Pragmatic Digital Transformation

Through the Systematic Use of Data and Models

Jim Tung
MathWorks Fellow

Consider the doorbell

Access to the cloud

Add a camera

Add a motion sensor

Is this still a doorbell?

Digital transformation has changed the doorbell

Digital technology

- HD video
- Motion detection
- Smartphone interface
- AWS Cloud

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Business value

- Amazon buys Ring for $1.2 billion+ in 2018


Amazon Acquires Ring, Maker of Video Doorbells

Front-door monitoring device plays to buyer's ambitions in home-security business

Digital transformation has changed the doorbell

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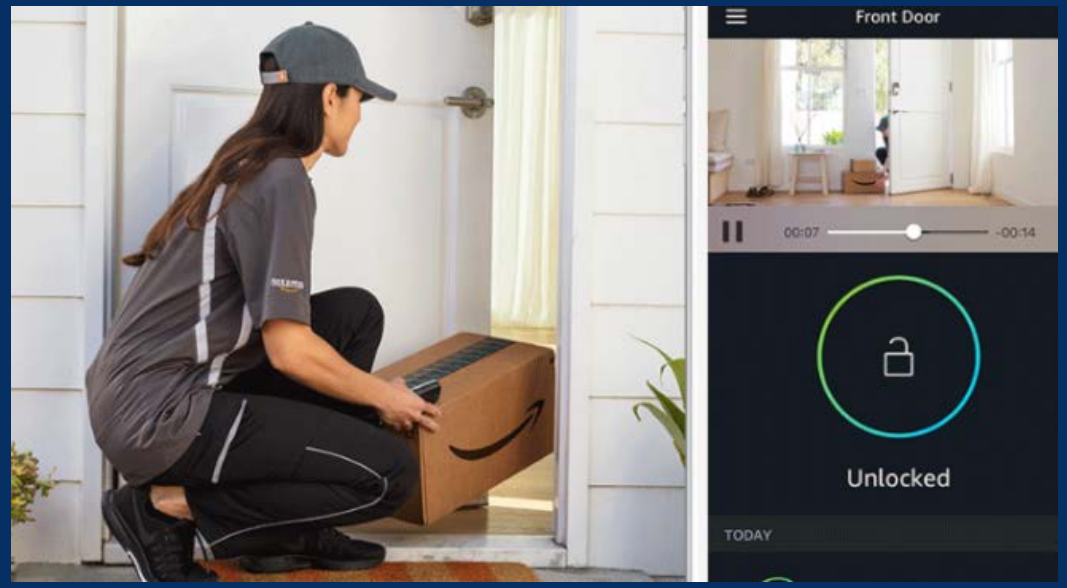
New revenue opportunities

- “Ring Protect” subscription plans ($99-$499)
- Additional security with Ring Alarm kit
- More secure delivery through Amazon Key



Who and what were required to undergo this transformation?

App developers

Smartphone interfaces

Data engineers

System architects

Computer vision

Cloud experts

Wireless systems

Software engineers

Algorithm designers

Image processing

IoT platform

Enterprise systems

Data analytics

Business partnerships

Controls design

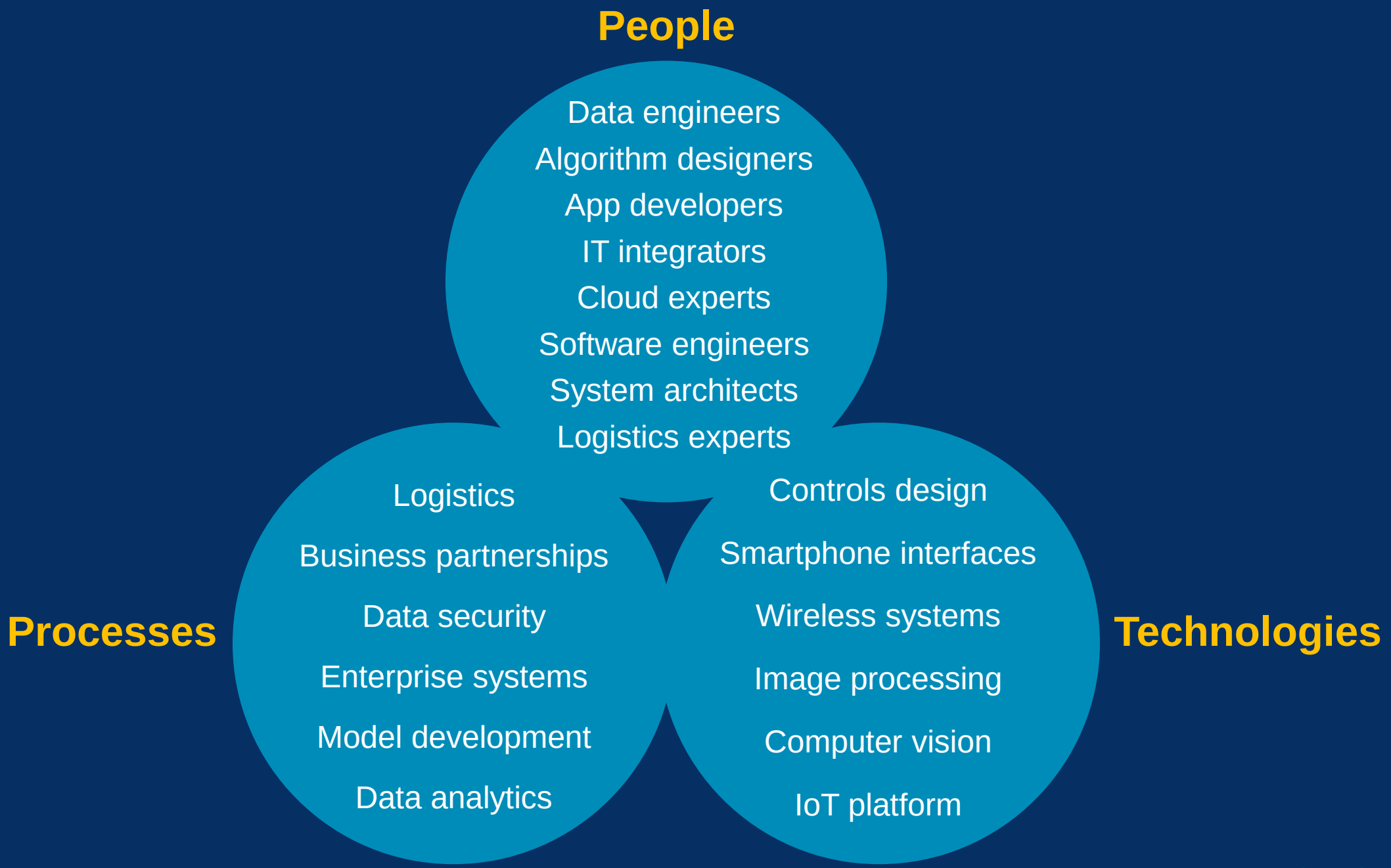
Logistics

IT integrators

Logistics experts

Model development

Data security



More than just doorbells …

Industrial Automation

Individually customized manufactured units

Automotive

Fully autonomous driving capabilities

Utilities & Energy

Increased energy efficiency with predictive maintenance

Medical

Wearable devices to monitor mental health

Aerospace

Global management of aircraft fleet

Finance

Real-time data analytics for predictive insights

Why Digital Transformation?

