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BUILD BETTER SYSTEMS FASTER

The application of Industrial DevOps™ with Digital Twins to deliver Cyber-Physical Systems

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Introductions

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Game Plan

- Objective
- MBSE
- Digital Twin
- Industrial DevOps™
- The intersection of Industrial DevOps™ and Digital Twins Applied
- Getting Started
- Resources

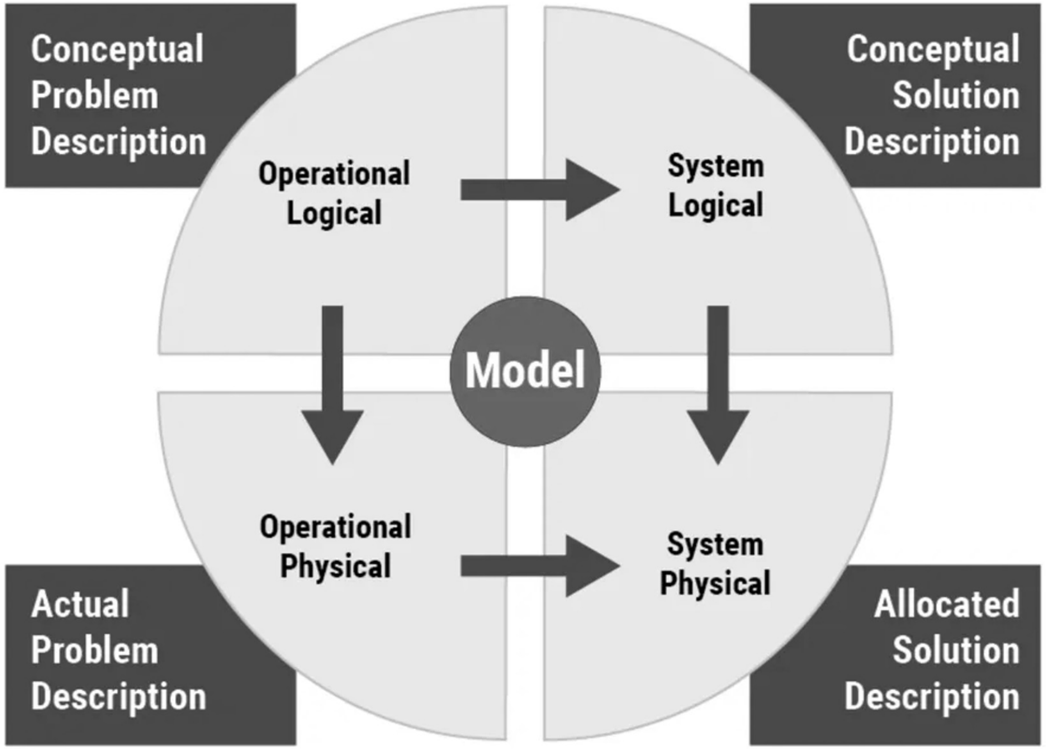
Objective

To explore the synergy to create a seamless, real-time development environment for cyber-physical systems to build better systems faster

Model Based Systems Engineering

Why

1. *Enhanced Communication*
2. *Improved System Understanding*
3. *Requires Traceability*
4. *Better Design*
5. *Reduce risk*



A formalized methodology that is used to support the requirements, design, analysis, verification, and validation associated with the development of complex systems.

