CS 4530: Fundamentals of Software Engineering
Module 7.2: Software Development Processes

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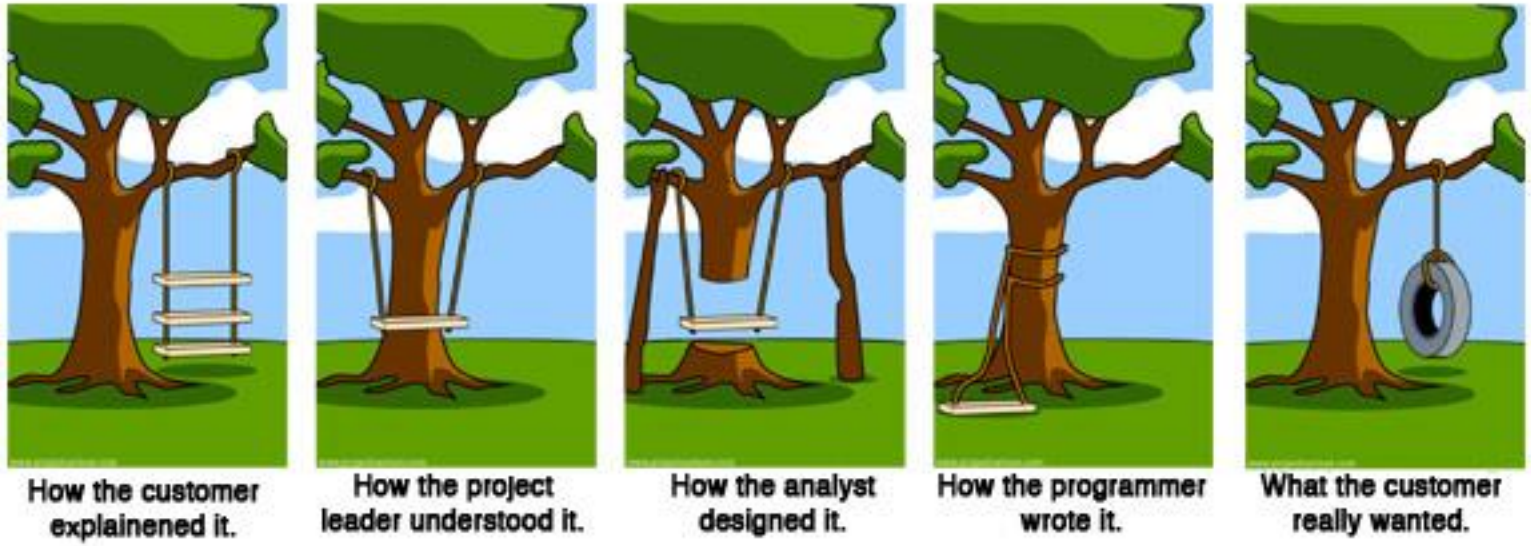
Learning Goals for this Lesson

- At the end of this lesson, you should be able to
  - Know the basic characteristics of the waterfall software process model
  - Be able to explain when the waterfall model is appropriate and when it is not
  - Understand how the waterfall and agile models manage risk
  - Be able to explain how agile process instill quality, including through test driven development

