Can we use Agile to Build Gas Stations in Space?

And other cyber-physical systems

SAFe®

SUMMIT

NASHVILLE, TENNESSEE

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Background

21st century development approaches, such as Agile and DevOps have benefitted *small initiatives* with a *single team building software* in their ability to respond to change, reduce product delivery schedules, reduce product cost, increase product quality, and Increase employee morale.

Can one innovative company leverage Agile to build their docking and refueling hardware (RAFTI) to make Gas Stations in Space a reality? Does Orbit fab experience the same problems that other Cyber-physical systems do?

Agile – An iterative and incremental approach to project management. It aims to improve project ability to adapt to changing needs.
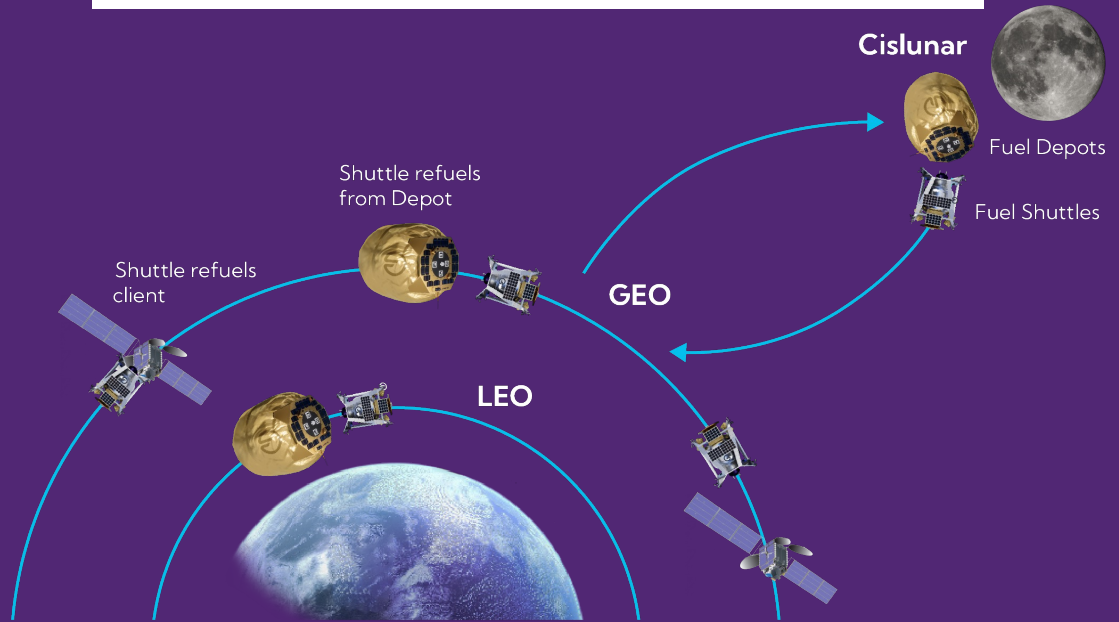
Typically used in software projects

DevOps – A set of practices that combines development (Dev) and operations (Ops). It aims to shorten the systems development life cycle.

Typically used in software projects
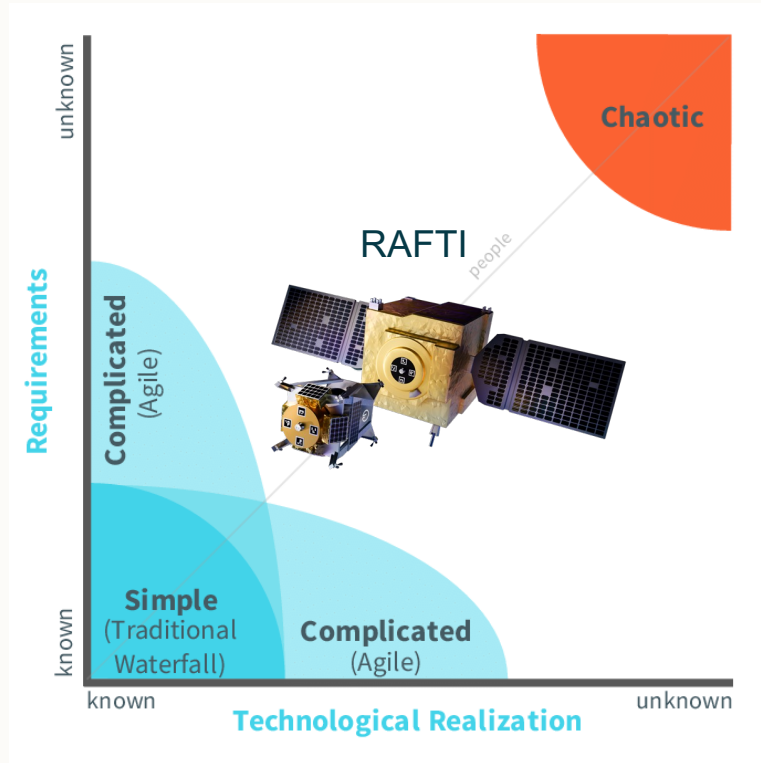
Tanker-001 - Tenzing