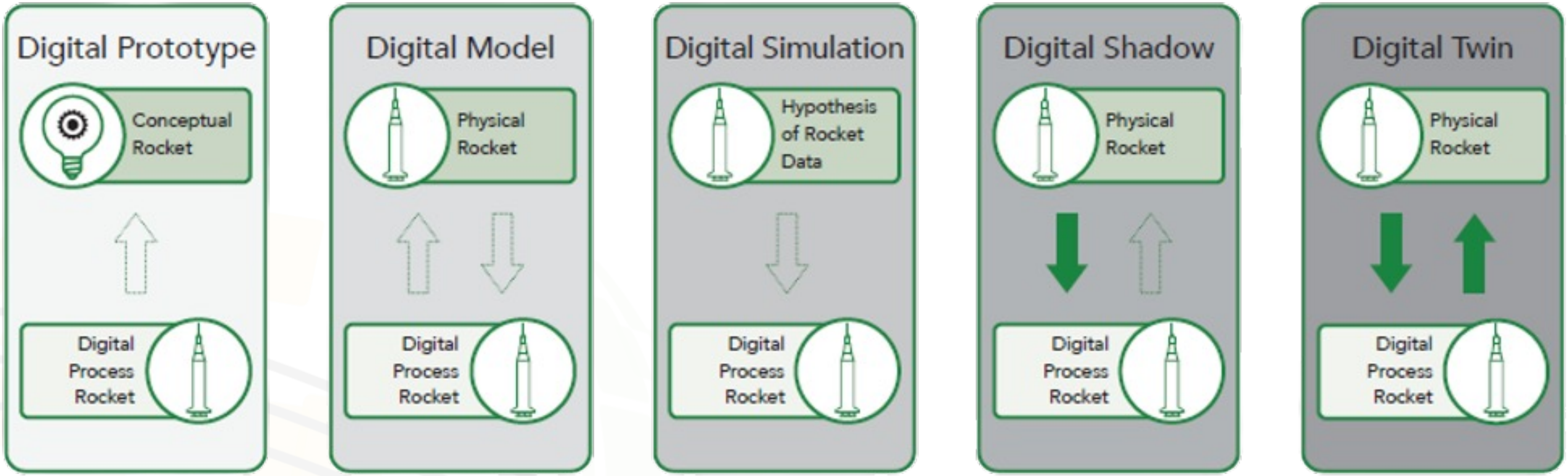
Shevchenko, N. (2020, December 21). An Introduction to Model-Based Systems Engineering (MBSE). Retrieved June 25, 2024, from https://insights.sei.cmu.edu/blog/introduction-model-based-systems-engineering-mbse/.

MBSE and Digital Twins

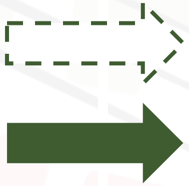
Aspect	MBSE	Digital Twin
Lifecycle Focus	Primarily design and development phases	Entire Lifecycle, especially operations
Model Type	Static or dynamic models for design and analysis	Real-time, dynamic models updated with live data
Purpose	Specification, design, analysis, verification, and validation of systems	Real-time monitoring, simulation, and optimization of physical systems
Data Integration	Limited real-time data integration	Continuous integration of real-time data from the physical system
Tools	SysML, MATLAB/Simulink, MagicDraw, Enterprise Architect	IoT platforms, data analytics tools, machine learning, simulation tools
Outcomes	Comprehensive design models guiding development and integration	Live virtual environment for monitoring, analysis, and optimization of physical systems
Benefits	Improved consistency and traceability, early flaw detection, enhanced communication	Real-time performance insights, predictive maintenance, improved decision-making

Evolution of Modeling to Digital Twin

Digital Twins leverage real-time data, simulation, machine learning, and reasoning to create living digital simulation models that update and change as their physical counterparts change.



Reference: Johnson and Yeman. The Application of Industrial DevOps using Digital Twins. 2024. IT Revolution.



