CSE 403: Software Engineering, Spring 2015

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Software Lifecycle

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Outline

- Essential tasks of development
- What is a software development lifecycle?
- Why do we need a lifecycle process?
- Five basic lifecycle models and their tradeoffs
- Evaluating models
- Summary

Essential tasks of development

- Requirements
- Design
- Implementation
- Testing
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Each phase requires different tools, knowledge, skill-set. A lot of ways to split responsibilities!

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How are these related?
What is a good order?

The software lifecycle

Software lifecycle is a series of phases through which software is produced:

- from conception to end-of-life
- can take months or years to complete

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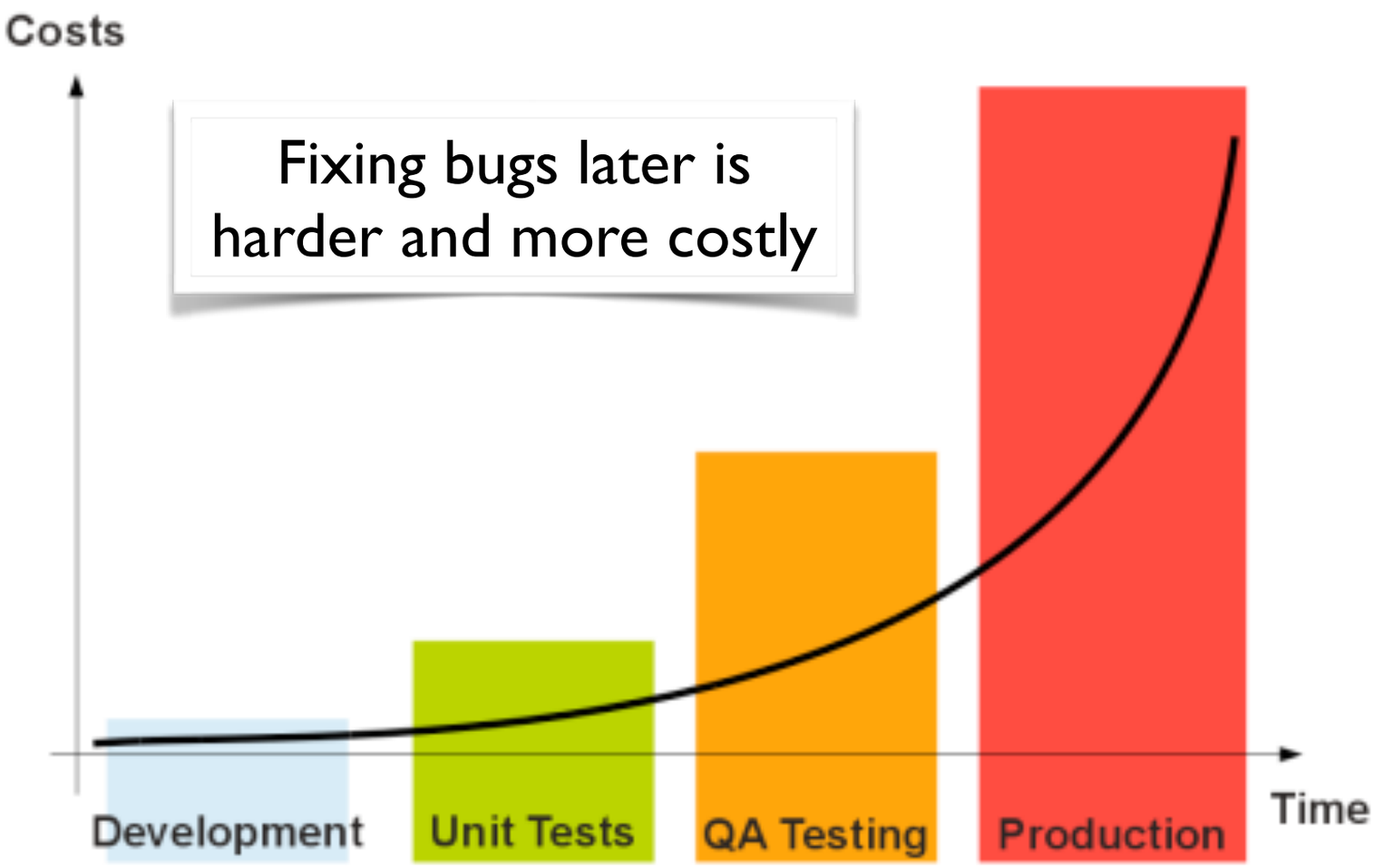
Goals of each phase:

- mark out a clear set of steps to perform
- produce a tangible item
- allow for review of work
- specify actions to perform in the next phase

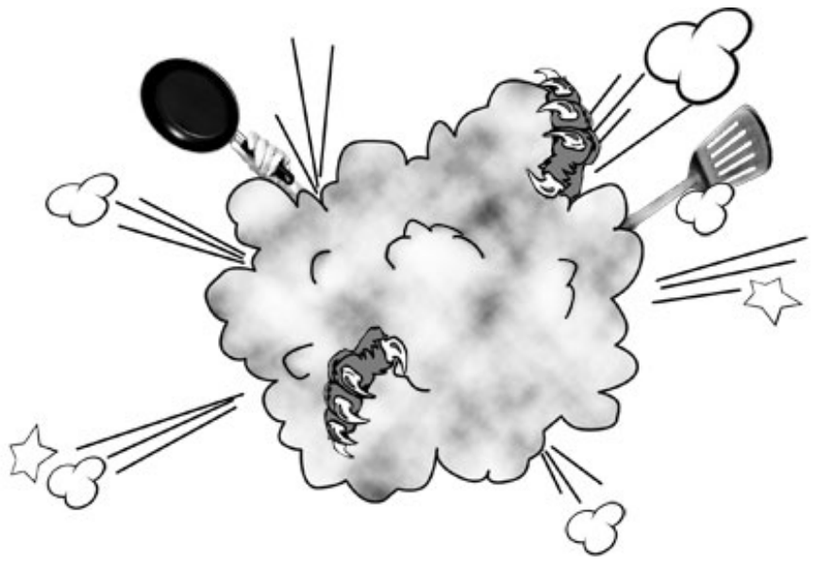
Why do we need process?



