Applying Lean-Agile practices Large, Engineered Systems

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Agenda

- Overview of Lean-Agile principles
- Apply Lean-Agile principles to engineered systems

1. Align on a common cadence
2. Organize around value
3. Plan at multiple levels
4. Manage change
5. Build the solution incrementally
6. Build quality in

Why was the Wright Flyer an example of Lean Engineering?

SAFe Lean-Agile principles

#1-Take an economic view

#2-Apply systems thinking

#3-Assume variability; preserve options

#4-Build incrementally with fast, integrated learning cycles

#5-Base milestones on objective evaluation of working systems

#6-Visualize and limit WIP, reduce batch sizes, and manage queue lengths

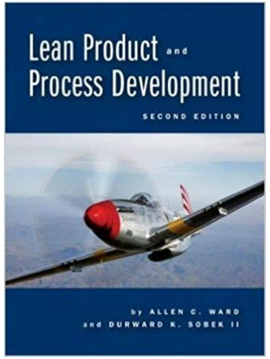
#7-Apply cadence, synchronize with cross-domain planning

8-Unlock the intrinsic motivation of knowledge workers

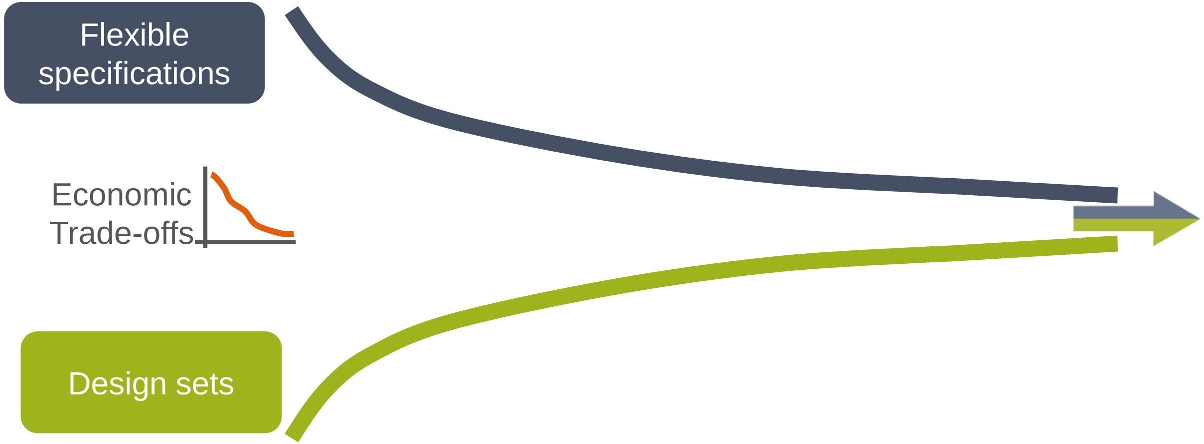
#9-Decentralize decision-making

Assume variability, preserve options

Aggressively evaluate alternatives. Converge specifications and solution set.
—Allen Ward



- You cannot possibly know everything at the start
- Requirements must be flexible to make economic design choices
- Preservation of options improves economic results



Flexible specifications

Economic Trade-offs

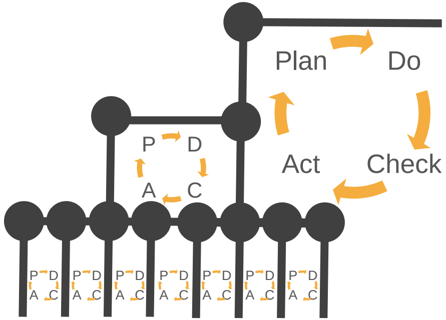
Design sets

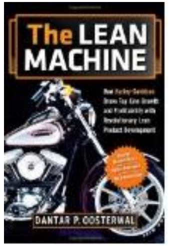
Apply fast, cadence-based learning cycles

> *Product development is the process of converting uncertainty to knowledge*
>
> *—Dantar P. Oosterwal*

Integration points control product development

- Integration points accelerate learning
- Development can proceed no faster than the slowest learning loop
- Improvement comes through synchronization of design loops and faster learning cycles



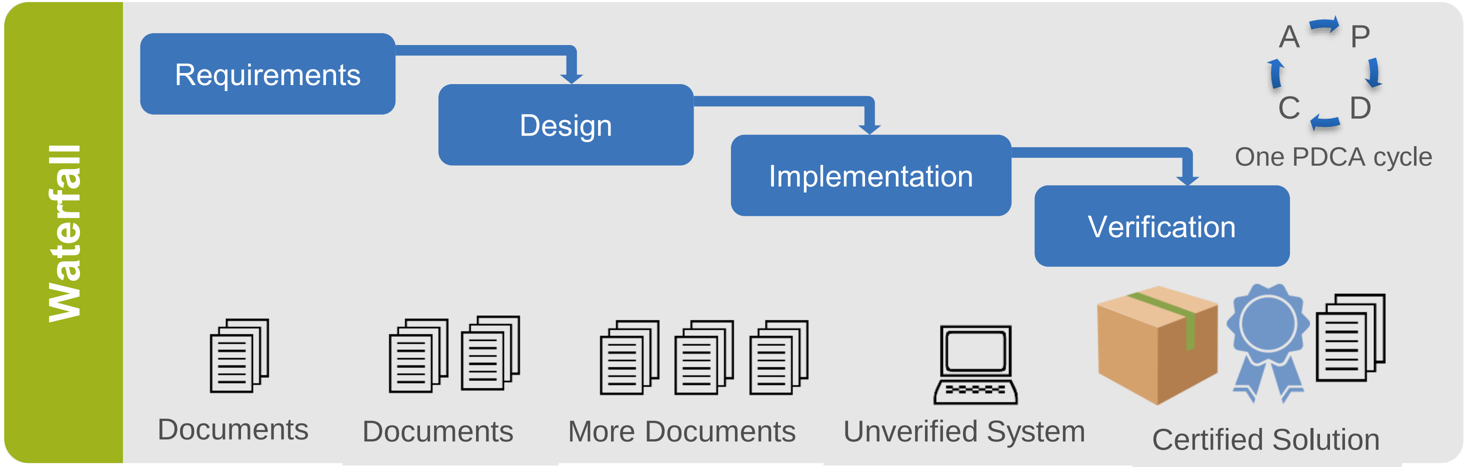


***The Lean Machine**: How Harley Davidson Drove Top-Line Growth and Profitability with Revolutionary Lean Product Development*