- Founded in 2018
- Located in Lafayette, CO
- Resupplied water to ISS
- Mission – Building the In-Space Propellant Supply Chain
- Sustainability starts with unlimited fuel in space

Sustainability starts with unlimited fuel in space.

- ✓ *Reduce single-use satellite*
- ✓ *Re-use and extend satellite mission*
- ✓ *Responsibly de-orbit and dispose of debris*

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Cislunar
Fuel Depots
Fuel Shuttles

Shuttle refuels from Depot

Shuttle refuels client

GEO

LEO

Why would they move to Agile?

*The motivation to migrate to Agile is a demand for **faster** development, difficulty managing **change**, and increased product **complexity**.*

OrbitFab Program Description

Goals	Products
• Adaptability • Predictability • Transparency • Shorter Schedule	• RAFTI • GRIP • CORE / Rancore

# Teams	# Sprints
6 3-7 people *Moving to all from manufacturing to executive*	**12** 1 Week

Experiment

Hypothesis

Transitioning Orbit Fab to Agile will enable them to achieve Adaptability, Predictability, Transparency, Shorter Schedules.

Actions

- Educate the teams (2 day initial training, Lunch/Learn)
- Document known Cyber-physical challenges with Agile
- Select practices to overcome challenges
- Measure the results

Outcome

- Improved ability to adapt to change
- Improved Transparency
- Improved Predictability
- Still waiting to see if we can reduce schedule

Orbit Fab's Propellant tanker to
Fuel satellites in geostationary orbit

Agile Challenges for Cyber-physical Systems

❖ **Organization and language**

❖ **Less Homogenous Teams**

❖ **Constraints of physicality**

❖ **Cost of learning**
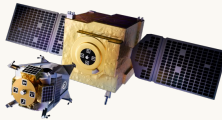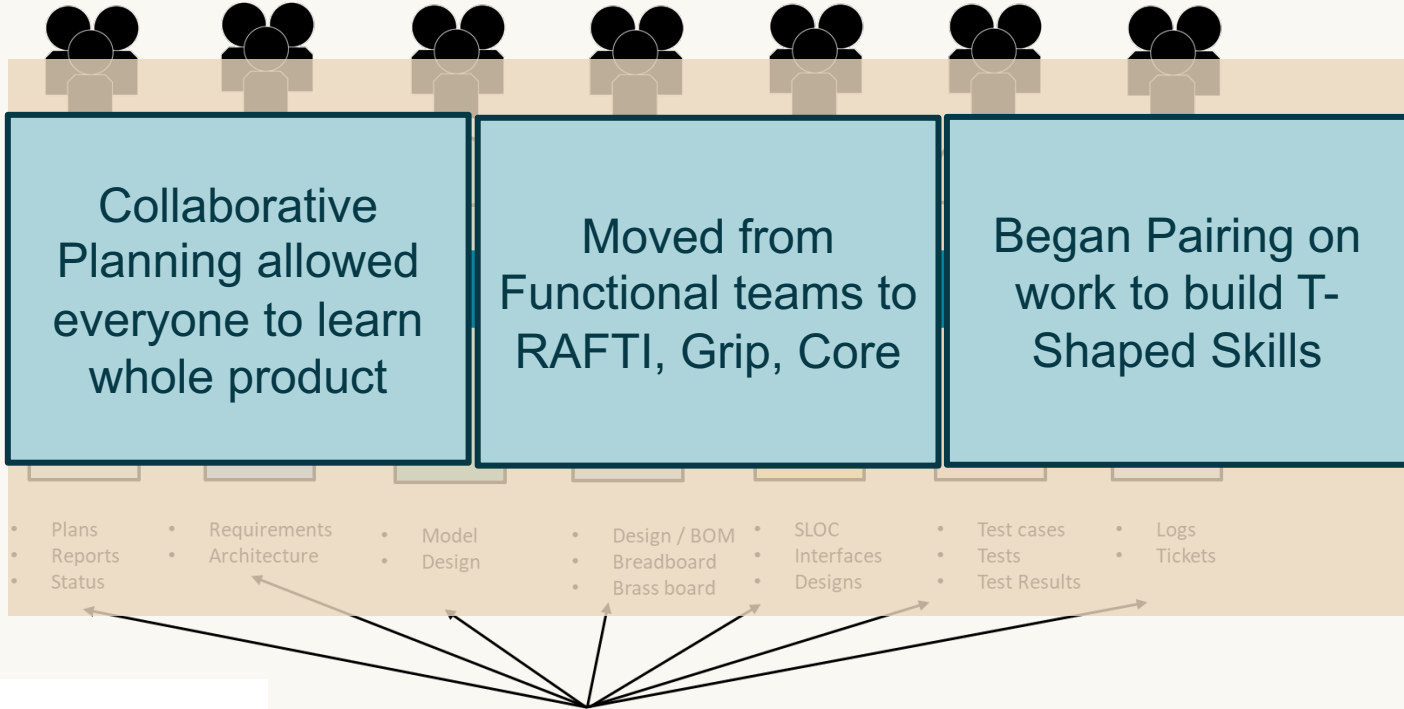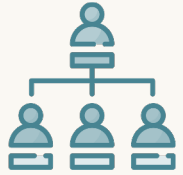
❖ **Compliance Requirements**