Why do we need process?

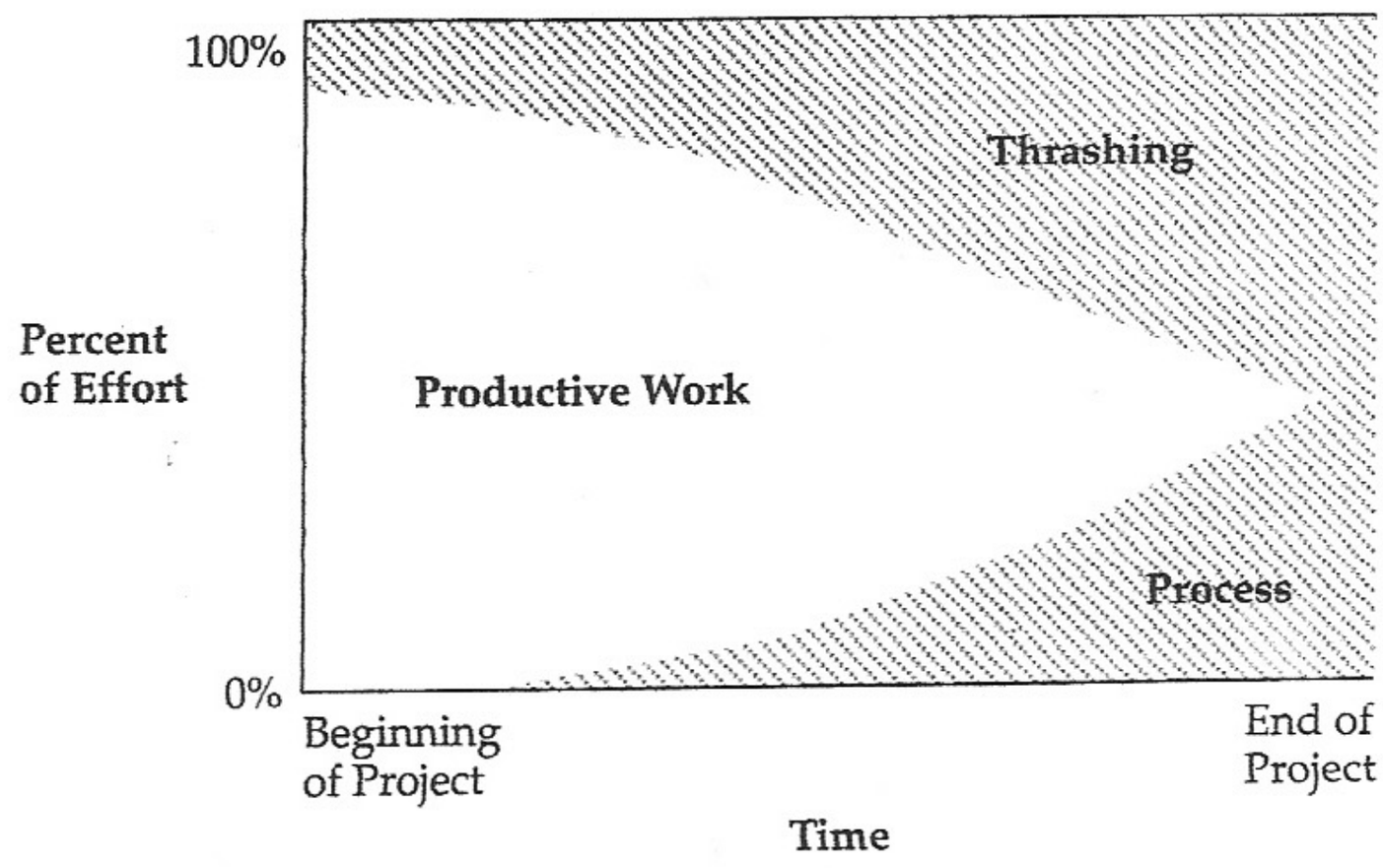
A bug in the requirements.