—Dantar P. Oosterwal

1) Align everyone on a common cadence

Driven by early decisions and fixed schedule



Waterfall

Requirements

Design

Implementation

Verification

A P C D

One PDCA cycle

Documents

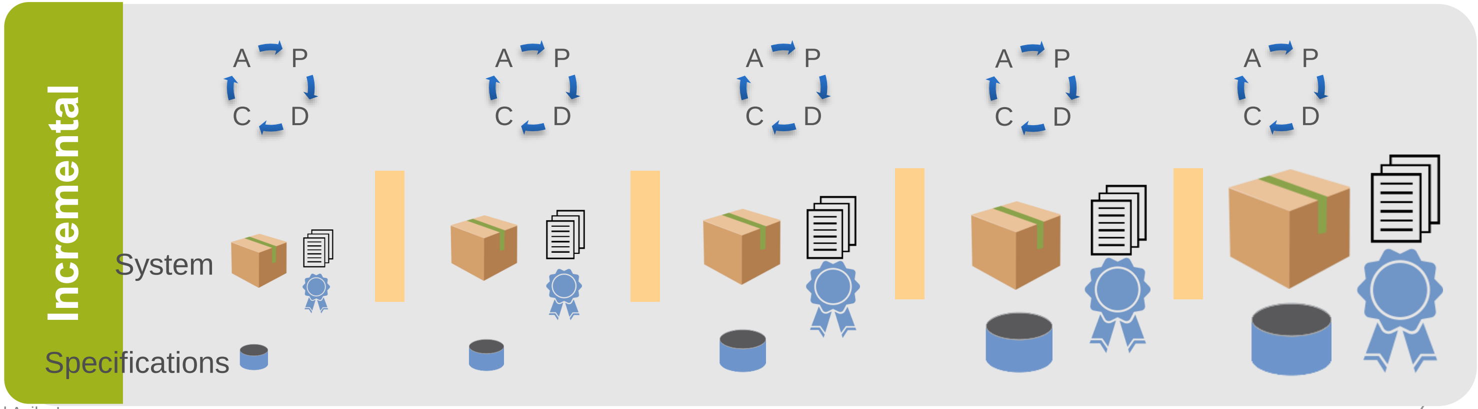
Documents

More Documents

Unverified System

Certified Solution

Driven by learning and feedback



Incremental

A P C D

A P C D

A P C D

A P C D

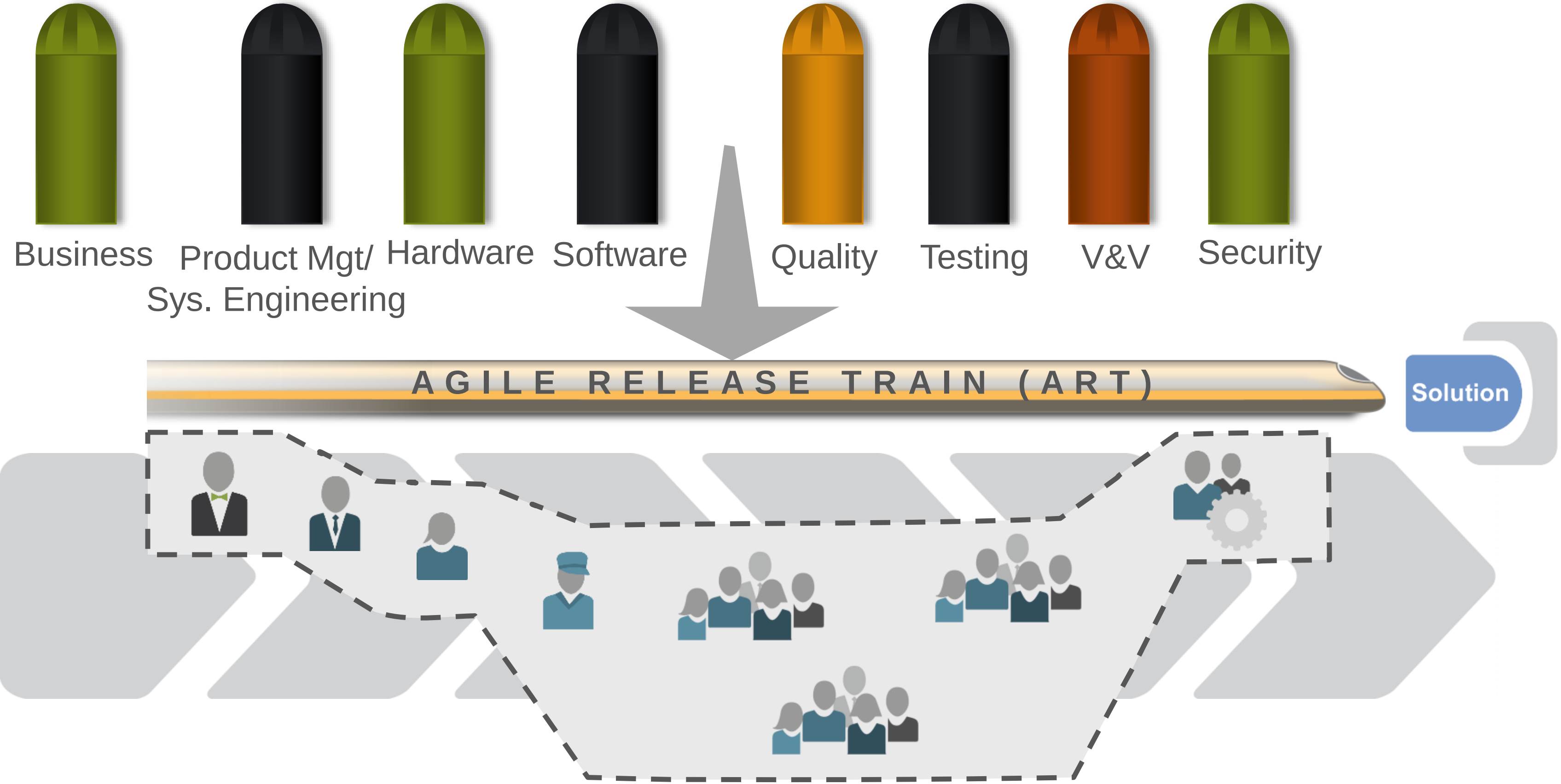
A P C D

System

Specifications

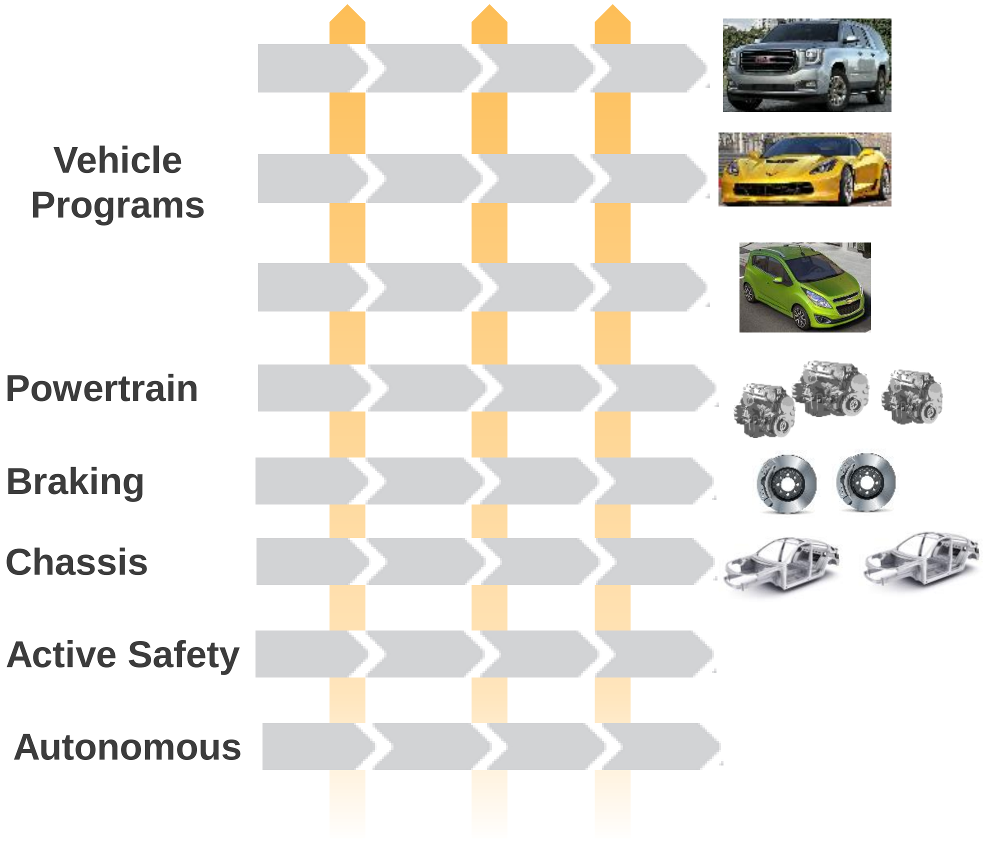
