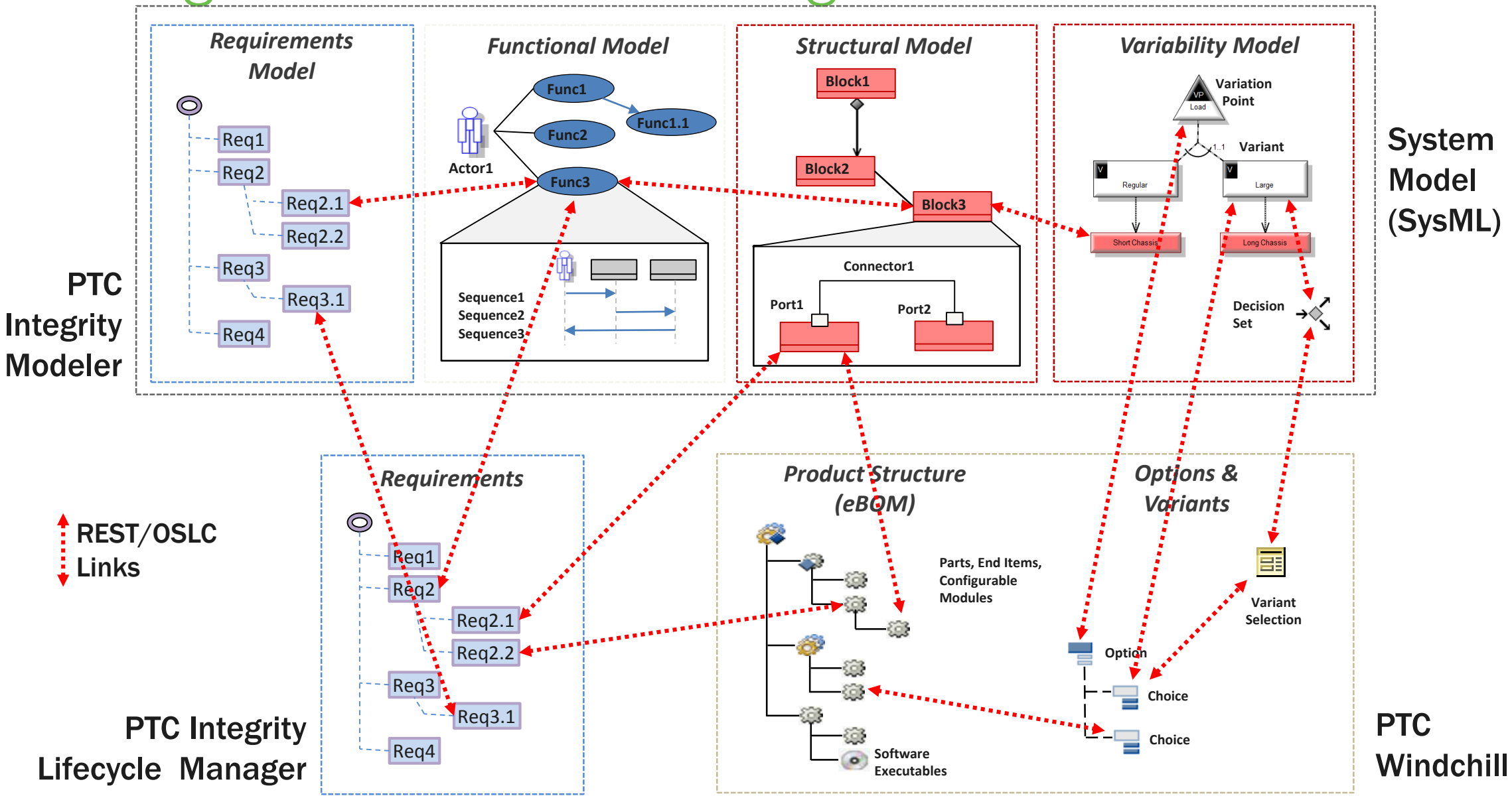
Understand

Make **better engineering decisions and designs** using real-world data

Advance

Achieve **new levels of innovation and business results** by incorporating IoT technologies into your design practices

PLE integration across Modeling and PLM

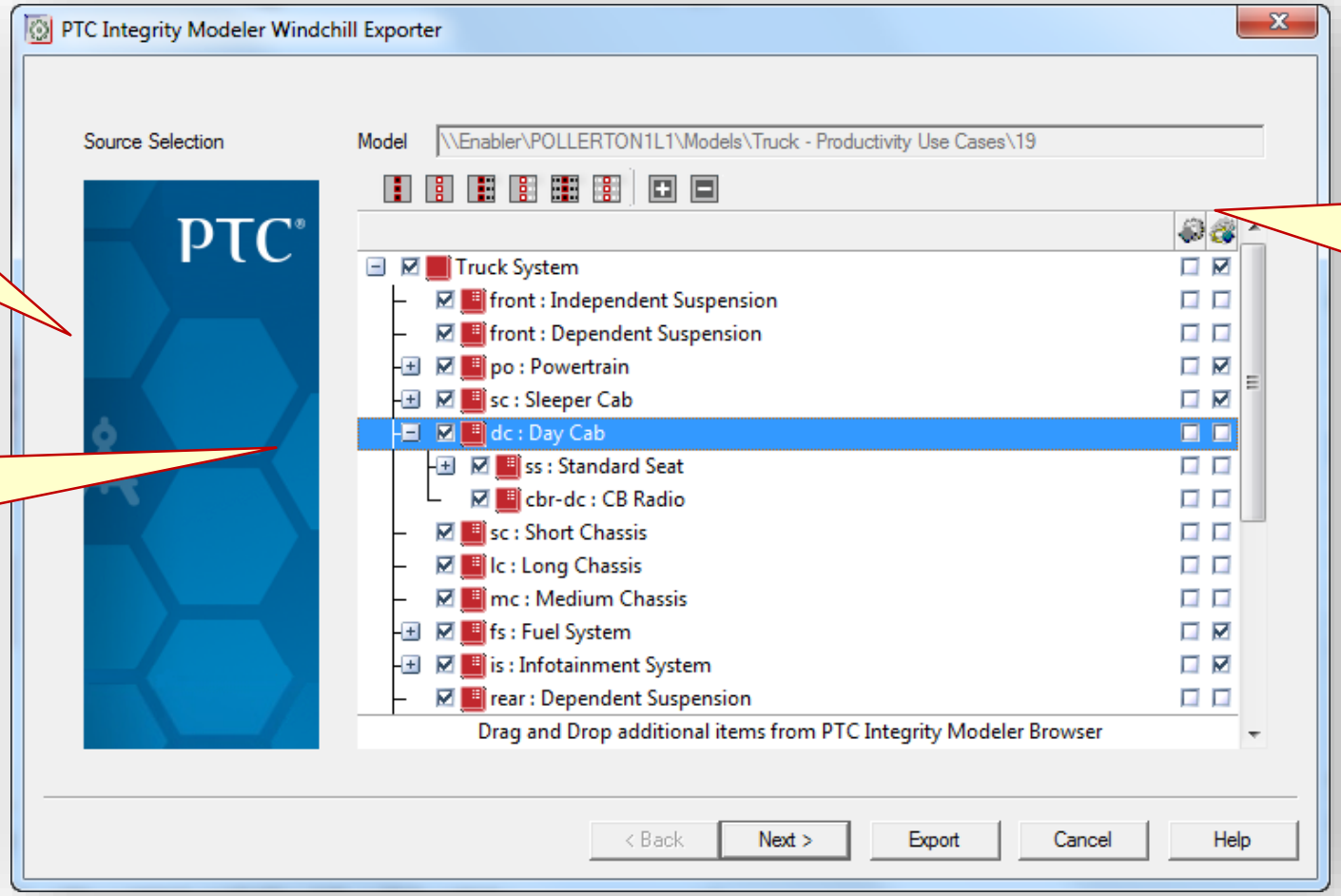


MBSE to PLM Selection of Parts

Review and confirm the items selected for export
Drag and drop additional items from standard Modeler Browsers

Structure can be expanded/collapsed

Items can be marked as included/excluded for export

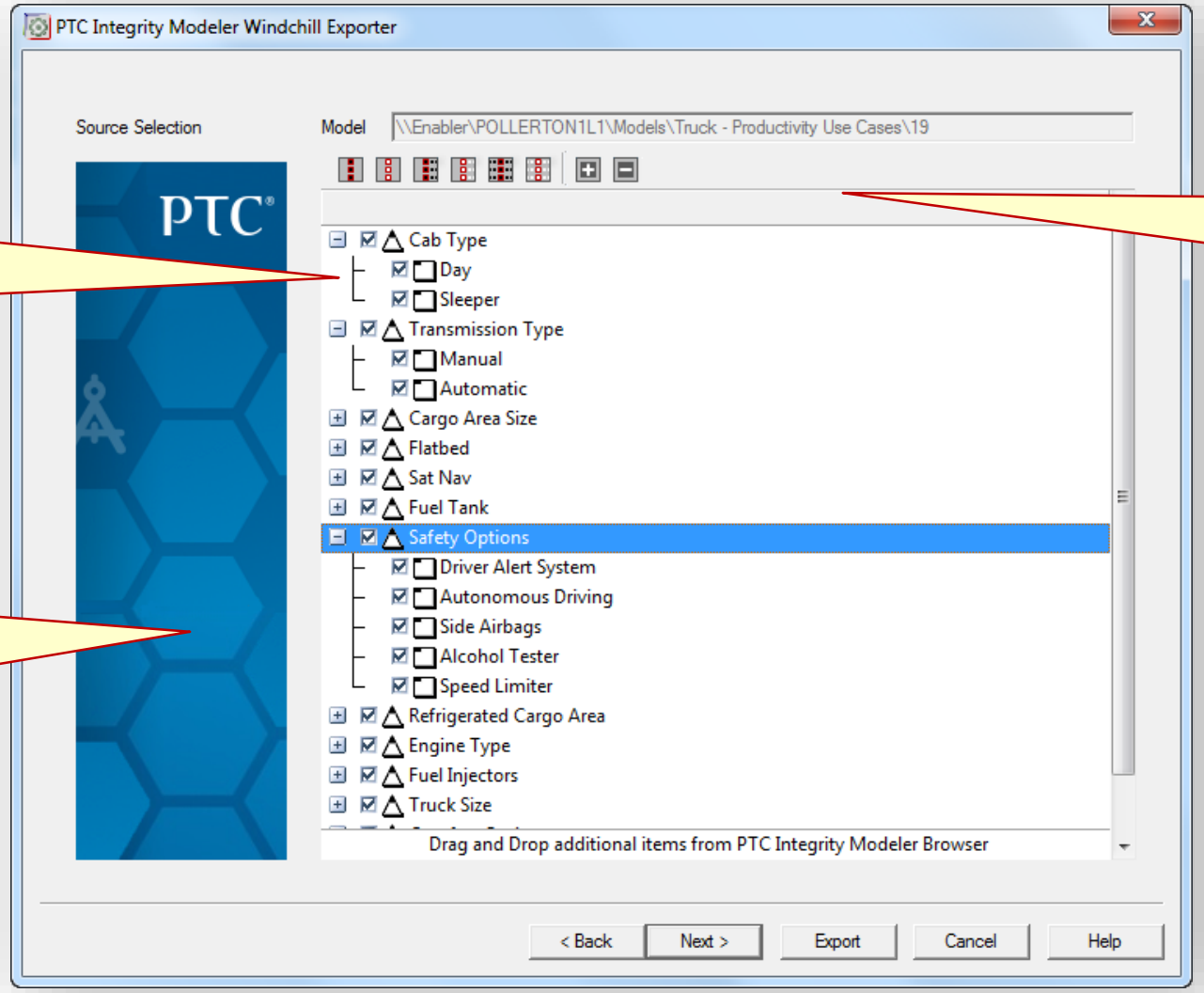


Items can be defined as Windchill PDMLink End Items or Configurable Modules

Export of MBSE Variability to PLM

If the included Blocks/Block Properties have related variability items, they are automatically included in step 2 of the Exporter