Life without software process



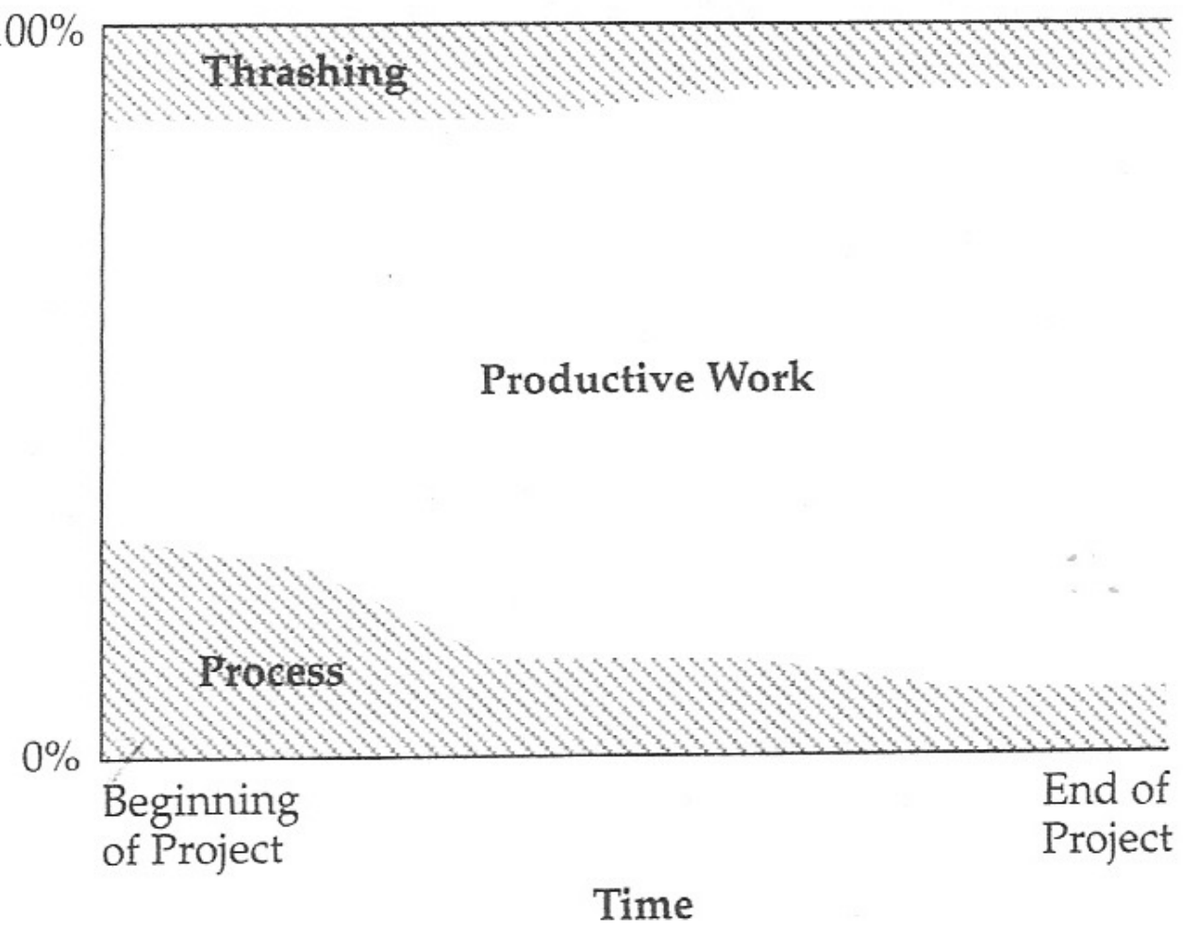
- Advantages:
  - nothing to learn or plan!
  - work on whatever is interesting, ignore the rest.
- Disadvantages:
  - may ignore some important tasks (testing, design)
  - not clear when to start or stop doing each task
  - scales poorly to multiple people
  - hard to review or evaluate one's work
  - code may not match user's needs (no requirements!)
  - code was not planned for modification, not flexible

Project with little attention to process



Survival Guide, McConnell, p. 24

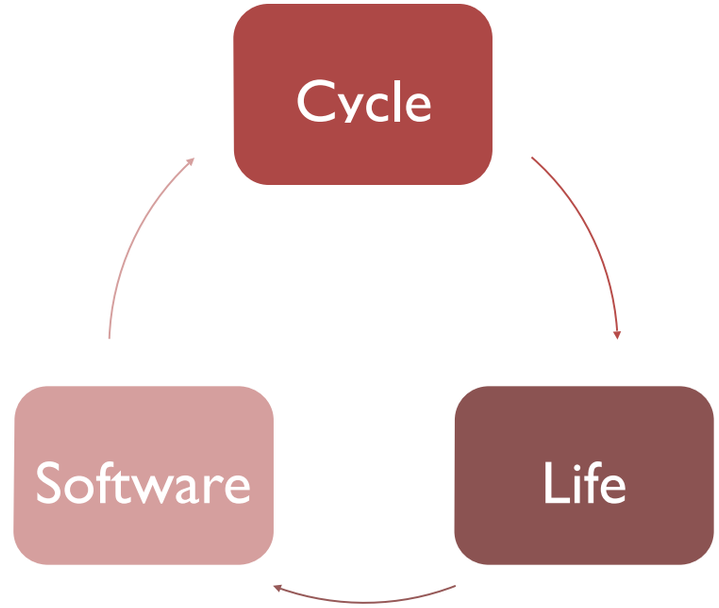
Project with early attention to process



Survival Guide, McConnell, p. 25

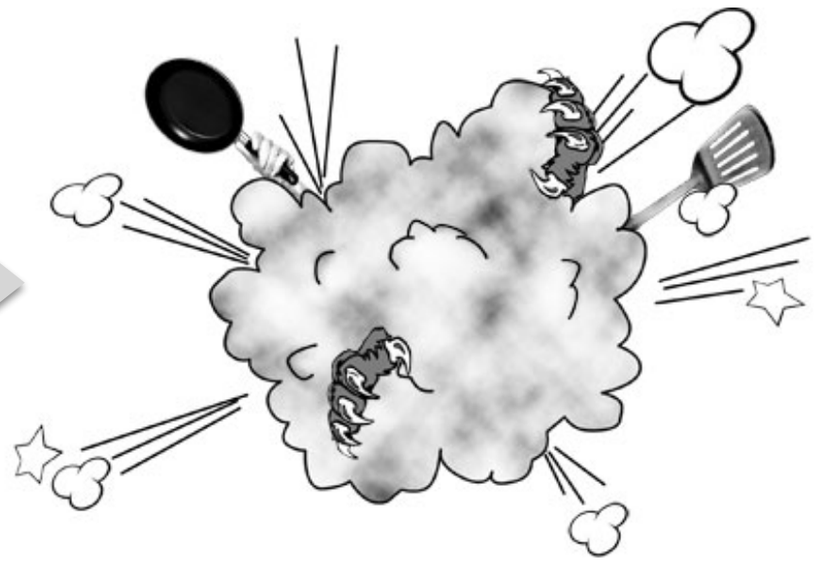
Some lifecycle models

- **Code-and-fix**: write code, fix it when it breaks
- **Waterfall:** perform each phase in order
- **Spiral**: triage/figure out riskiest things first
- **Staged delivery**: build initial requirement specs or several releases, then design-and-code each in sequence
- **Evolutionary prototyping**: do the next easiest thing that could possibly lead to feedback



Code-and-fix model

requirements
(maybe)



release
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Code-and-fix model

- Advantages:
  - Little to no overhead, see progress quickly
  - Applicable for very small projects and short-lived prototypes
- Disadvantages:
  - No way to asses progress, quality, or risks
  - Unlikely to accommodate changes without a major design overhaul
  - Unclear delivery features (scope), timing, and support