SCALED AGILE

2) Organize around value



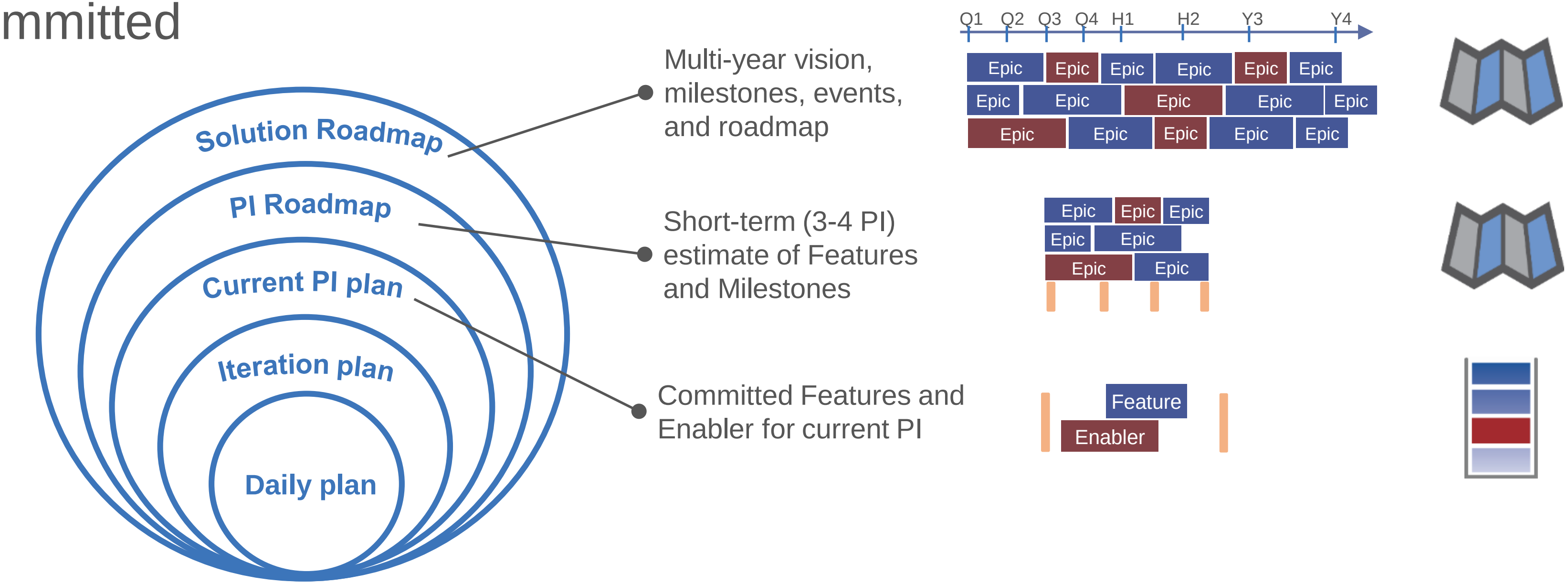
Organizing around value at scale

- Aligned on a common cadence
- Get comfortable with Collective Ownership
- Requires Continuous Integration
- Leverage Community of Practices / Scrum of Scrums



3) Plan at multiple levels

- Outer levels less defined, committed
- Inner levels more understood, detailed, committed



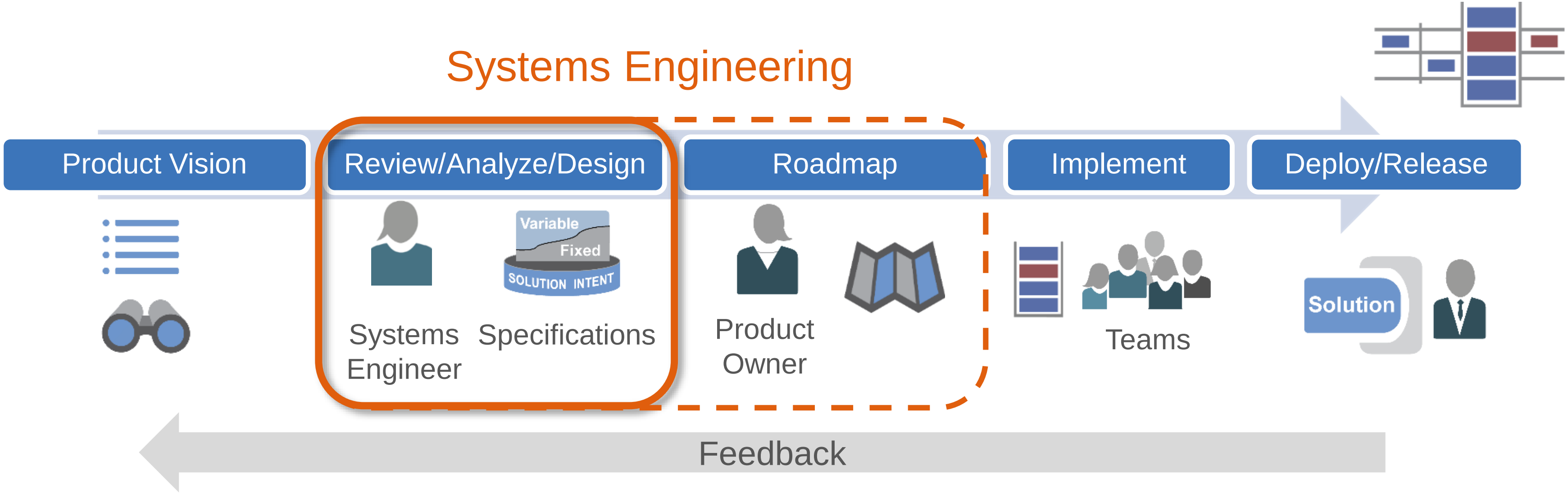
Multi-year vision, milestones, events, and roadmap