Do things better
Optimization

- Optimize design performance in-operation
- Predict when system needs maintenance
- Manage a fleet of connected systems

Do new things
Transformation

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Do new things
Transformation

- Go into new industries and markets
- Expand into an entire platform service
- Provide unique value to your customer

The doorbell illustrates both types

Plan and Pilot **Launch!**

Expected project duration

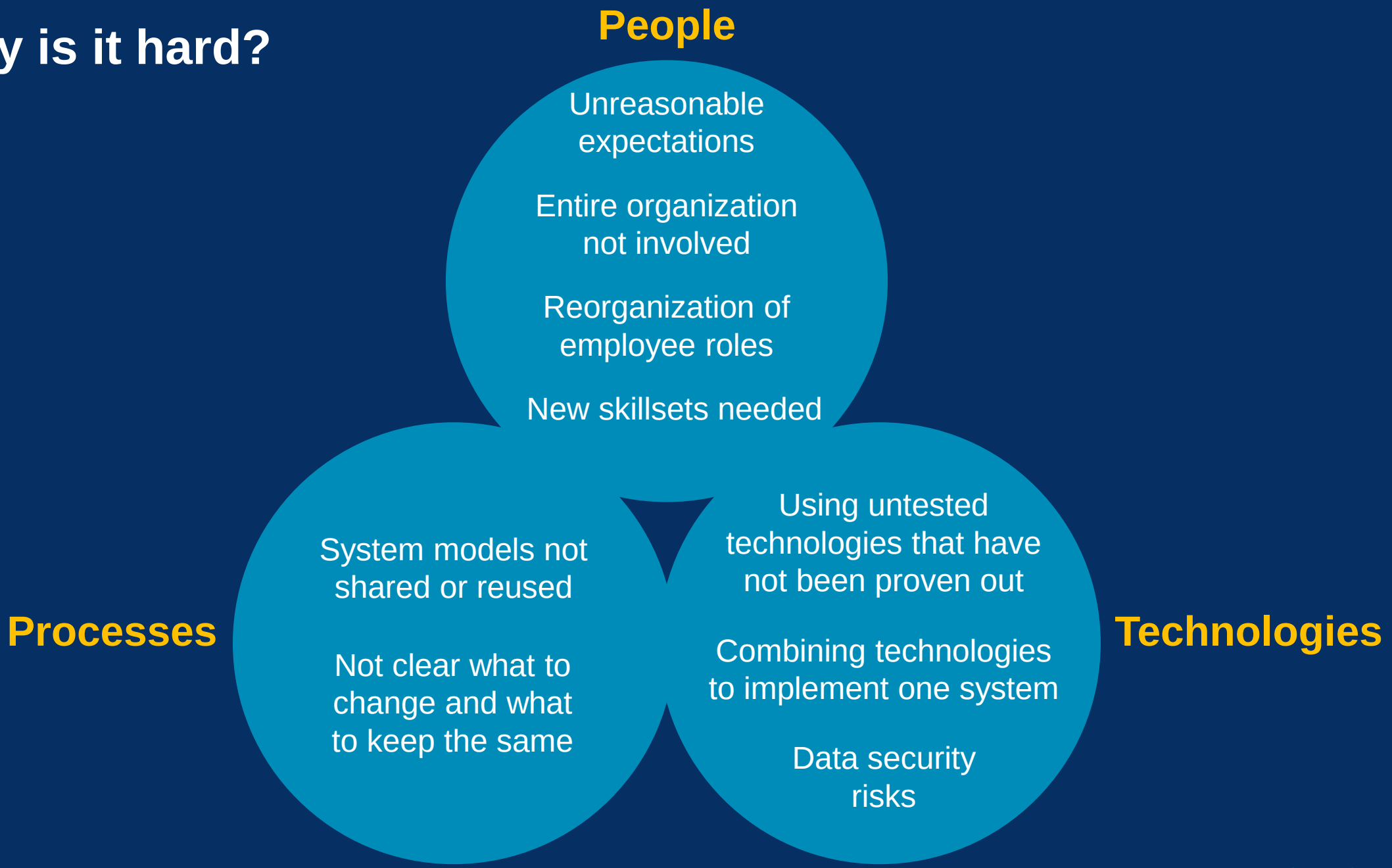
Actual project duration

Plan | Plan Some More | Pilot | Keep Piloting | **Launch?**

< 20% of organizations are on target with their digital transformation objectives

Source: McKinsey, *Can IT Rise to the Digital Challenge?*, October 2018.

Why is it hard?



What approaches have people tried?

Big Bang Approach

Build complete infrastructure first

Value not delivered to customer

Risky

Pragmatic Approach

Build on models you already have

Extend beyond siloed use of data

Unleash untapped value

Siloed Approach

Each group works in own silo

Stuck in business model

Obsolete

Pragmatic Digital Transformation

Systematic use of data and models
to **create** and **deliver** superior value to customers
throughout the entire lifecycle

Systematic Use of Data

Data centralization has made engineering even more difficult

Field data

System data

User data

Environment data

Big Data

databricks hadoop CLOUDERA

Cloud Platforms

docker amazon web services Azure

Data diversity complexity

- Engineering, Scientific, and Field
- Business & transactional
- Noisy, Outliers, Missing data
- Time series synchronizing

Modern data management multiplies complexity

- Proliferation of data systems
- More siloes
- Cloud, on-premise, hybrid
- Big Data

Example: GSK Consumer Healthcare

Using big batch process data to make better products

£1 billion brand

~8% growth

Close to capacity at all 20+ factories

"Trying to squeeze every last drop of efficiency …
Last thing we want to do is build another toothpaste factory"
Dr. Bob Sochon

Challenge #1: Big data lives in many siloes

Formulations Archive

Mix
Formulation
Year, month, date, time
Operators

Production Process

Every process variable!
Vessel temperature
Batch properties
Mixer/formula concentrations