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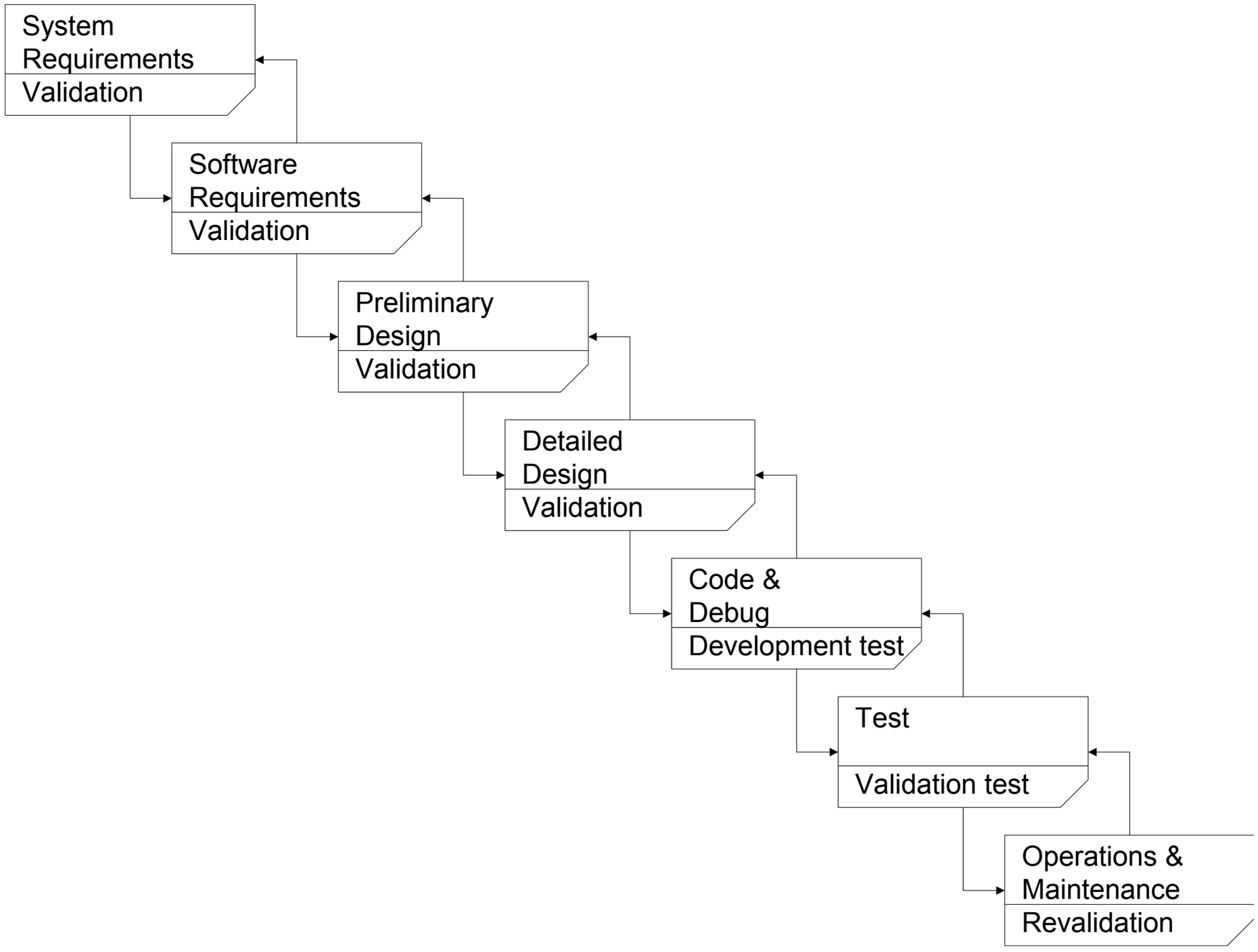
Waterfall model



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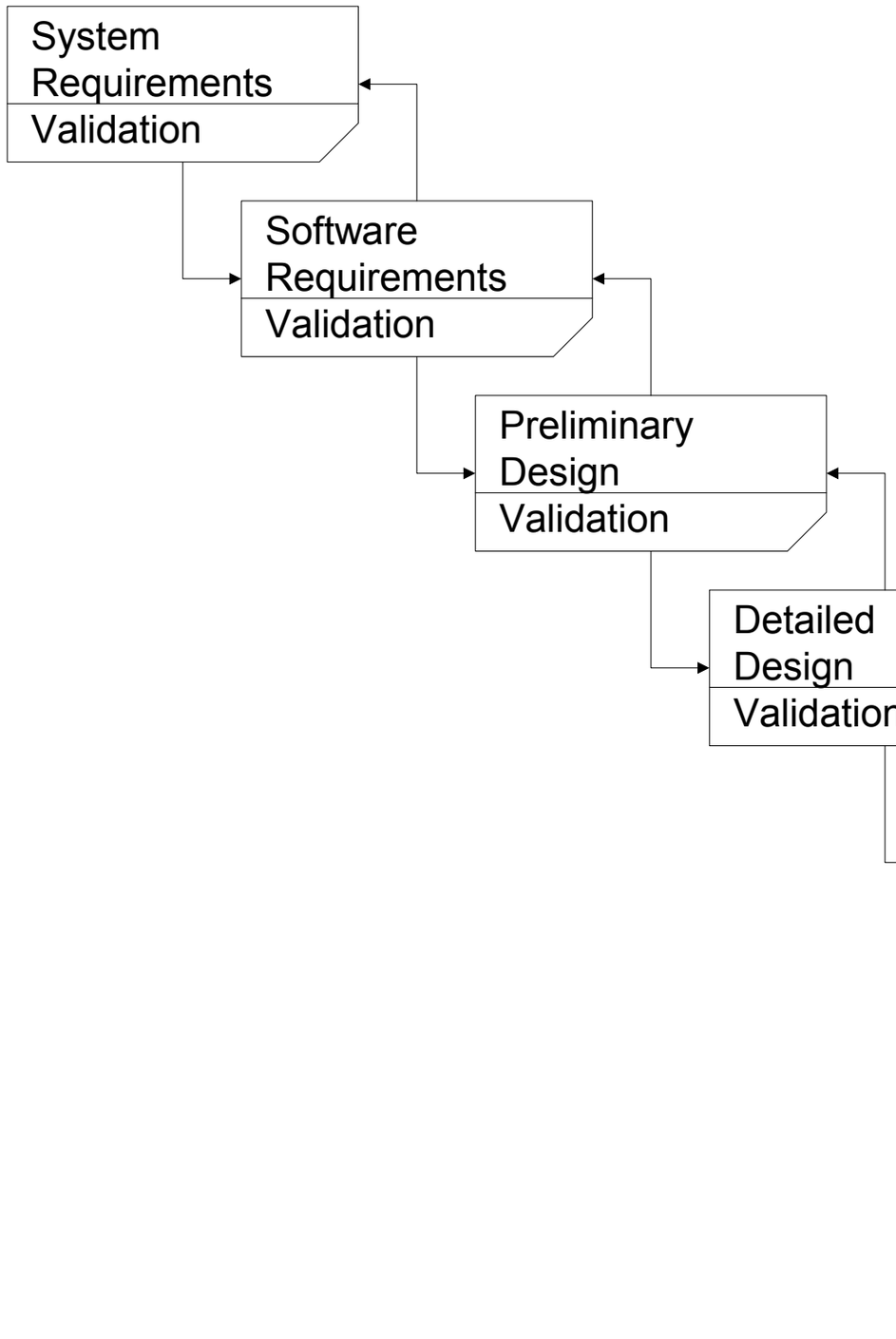