Review:
How to make sure we are building the right thing

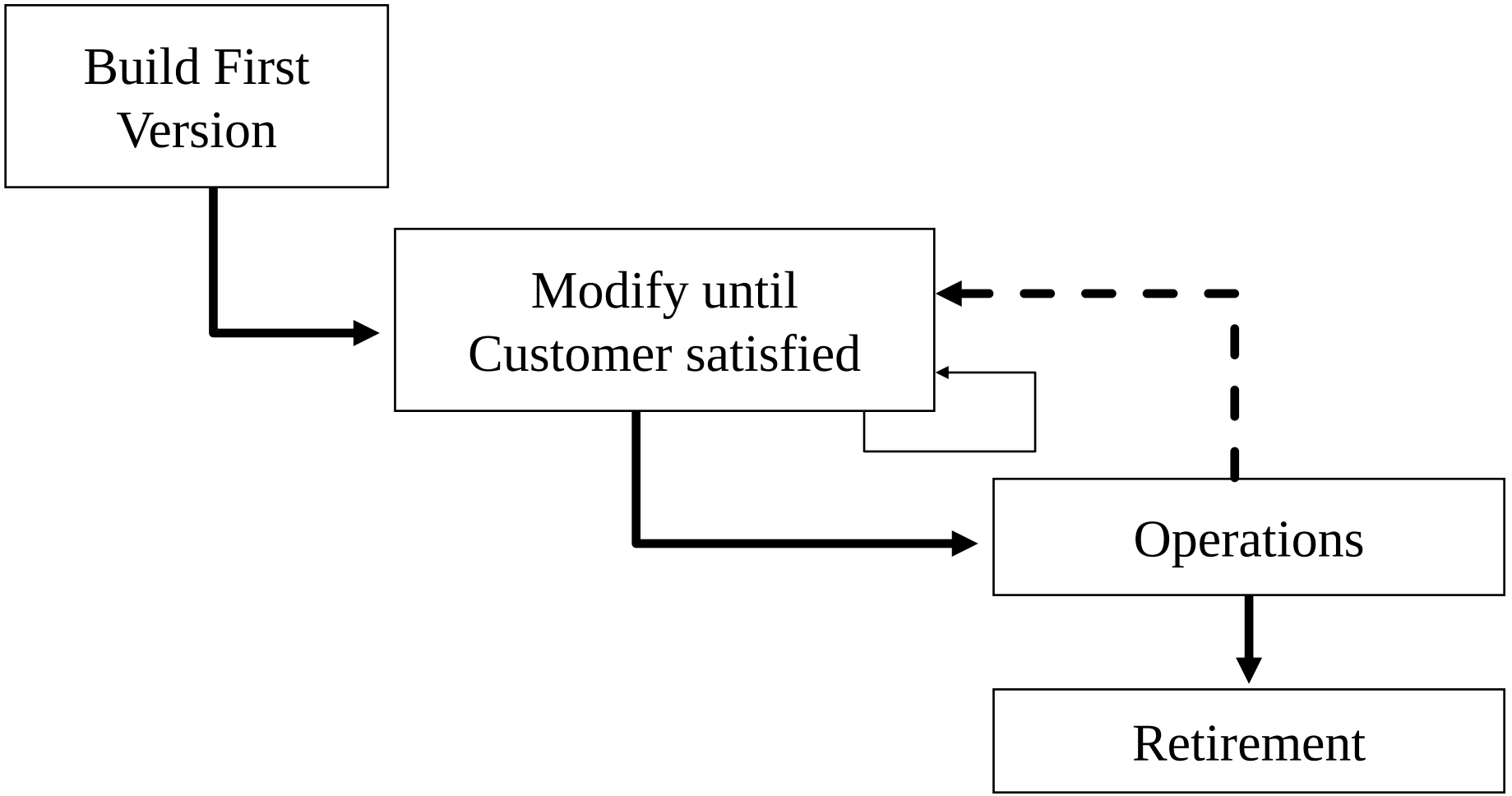


Requirements Analysis

Planning & Design

Implementation

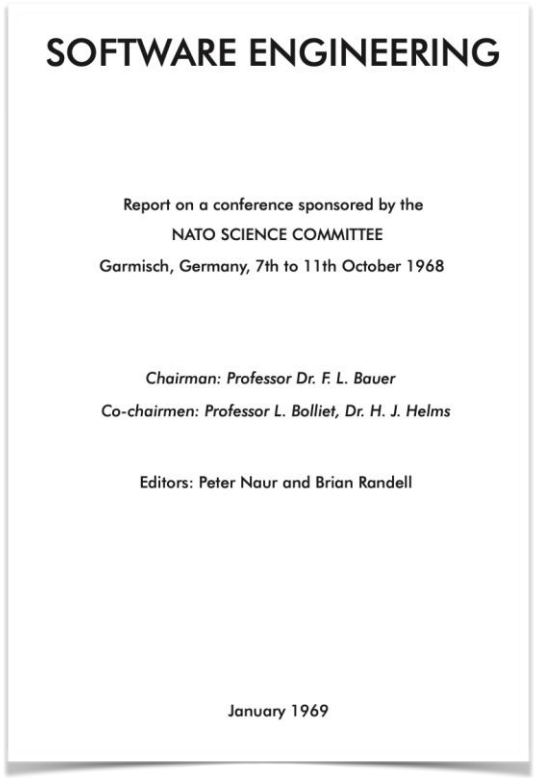
Software Process: Code + Fix



A brief history of software planning

NATO conference on Software Engineering + Outcomes

- Software was very inefficient
- Software was of low quality
- Software often did not meet requirements
- Projects were unmanageable and code difficult to maintain
- Software was never delivered


SOFTWARE ENGINEERING

Report on a conference sponsored by the
NATO SCIENCE COMMITTEE
Garmisch, Germany, 7th to 11th October 1968

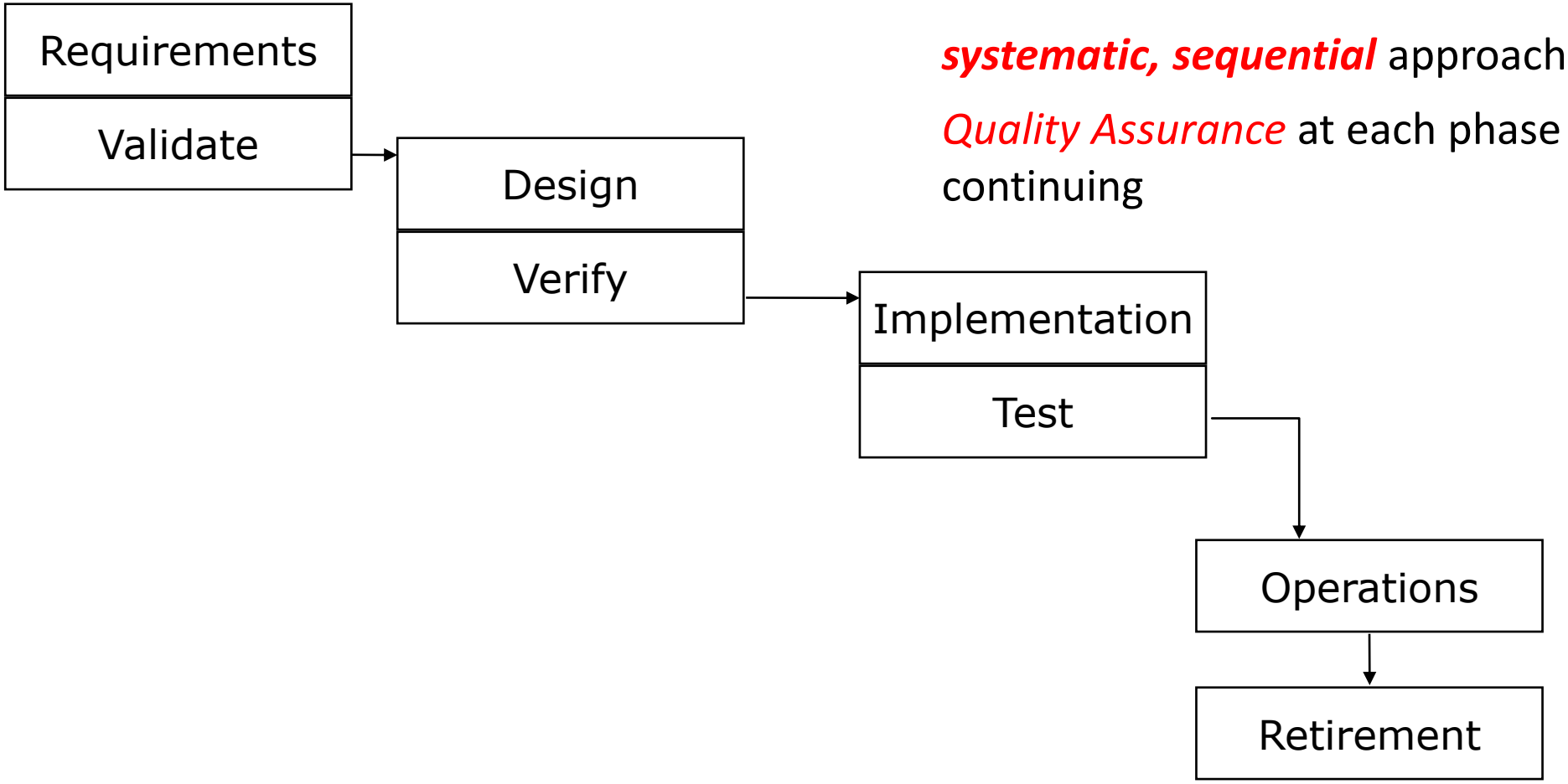
Chairman: Professor Dr. F. L. Bauer
Co-chairmen: Professor L. Bolliet, Dr. H. J. Helms