20 factories
5 years of data
Top-10 formulations

10,000 batches

Terabytes of data

Sales History

What people are buying
What stores are selling
What time made

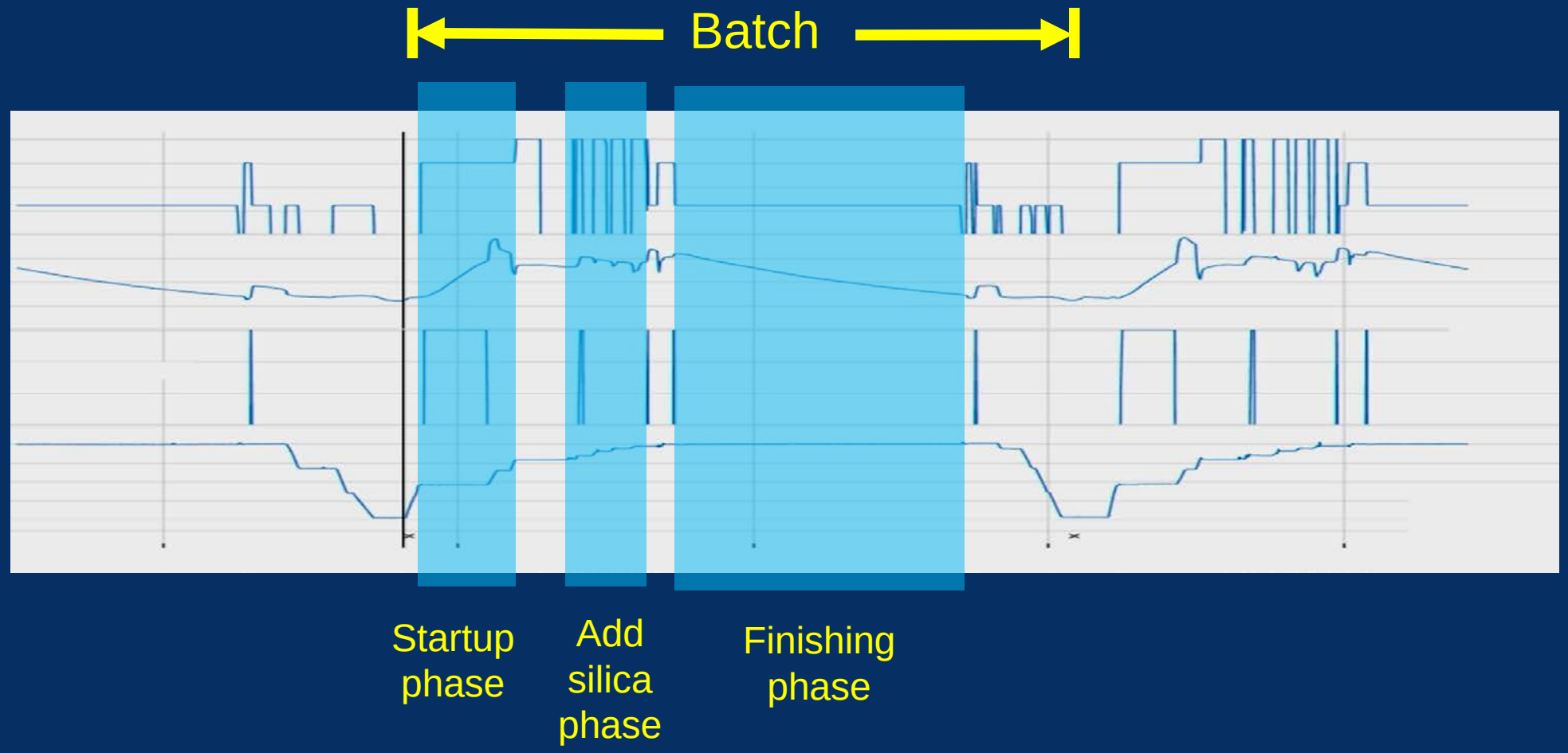
Excel Files

Miscellaneous
Historical

Used MATLAB to combine and clean data

Challenge #2: Need systematic pre-processing

Production Process



Used MATLAB to sort and tag data by phase

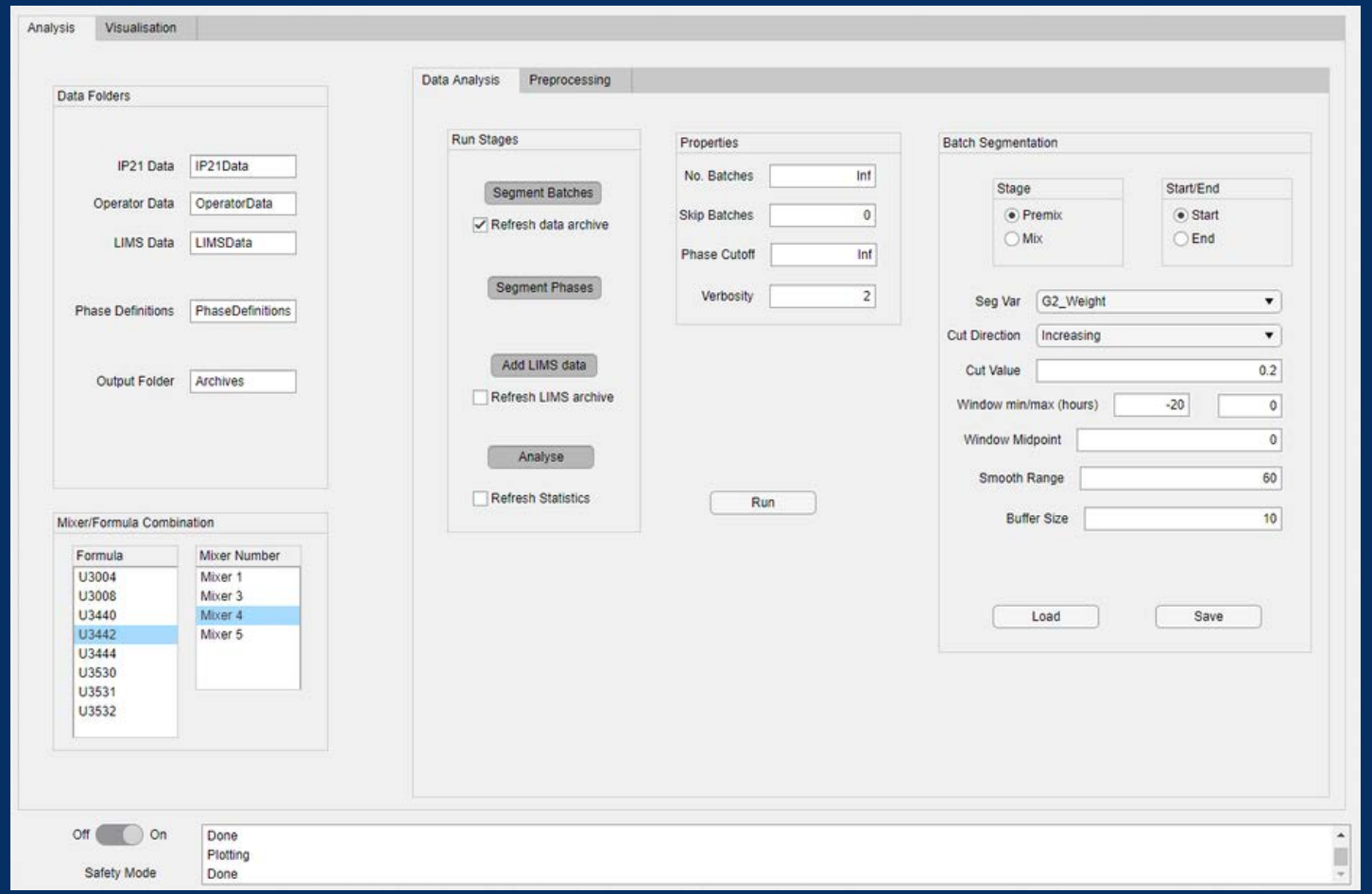
Challenge #3: Need systematic views of data

Formulations Archive

Sales History

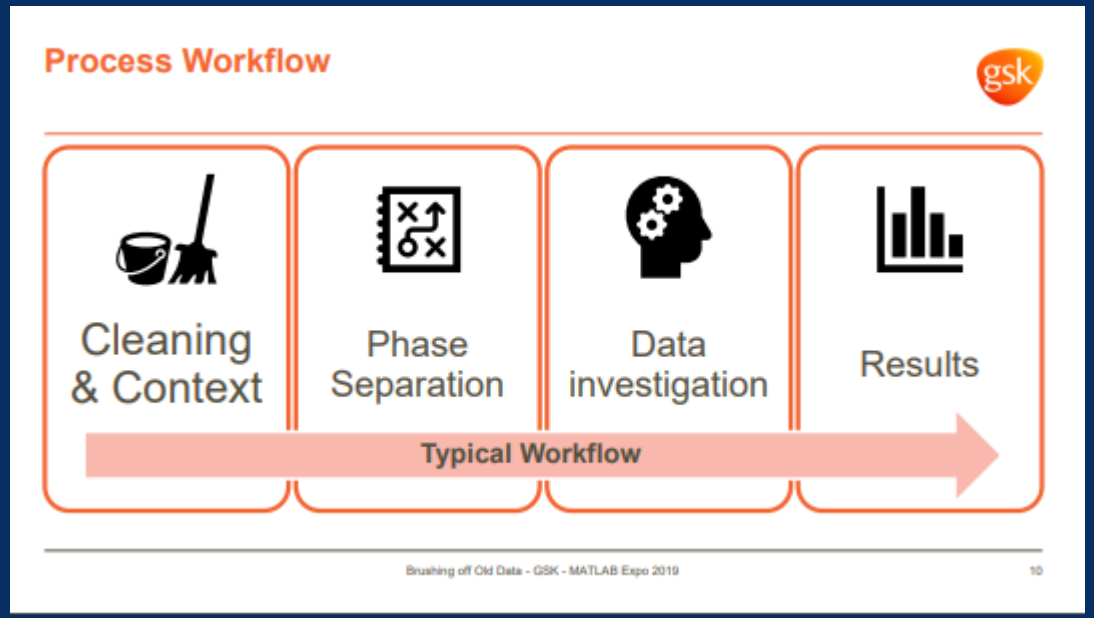
Production Process

Excel files



Used MATLAB to build views

Results of Digital Transformation at GSK



Systematic use of data

- Combine siloed data
- Sort and tag
- Views to select

Can now use data to answer questions

- What affects the process
- How is each phase performing
- What happens if we adjust parameters

