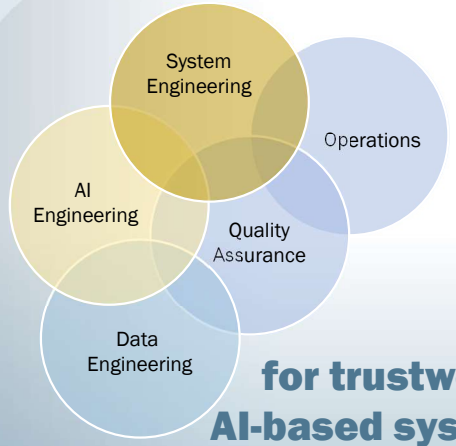


for trustworthy AI-based systems

# SEAMLESS SYSTEMS ENGINEERING & LIFECYCLE MANAGEMENT

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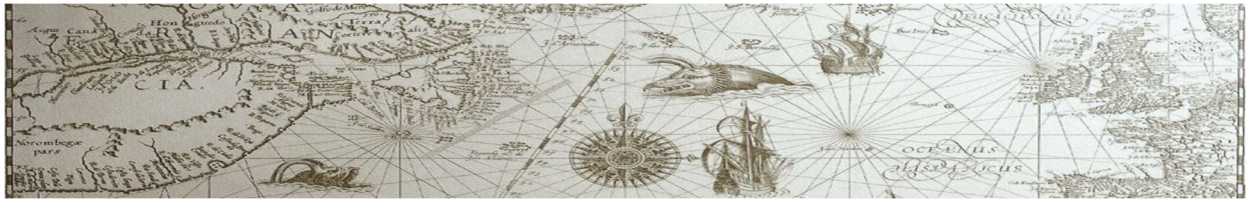
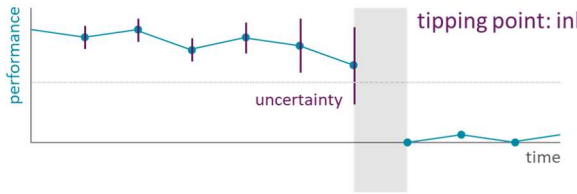
# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS


**Engineering these?**

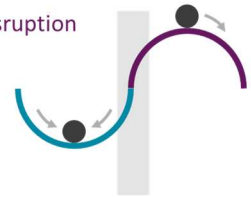
we might well be in terra incognita



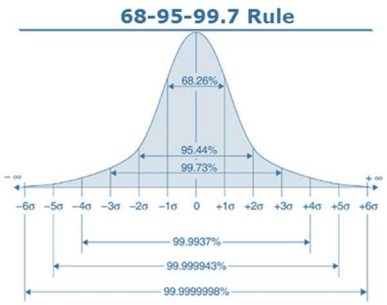
# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS




tipping point: inherent or due to abrupt disruption




© ASML




> 6Sigma Requirements @ ASML

## High Tech Industry

Cannot analyse adaptive control with unknown limits or functional gestalt

Cannot simulate on necessary level of detail

Can absolutely not solve this by trial and error on site



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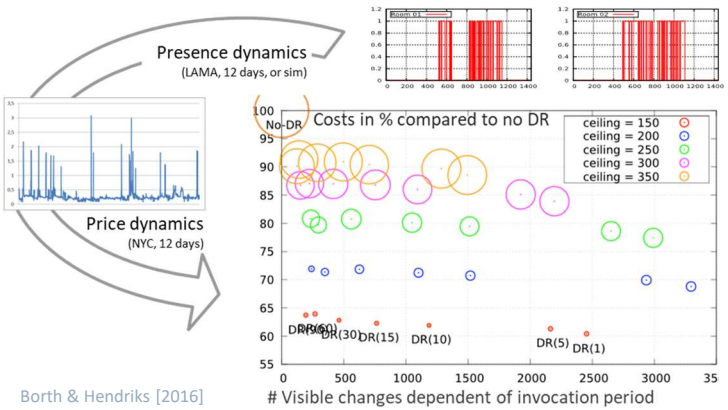
# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS

## Emergence

Smart Demand-Response links independent dynamics.