Editors: Peter Naur and Brian Randell

January 1969

A call to action: We must study *how to build software*

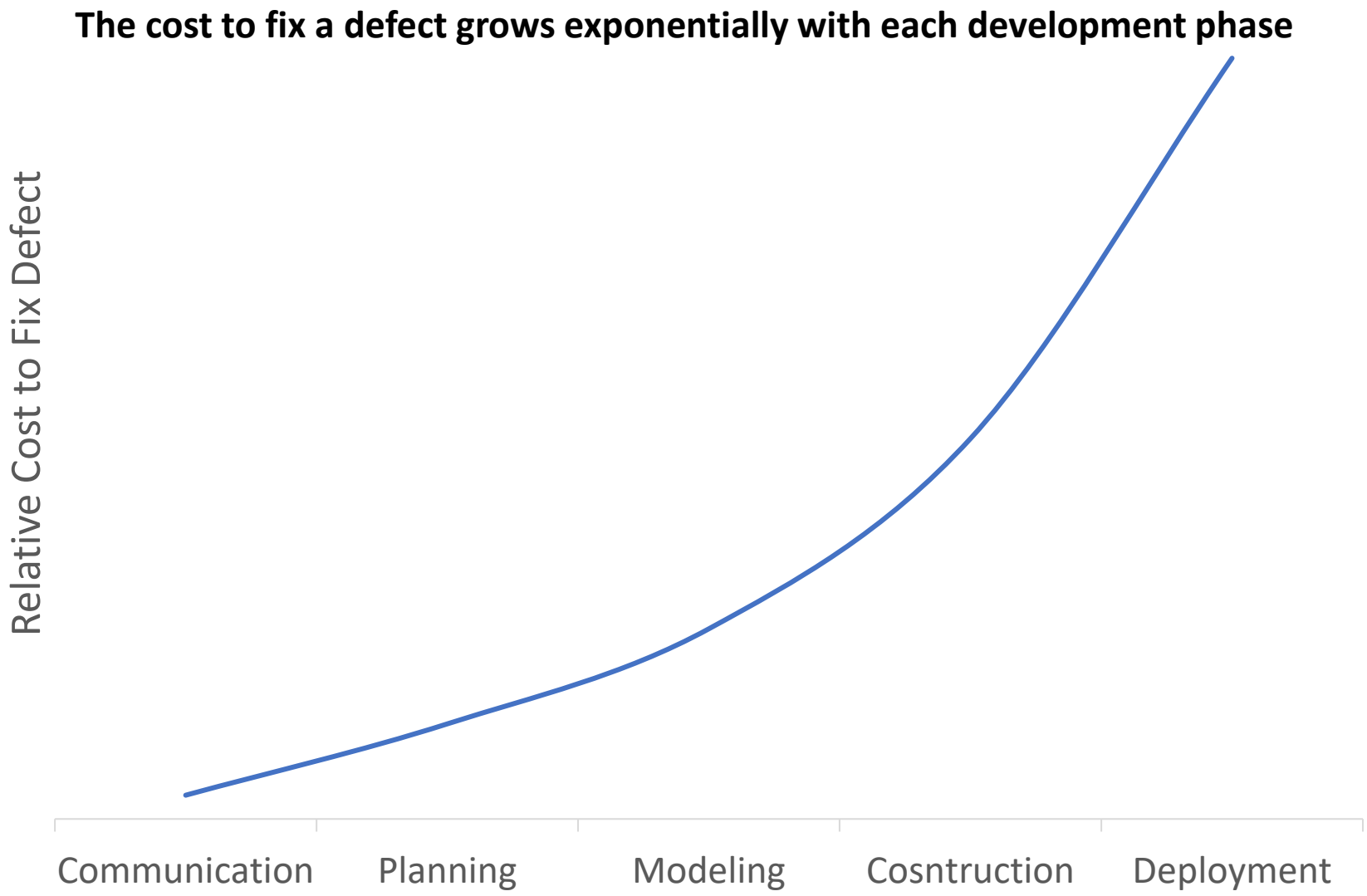
Software Process: Waterfall (~1970)