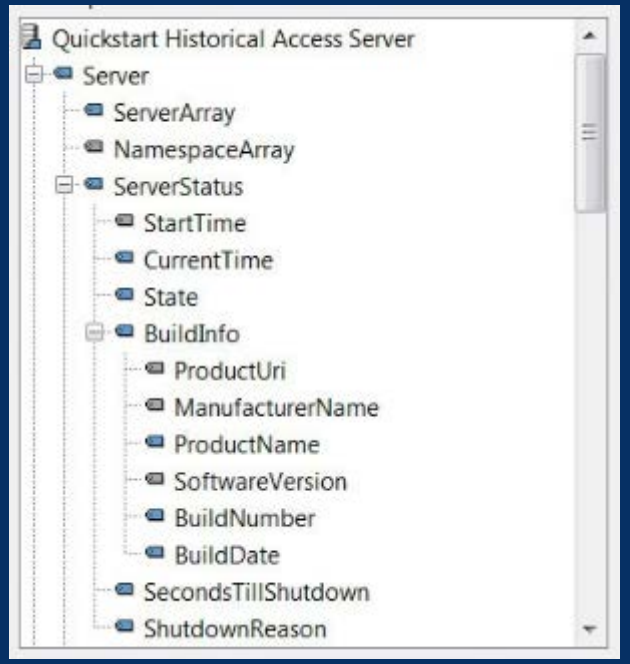
Benefits

- Reduced time to market for new formulas
- Automated reports for process improvement
- Added capacity without building a new factory

What is new to make this easier?

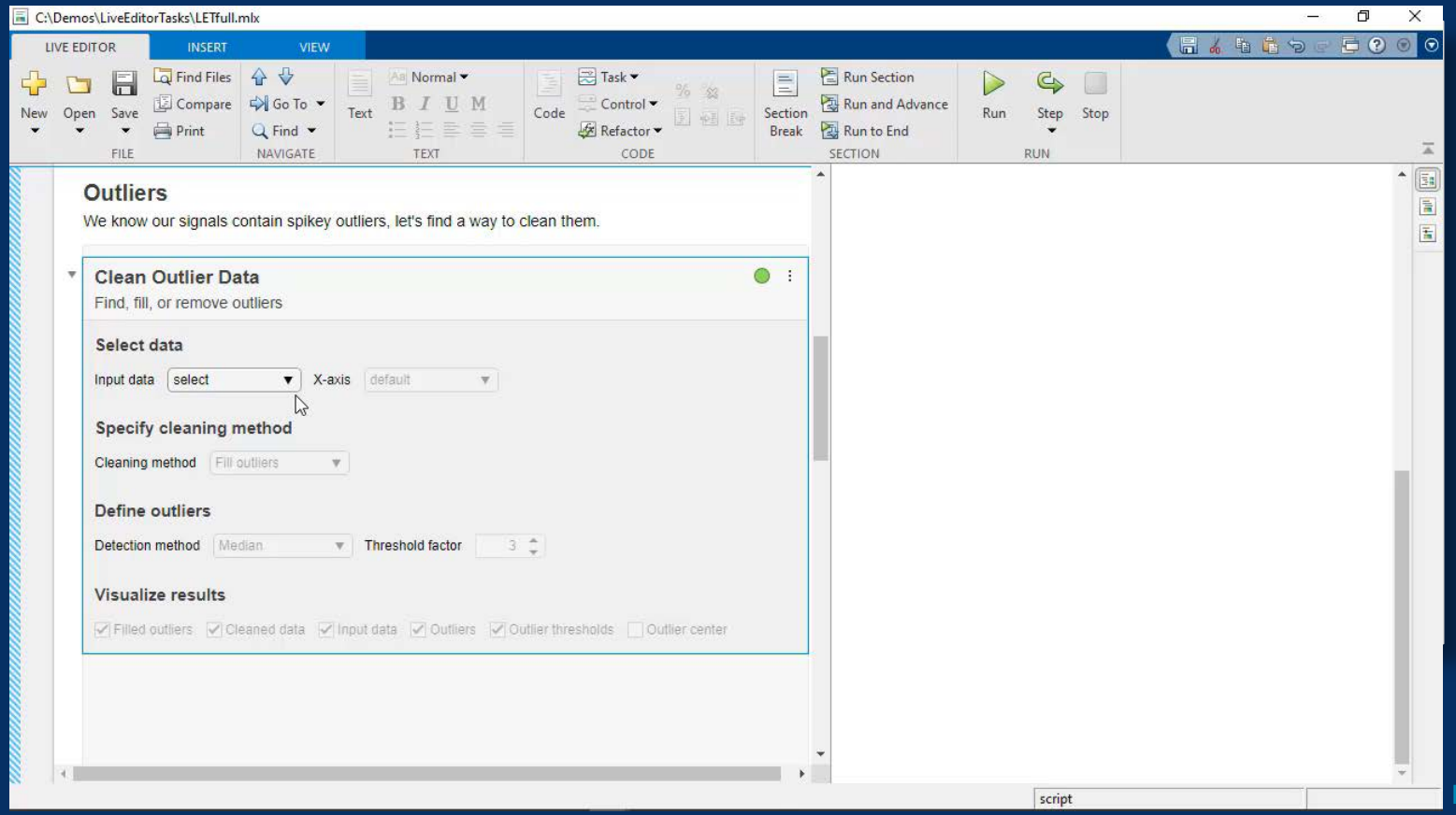
OPC UA

Access plant data securely from OPC UA-compliant servers.



Live Editor Tasks

Apps that help you reduce development time and errors



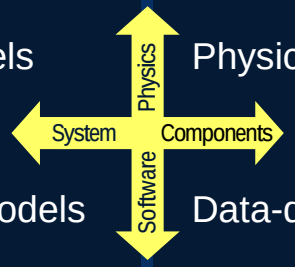
Predictive Maintenance Toolbox

Design condition indicators and estimate RUL of machinery

Systematic Use of Models

Model-Based Design: Systematic Use of Models in Development

System Requirements	System Functionality and Architecture	Subsystem Design	Subsystem Implementation	System Integration and Qualification
Use Cases	Behavior models	Physics-based	C,C++	Model-based V&V
Docs & models			VHDL, Verilog	Code-based V&V
	Architecture models	Data-driven	GPU code	Certification workflows
			Structured text	