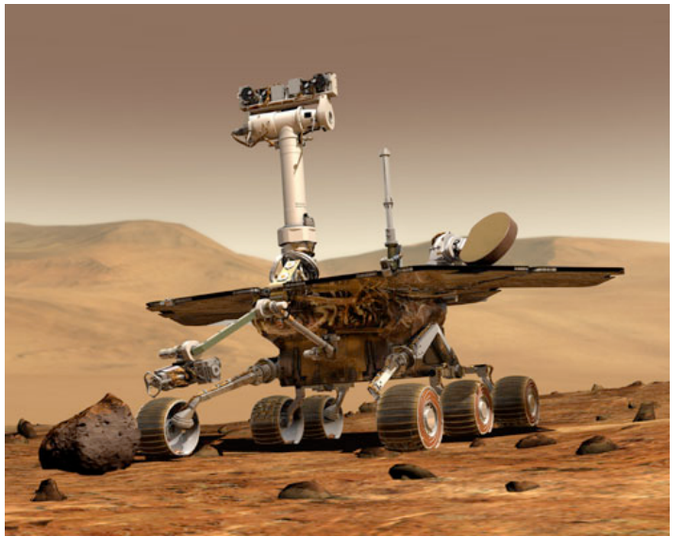

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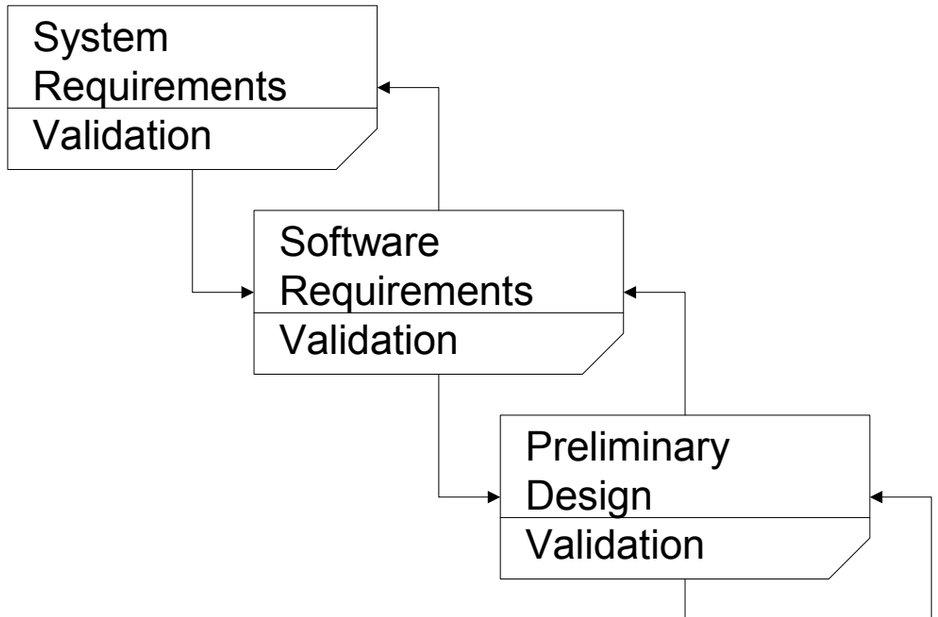
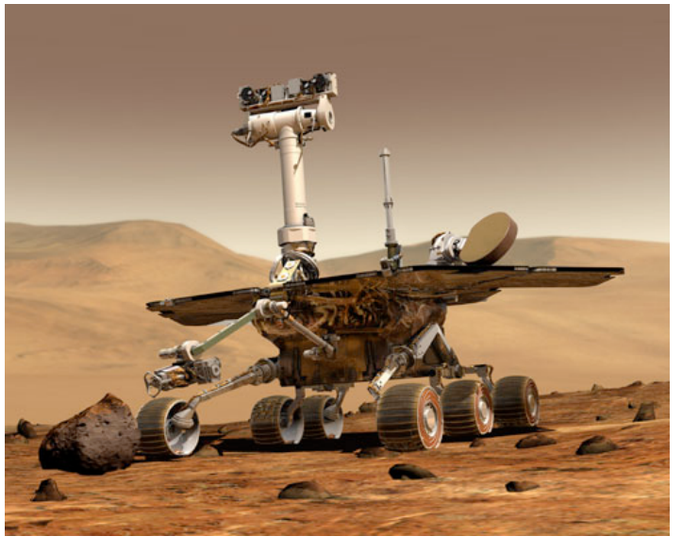