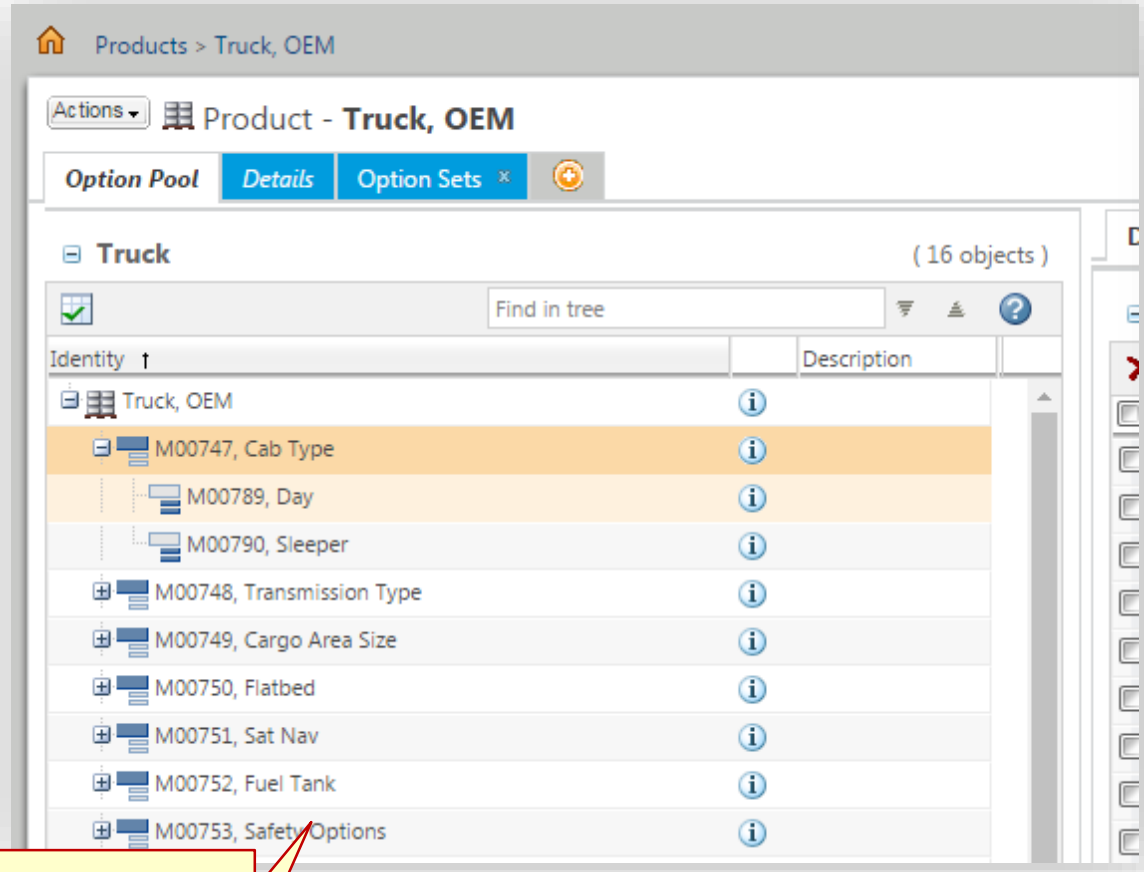
Review and confirm the variability items selected for export