Digital Thread

Model-Based Design: Systematic Use of Models in Development

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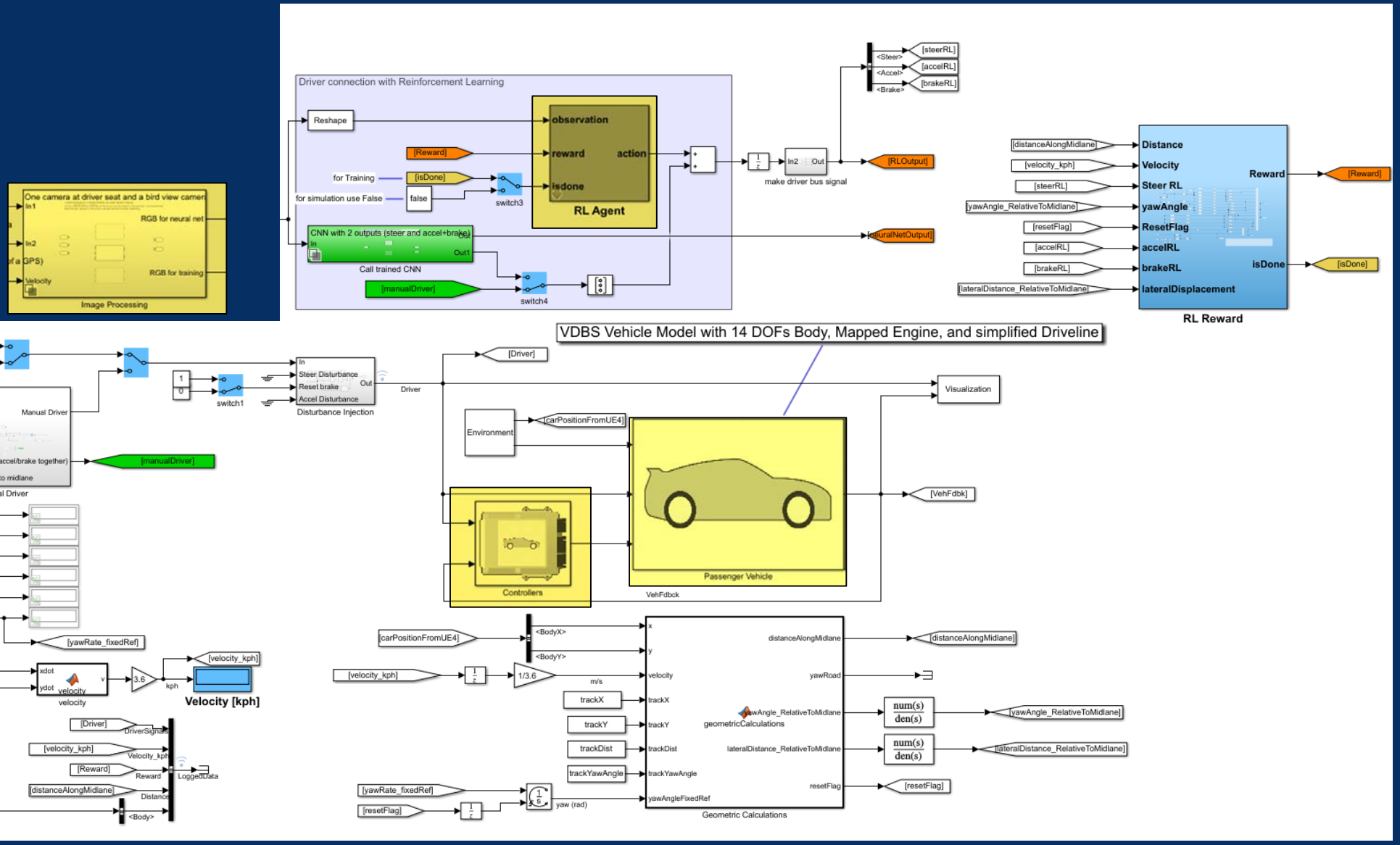
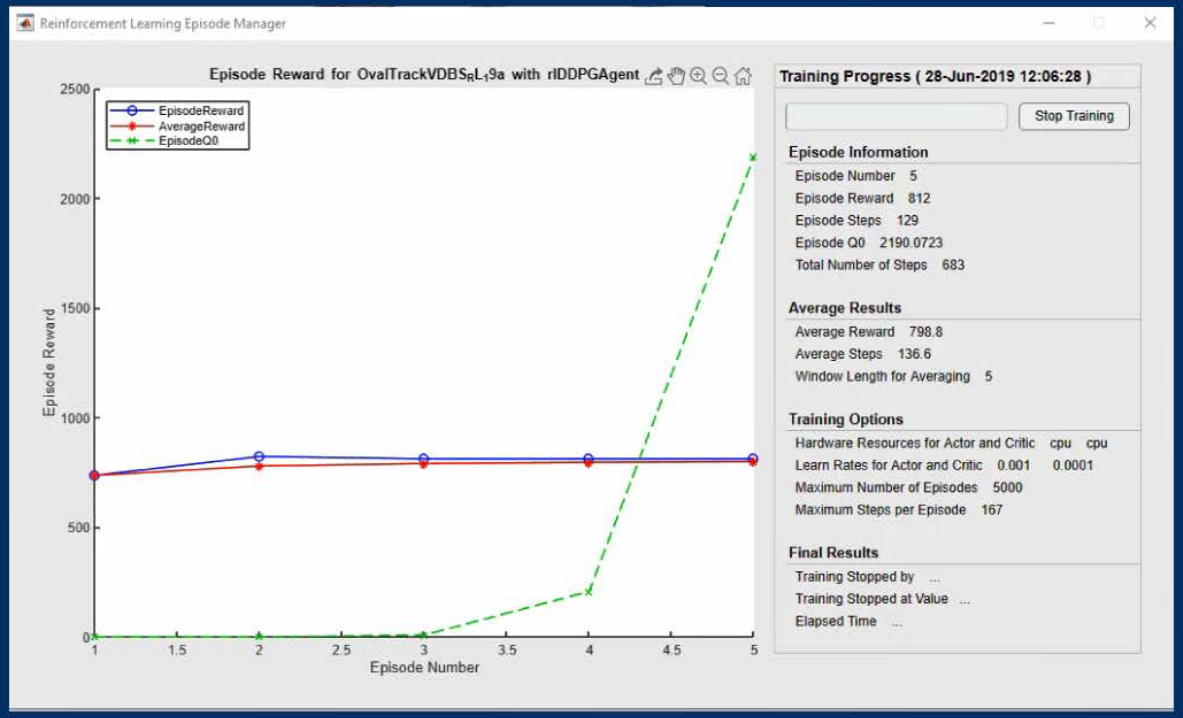
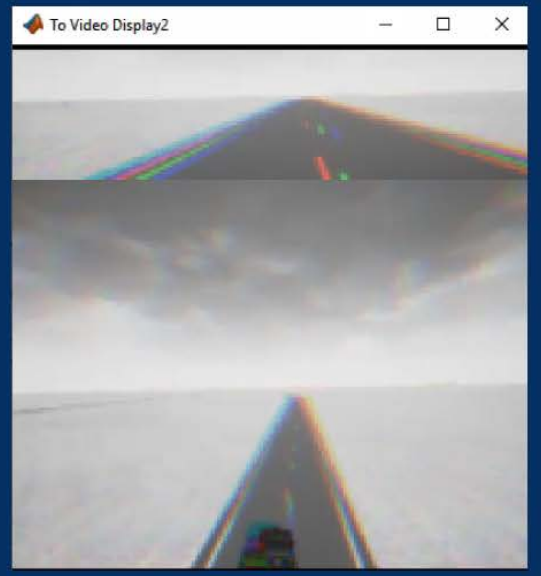
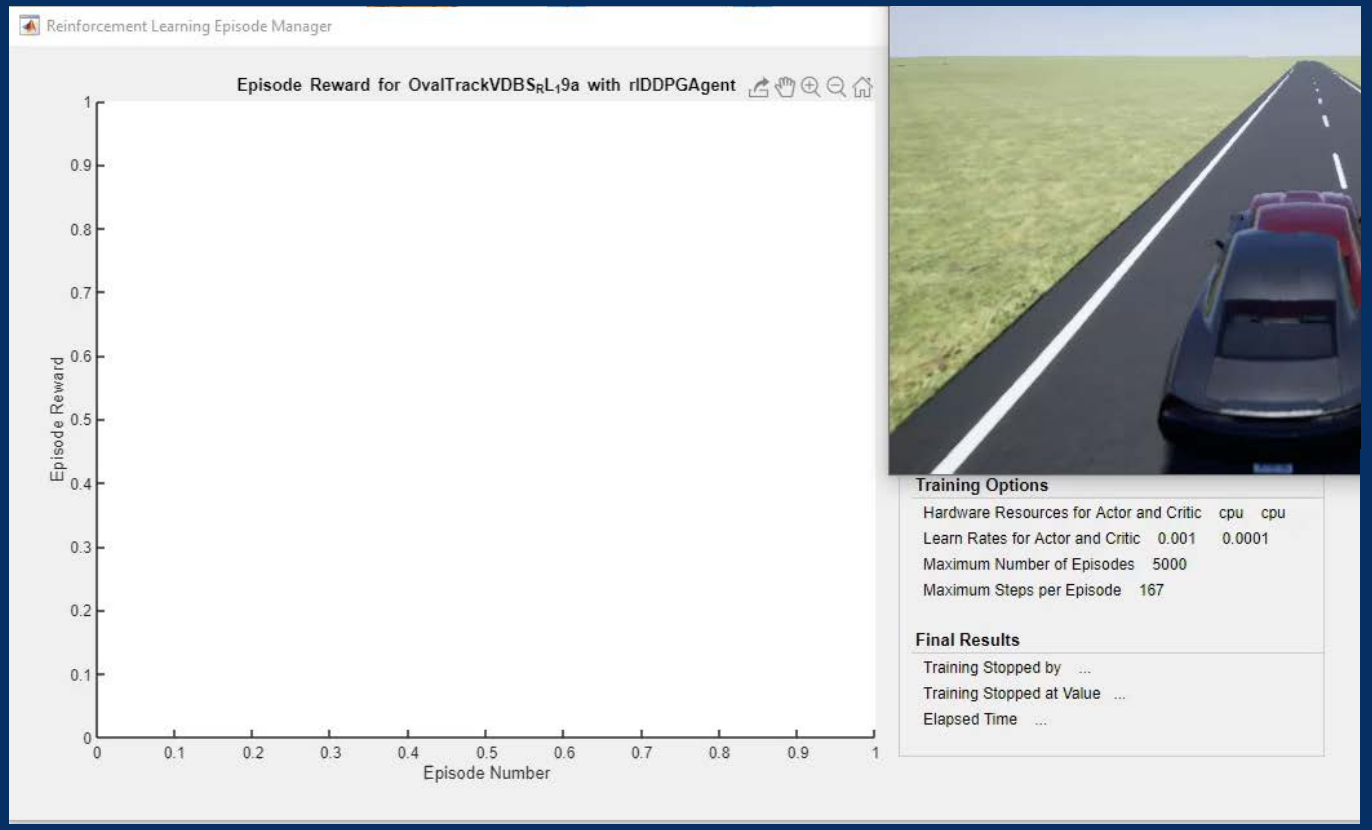
Use Cases Docs & models	Behavior models Architecture models	Physics-based Data-driven	C,C++ VHDL, Verilog GPU code Structured text	Model-based V&V Code-based V&V Certification workflows
	AI 	Data labeling Training Quantizing	C,C++ GPU code	AI Integration in Simulink models