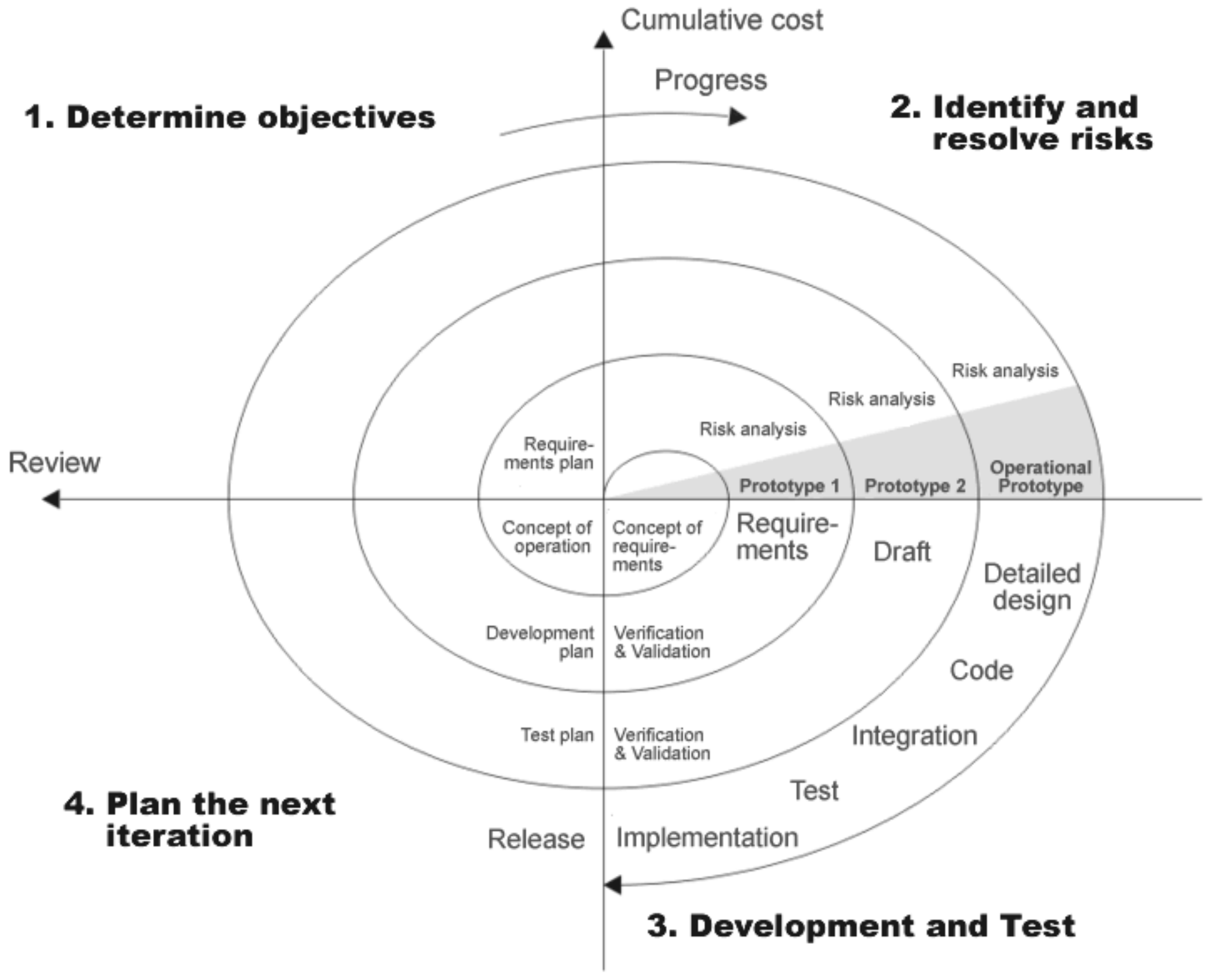
Waterfall model advantages

- Suitable for projects that are very well understood but complex
    - Tackles all planning upfront
    - The ideal of no midstream changes equates to an efficient software development process
- Supports inexperienced teams
    - Orderly, easy-to-follow sequential model
    - Reviews at each stage determine if the product is ready to advance

Waterfall model disadvantages

- Requires a lot of planning up front (not always easy)
  - assumes requirements will be clear and well-understood
- Rigid, linear; not adaptable to change in the product
  - costly to "swim upstream" back to a previous phase
- No sense of progress until the very end
  - nothing to show until almost done
- Integration occurs at the very end
  - defies “integrate early and often” rule
  - solutions are inflexible, no feedback until end
- Delivered product may not match customer needs
  - phase reviews are massive affairs
  - inertia means change is costly

Spiral model (risk oriented)