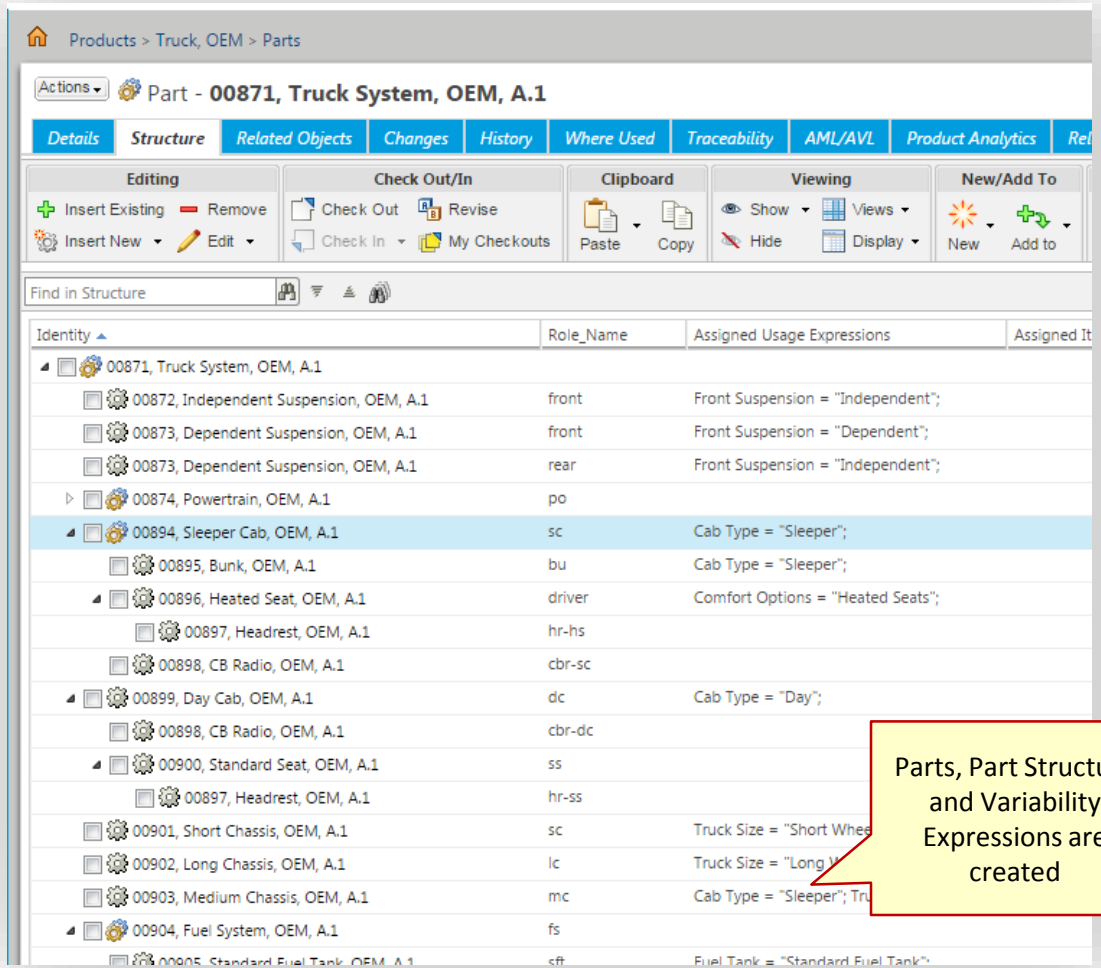
Structure can be expanded/collapsed

Items can be marked as included/excluded for export

MBSE and PLM Traceability

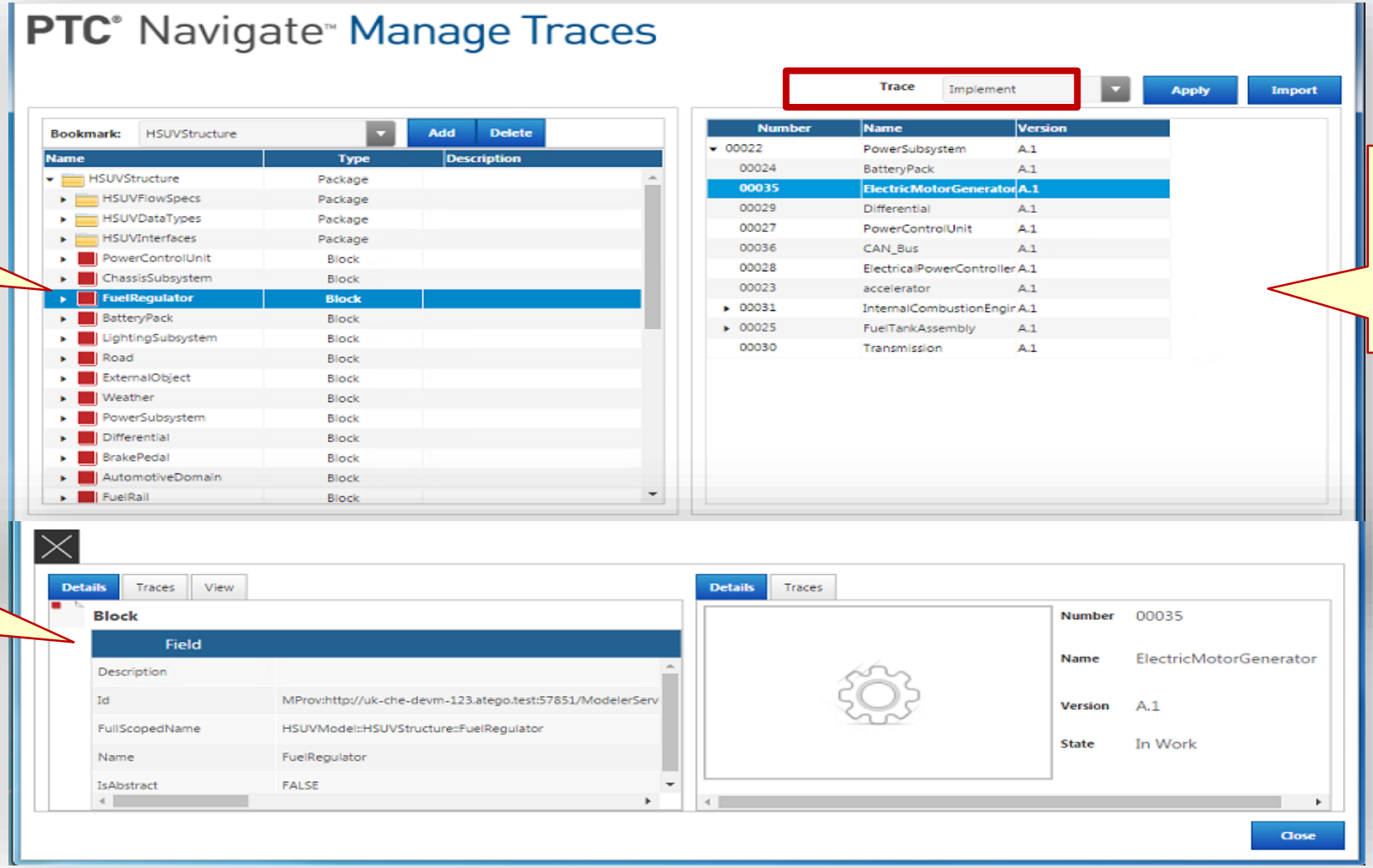


Options, Choices and Option Set are created



Parts, Part Structure and Variability Expressions are created

ptc navigate™ ALM, MBSE and PLM Bi-Directional Traceability

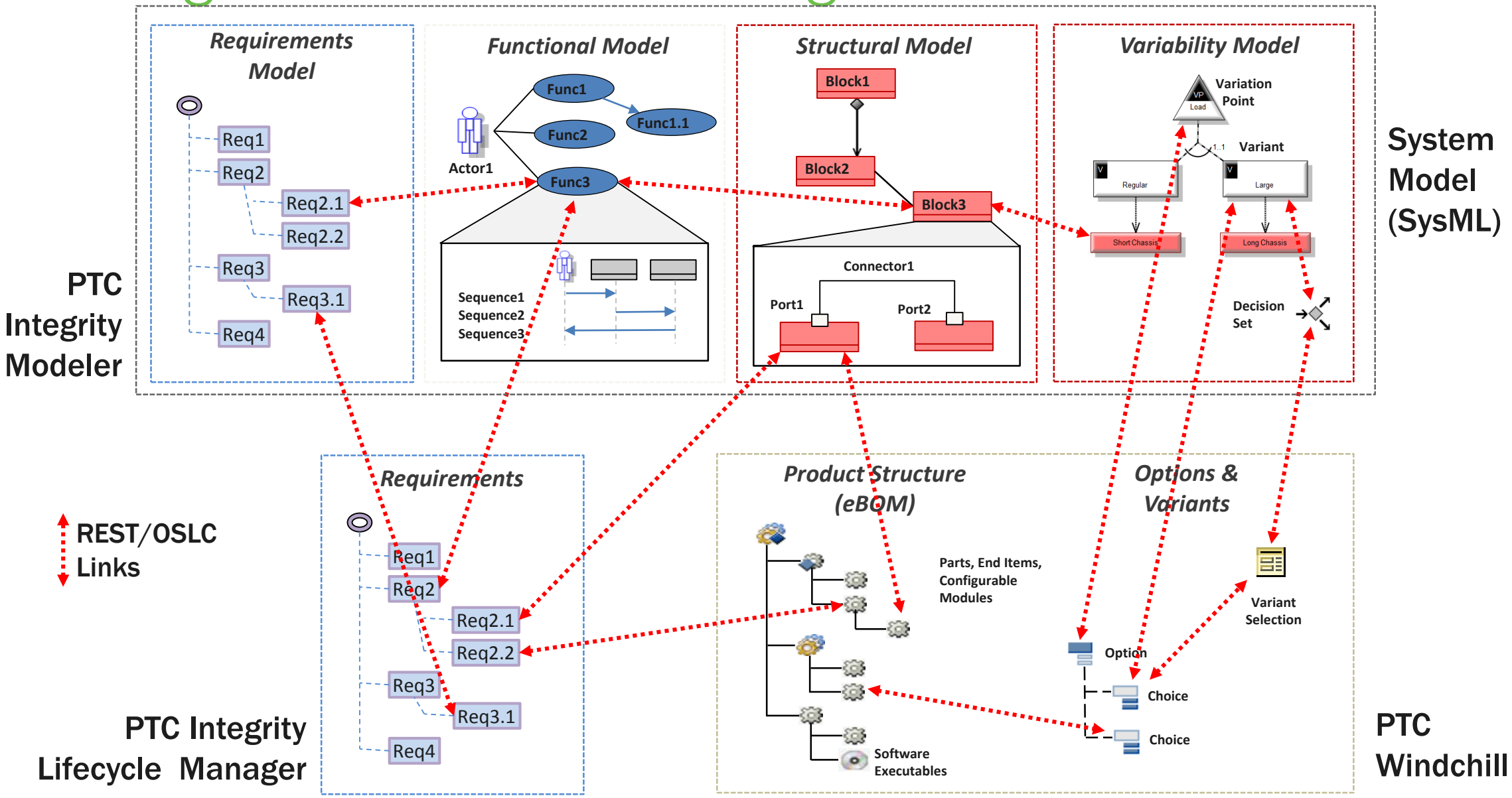


Browse Modeler data and select items

View details and existing traces for selected item

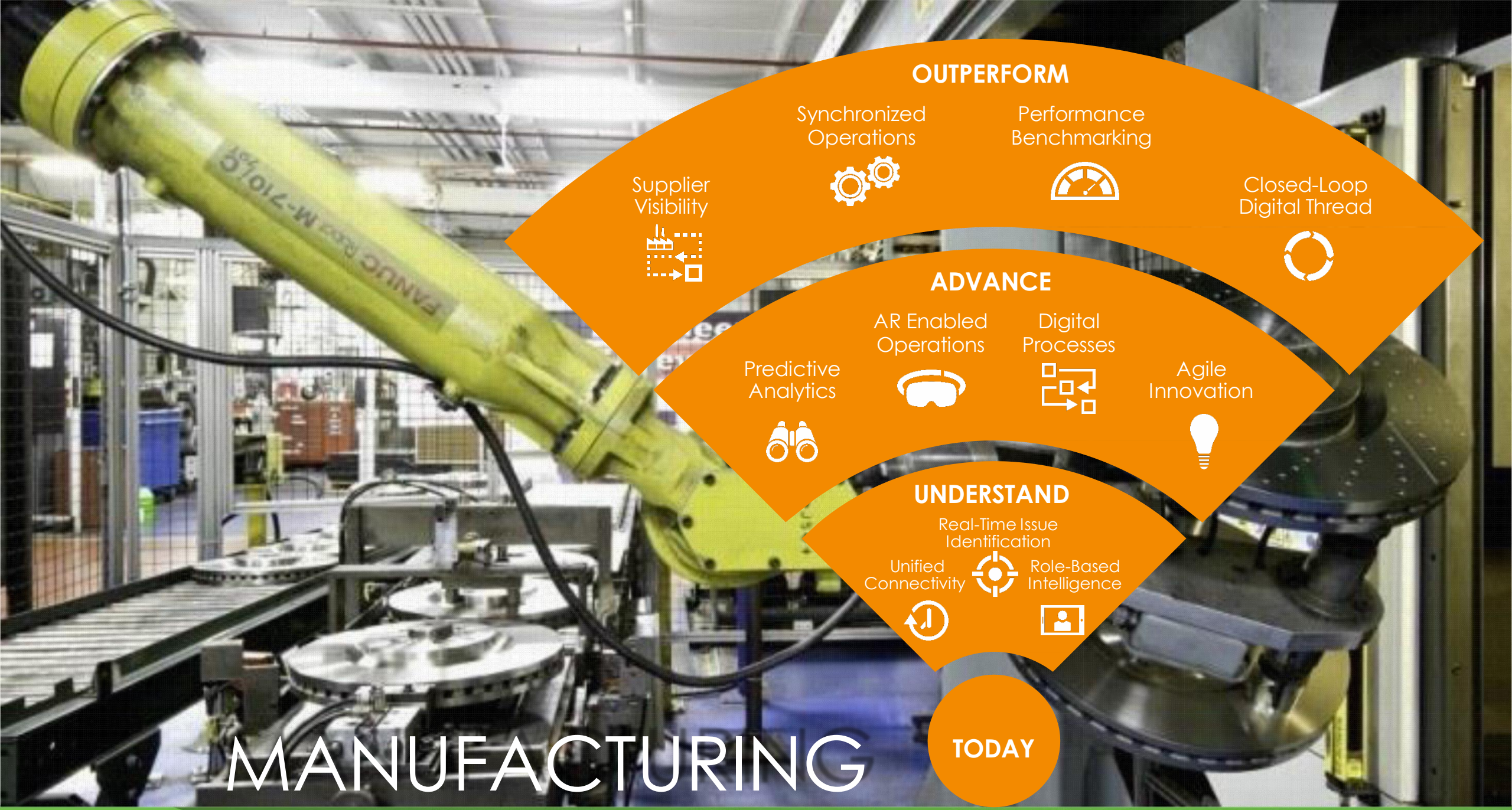
Select items on both sides and click Apply to create new trace links