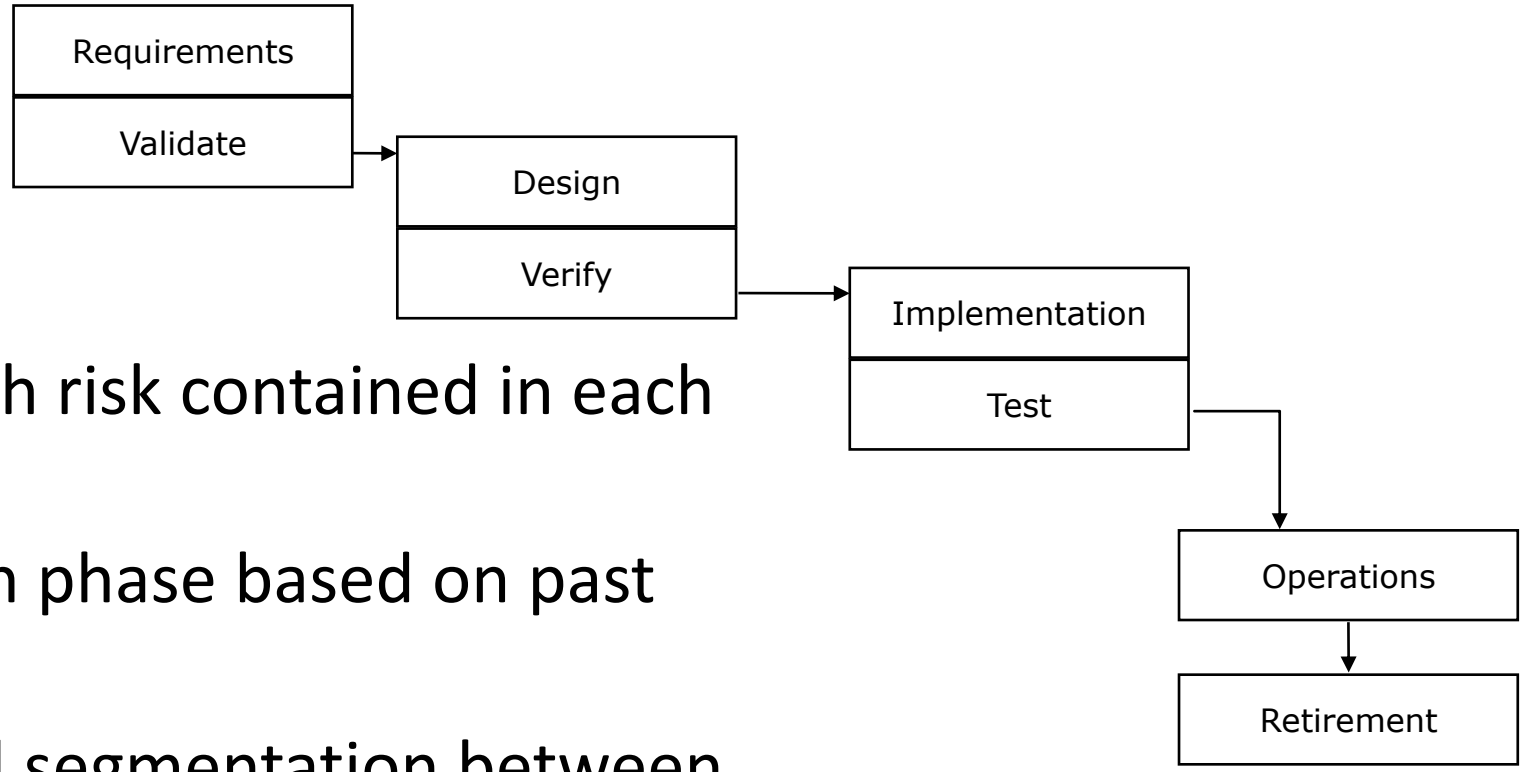
systematic, sequential approach

Quality Assurance at each phase before continuing

Waterfall Model: Risk Assumptions



Waterfall Process Improves on Code + Fix



- Measurable progress with risk contained in each phase
- Possible to estimate each phase based on past projects
- Division of labor: Natural segmentation between phases

Waterfall Model adds process overhead

Since formal quality assurance happens at each phase, it's necessary to produce extremely detailed…

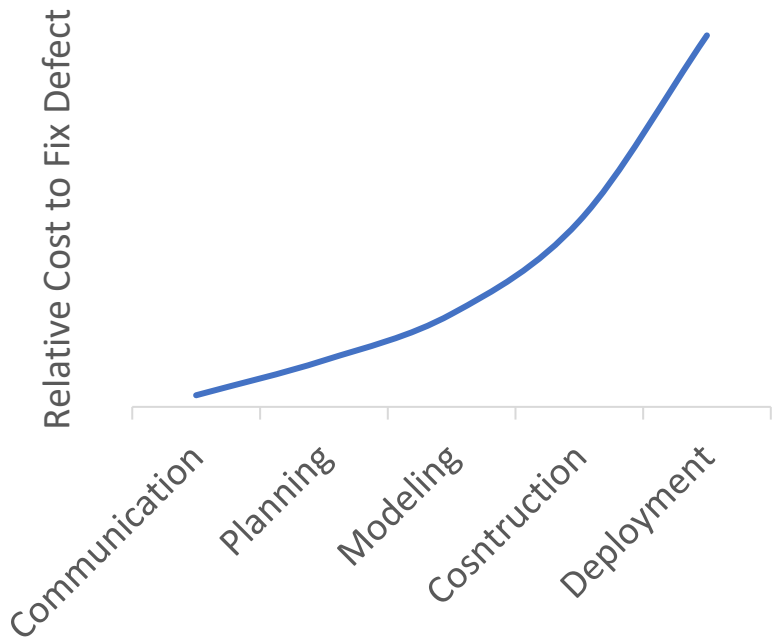
- Requirements documents
- Design documents
- Source code with documentation

Waterfall Model Reduces Risk by Preventing Change

Traditional waterfall model: no way to go back “up”

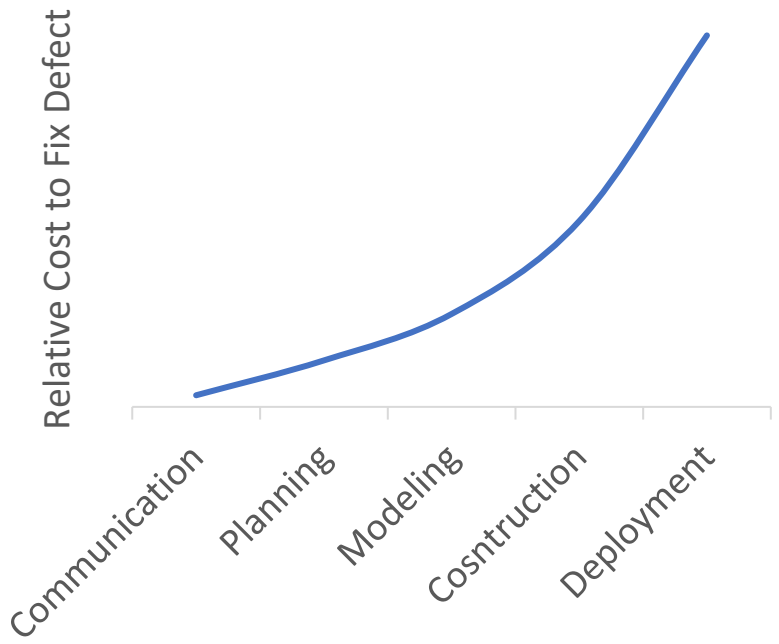
Waterfall Model: Applications

- What projects would this work well in?
  - Projects with tremendous uncertainty
  - Projects with long time-to-market
  - Projects that need extensive QA of requirements and design
  - Projects for which the expense of the planning is worth it
  - Classic examples: military/defense
    - Warship that needs to have component interfaces last 80 years
    - Spacecraft?