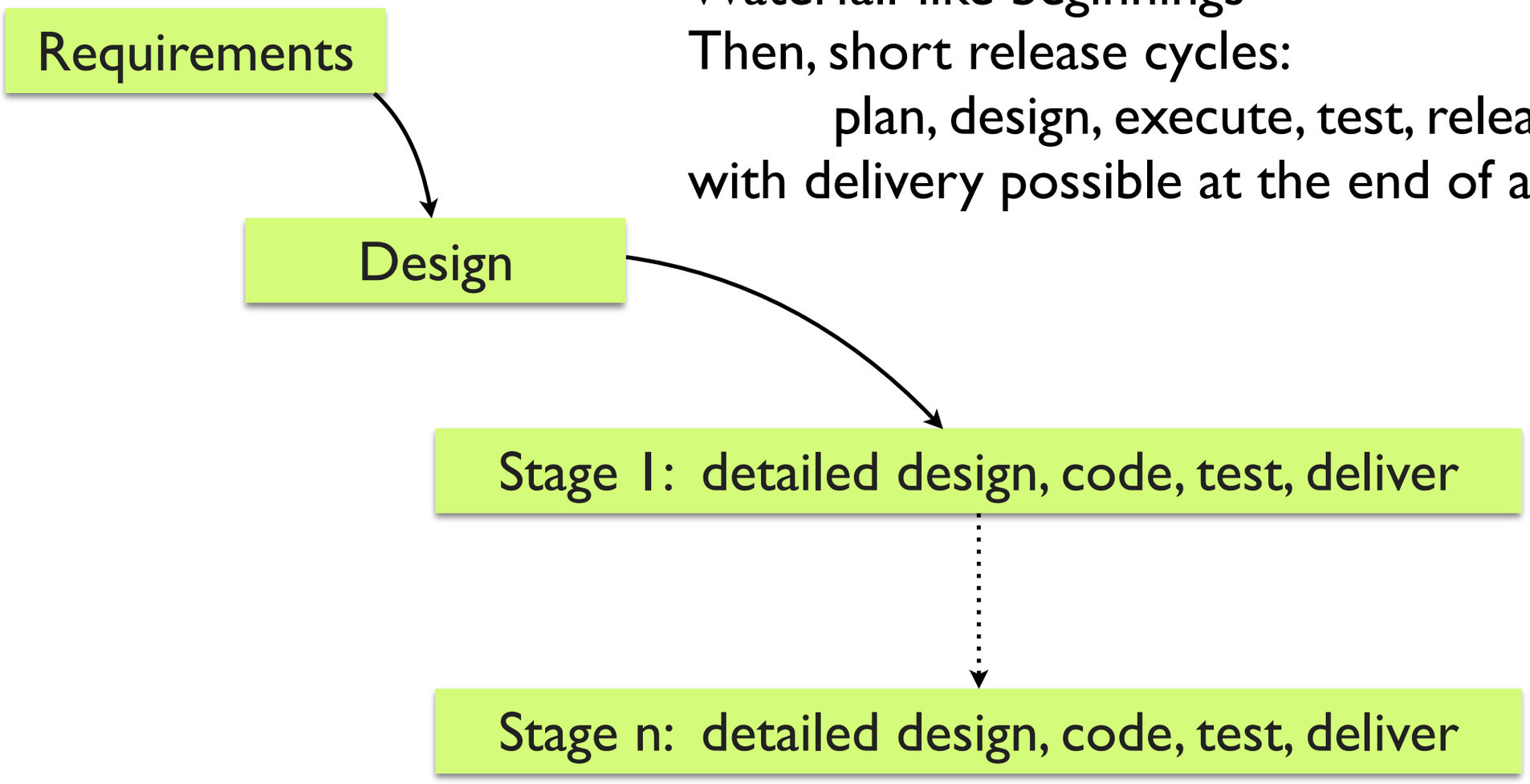
Spiral model advantages

- Especially appropriate at the beginning of the project, when the requirements are still fluid
- Provides early indication of unforeseen problems
- Accommodates change
- As costs increase, risks decrease!
- Always addresses the biggest risk first

Spiral model disadvantages

- A lot of planning and management
- Frequent changes of task
    - But, get to stick with one product feature/goal
- Requires customer and contract flexibility
- Developers must be able to assess risk
    - Must address most important issues

Staged delivery model



Waterfall-like beginnings
Then, short release cycles:
plan, design, execute, test, release
with delivery possible at the end of any cycle

Staged delivery model advantages

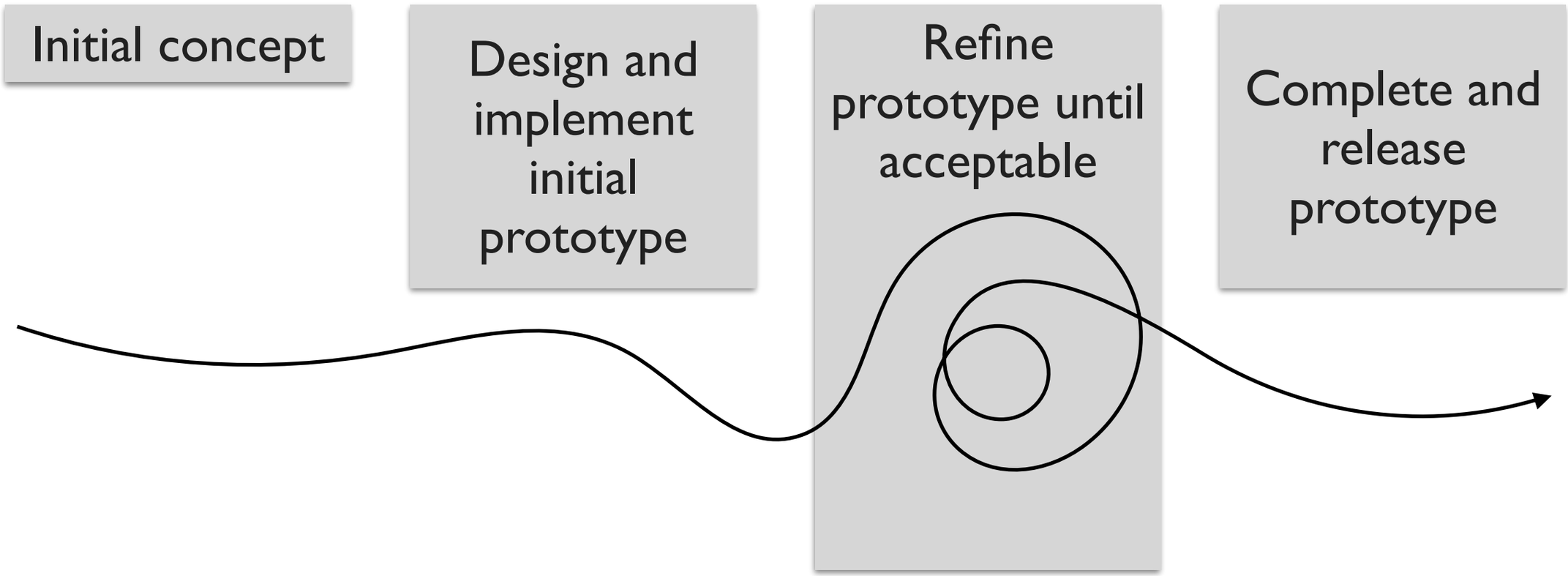
- Can ship at the end of any release cycle
    - Looks like success to customers, even if not original goal
- Intermediate deliveries show progress, satisfy customers, and lead to feedback
- Problems are visible early (e.g., integration)
- Facilitates shorter, more predictable release cycles