PLE integration across Modeling and PLM



MANUFACTURING TRANSFORMATION

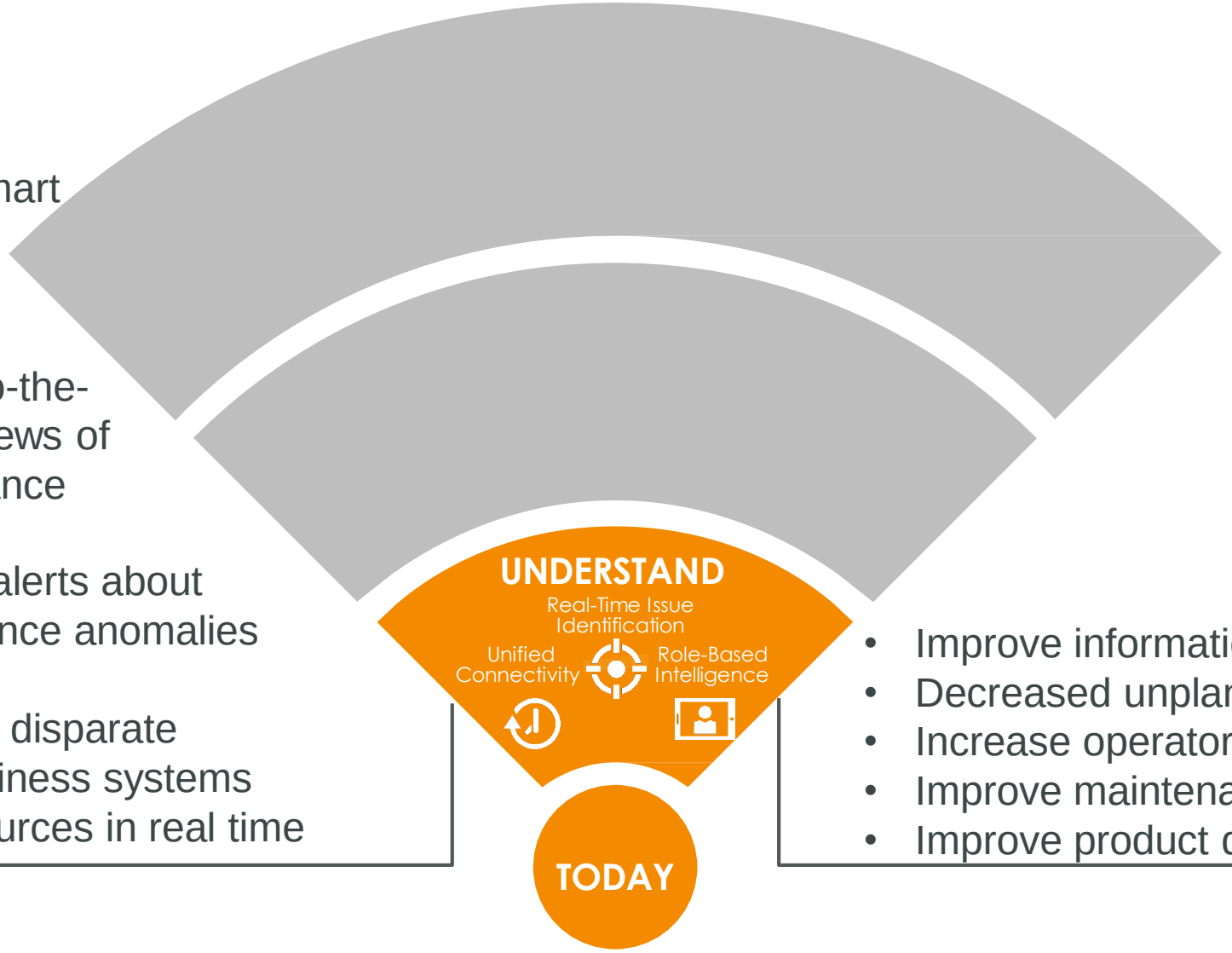
Continuously improve your operational performance and flexibility



MANUFACTURING

STAGE ONE: UNDERSTAND

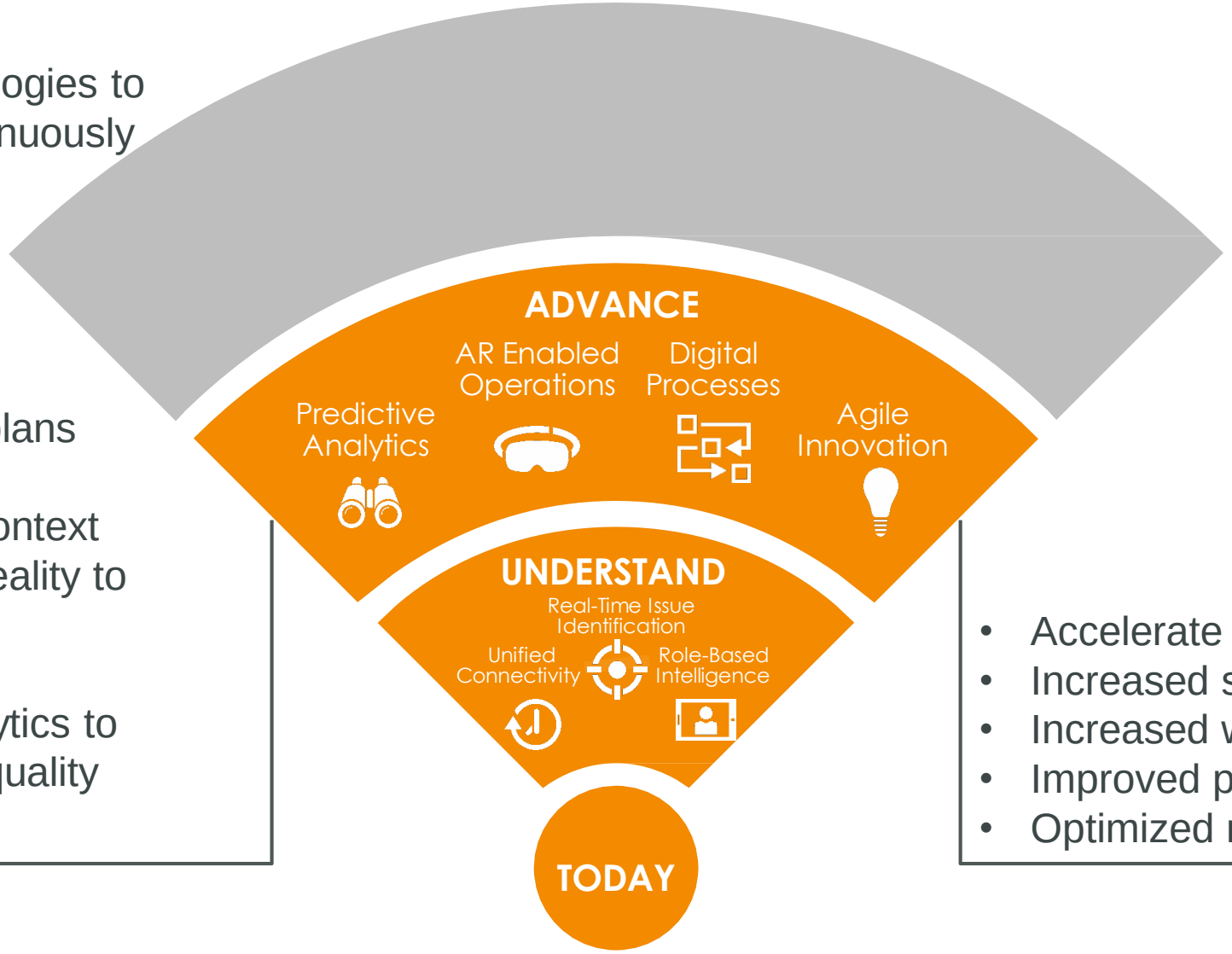
- Enhance existing infrastructure with smart sensors and modern technologies
- Simplify data in up-to-the-minute role-based views of operational performance
- Broadcast real-time alerts about assets and performance anomalies
- Connect diverse and disparate assets, sensors, business systems and external data sources in real time



- Improve information quality & reliability
- Decreased unplanned downtime
- Increase operator efficiency
- Improve maintenance efficiency
- Improve product quality

STAGE TWO: ADVANCE

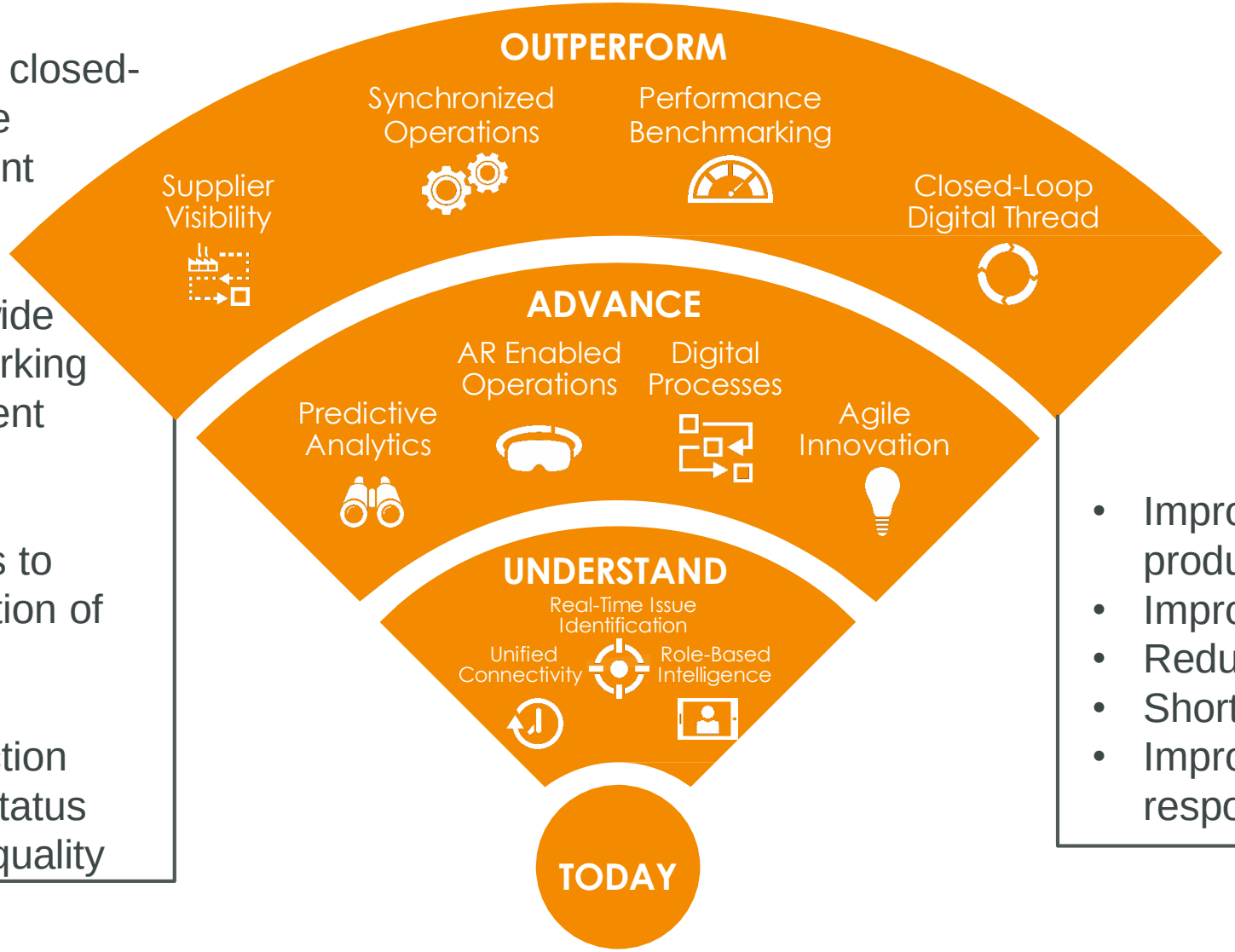
- Utilize agile methodologies to rapidly create & continuously evolve manufacturing applications
- Digitally design your manufacturing processes & quality plans
- Employ intuitive, in-context 3D and augmented reality to guide workers
- Apply predictive analytics to machine health and quality processes