❖ **Tool Integration**

Initial Practices

❖Cross Functional Team

❖Pairing

❖Collaborative Group Planning (Program / Sprint)

❖Timeboxing: One-week sprints

❖Feature / Story / Task Definition

❖Modeling

❖Test Driven

❖Demonstrations

❖Retrospectives

❖Visualizing Work

Selected practices to overcome typical Agile Cyber-physical challenges

Organization and Common Language

Collaborative Planning allowed everyone to learn whole product

Moved from Functional teams to RAFTI, Grip, Core

Began Pairing on work to build T-Shaped Skills

- Plans
- Reports
- Status
- Requirements
- Architecture
- Model
- Design
- Design / BOM
- Breadboard
- Brass board
- SLOC
- Interfaces
- Designs
- Test cases
- Tests
- Test Results
- Logs
- Tickets

Less homogenous teams

1. Began Pairing on work to build T-Shaped Skills

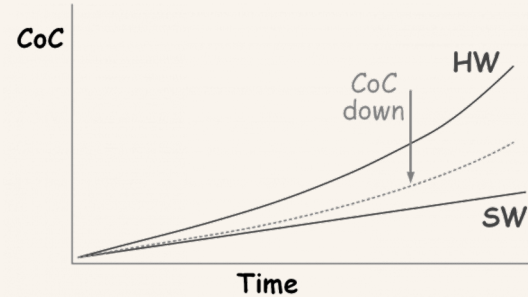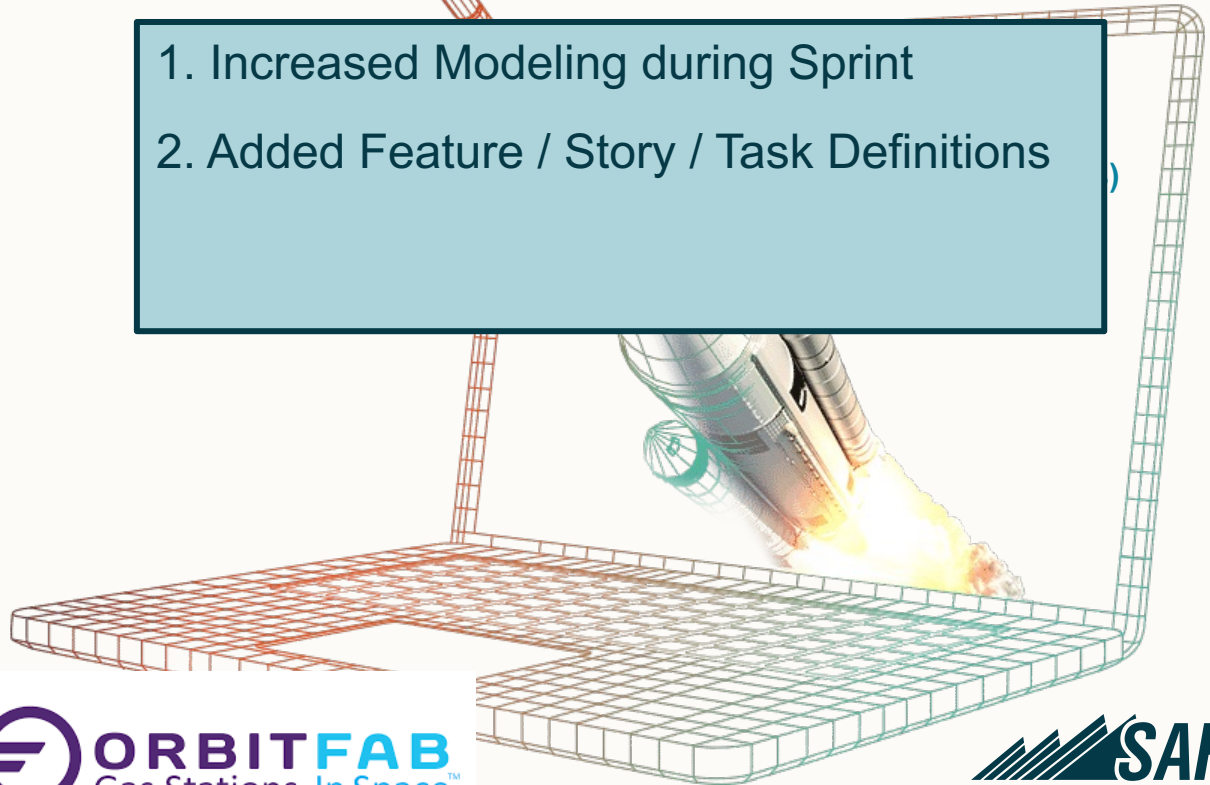2. Training.   (Some teams learned to do machining on parts)

RF System

Electronics

Thermal

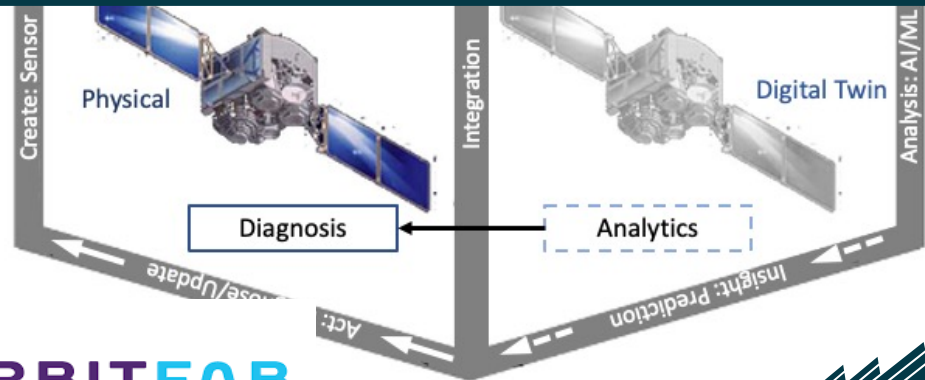# The cost to make change increases with hardware