Cannot foresee behavior impact




Borth & Hendriks [2016]

## Smart Buildings


© Philips / Signify / Deloitte
The Edge in Amsterdam



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# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS


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**Autonomous Systems**

@ IVS :: AI4Safety | Safety4AI

Cannot validate and verify systems

with adaptive behavior based on AI that acts within an open world

as long as it remains unclear how AI edge cases and errors transverse through the functional chains

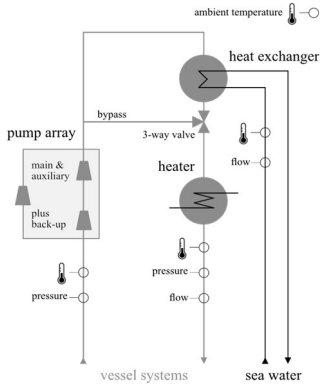
as long as it remains unclear how AI risks manifest

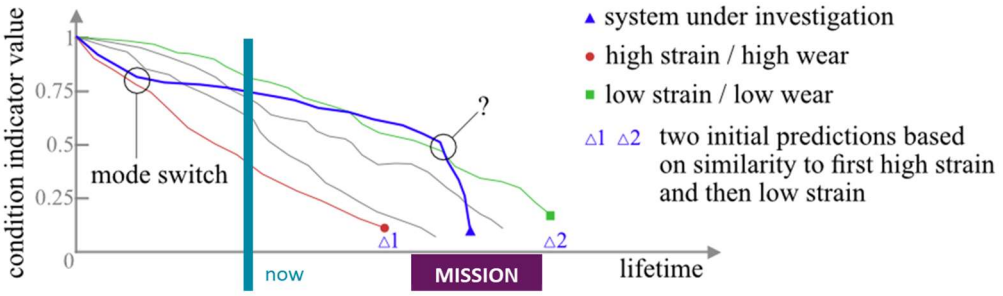
# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS

Cannot trust known techniques for preventive maintenance

**Autonomous Systems**

with adaptive behavior hiding degradation, invalidating KPIs and other knowledge



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# THE PROBLEM OF ENGINEERING AI-BASED SYSTEMS

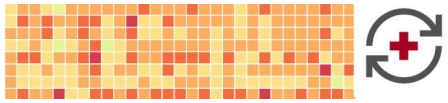


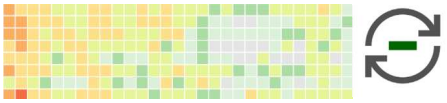
**Self-learning Systems**

**One fundamental difference between the approaches of, e.g., Google and Mercedes is what the system is allowed to learn.**

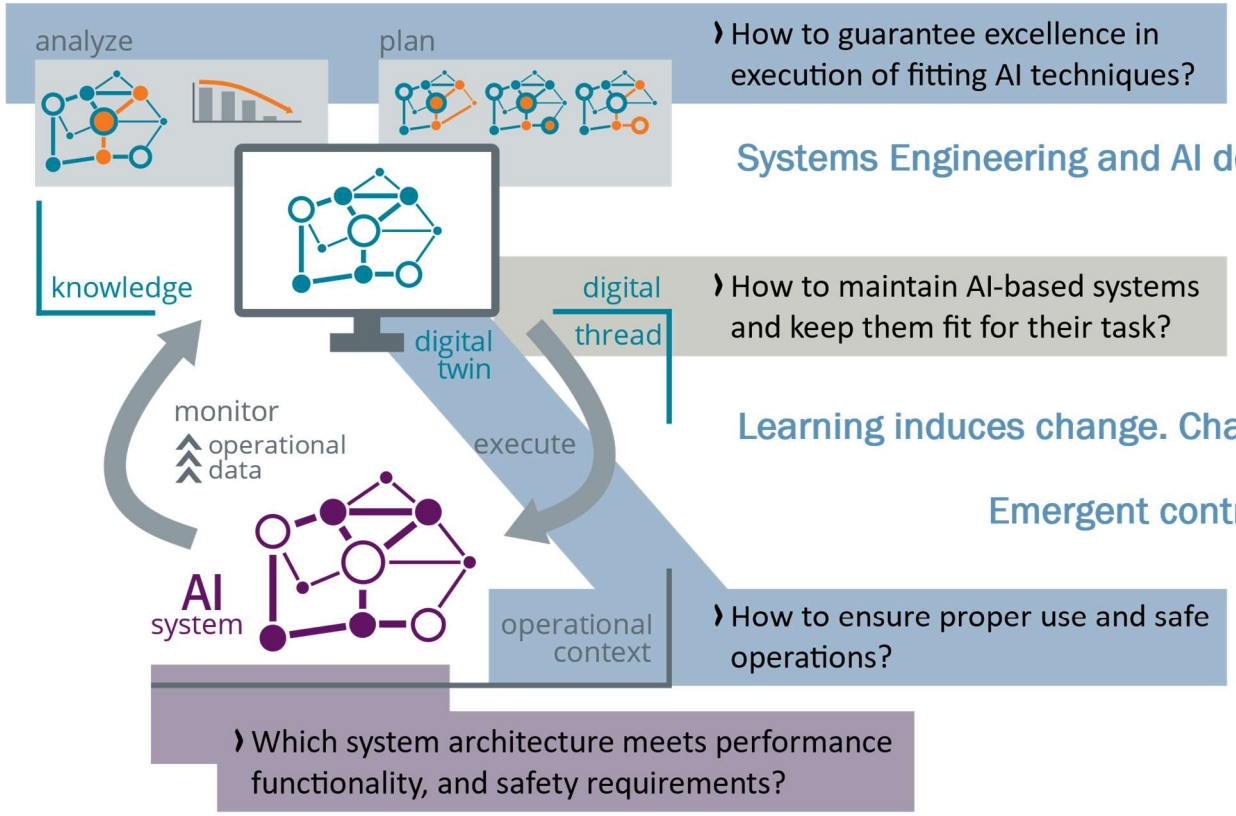
Behavior and systems' state space depends on feedback cycles and the driving reward.