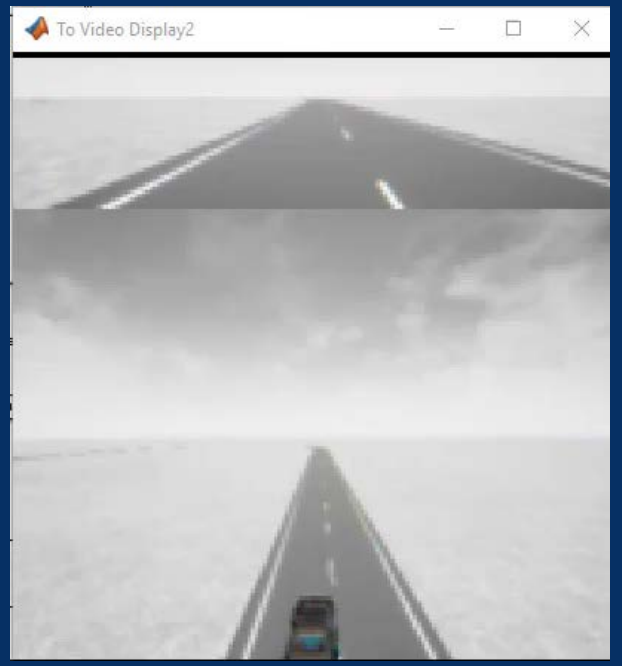
Example: Reinforcement Learning for Autonomous Vehicles



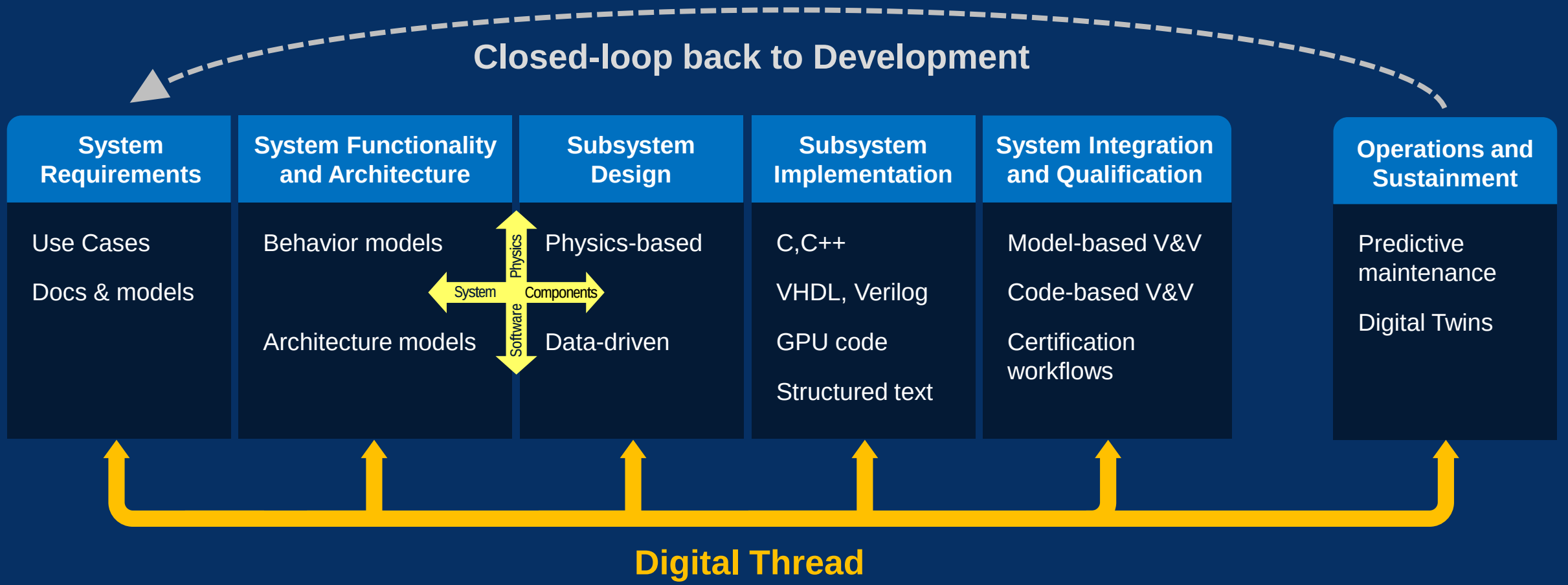






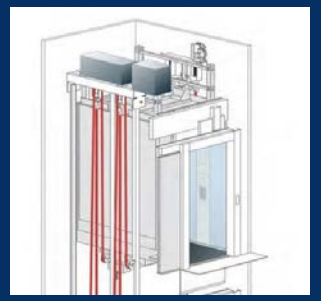


Extending Through the System's Lifecycle



Case Studies: Use of Data and Models in Operation

Atlas Copco: Digital thread for compressor systems



Schindler Elevator: Virtual commissioning

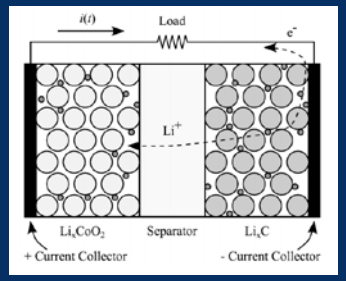
BuildingIQ: Predictive energy optimization