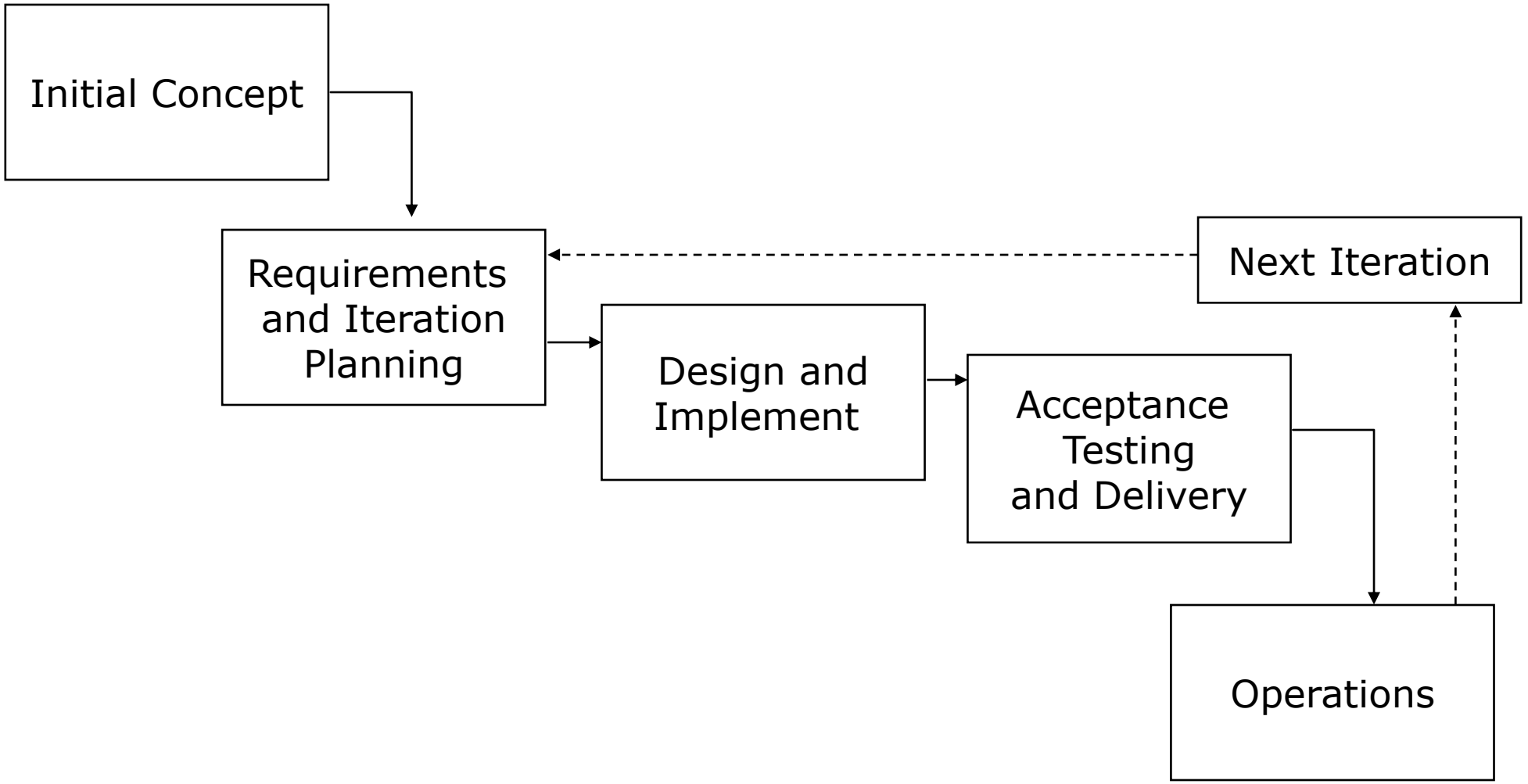


Waterfall Model: Wasted Work Product

- Wasted productivity can occur through each phase's QA process:
  - Requirements that become obsolete
  - Elaborate architectural designs never used
  - Code that sits around not integrated and tested in production environment, eventually discarded
  - Documentation produced per requirements, but never read
- What if we could eliminate that waste, and reduce the cost of defects later in development cycle?
  - Example: with shorter time-to-market?



Waterfall Variation: Iterative Process (~1980s)



The Agile Model Reduces Risk by Embracing Change (~2000)

- The Waterfall philosophy:
  - "The project is too large and complex, and it will take months (or years!) to plan, so once we come up with the plan, that plan can not change"
  - Reduce risk by proceeding in stages
- The Agile philosophy:
  - The project is too large and complex, it is unlikely that we will know exactly what we need right now, and to some extent, we are inventing something new. We think that as we make it, we will figure it out as we go”
  - Reduce risk by limiting time on any one stage; then reassess. (“time-boxing”)