Learning and control engineering favor the opposite.
We understand interwoven loops only for simple systems.





# THE WICKED PROBLEM OF ENGINEERING AI-BASED SYSTEMS




› How to guarantee excellence in execution of fitting AI techniques?

Systems Engineering and AI development do not mesh.

› How to maintain AI-based systems and keep them fit for their task?

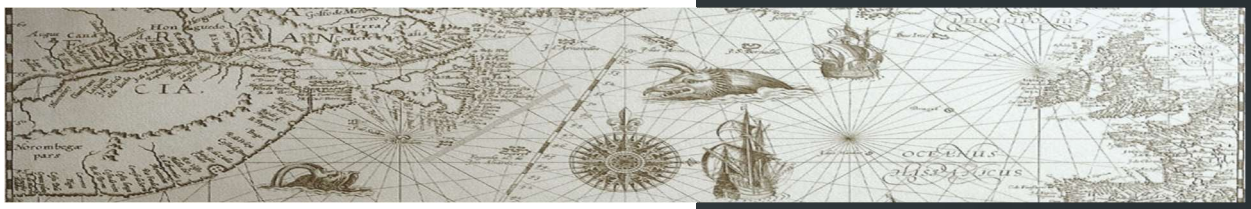
Learning induces change. Change invalidates knowledge

Emergent control is both boon and bane.

› How to ensure proper use and safe operations?

› Which system architecture meets performance functionality, and safety requirements?

# A STEP TOWARD THE ART AND SCIENCE OF ENGINEERING AI-BASED SYSTEMS



My Time I will not refuse;
My Thought I will not grudge;

My Care I will not deny towards the honor, use, stability and perfection of any works to which I may be called to set my hand.