CoC / Time graph showing HW, CoC down, SW

Constraints of Physicality

1. Increased Modeling during Sprint

2. Added Feature / Story / Task Definitions

Decrease cost of learning

Moving the physical system into the digital ...er-
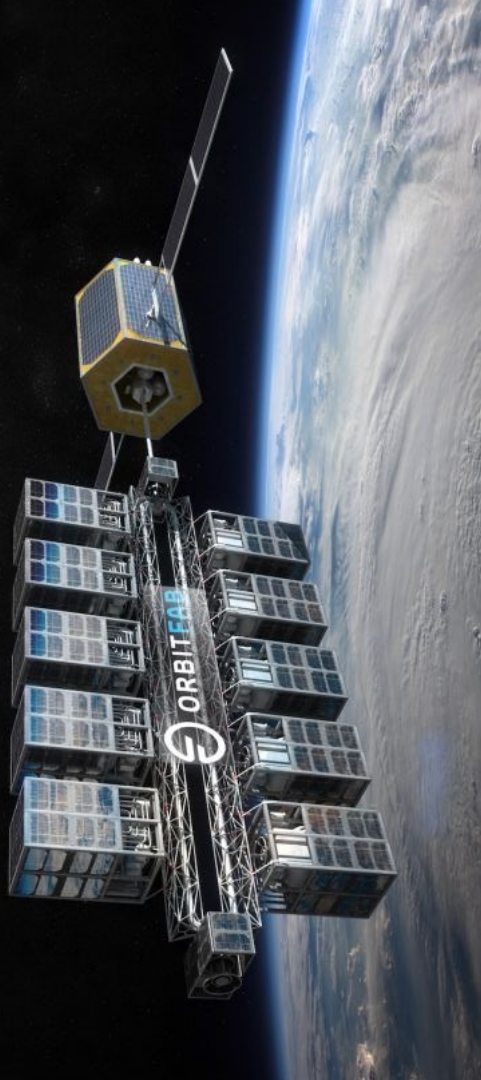
1. Timeboxing

2. Demonstrations

3. Retrospectives

4. Look to Introduce Digital Twin in future

Compliance Requirements

NASA-STD **8000**

8000

1. Feature / Story / Task Definition

2. Compliance Test Driven
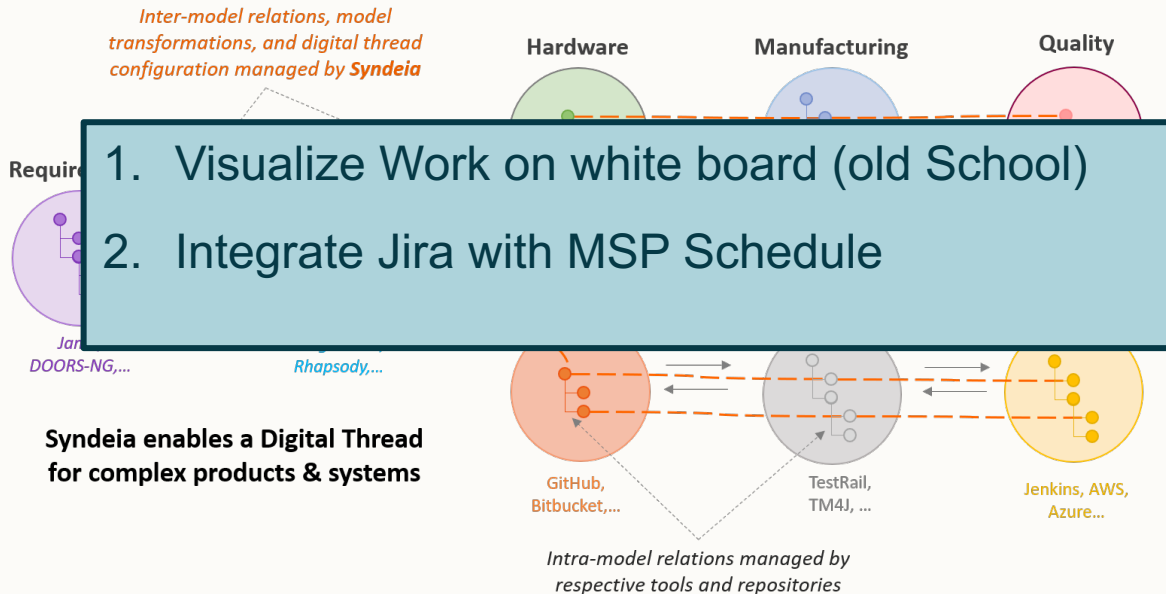
8719.13   8739.2   8739.7

8739.3   8739.8

8739.4   8739.9

8739.5

Space vehicles need to comply with extensive regulatory criteria

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Integrate the tools

Inter-model relations, model transformations, and digital thread configuration managed by **Syndeia**

Hardware

Manufacturing

Quality

Require...

1. Visualize Work on white board (old School)

2. Integrate Jira with MSP Schedule

DOORS-NG,...

Rhapsody,...

Syndeia enables a Digital Thread for complex products & systems

GitHub, Bitbucket,...

TestRail, TM4J, ...

Jenkins, AWS, Azure...

Intra-model relations managed by respective tools and repositories

Example tool

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Results

The Implementation of Agile has shown to provide benefits to the application of cyber-physical systems.