Agile Manifesto

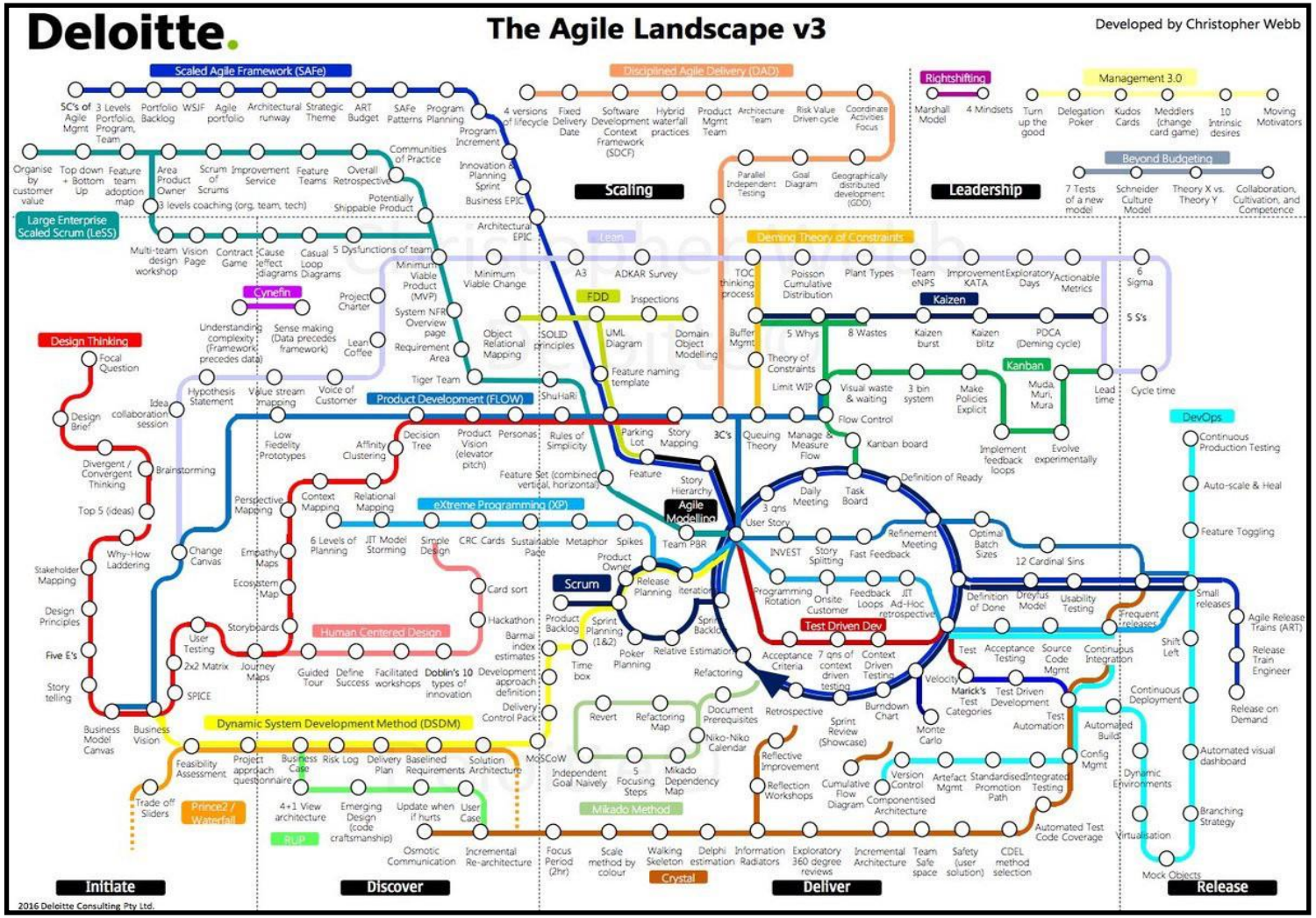
We are uncovering better ways of developing
software by doing it and helping others do it.
Through this work we have come to value:

Individuals and interactions	over processes and tools
Working software	over comprehensive documentation
Customer collaboration	over contract negotiation
Responding to change	over following a plan

That is, while there is value in the items on
the right, we value the items on the left more.

https://agilemanifesto.org

Warning: Agile can be a buzzword



Agile and Waterfall have different philosophies about rist

- Waterfall says: "The project is too large and complex, and it will take months (or years!) to plan, so once we come up with the plan, that plan can not change"

- Agile says “The project is too large and complex, it is unlikely that we will know exactly what we need right now, and to some extent, we are inventing something new. We think that as we make it, we will figure it out as we go”

Agile Values Embrace Change

Compare to problems in waterfall:

- Requirements that become obsolete
  - Don’t make detailed requirements until you need them
- Elaborate architectural designs never used
  - Don’t design until you need
- Code that sits around not integrated and tested in production environment, eventually discarded
  - Integrate and test continuously
- Documentation produced per requirements, but never read
  - Don’t require documentation

Or only as much documentation as you really need.

Agile Practice: Everyone is Responsible for Quality

- “Collective ownership”
- Requirements (user stories) are developed collaboratively with customer, and are *negotiable* (INVEST qualities)
- Functional and non-functional correctness is checked *on the cheap*, and often
- Developers improve code anywhere in the system if they see the opportunity
- Many parallels with “Toyota Process System;” a variety of other software processes developed in the 90’s share these basic values

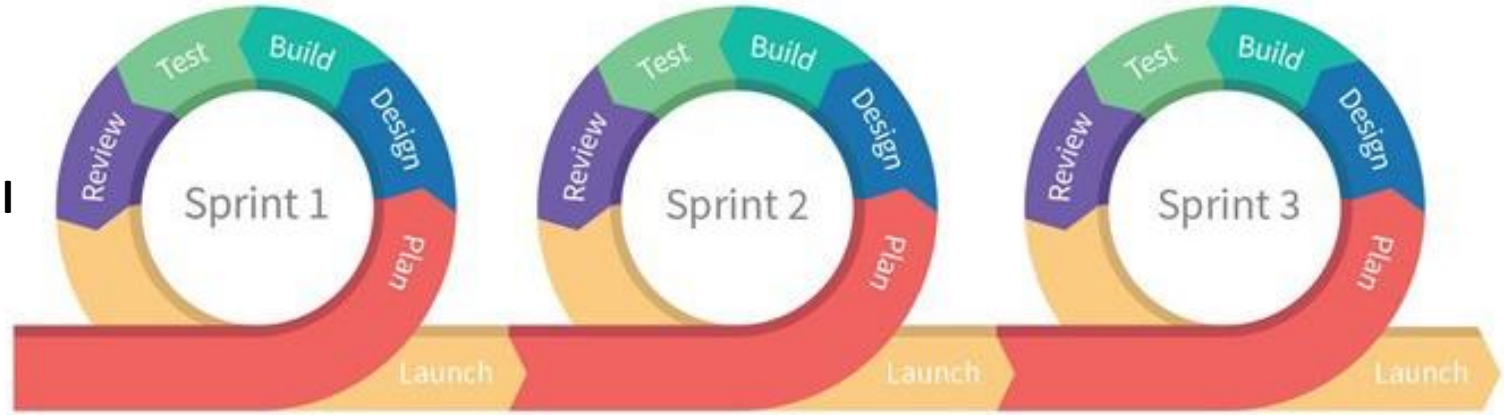
Agile requires a quality assurance process