Short-term (3-4 PI) estimate of Features and Milestones

Committed Features and Enabler for current PI

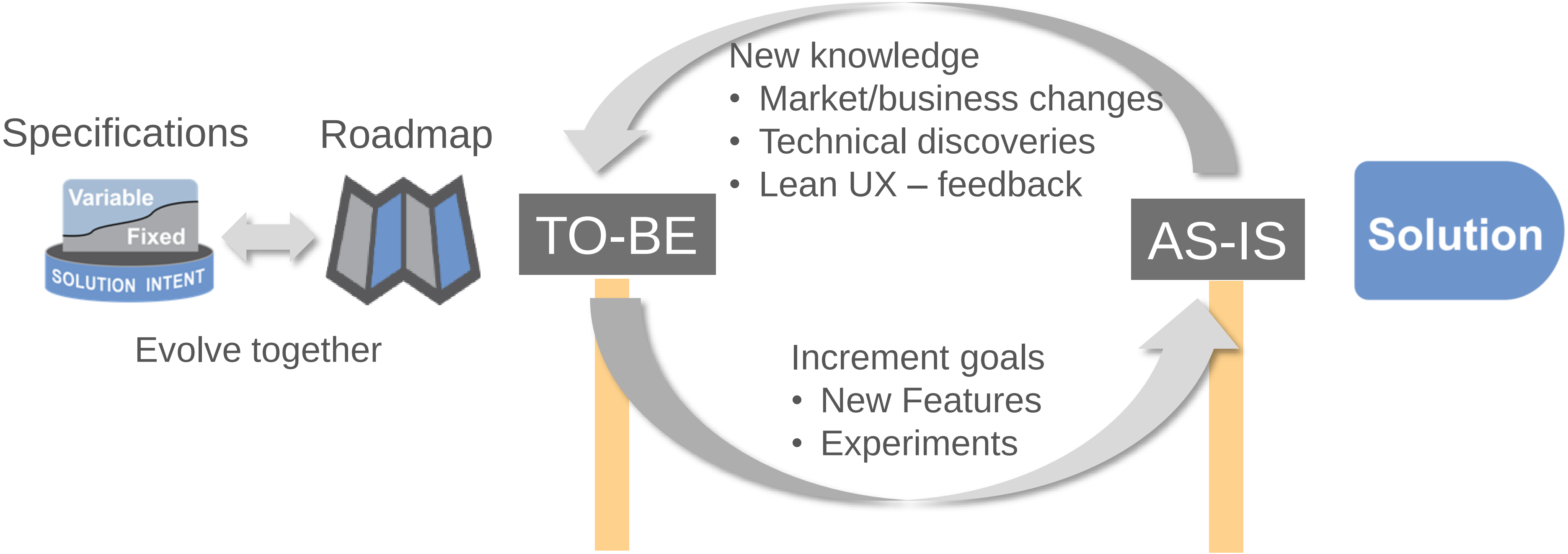
Make Systems Engineering work part of agile flow

- In Lean-Agile, all work is flow-based and performed in small batches
- Consequently, SE activities must be part of flow



Define intent and roadmap to move from as-is to to-be

- Evolve the intent and roadmap based on learning



Specifications

Roadmap

Evolve together

TO-BE

New knowledge
- Market/business changes
- Technical discoveries
- Lean UX – feedback

AS-IS

Solution

Increment goals
- New Features
- Experiments

How do we sequence the work?

High risk

- High learning – could cancel the project
- High risk - impacts budget or schedule

High value

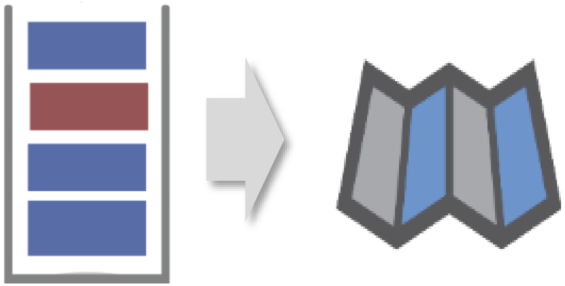
- Core value (MVP)
- High value (MMF)

Understand dependencies

- Priority inversion for dependent items

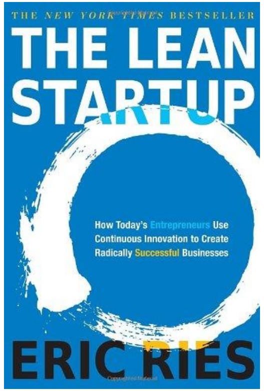
Consider ART capacities

- Capacity limited by ART throughput

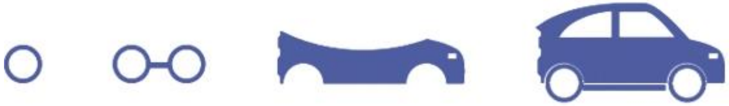


Validate assumptions early with MVPs

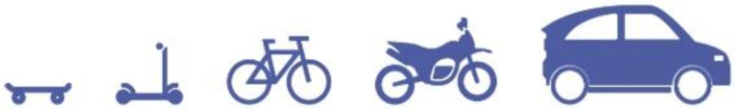
- Don’t assume point solutions
- Explore alternatives through exploration activities to gain knowledge
- Build minimum solution to gain desired knowledge (MVP)
- Utilize proxies for parts of the system not yet built


THE NEW YORK TIMES BESTSELLER
THE LEAN STARTUP
How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses
ERIC RIES

MVP by building parts



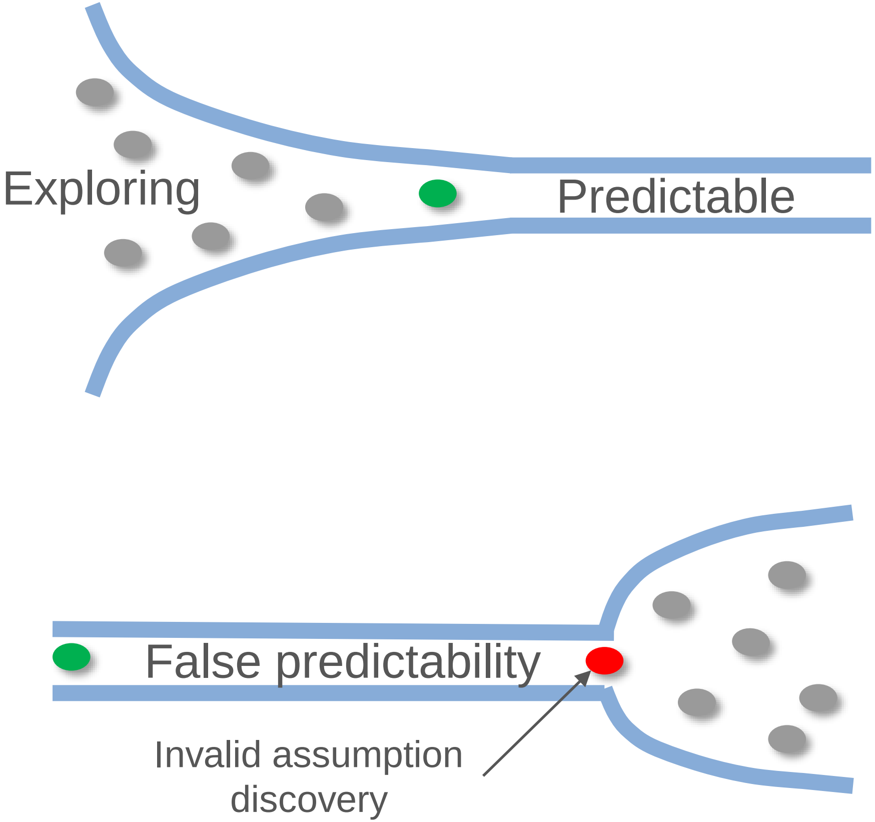
MVP by demonstrable learning



Mitigate risks using Set-Based Design (SBD)