Very practical, widely used and successful

Staged delivery model disadvantages

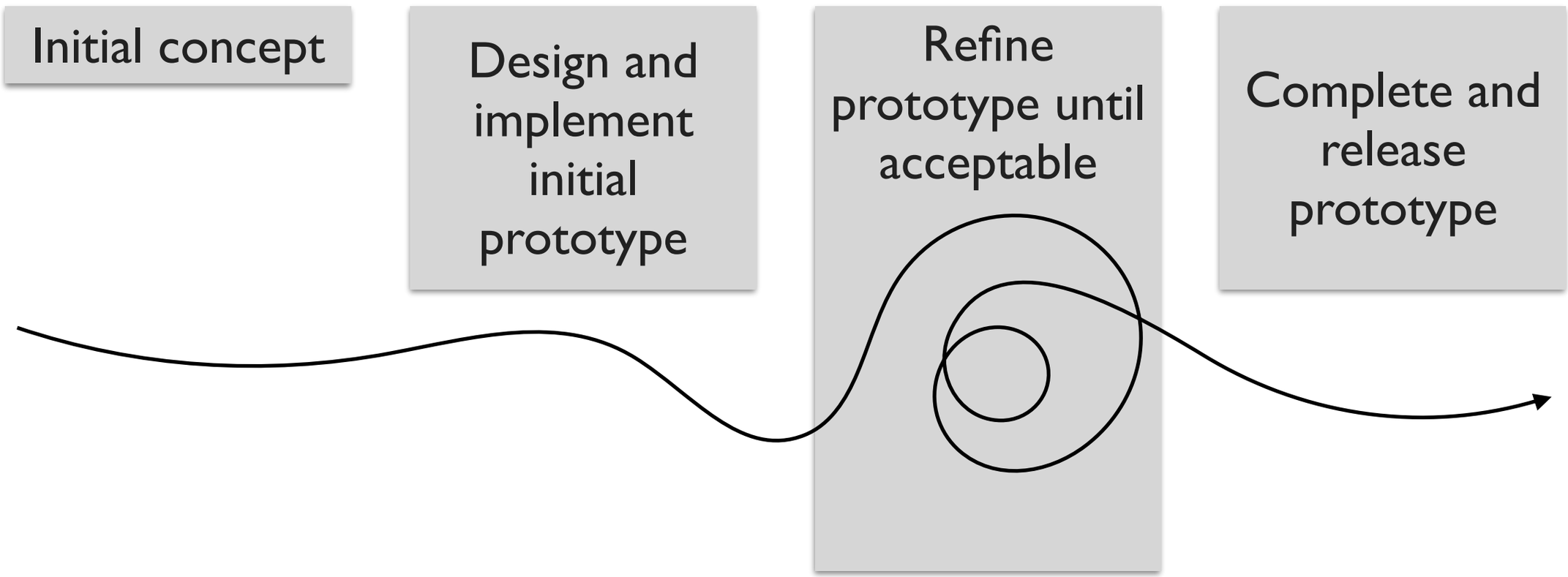
- Requires tight coordination with documentation, management, marketing
- Product must be decomposable
- Extra releases cause overhead

Evolutionary prototyping



Develop a skeleton system and evolve it for delivery

Evolutionary prototyping



Develop a skeleton system and evolve it for delivery

Different from staged delivery in that requirements are not known ahead of time. Discovered by feedback.

Evolutionary prototyping advantages

- Addresses risks early
- Steady signs of progress build customer confidence
- Useful when requirements are unknown or changing
- Participatory design / useful feedback loops

Very practical, widely used and successful

Evolutionary prototyping disadvantages

- Requires close customer involvement
- Assumes user's initial spec is flexible
- Problems with planning
    - especially if the developers are inexperienced
    - feature creep, major design decisions, use of time, etc.
    - hard to estimate completion schedule or feature set
    - unclear how many iterations will be needed to finish
- Integration problems
    - fails for separate pieces that must then be integrated
    - bridging; new software trying to gradually replace old
- Temporary fixes become permanent constraints
- Requires low friction deployment and experimentation

Embracing or fighting timelines

- Fit-to-schedule
    - "We will ship on a certain date and cut until it fits"
    - similar to the staged delivery model
        - but less flexible because of the fixed shipping date
    - requires careful prioritization of features and risks

- Fit-to-features/quality
    - "We'll ship the product when it is ready"
    - Trade predictable schedules for quality control

Why are there so many models?

- The choice of a model depends on the project circumstances and requirements.
- A good choice of a model can result in a vastly more productive environment than a bad choice.
- A cocktail of models is frequently used in practice to get the best of all worlds. Models are often combined or tailored to environment

What's the best model?

- Consider
  - The task at hand
  - Risk management
  - Quality / cost control
  - Predictability
  - Visibility of progress
  - Customer involvement and feedback

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Aim for good, fast, and cheap.
But you can't have all three at the same time.

Model category matrix (on a scale from 1 to 5)

	Risk mgmt.	Quality/ cost ctrl.	Predict-ability	Visibility of progress	Customer involvement
Code-and-fix	1	1	1	3	2
Waterfall	2	4	3	1	2
Spiral	5	5	3	3	3
Evolutionary prototyping	3	3	2	5	5
Staged delivery	3	5	3	3	4
Fit-to-schedule	4	3	5	3	2

What's the best model for ...

- A system to control anti-lock braking in a car
- A hospital accounting system that replaces an existing system
- An interactive system that allows airline passengers to quickly find replacement flight times (for missed or bumped reservations) from terminals installed at airports
- A mobile app for finding romantic partners

Summary

- Software lifecycle models as management tools
  - System for organizing effort among workers
  - Forces planning and seeing consequences
  - Splits work into smaller, tractable units
  - Supports feedback and accurate timescales
  - Processes support production at scale
- Limitations of lifecycle models
  - Can lead to artificial design constraints
  - Risk of overemphasizing process over results
  - Models only approximate actual practices