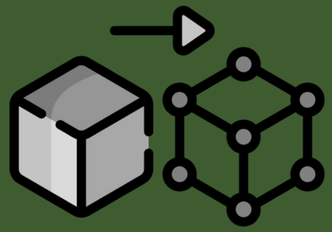
Manual Disconnected Data Flow

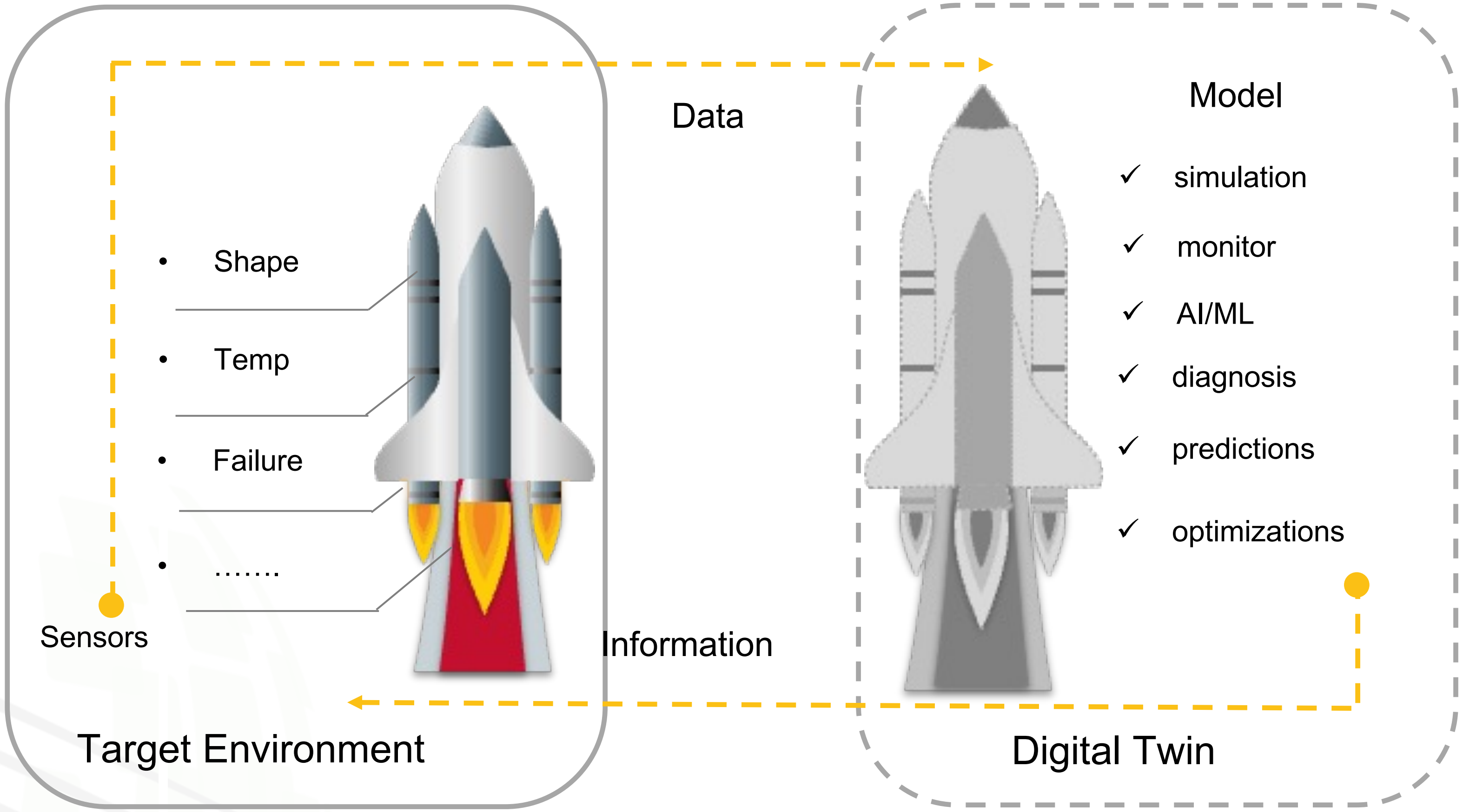
Automated Connected Data Flow

Digital Twin Defined

Why

1. *Design Optimization*
2. *Future proofing*
3. *Time / Cost savings*
4. *Operational Efficiency*
5. *Predictive Maintenance*





A digital representation of a physical object, person, or process, contextualized in a digital version of its environment

Reference: Johnson and Yeman. The Application of Industrial DevOps using Digital Twins. 2024. IT Revolution.