- Keep requirements and design options open as long as possible

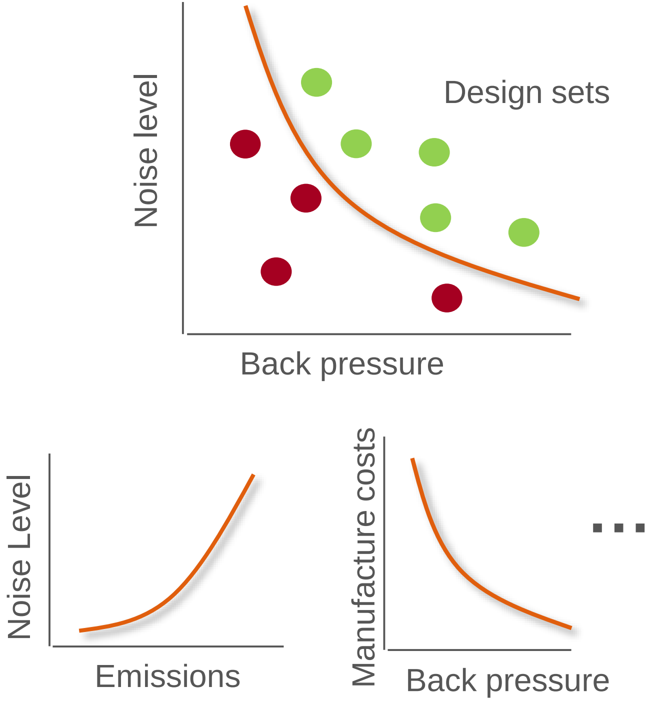
- Explore alternatives to arrive at the *optimal* decision, not the *first* decision



Record and communicate knowledge with tradeoff curves

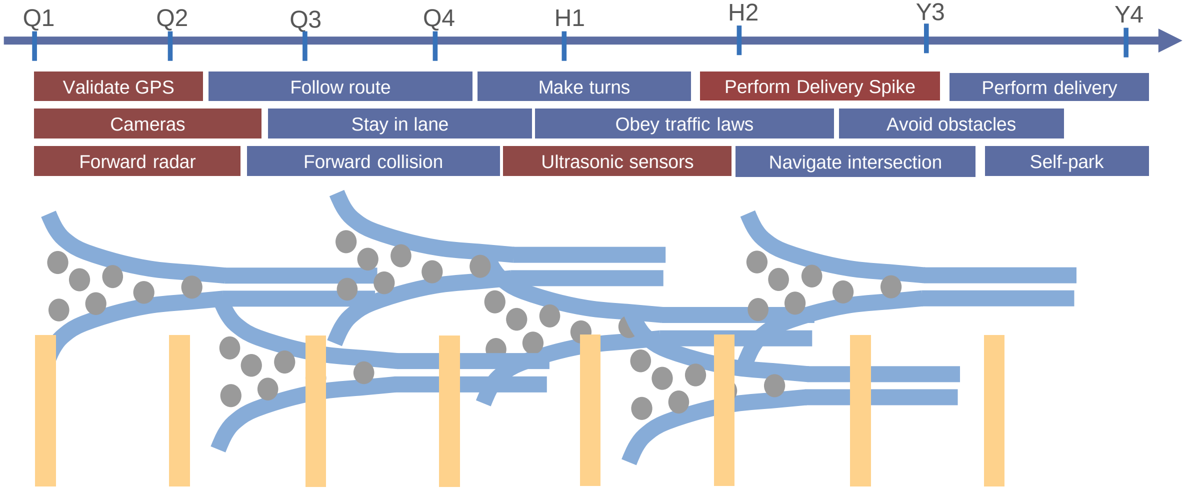
- Characterize the fundamental tradeoffs governing system performance
- Test, measure, and record those decisions in limit curves
- Understand the relationships between conflicting design parameters
- Intentionally vary parameters to understand limits of what is feasible

Exhaust system tradeoffs



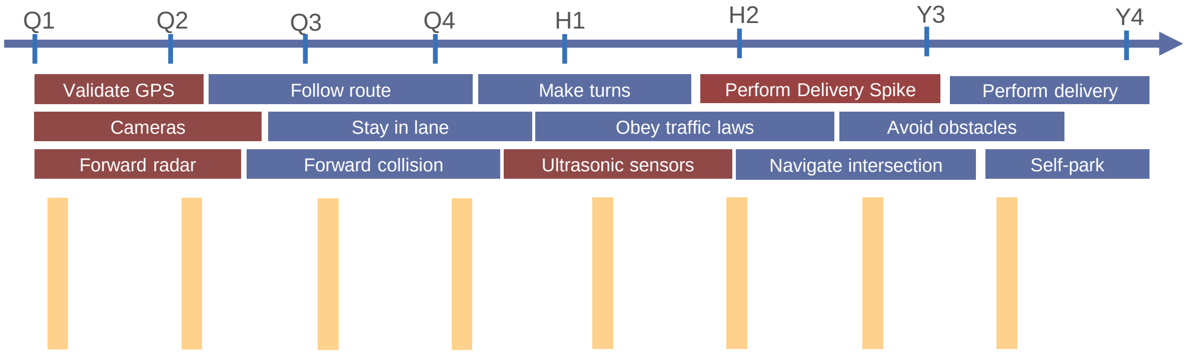
Exploration is continuous

- Learning performed in small batches
- Gain knowledge at last responsible moment



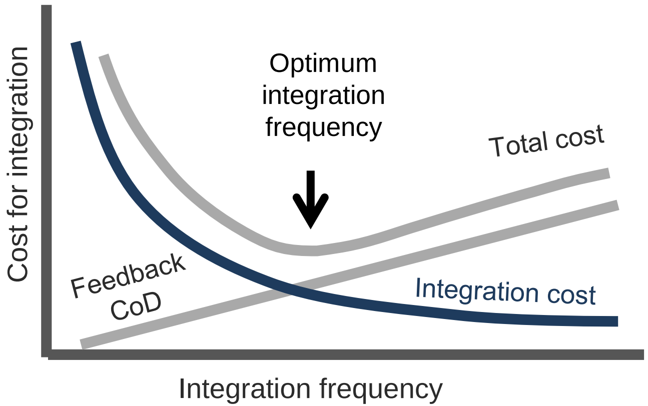
4) Build the solution incrementally

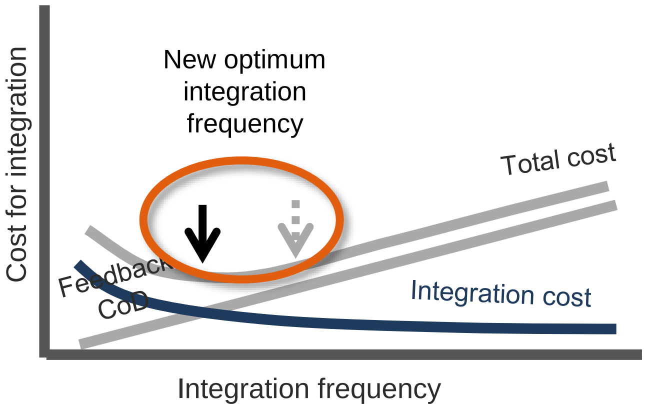
- Frequent integration provide fast feedback and new knowledge
- Trade-offs are inevitable in terms of:
  - Frequency of integration
  - Depth of integration
  - Fidelity of feedback