Safe, autonomous systems in an open world

Responsible decision-making between humans and machines

AI Systems Engineering & Lifecycle Management :: SELM

SEAMLESS :: flagship project

2024 Use Case Call open

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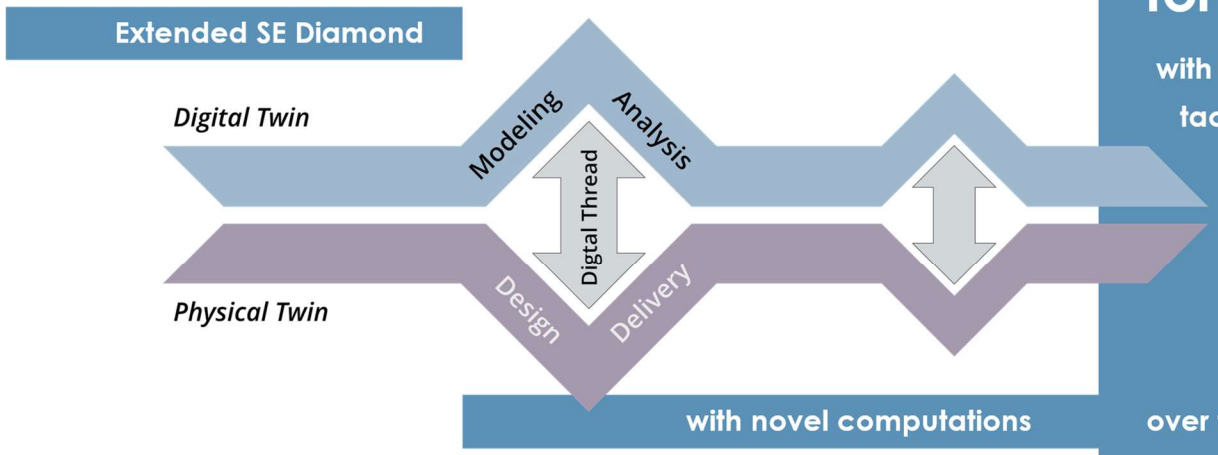
# SEAMLESS LIFECYCLE ENGINEERING OF AI-BASED SYSTEMS




## System Engineering for the full lifecycle

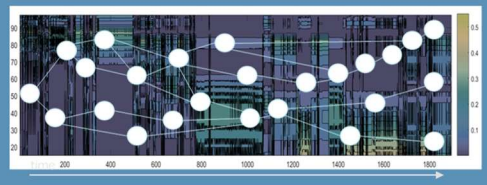
with Digital Twin & Digital Thread ops

tackling dragons in terra incognita


opposing feedback cycles

diagnosis / prognosis only in hindsight

over time in probabilistic fields



for major engineering tasks within

Design | Validation | Maintenance

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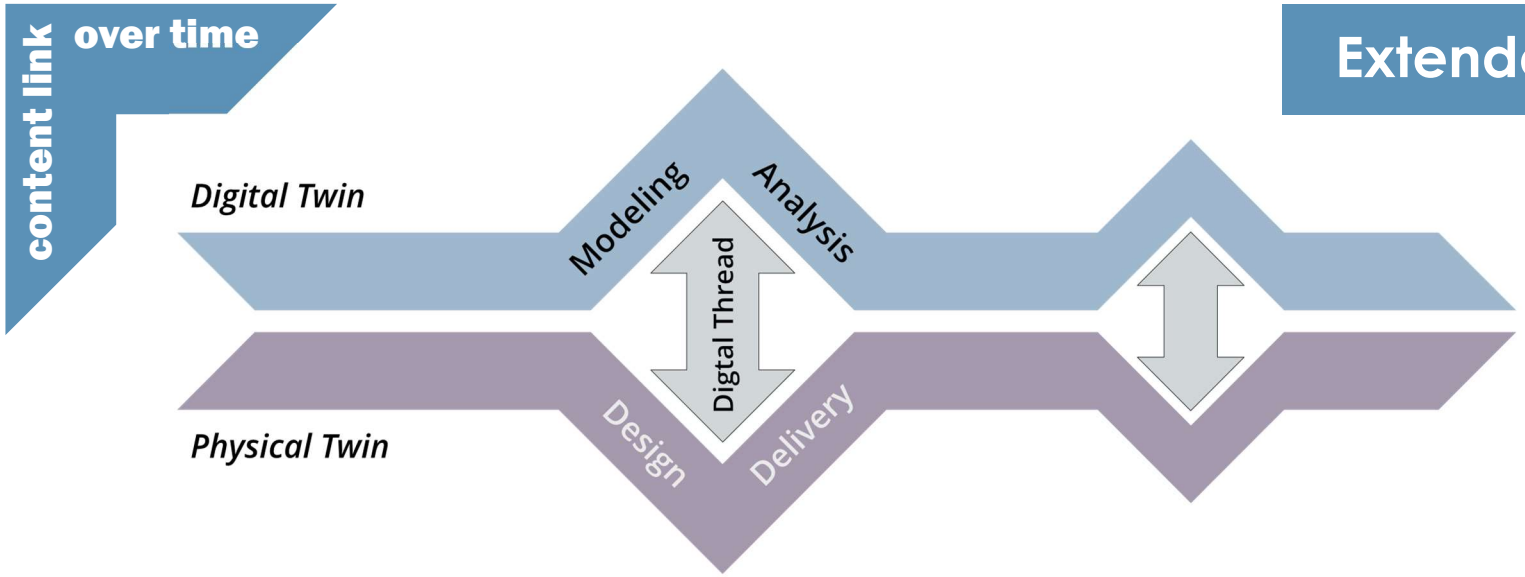
# SEAMLESS ::
# WHAT SEAMLESS ENGINEERING USES