Domains Where Twins Applied

Manufacturing
- Virtual replicas of production lines, Predictive maintenance
- Reduce downtime, Increase efficiencies

Urban Planning
- Simulate urban environments, buildings, transportation systems, utilities
- Enhances sustainability, quality of life, efficient resource management

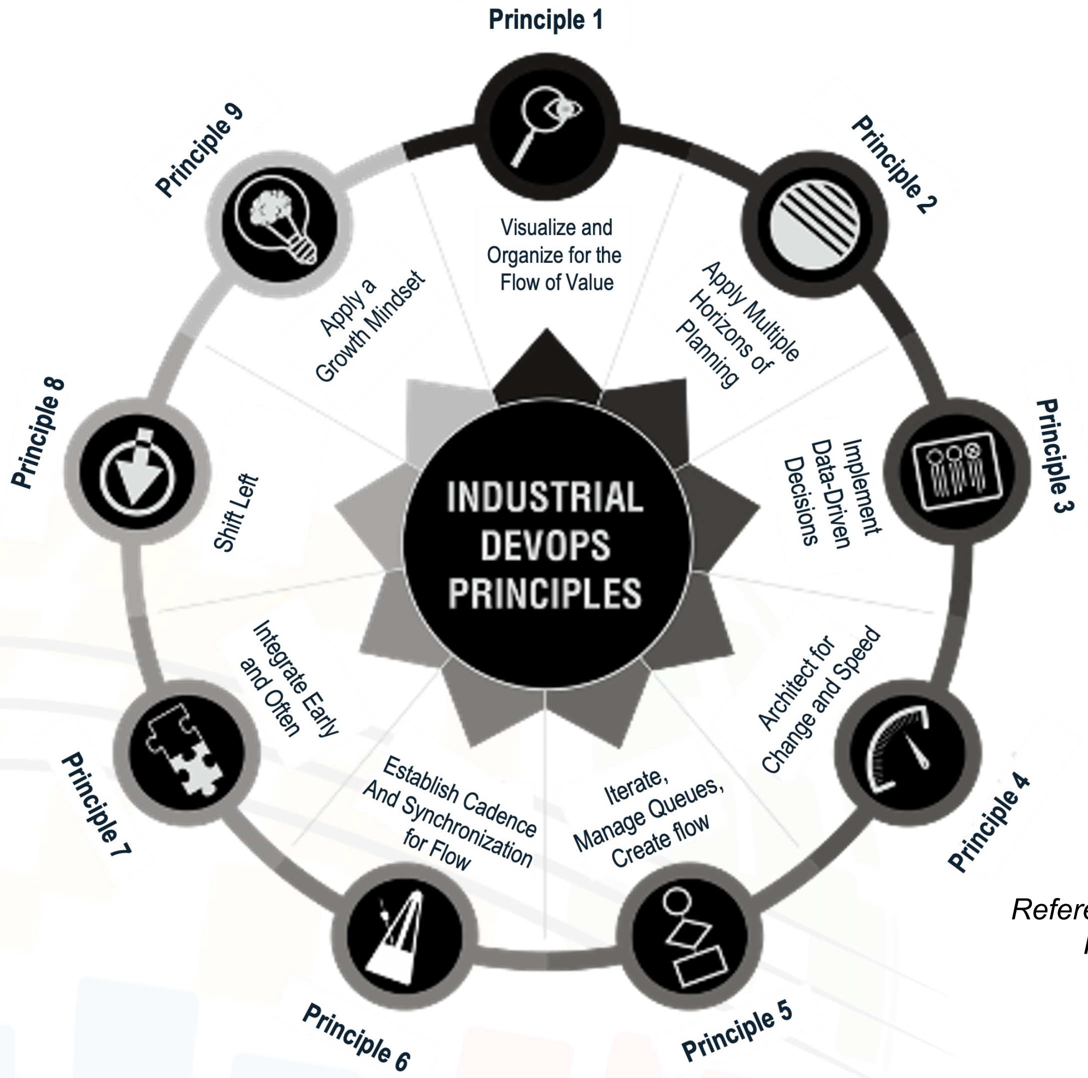
Automotive
- Design and test vehicles virtually, simulate traffic systems
- Improves vehicle efficiency, safety, reduce TTM

Aerospace
- Desing, test, maintain aircraft/spacecraft, simulate performance under different conditions
- Improves safety, extends lifespan of assets

Digital twins can simulate real-world conditions, predict outcomes, and recommend actions to improve performance, prevent failures, and support decision-making processes.