Tata Steel: Controller optimization

Fuji Electric: Real-time analysis of Smart Grid

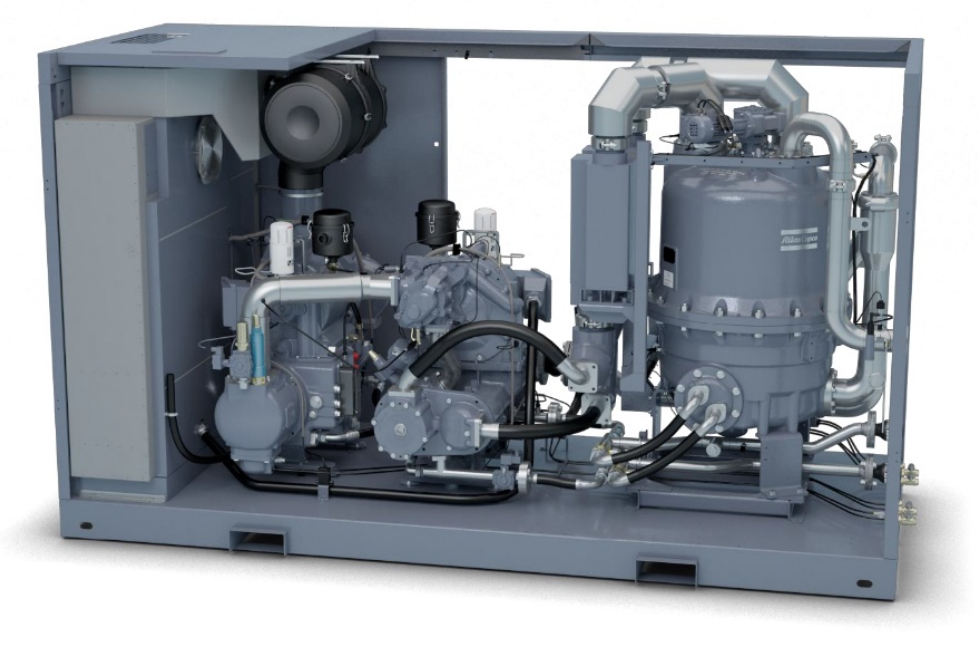
Lockheed: Aircraft fleet management

Mining company: Fault detection and predictive maintenance



NIO: Battery management for electric vehicles

Atlas Copco: Challenges



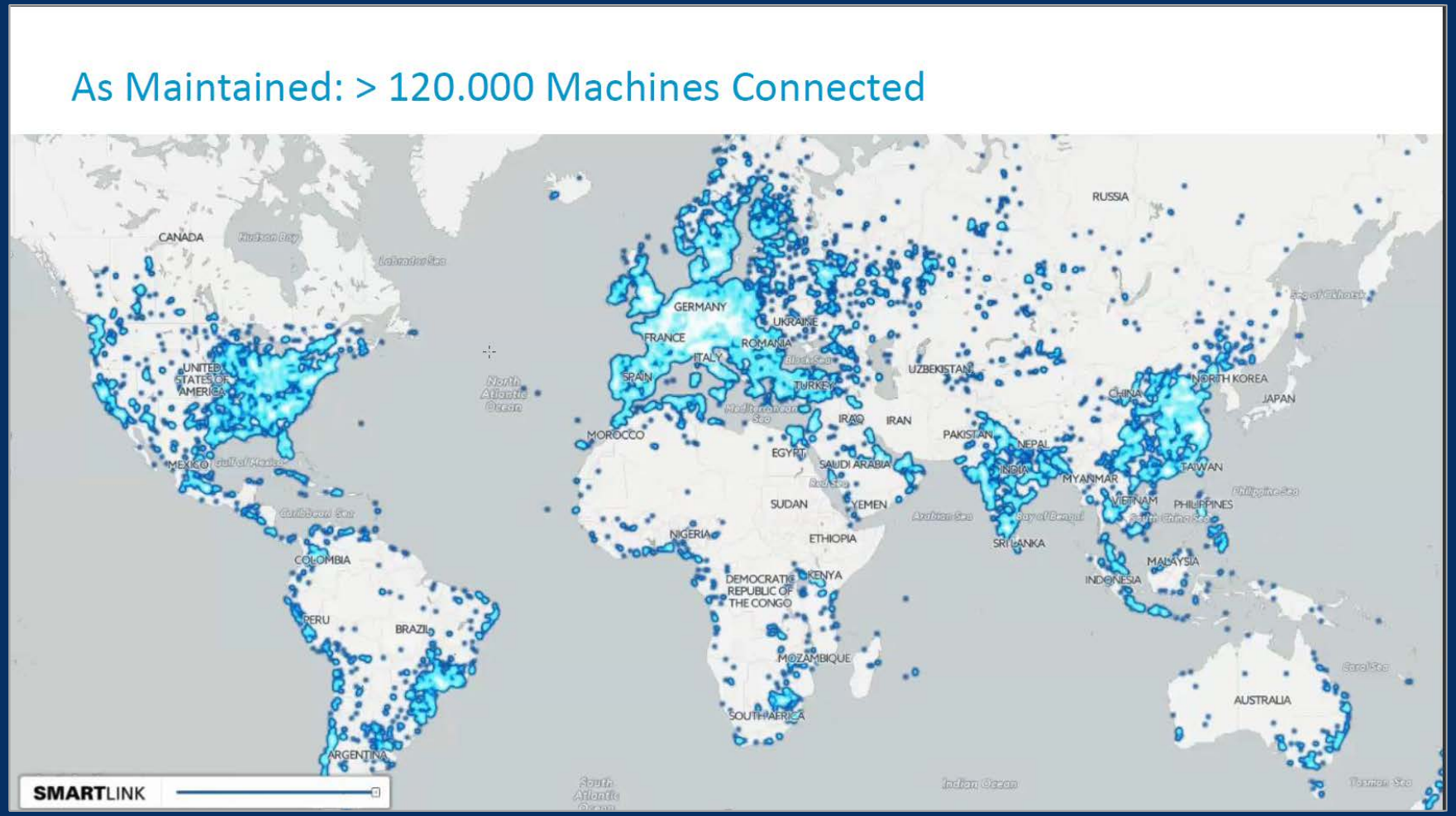
Air Compressor System

- Shorter Time to Market
- Cross divisional development
- Improve reliability and efficiency
- Control total development, production and service costs
- High product variability

Atlas Copco

System Lifecycle Use with MATLAB & Simulink

As Designed
As Configured
As Produced
As Maintained



As Achieved: Standardized Model Based Engineering Platform

Process

- Company-wide workflow
- Used throughout product lifecycle
- Optimized maintenance and Data Analytics platform
- Continuously updated digital twins

People

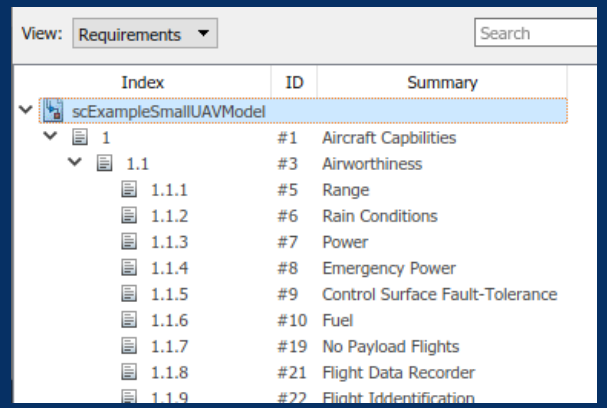
- Collaboration platform for efficient communication
- Standardized accurate configuration tool used by global sales

Results

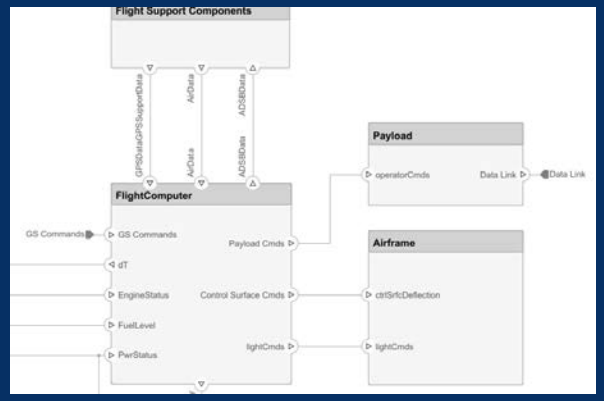
- 120k+ connected machines
- Quick implementation of upgrades
- Re-establishing Atlas Copco as undisputed global market leader

What is new to make this easier (more powerful/effective)?