Invest in infrastructure and practices to lower integration cost

- Large hidden delays in the build-integrate-test-deploy process
- Strive to automate the entire end-to-end process for the entire system

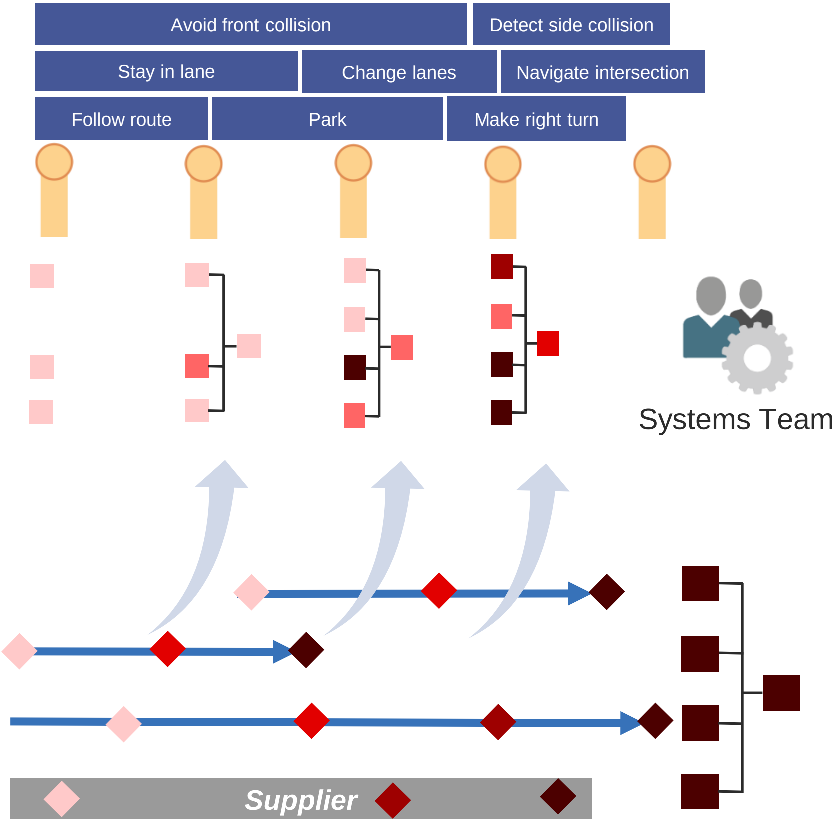




Principles of Product Development Flow, Don Reinertsen

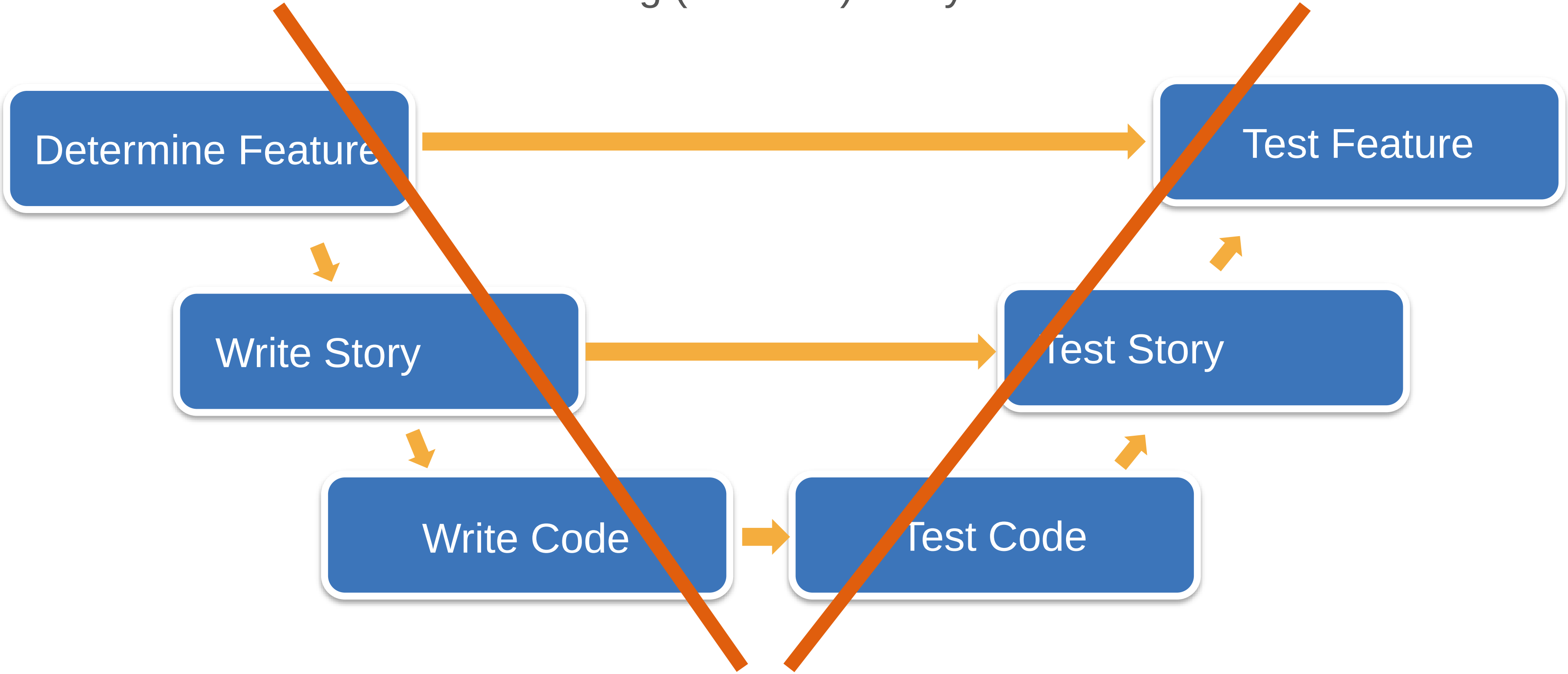
Align functional and physical roadmaps

- Hardware teams create proxies for their learning – coordinate them
- Strive for early, end-to-end solution mockup that matures in fidelity over time
- Hardware teams responsible for supporting incremental demonstrations