- Multiple processes have to work together to ensure quality:
  - unit testing/TDD
  - mix of unit tests & integration tests (we'll see more of this)
  - code review
  - continuous integration (also: watch for canaries
  - continuous deployment (A/B, canaries, etc.)
  - quality includes non-functional requirements (resource consumption, response time) or generally speaking extensibility, maintainability, etc.
- Quality is everyone’s responsibility

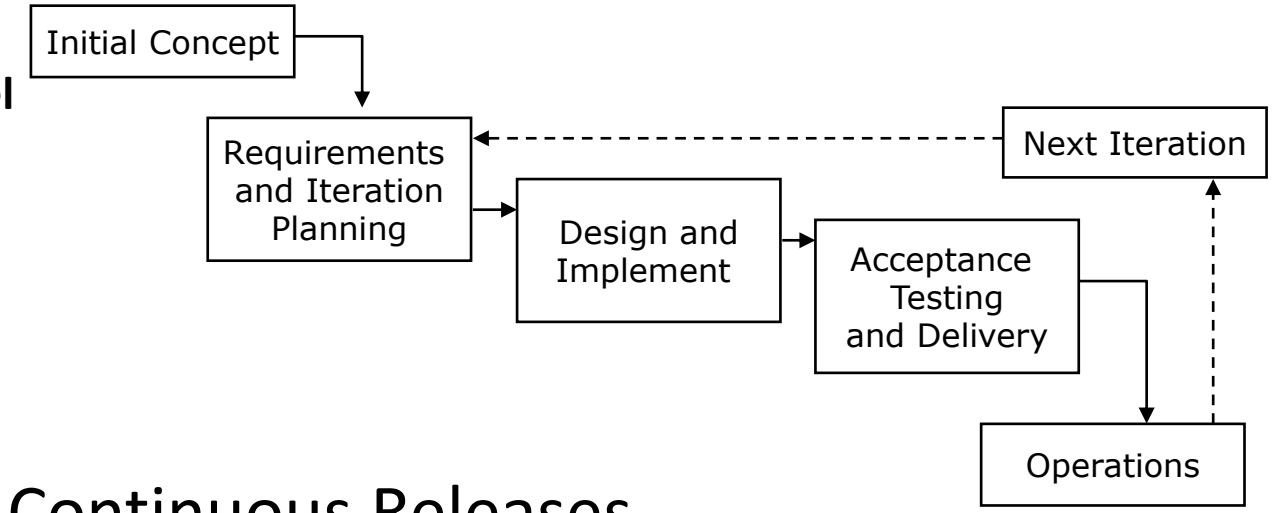
Agile Empowers Workers to Improve Processes: Toyota Production System (1990’s)