- Accelerate continuous improvement
- Increased speed and flexibility
- Increased workforce efficiency
- Improved product quality
- Optimized maintenance processes

STAGE THREE: OUTPERFORM

- Deploy physical-digital closed-loop processes to drive continuous improvement
- Implement consistent KPIs and operations-wide performance benchmarking to identify and implement best practices
- Synchronize resources to ensure flawless execution of production
- Obtain supplier production visibility to gain early status into performance and quality



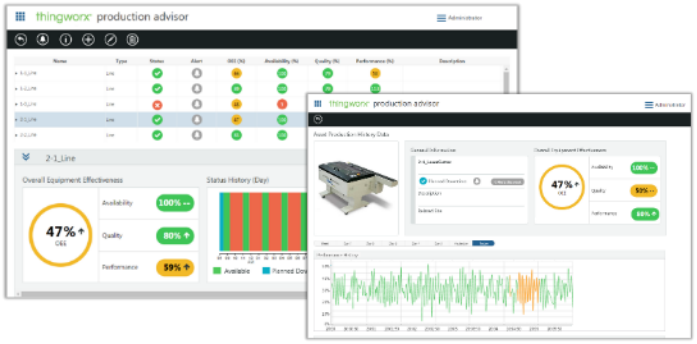
- Improve and perfect production processes
- Improve profitability
- Reduce unplanned downtime
- Shorten lead times
- Improve agility and responsiveness

ThingWorx Manufacturing Apps

Transform your performance by giving your operations teams unprecedented capabilities to see, understand and act in real time. ThingWorx manufacturing apps accelerate your time-to-value and offer unmatched flexibility.

ThingWorx Production Advisor

Plant Manager

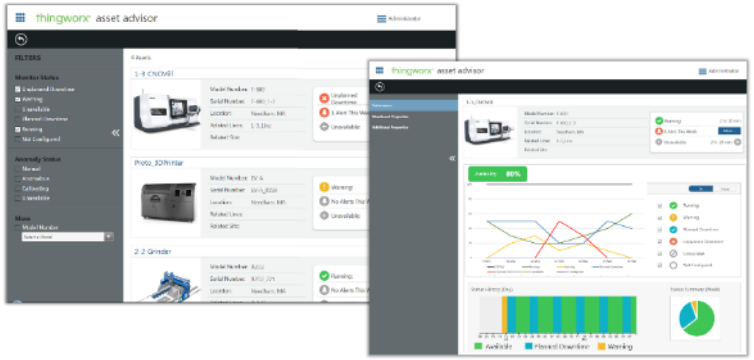


Optimize Production Performance

Real-time monitoring of production status and critical KPI's. Detect and react instantly to production schedule and quality issues.

ThingWorx Asset Advisor

Maintenance

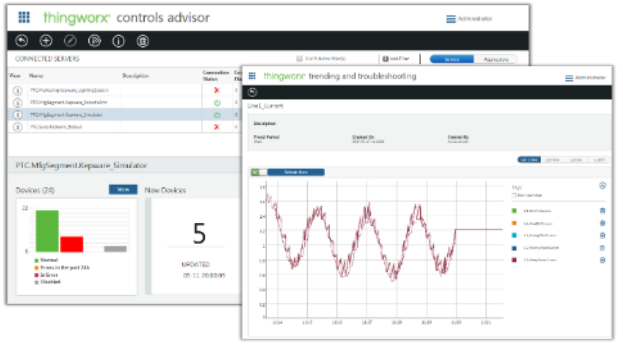


Reduce unplanned downtime

Real-time monitoring of the status and health of critical production assets. Detect anomalies to identify potential issues that could result in unplanned downtime.

ThingWorx Controls Advisor

Controls Engineer



Ensure OT Network Data Quality

Unified real-time monitoring of all connected end points and related data elements on the OT system network. Rapidly and flexibly trend data to troubleshoot issues

CONNECT

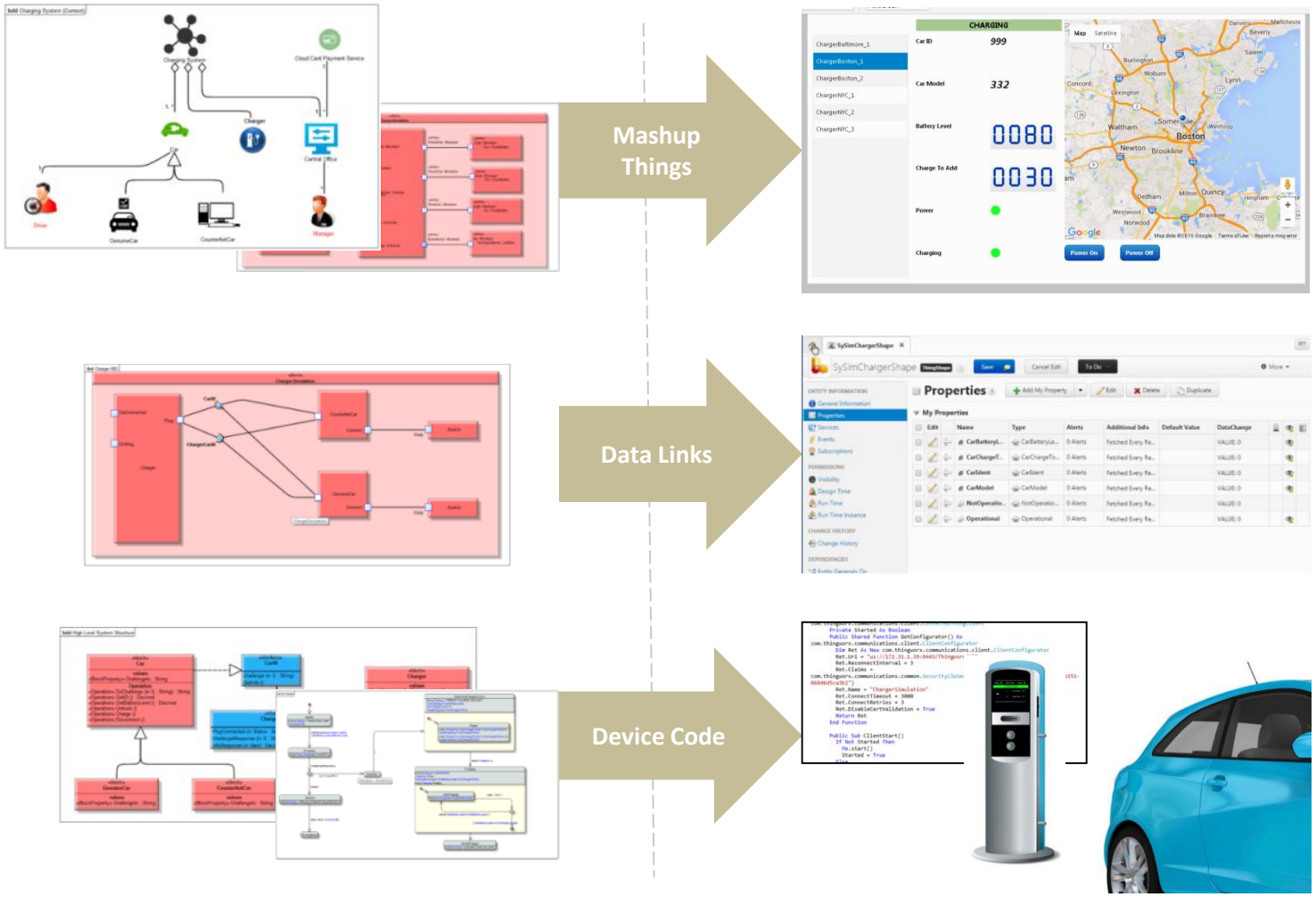
MODEL-DRIVEN IOT

- IoT system architecture design for complex systems
- Systems flow-down to IoT software modeling
- Automated IoT code generation for ThingWorx
- Edge-device to Cloud and Edge-device to Edge-device

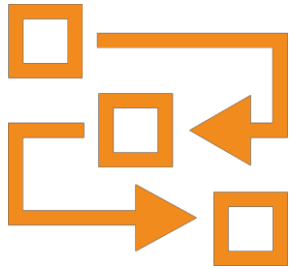
PTC MBSE

PTC Integrity™ Modeler™

ThingWorx



DIGITAL PROCESSES



Digital Processes

Manufacturing processes, quality plans, and work instructions are defined and delivered digitally

- Accelerates **time-to-volume production** through the digital validation of manufacturing processes
- Improves **operator efficiency** through delivery of 3D/AR work instructions and in-process quality validation
- Improves **product quality** by defining control characteristics and validation requirements from the 3D models
- Accelerates **change propagation** with associative engineering and manufacturing change management

PTC Solutions:
- ThingWorx Platform
- Windchill MPMLink

Customers:

AIRBUS Solar Turbines A Caterpillar Company CNB GROUPE BENETEAU

DEMO VIDEO

Import Creo NC process plan

File Edit View History Bookmarks Tools Help

CreoMechanicalPart - AFE-... | CreoMechanicalPart - AFE-...

icenterv01.ptcnet.ptc.com/Windchill/app/#ptc1/tcomp/infoPage?oid=VR:wt.part.WTPart:4311521

Most Visited | Windchill R11 | WTSHIP1 | WPA | Dame Catherine's › Lo... | PTC R&D Integrity 10 ... | Visualization - listcont... | PTC Navigate | ThingWorx Composer | WQS IOT | Sign In - Skytap | Dashboard - PTC Servi... | thingworx sample

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Recently Accessed

Actions | CreoMechanicalPart - **AFE-CR-0100-01-MFG, AFE-CR-0100-01 Mold Bottom MFG Assembly, PTC, A.4 (Design)**

In Work

Details | **Structure** | Related Objects | Changes | History | Where Used | Traceability | AML/AVL | Relationship Explorer | Theos Info Page | Product Analytics | Variant Spec | Baslines | Variants | WQS

Editing: Insert Existing, Remove, Insert New, Edit
Check Out/In: Check Out, Revise, Check In, My Checkouts
Clipboard: Paste, Copy
Viewing: Show, Views, Hide, Display
New/Add To: New, Add to
Filter: Edit Filter, Current Filter, Saved Filters
Tools: Compare, Open in
Service: Generate
Reports: Reports, Export

Find in Structure

Loaded 4 objects

Number	Name	Version
AFE-CR-0100-01-MFG	AFE-CR-0100-01 Mold Bottom MFG Assembly	A.4 (Design)
0000001923	MFG Medium Clamp	A.3 (Design)
0000001925	MFG Base Plate 001	A.2 (Design)
AFE-CR-0100-01	Conrod Forging Mold Bottom	A.2 (Design)
MB-240X160X62	Mold Billet 240x160x62 mm	A.2 (Design)

(5 objects)

Classification | **Visualization** | Uses | Occurrences | Attributes | Supersedes

Loading...