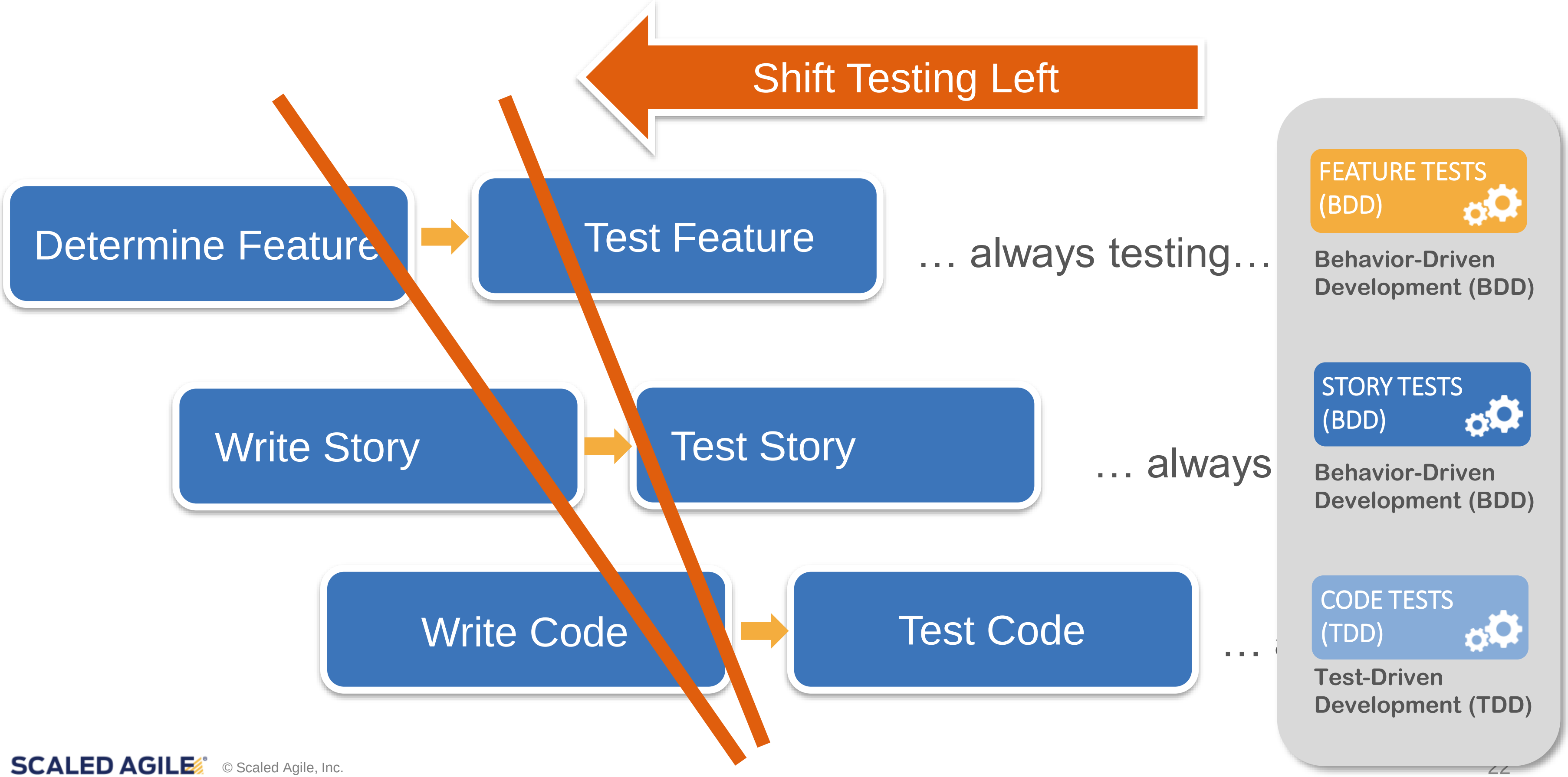


5) Build quality (and compliance) in

Traditional testing (V-Model) delays feedback



Shift testing left for fast and continuous feedback



Shift Testing Left

Determine Feature → Test Feature … always testing…

Write Story → Test Story … always

Write Code → Test Code … a

FEATURE TESTS (BDD)

Behavior-Driven Development (BDD)

STORY TESTS (BDD)

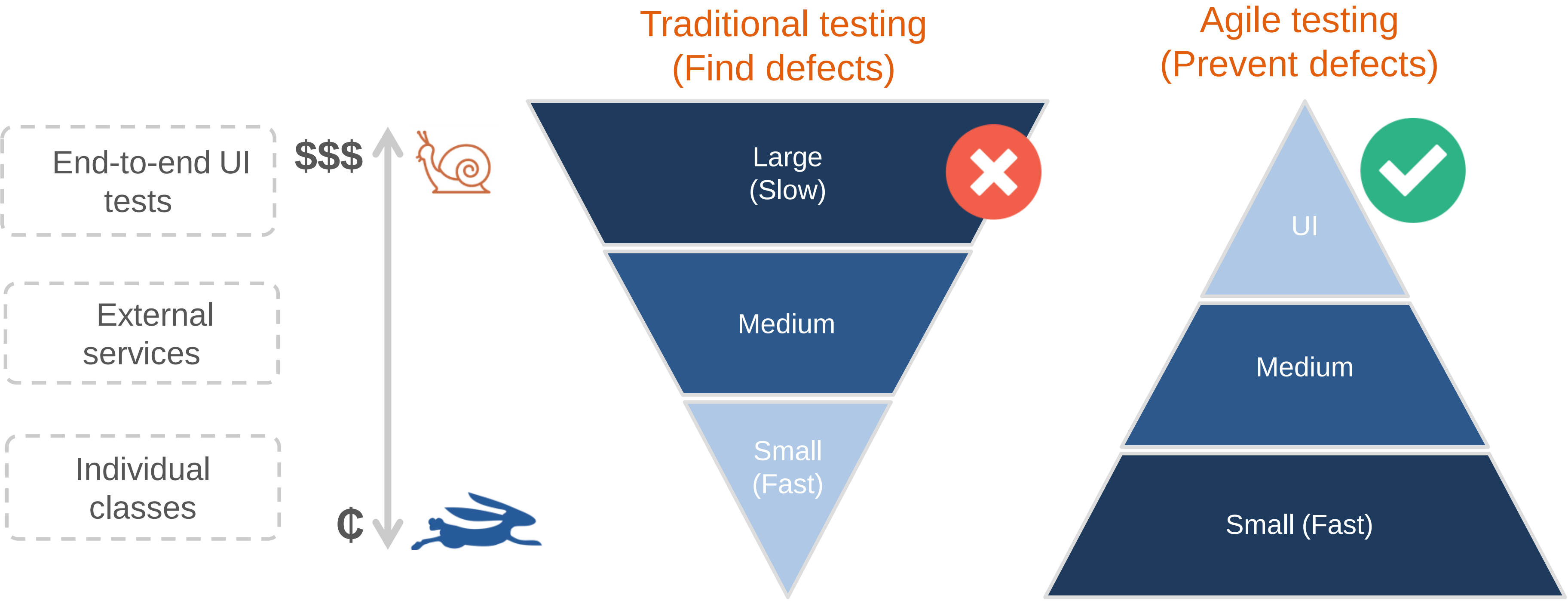
Behavior-Driven Development (BDD)