## Extended SE Diamond

system :: as designed
system :: as build
system :: as configured
system :: as used
system :: as it changes

integrated use of digital twins and digital threads for both the design process and the system operation



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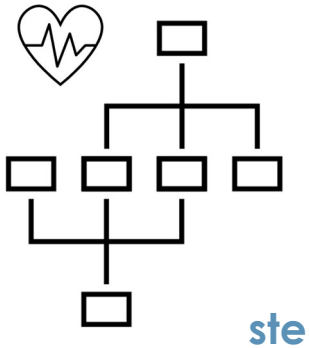
# SEAMLESS ::
# WHAT A SEAMLESS COMPUTE MODEL LOOKS LIKE

**a notion of fitness** **within an operational context**

the ability to perform and to last
within a given context



novel *computational* model:

a probabilistic estimation of a system's
current and future capabilities
to perform efficiently and effectively
to reach set goals given a dynamic environment

stems from design yet focused on validation,
offering concurrent online assessments

suitable for predictive lifecycle management

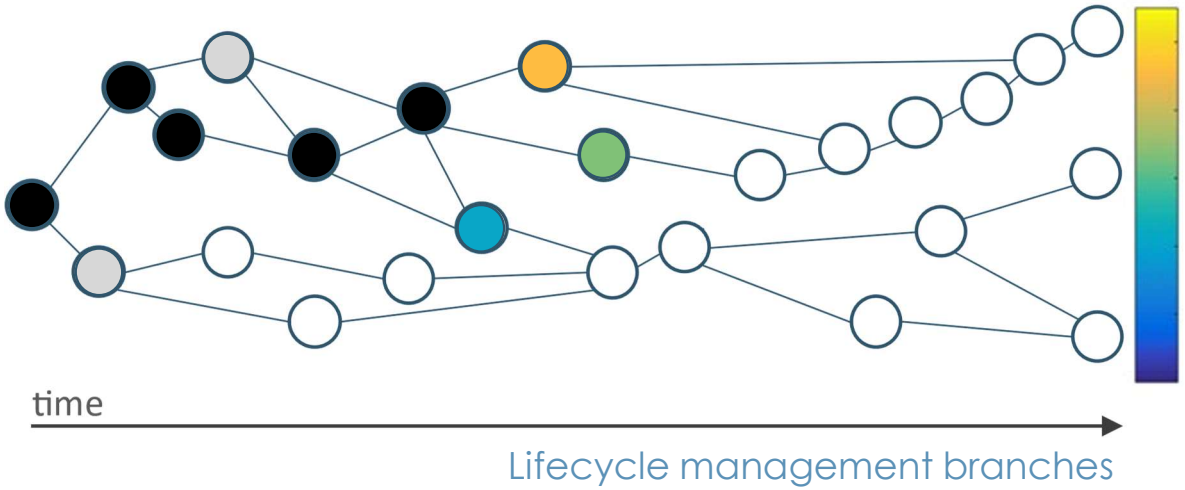
# SEAMLESS ::
# WHAT A SEAMLESS COMPUTE MODEL DOES

**a notion of fitness** **over time in probabilistic fields**

Factors and triggers for change

Likelihood of change

Expected effects of change on behavior, system, context




**reason about change**

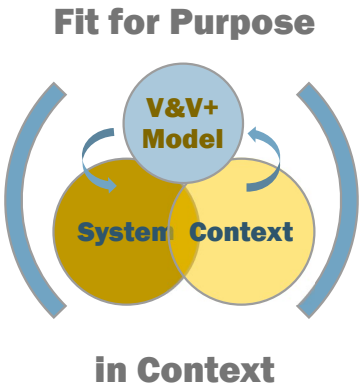
# SEAMLESS ::
# WHAT SEAMLESS SEES AS CRITICAL LINK