Search | Browse

Navigator

AUGMENTED REALITY ENABLED OPERATIONS

AR Enabled Operations

Immersive factory experiences improve training, work instructions, quality validation, maintenance execution, and operations monitoring by layering digital information onto the user's physical world

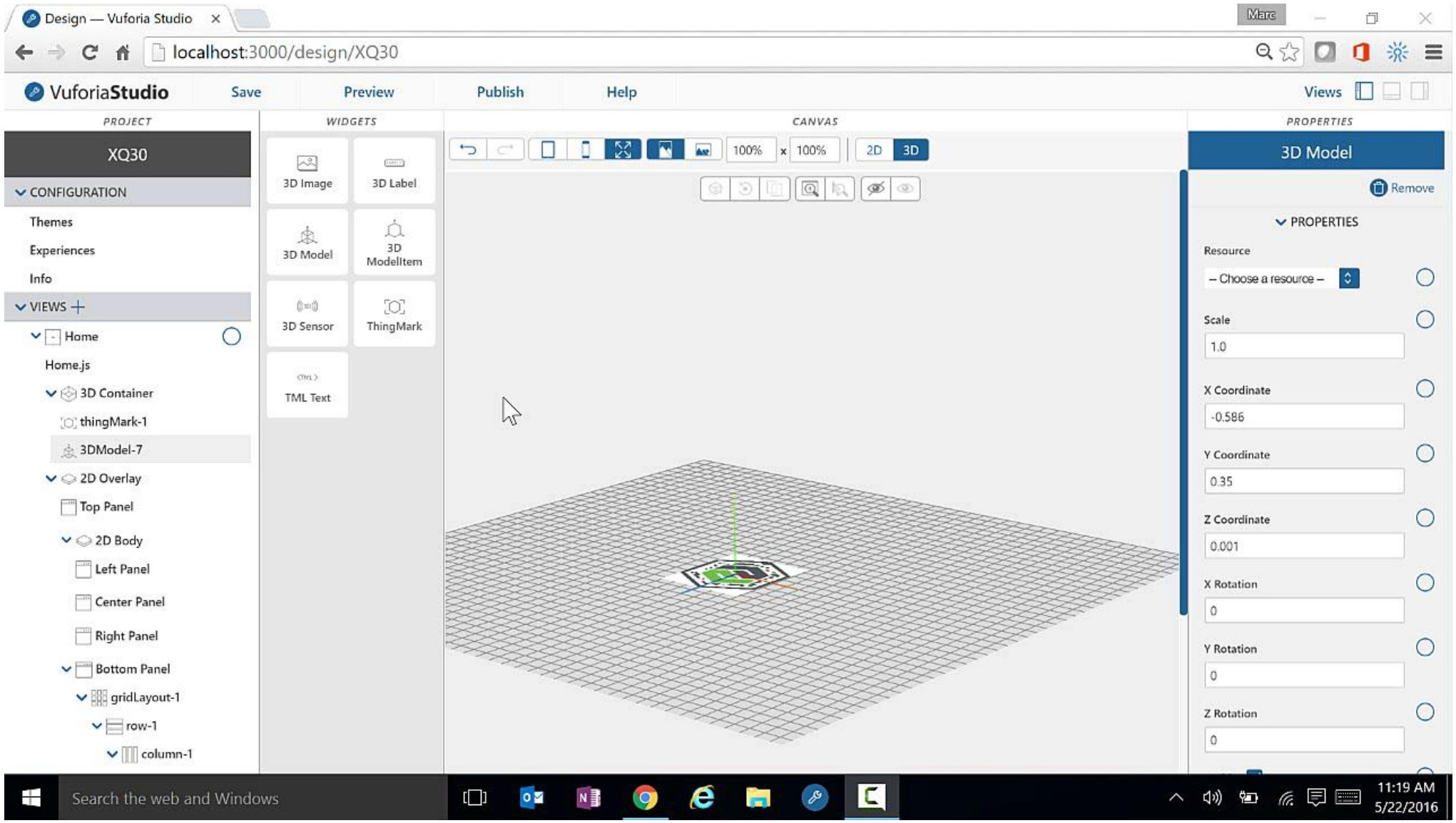
- Increases **workforce efficiency** and flexibility by delivering easy-to-consume, guided instructions
- Dramatically **improves training** speed and outcomes through cognitively rich digital / physical user experiences
- **Improves quality** assurance through use of AR as a quality-control visual validation technique
- **Improves safety** by making workers aware of in-context safety risks

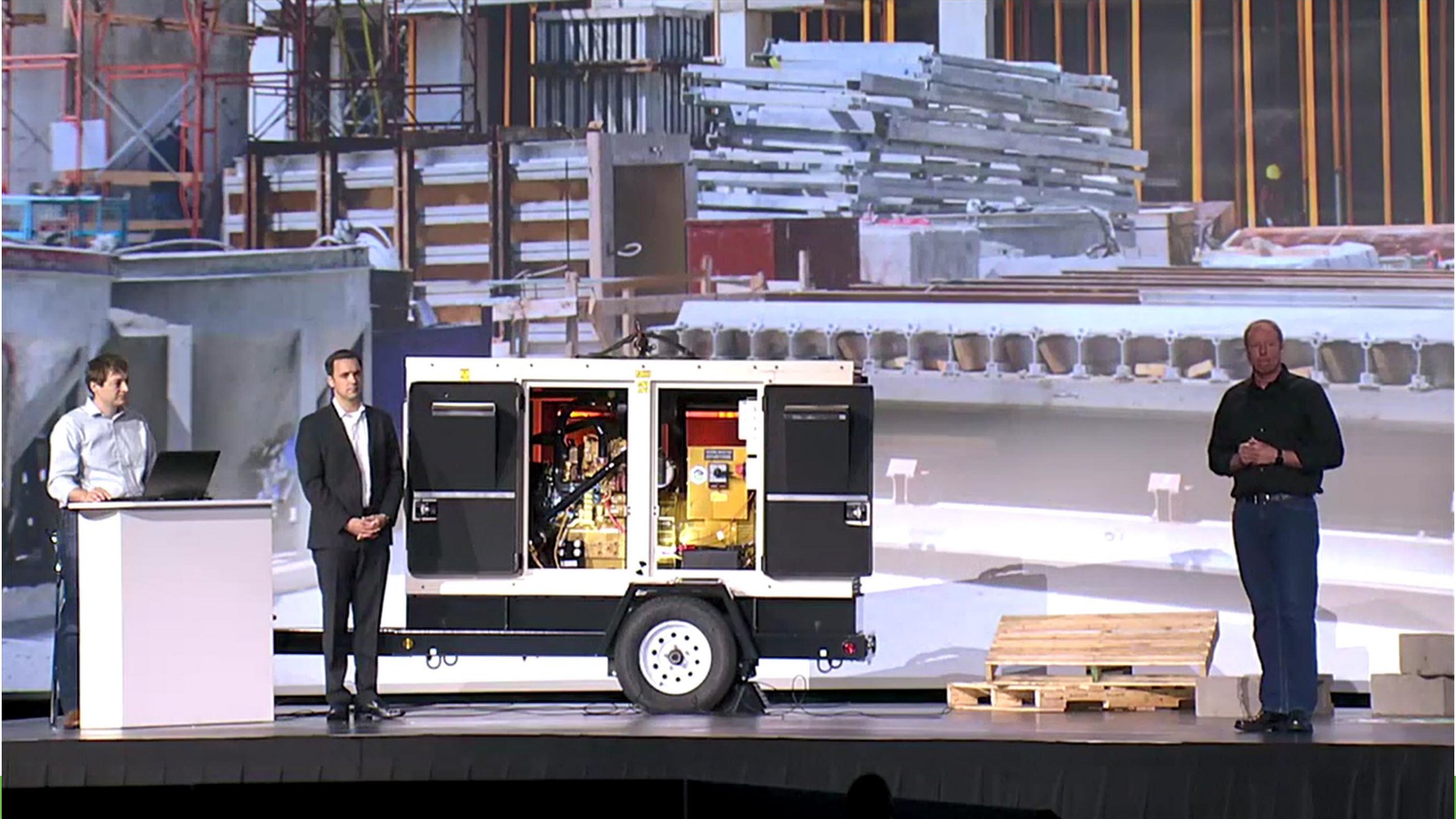
PTC Solutions:
- ThingWorx Studio and ThingWorx View
- MPMLink

Customers:

Solar Turbines
A Caterpillar Company

What if you could create and use augmented reality experiences in less than a minute? … with **your** engineering data?





CLOSED-LOOP DIGITAL THREAD

Closed-Loop Digital Thread

Physical manufacturing processes are compared with digital models to identify opportunities for continuous improvement.