Reference: Johnson and Yeman. The Application of Industrial DevOps using Digital Twins. 2024. IT Revolution.

What is Industrial DevOps?



Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution.

The application of Lean, Agile, and DevSecOps principles to the planning, development, manufacturing, deployment, and serviceability of significant cyber-physical systems.

Principles realized through digital twins

Organize around Value

Enables real-time monitoring and simulation of systems, helping to visualize and optimize the flow of value throughout the lifecycle

Multiple Horizon's of Planning

Provide a dynamic representation of the system at different stages, aiding in long-term and short-term planning.

Data Driven Decisions

Continuously collect and analyze operational data, providing insights for informed decision-making.

Architect for Change/ Speed

Simulate changes and their impact on the system in real-time, allowing for rapid adaptation.

Iterate, manage Queues

Provide a live environment for continuous testing and iteration, helping manage development queues

Principles realized through digital twins

Cadence and Synchronization

Align physical and virtual models, ensuring synchronized development cycles.

Integrate early and often

Enable real-time integration testing in a virtual environment, reducing integration risks.

Shift Left

Allow for early detection of issues by mirroring the system in real-time and running simulations.

Growth Mindset

Facilitate continuous improvement by providing the ability to testing new ideas and scenarios.

Get Started

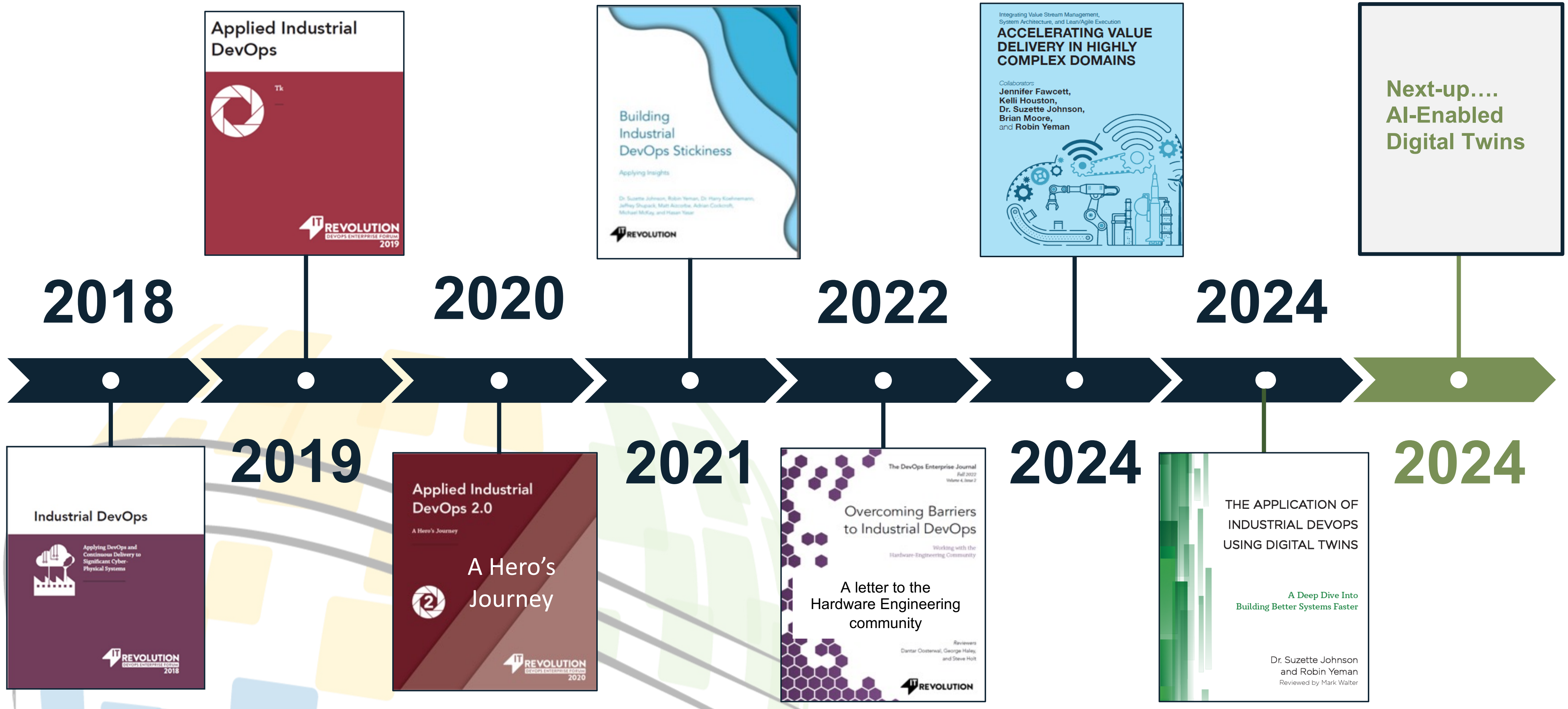
Where to Start

Follow our 7 patterns of success

- **01 Identify Goal**
  - Define Goals
  - Determine Investment strategy
- **02 Assess Feasibility**
  - Assess current state of people, process, and tools
  - Determine Business, Operational, and Tech
- **03 Build Blueprint**
  - Create roadmap for future (MVP/NVP)
  - Define Use Cases
- **04 Assemble / Integrate Data**
  - Data Collection, integration, and management are key
- **05 Develop Digital Twin**
  - Build MVP
  - Determine the level of fidelity and coverage
- **06 Implement and Scale**
  - Scale up
  - Adjust operating model for ROI
- **07 UpSkill your people**
  - Hire people with the right skills
  - Provide continuous learning

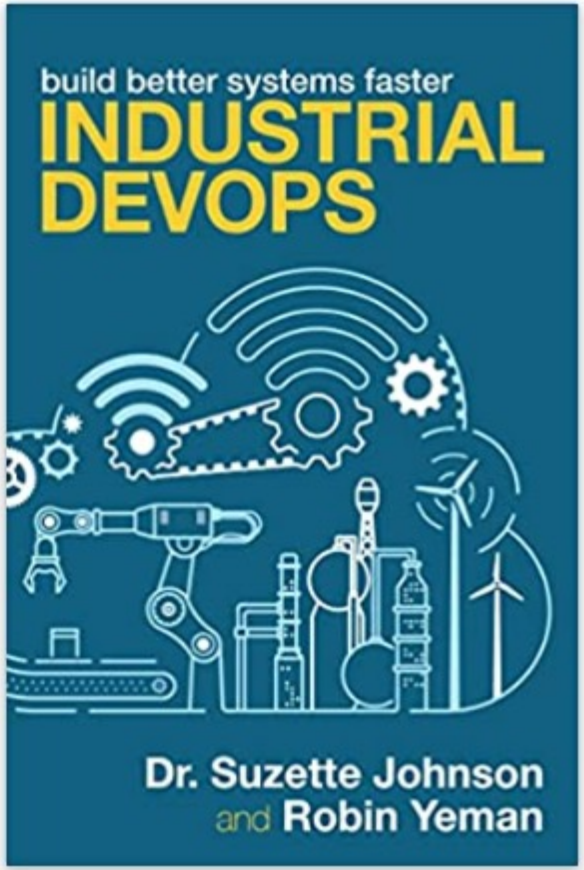
Embrace continuous learning and improvement mindset

Industrial DevOps



https://itrevolution.com/book/industrial-devops//

First Chapter



Q & A

ASK AWAY!