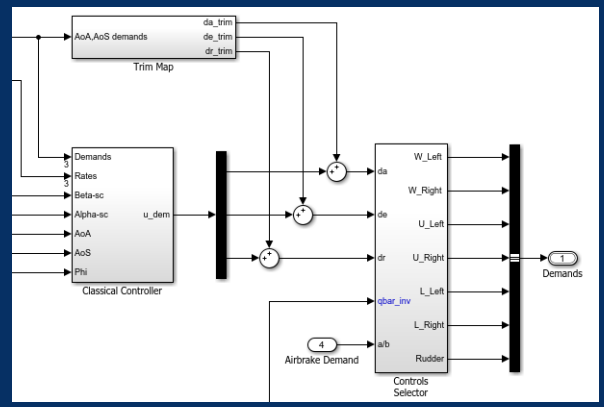
Simulink Requirements



System Composer



Simulink



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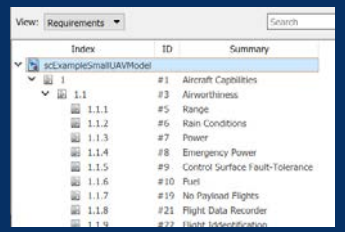

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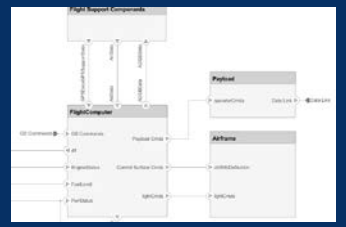
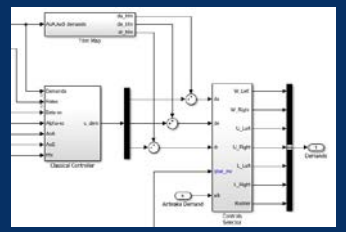
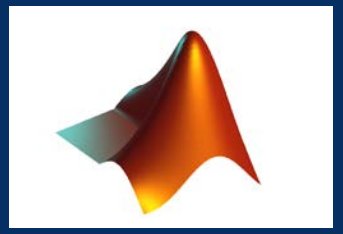


Simulink





MATLAB

Digital Twins and Predictive Maintenance

Big Data/Dashboards

Power BI, tableau, TIBCO Spotfire, databricks, hadoop, CLOUDERA

Cloud

docker, amazon web services, Azure, kafka, Amazon Kinesis, Azure Stream Analytics

Edge

Windows, SCADA, Modbus, TCP/IP, MQTT

Embedded

intel, ARM, NXP, STM, NVIDIA, XILINX

MathWorks®

A **Leader** in the Gartner Magic Quadrant for 2020 Data Science and Machine Learning Platforms

*Gartner Magic Quadrant for Data Science and Machine Learning Platforms, Peter Krensky, Erick Brethenoux, Jim Hare, Carlie Idoine, Alexander Linden, Svetlana Sicular, 11 February 2020 .

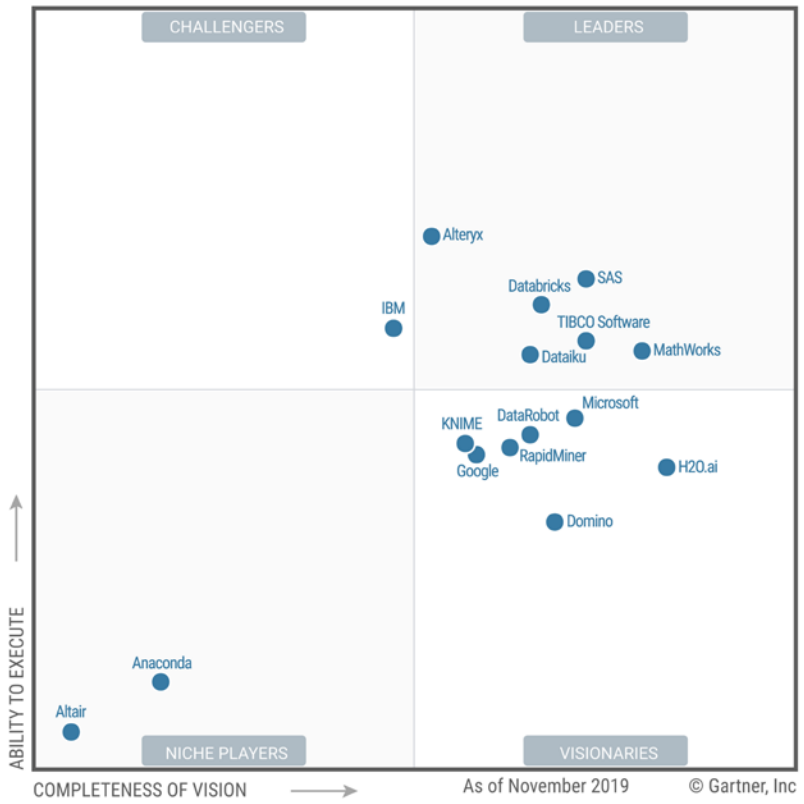
MathWorks®

A **Leader** in the Gartner Magic Quadrant for 2020 Data Science and Machine Learning Platforms

We believe this recognition demonstrates our ability to:

- Empower teams, even those with limited AI experience
- Support entire AI workflows
- Deploy to embedded, edge, enterprise, and cloud
- Tackle integration challenges
- Manage risk in designing AI-driven systems

Figure 1. Magic Quadrant for Data Science and Machine Learning Platforms



Source: Gartner (February 2020)

*Gartner Magic Quadrant for Data Science and Machine Learning Platforms, Peter Krensky, Erick Brethenoux, Jim Hare, Carlie Idoine, Alexander Linden, Svetlana Sicular, 11 February 2020 .

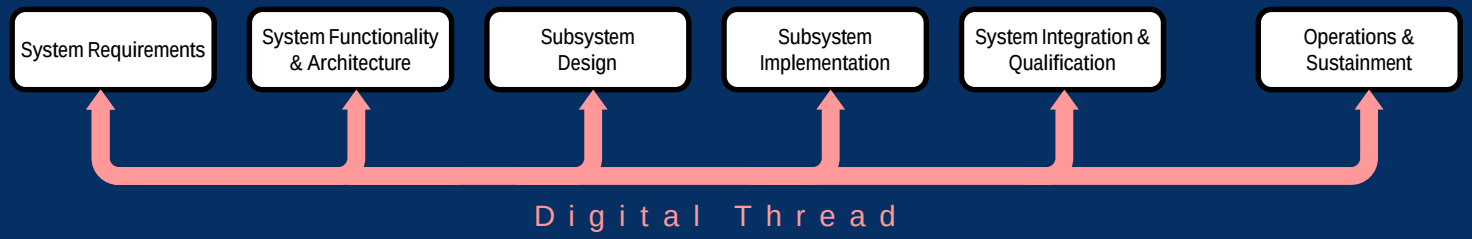
Why MathWorks for Pragmatic Digital Transformation?

Systematic use of data and models

MATLAB® & SIMULINK®

to create and deliver superior value to customers

throughout the entire lifecycle



Keep in mind today:

How can you systematically use models and data as part of your pragmatic digital transformation?

Enjoy the Conference!