- Uses closed-loop feedback from production to identify product **design improvements**
- Identifies manufacturing **process and quality improvements** based on production outcomes
- Continuously assesses gaps between the physical/digital realities to **improve and perfect production** processes

PTC Solutions:
- ThingWorx Platform (Connectivity, Foundation, analytics)
- MPMLink
- Q3 – Kinex for Manufacturing

Customers:

CNB GROUPE BENETEAU

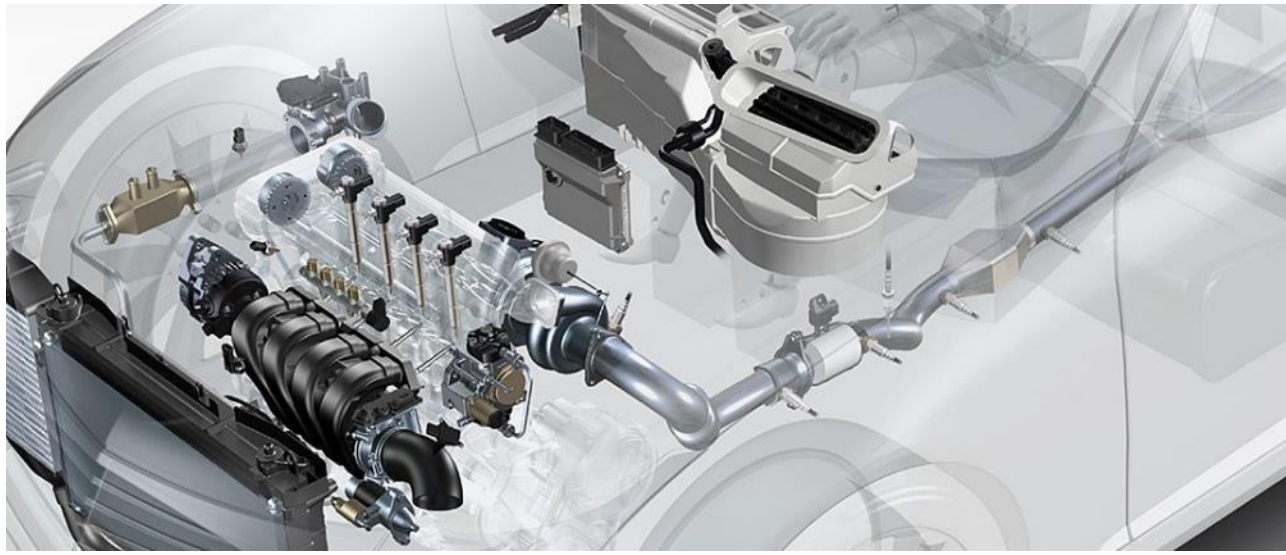
IN THE WORDS OF LEADING MANUFACTURERS

GE Brilliant Factory

- "Get Connected, Get Insights, Get Optimized"
- 530 plants in total. 75 in 2016

Airbus Factory of the Future

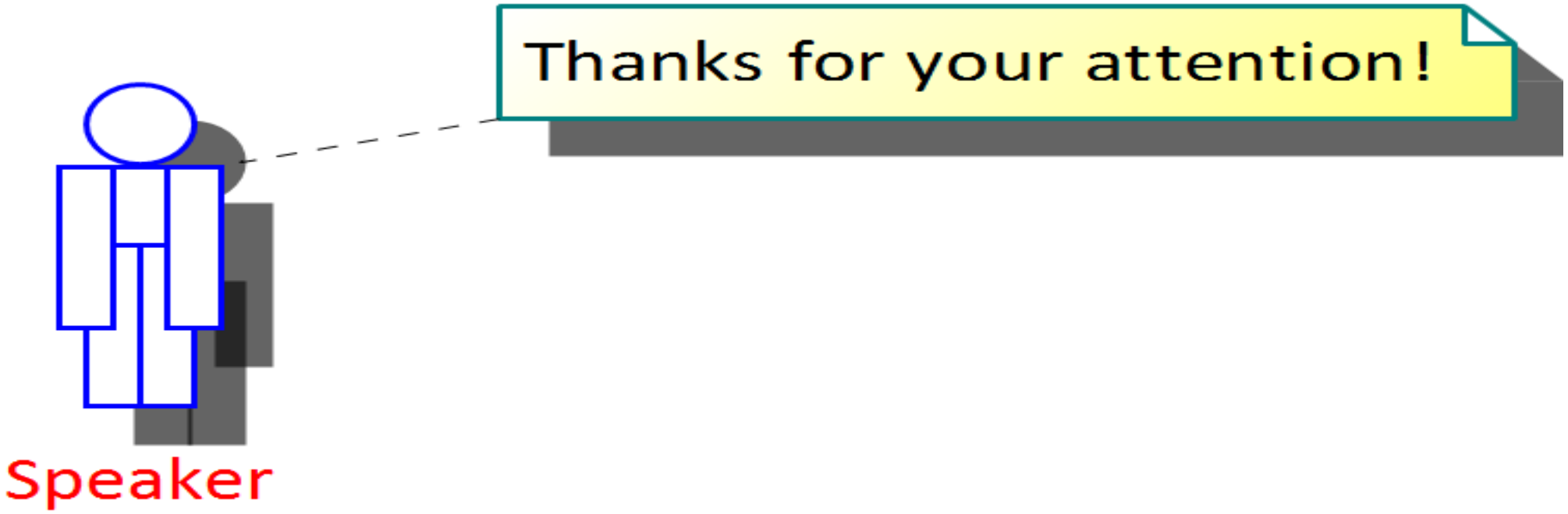
- "Future digital technology will be introduced everywhere in the factory"



DENSO "Dantotsu" Factories

- "Linking 130 factories at home and abroad by 2020"

Questions and Answers



ptc

CUSTOMER STORIES

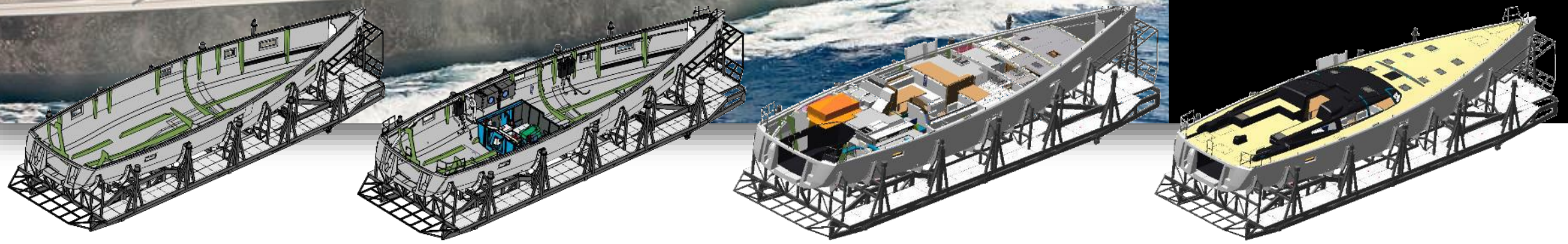
CNB STREAMLINES MANUFACTURING WITH DIGITAL PROCESS PLANNING

CNB superyachts

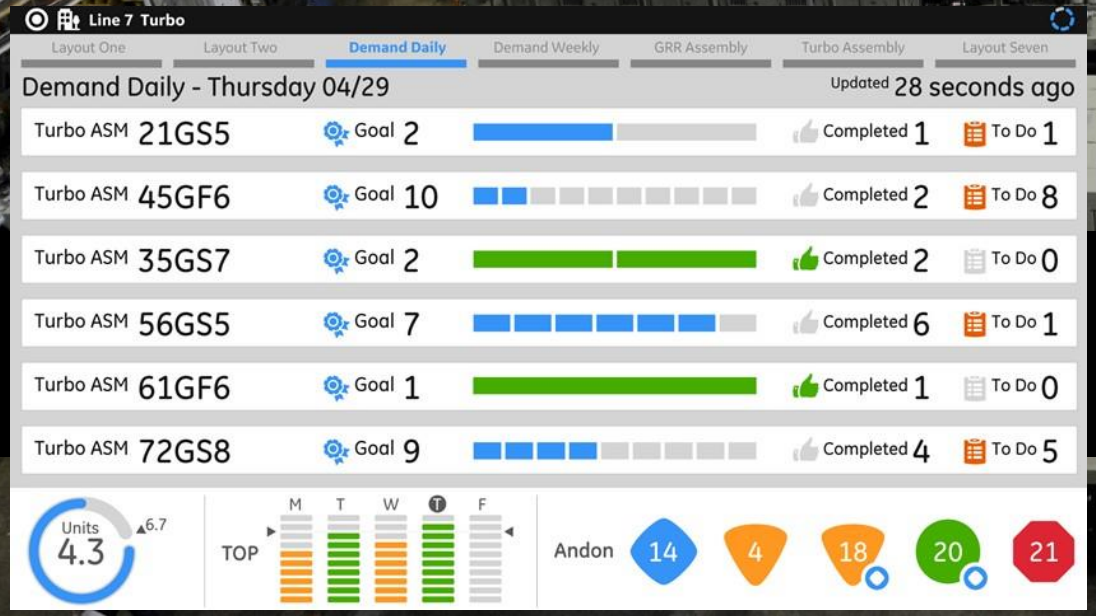
"The PTC Manufacturing Process Management solution helps streamline our R&D and manufacturing processes."

"PTC has delivered a solution that is in line with the vision we have for improving our product development and manufacturing processes."