**Causality of AI Performance**

impact model on AI behavior with
AI FMAE Risk Assessment

**Fit for Purpose Analysis and Prediction**

based on a dual WHY
always safe & fit to perform



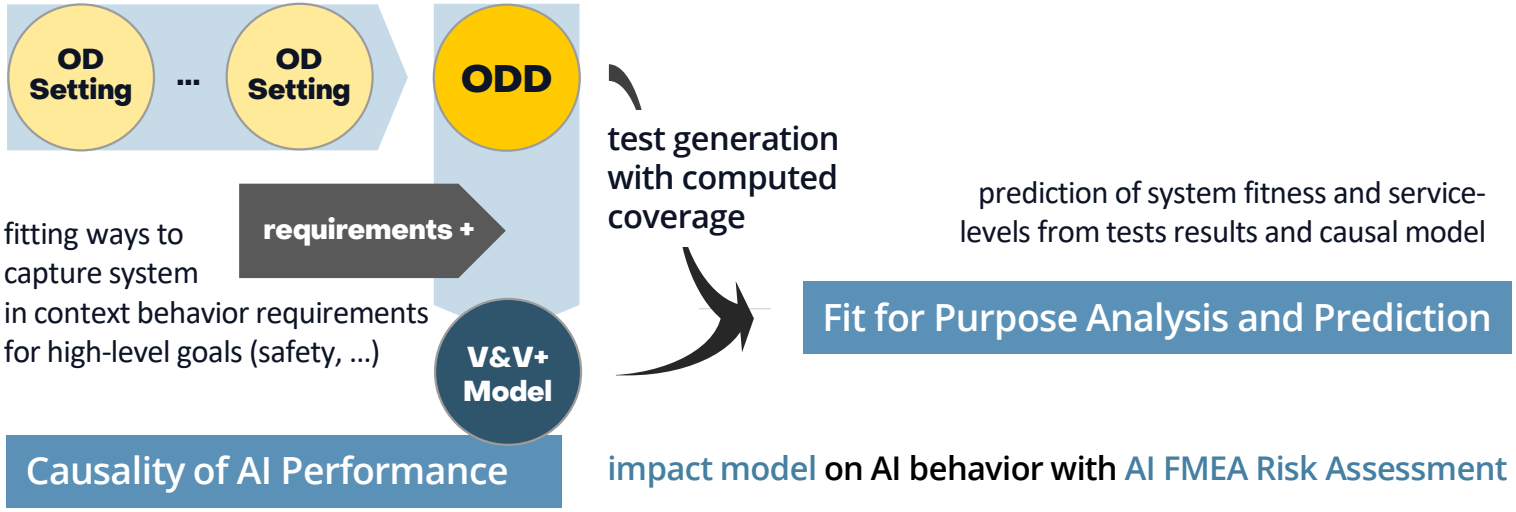

designed | deployed | operated | maintained | changing

For AI-based systems that learn and act within their open context ::