Space Twin from Slingshot Aerospace Stratfi

- In partnership with the US Space Force
- Slingshot Laboratory: a digital space twin and a space training product
- Simulate various scenarios for mission planning, wargaming, and spacecraft and constellation design.
- Combines real-time mapping of objects in orbit and space weather data with physics-based simulations
- Provides a real-world, hands-on environment to simulate mission execution.

"…simulate and analyze the complex dynamics of space, improve the design and operation of satellite constellations, reduce costs and risks, and enhance the training and preparedness of its personnel."

Reference: Johnson and Yeman. The Application of Industrial DevOps using Digital Twins. 2024. IT Revolution.

Digital Twin Applications

Domain	Application	Benefits
Manufacturing	Virtual replicas of production lines, machinery, and products. Simulating manufacturing processes, predicting maintenance needs, and optimizing production schedules.	Reduces downtime, increases production efficiency, and minimizes waste, leading to cost savings and improved product quality.
Urban Planning	Simulate urban environments, including buildings, transportation systems, and utilities to improve city planning, monitor environmental impacts, and manage resources.	Enhances sustainability, improves residents' quality of life, and facilitates efficient resource management.

"Digital twins can simulate real-world conditions, predict outcomes, and recommend actions to improve performance, prevent failures, and support decision-making processes."

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Digital Twin Applications

Domain	Application	Benefits
Automotive	Design and test vehicles virtually, simulate traffic systems, and optimize logistics and fleet management.	Increase vehicle efficiency, reduce time-to-market for new models, and improve transportation systems.
Aerospace	Design, test, and maintain aircraft and spacecraft, simulating their performance under various conditions.	Improves safety, reduces maintenance costs, and extends the lifespan of aerospace assets.

"Digital twins can simulate real-world conditions, predict outcomes, and recommend actions to improve performance, prevent failures, and support decision-making processes."

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Examples of how principles are realized by Digital Twins

Principle	Digital Twin	Scenario
Organize for the flow of value	Enable real-time monitoring and simulation of systems, helping to visualize and optimize the flow of value throughout the lifecycle	Siemens leverages digital twins to manage supply chains by creating a virtual representation of physical supply chains and productivity networks. This approach enables Siemens to mimic supply chains in real-time, test various scenarios, and provide insights to optimize supply chains for maximum flow of value
Apply Multiple Horizons of Planning.	Provide a dynamic representation of the system at different stages, aiding in long-term and short-term planning.	Digital twins enable us to get empirical data to further inform our planning horizons. In wind farms for example the twins allow for short term adjustments based on real data as well as enable long-term planning for predictive maintenance. Key benefits include predictive maintenance schedules and increased efficiency in energy production.

Examples of how principles are realized by Digital Twins

Principle	Digital Twin	Scenario
Implement Data Driven Decisions	Continuously collect and analyze operational data, providing insights for informed decision-making.	Hospitals can monitor patient flow and resource allocation with data which improves patient care and reduces wait times.
Architect for Change and Speed	Simulate changes and their impact on the system in real-time, allowing for rapid adaptation.	The automotive industry leverages modular design in electronic vehicle development to increase the speed of innovation and adoption of new technology. Tesla is an extreme example where they go to the extent of having modular reconfigurable manufacturing allowing A/B testing on new ideas all the time.
Iterate, Manage Queues, Create Flow	Provide a live environment for continuous testing and iteration, helping manage development queues.	
Establish Cadenced and Synchronization	Align physical and virtual models, ensuring synchronized development cycles.	
Integrate Early and Often	Enable real-time integration testing in a virtual environment, reducing integration risks.	
Shift Left	Allow for early detection of issues by mirroring the system in real-time and running simulations.	
Apply a Growth Mindset	Facilitate continuous improvement by providing the ability to testing new ideas and scenarios.	