Benefits

- Adaptive to change
- Transparency
- Predictability
- Customer Confidence
- Team Morale
- *Understanding* of how milestones intersect

Challenges

- Training
- Schedule

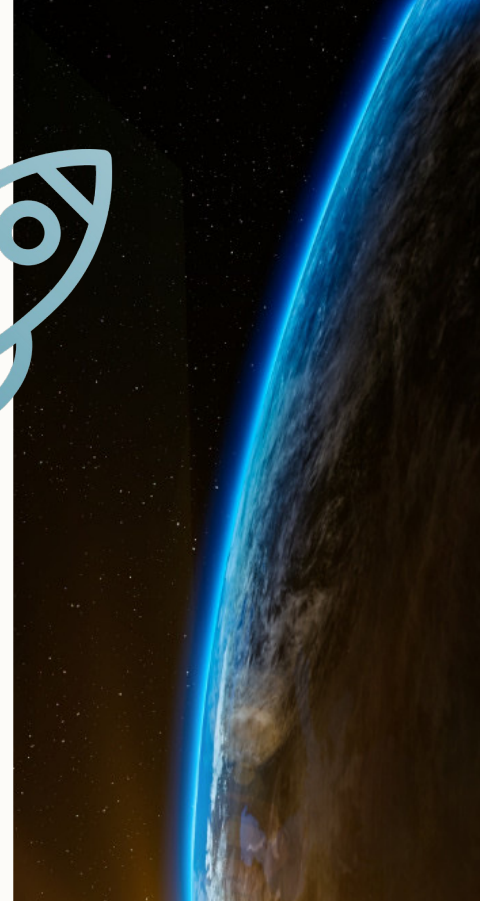*For this innovative company benefits far outweigh the challenges*

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Next Steps

Yes! indeed we think we can use Agile to build gas stations in space…
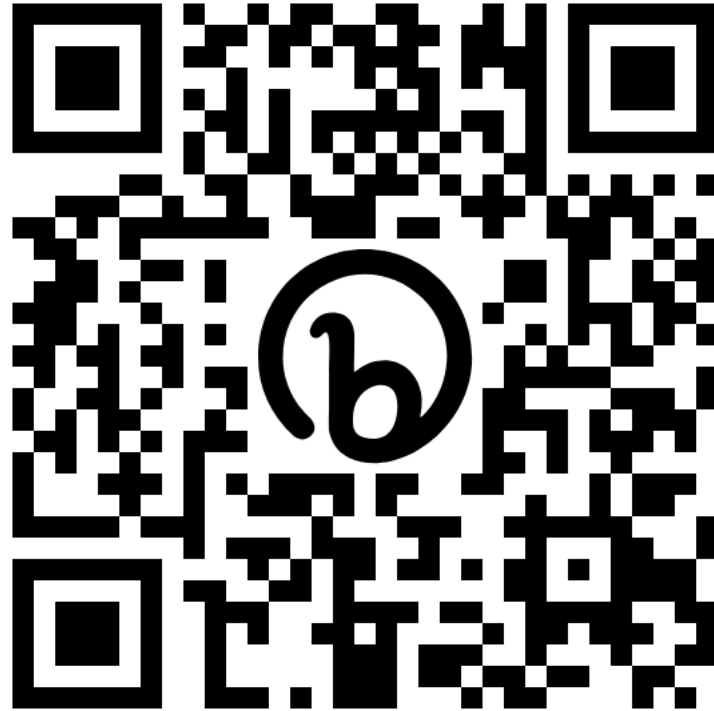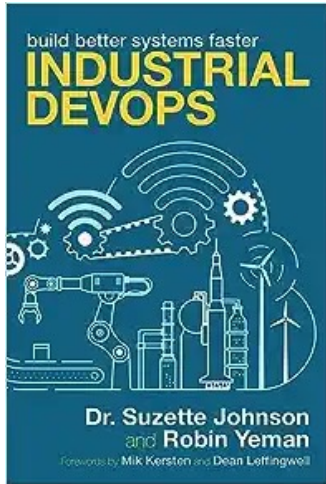
Add more teams

**Increase JIT Training
Digital Twin**

**Investigate Lead Times
Validate schedule reductions**

**Analyze data
Increase Tool Integration**

Industrial DevOps Excerpt

We would love your Feedback on chapter 1

THANK YOU

Please rate this session!