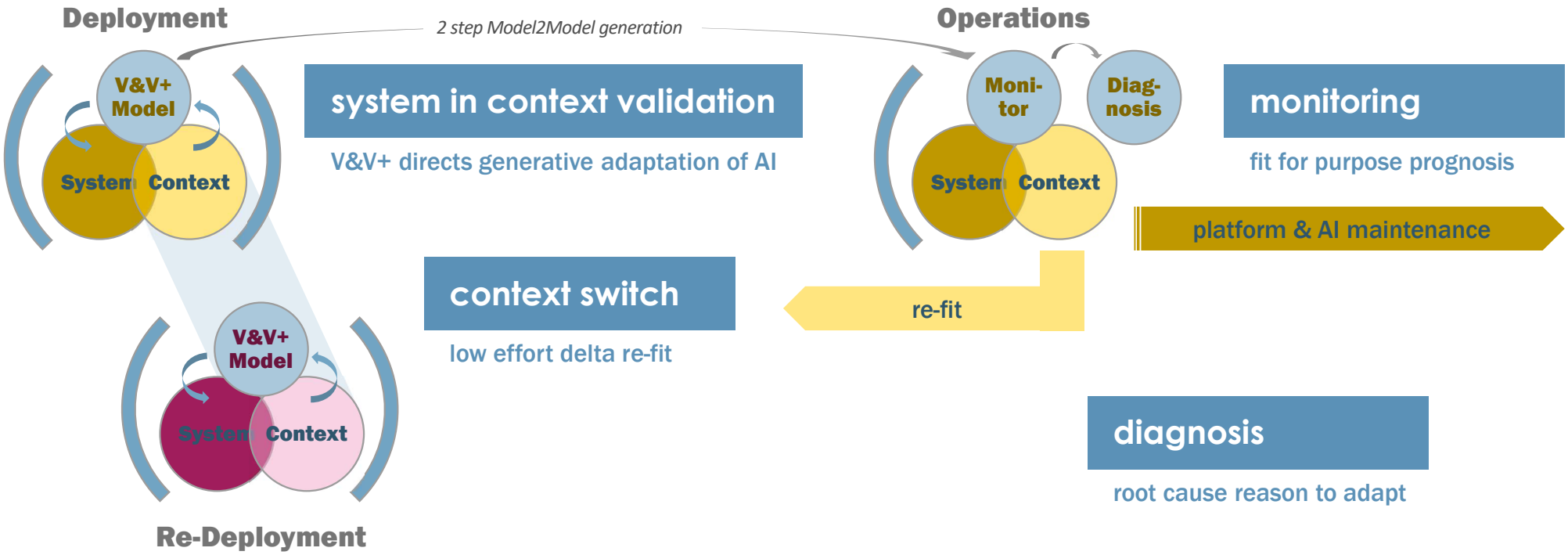
Assure that the system is working correctly

# SEAMLESS ::
# WHAT SEAMLESS ENABLES FOR VALIDATION & VERIFICATION

## Parametrized description of Operational Design Domain and methodology to generate it



# SEAMLESS ::
# WHAT SEAMLESS ENABLES OVER THE SYSTEM LIFECYCLE



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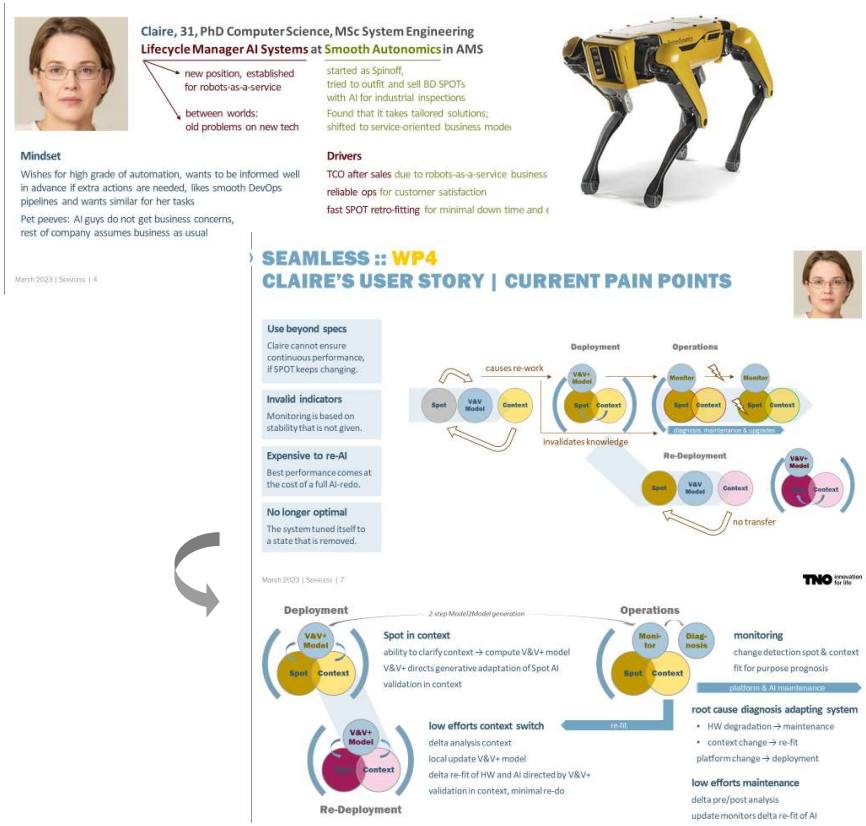
# SEAMLESS :: USER STORIES
# IDENTIFY RESEARCH FOCI

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## WHAT ABOUT YOU?



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