Agile Processes are Iterative

Agile Process Model



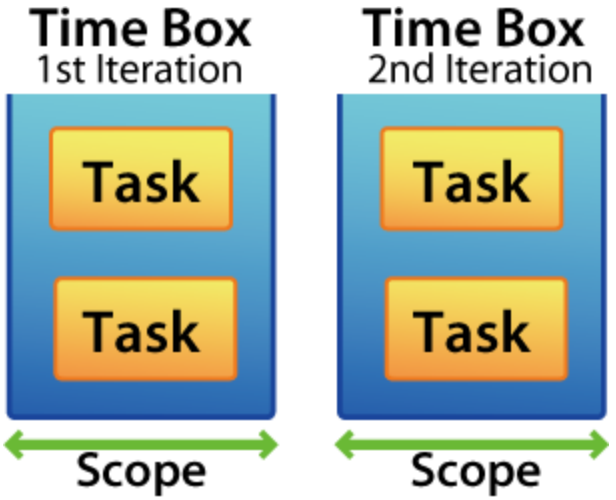
Iterative Waterfall Model



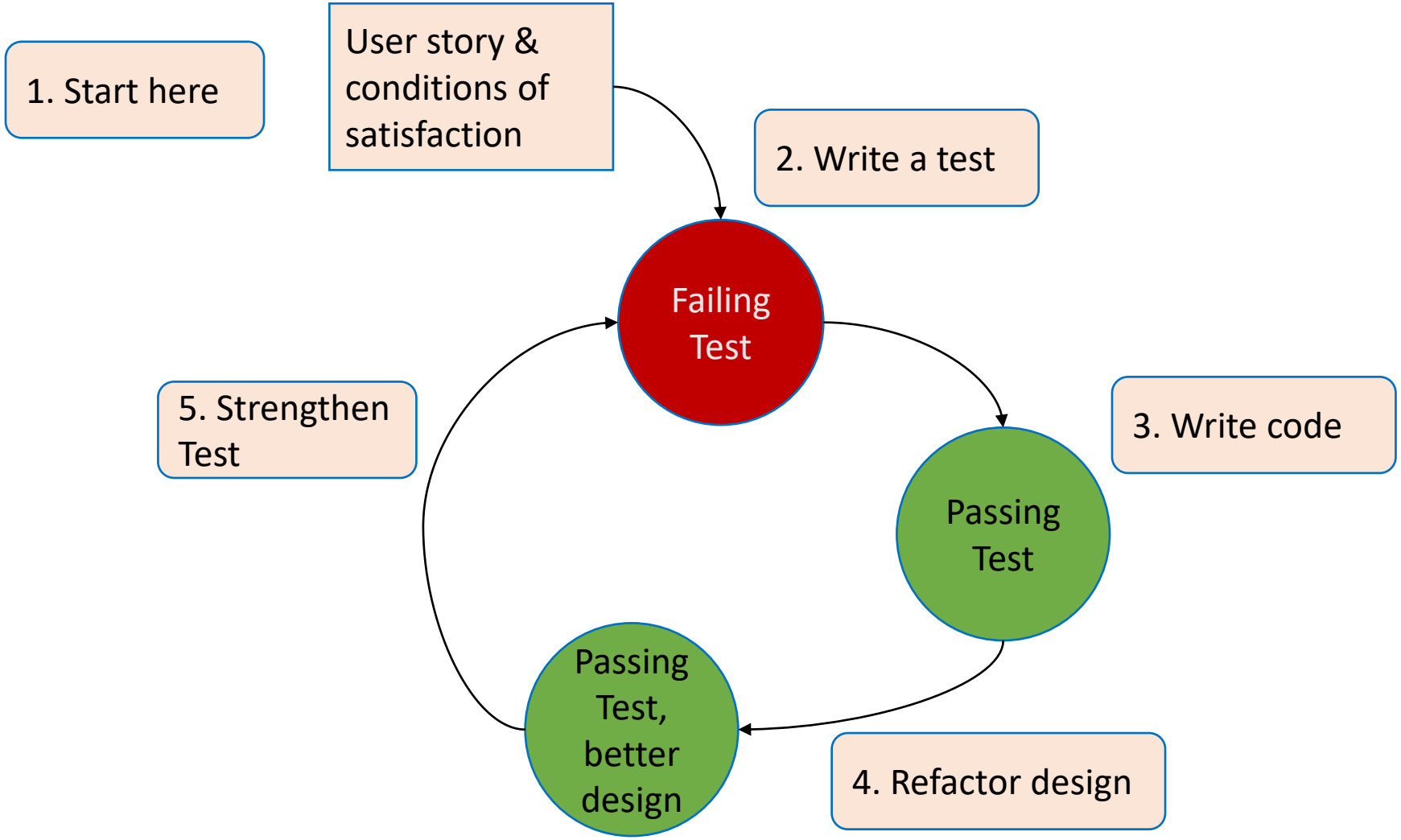
Key Idea: Small Continuous Releases

Agile Processes Reduce Risk by Time Boxing

- Each “iteration” is called a “sprint”
- Each sprint has a fixed duration
- Scope of features in a sprint is determined by the team
- Key insight: planning might be a guess at first, but gets better with time
- More on agile planning & estimation in the next module



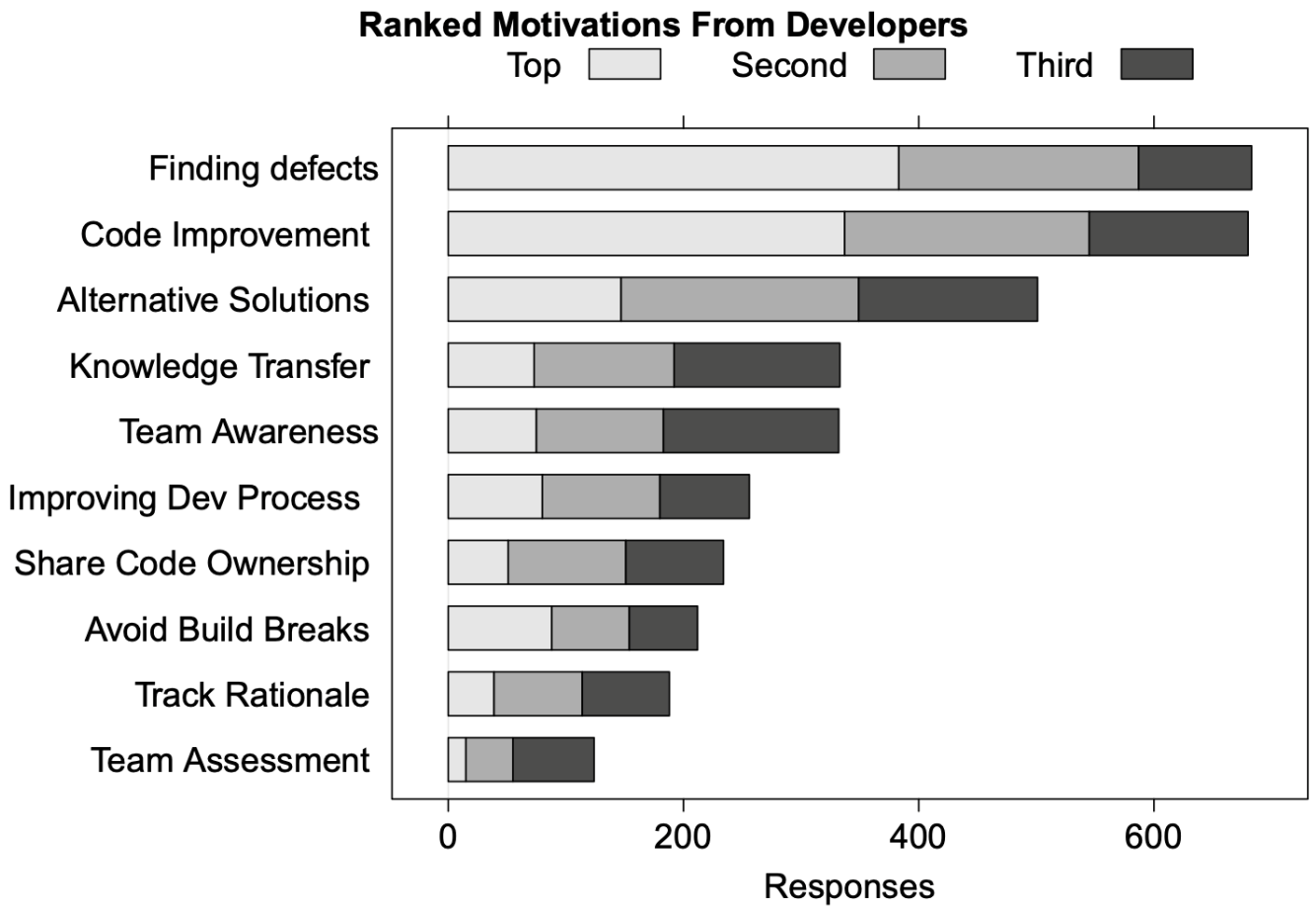
Agile Practice: Test Driven Development (TDD)



Agile Practice: Code Review

- A code review is the process in which the author of some code is asked to explain it to their peers:
  - What purpose the code has;
  - How the code accomplishes this purpose;
  - How the author is confident of this information,
    - E.g., show results of running tests (CI results)
- A code review often concerns a code change (“diff”)

SE Research Question: Why Do Code Review?



"Expectations, Outcomes, and Challenges of Modern Code Review", Bacchelli & Bird, ICSE 2013

Agility and You

- In your project, you can display agility in some of the following ways:
  - Renegotiate specs
  - Reorder priorities
  - Alter implementation strategy
  - Improve team communication patterns
- If you are agile, you can adjust these things to deliver your product on time and get a good grade ☺

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