CODE TESTS (TDD)

Test-Driven Development (TDD)

Early, automated tests build a balanced test portfolio

- Test Pyramid advocates many small, low-level, automate tests and fewer large, manual tests



Traditional testing (Find defects)

Agile testing (Prevent defects)

End-to-end UI tests

External services

Individual classes

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Large (Slow)

Medium

Small (Fast)

UI

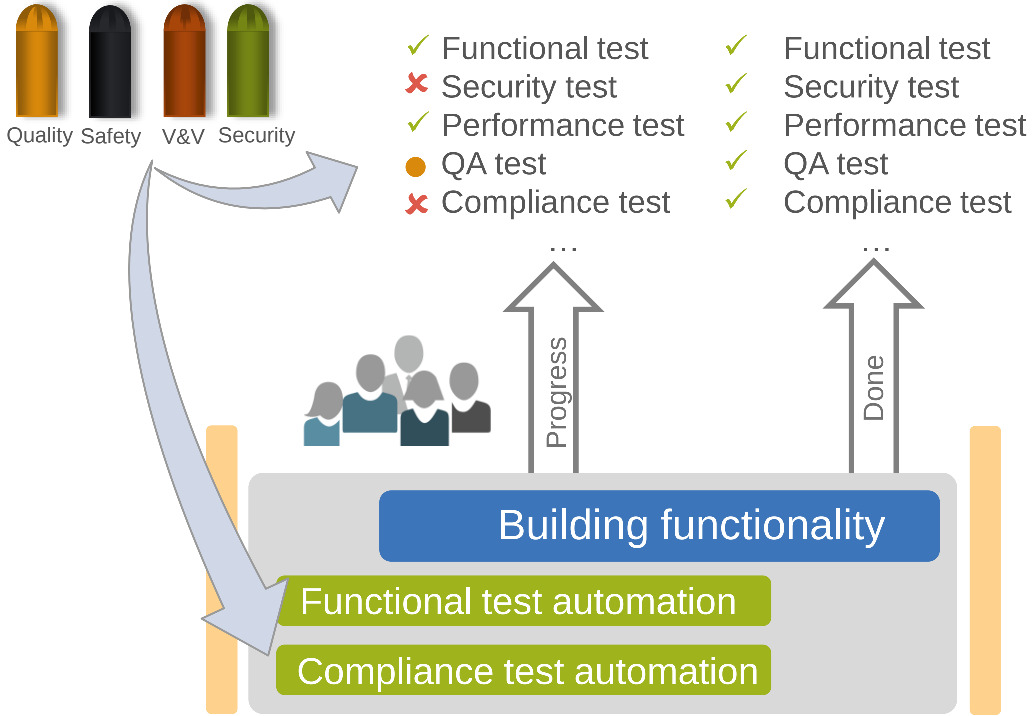
Medium

Small (Fast)

Test automation builds quality and compliance in

Give teams automated scripts instead of checklists

- Automate tests in the same iteration as the functionality
- Include tests for safety, security, performance, quality, etc.
- Invest in automated testing infrastructure to improve flow
- Actively maintain test data under version control



Quality Safety V&V Security

✓ Functional test
✗ Security test
✓ Performance test
● QA test
✗ Compliance test
…

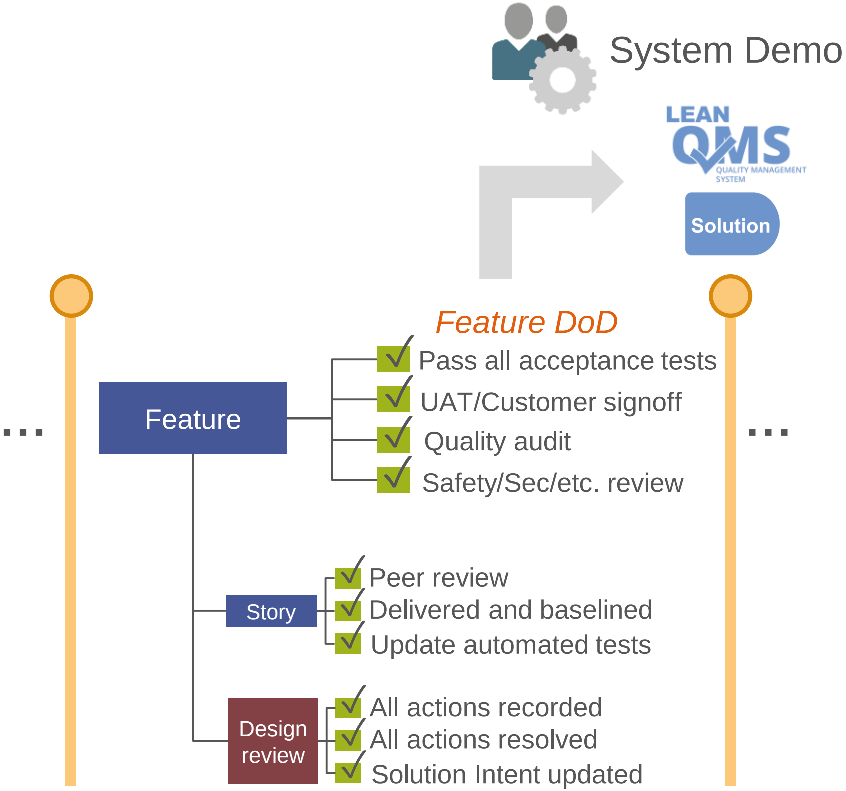
✓ Functional test
✓ Security test
✓ Performance test
✓ QA test
✓ Compliance test
…

Building functionality

Functional test automation

Compliance test automation

Perform verification and validation continuously



Evaluate full system increment

- Regression test all functional stories, NFRs, and feature acceptance tests
- Tested on end-to-end test environment
- User/Product Owner validation
- Update V&V tests
- Generate compliance docs and check progress towards acceptance

Development teams, system team and program shared V&V responsibilities

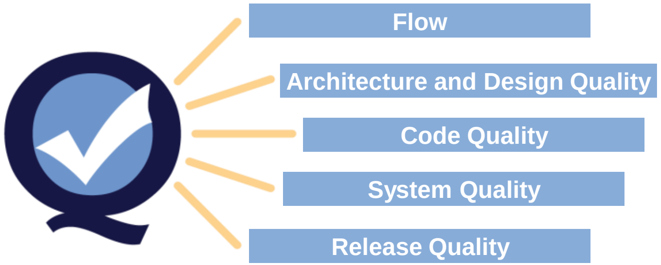
Lean-Agile is hyper-focused on built-in quality

Architect/Design Quality

- Design for testability with components and interfaces
- Abstraction, encapsulation, SOLID
- Set-based design

Code (artifact) Quality

- Test-First – TDD, BDD
- Pair work
- Collective ownership
- Refactoring
- Standards



System Quality

- Align with BDD
- Communicate with MBSE
- Continuous delivery pipeline

Release Quality

- Component-level and team-level release-ability
- Immutable infrastructure
- Continuous V&V and compliance

Summary

- Lean-Agile principles apply to engineered systems through…
  - Align on a common cadence
  - Organize around value
  - Manage change
  - Build the solution incrementally
  - Build quality in

Questions

Thank you!

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