CNB

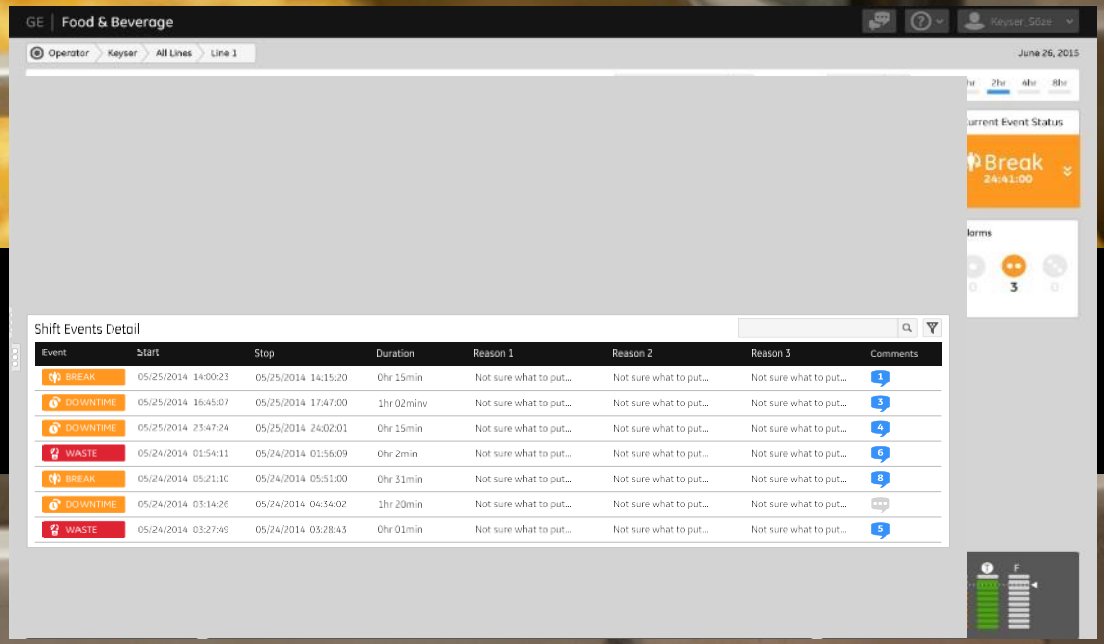


GE TRANSPORTATION, GROVE CITY



10 to 20% reduction in unplanned downtime

A GLOBAL FOOD LEADER INCREASES PRODUCTIVITY



5 to 8% improvement in productivity

SMART, CONNECTED ASSEMBLY LINE FOR IMPROVED QUALITY

AIRBUS

Leading aircraft manufacturer with €40 billion in revenue and 55,000 employees

SOLAR TURBINE

Display Work Instruction Wizard

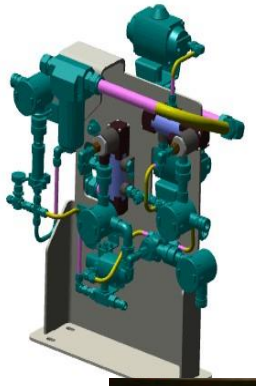
Solar Turbines
A Caterpillar Company

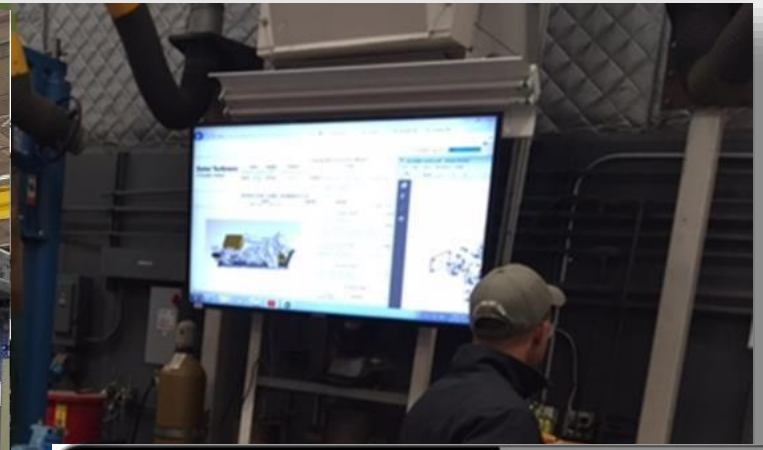
NAME	NUMBER	VERSION	TYPE	ASSOCIATED PART NAME	NUMBER	VERSION	ACTIVE
CONFIG,GF,PURGE,NITRO	1119344	A.19 (Manufacturing Process)	Production	CONFIG,GF,PURGE,NITRO	1119344	-.1.10 (Manufacturing Process)	Yes

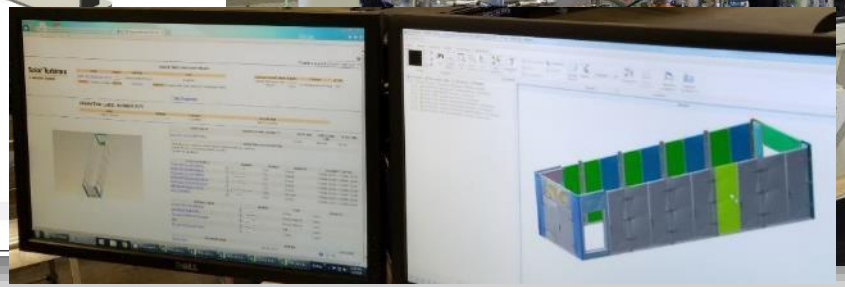
STATE: In Work STATUS: Work in progress CONTEXT: Configurable Packages [CAT-Confidential Yellow]

Filter Properties

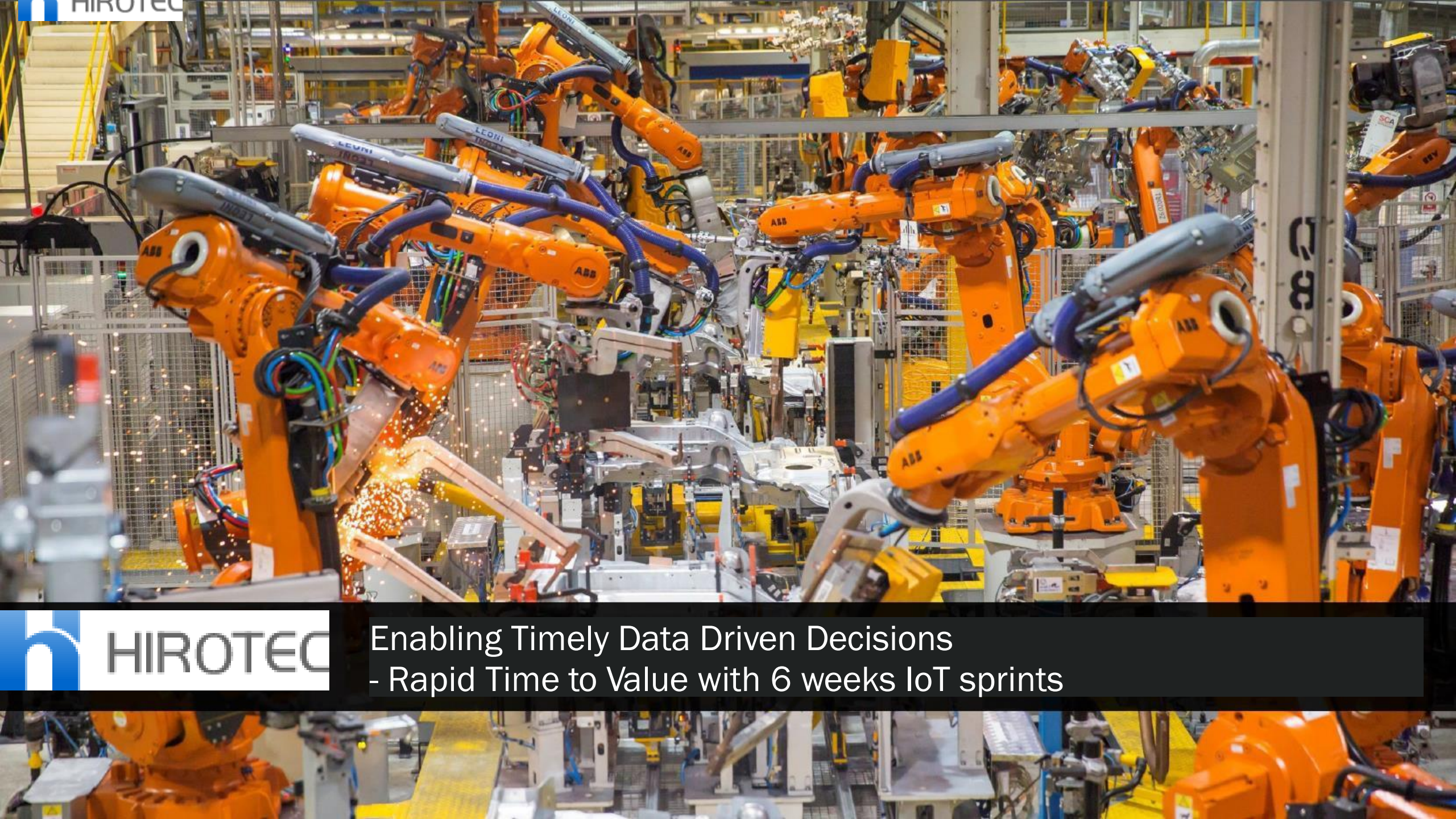
NAME
FIT AND INSTALL TUBING







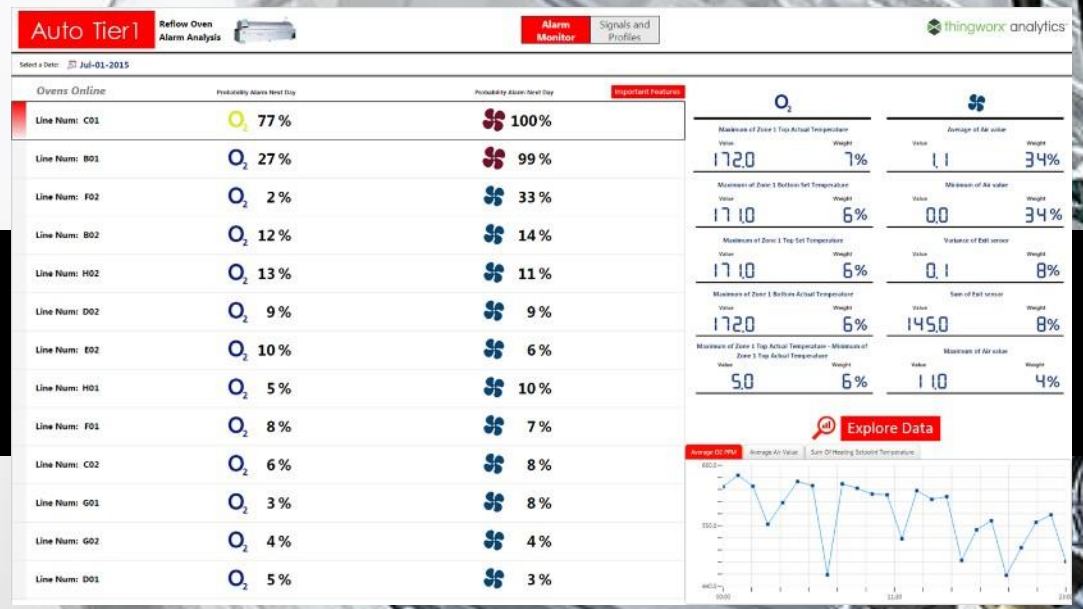
STATE	STATUS
In Work	Work in progress



HIROTEC

Enabling Timely Data Driven Decisions
- Rapid Time to Value with 6 weeks IoT sprints

PREDICTIVE MAINTENANCE TO REDUCE UNPLANNED DOWNTIME



Predicting alarms 24 hours in advance, with a 91% accuracy

CASCADES – CONNECTIVITY INSIGHT

Cascades

"I will show the tool to my team and use it every time we have support calls regarding data collection"

- Benoit Lapensee, Director of MES