Software Lifecycle

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 in Software Engineering

Requirements
Design
Implementation
Testing
Maintenance

Essential Tasks in Software Engineering

Requirements
Design
Implementation
Testing
Maintenance

Each phase requires different tools, knowledge, skill-set.
There are a lot of ways to divide responsibilities.

Essential Tasks in Software Engineering

Requirements
Design
Implementation
Testing
Maintenance

How are these phases related?
And what is the right order for these phases?

The 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.

The Software Lifecycle

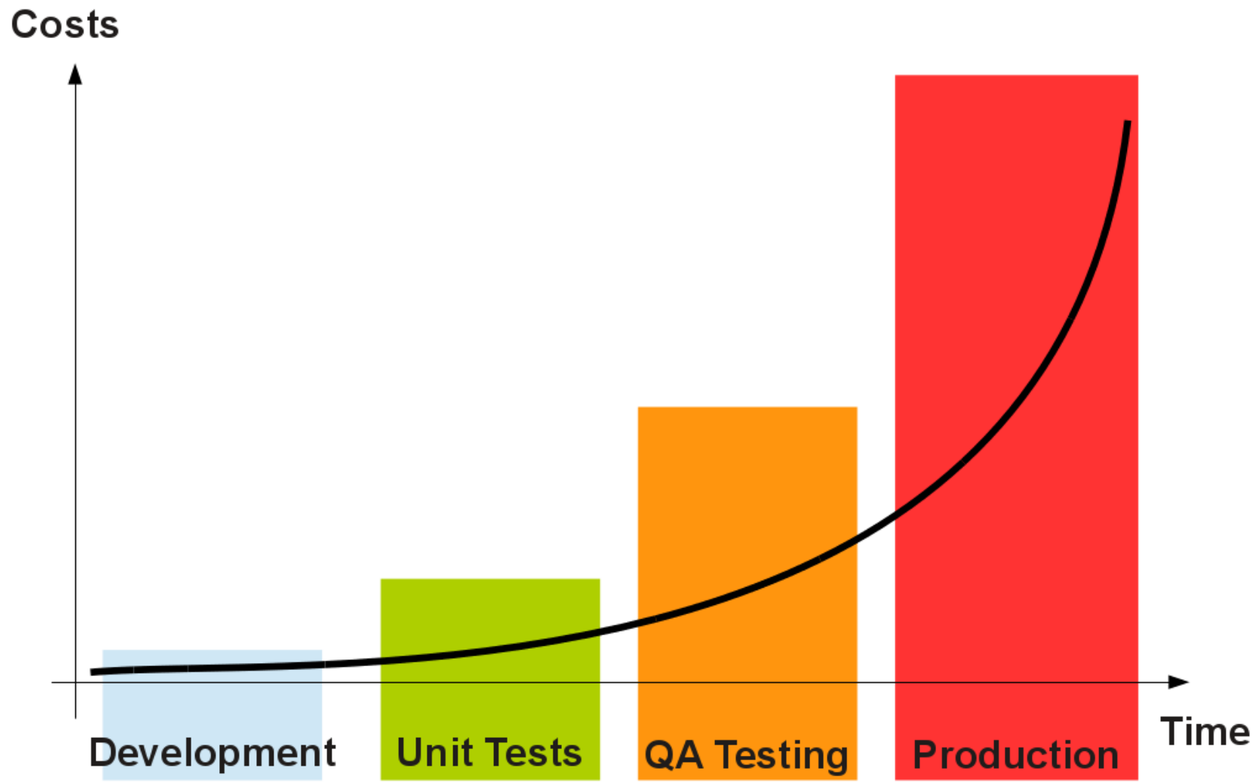
... is a series of phases through which software is produced.
... from conception to end-of-life.
... can take months or years to complete.

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 Models and Processes?

The cost of bugs fixed at different stages



Why Do We Need Processes?

Lufthansa 2904 crashed, in part, because of a bug in the software requirements.

Life Without Software Processes

Advantages

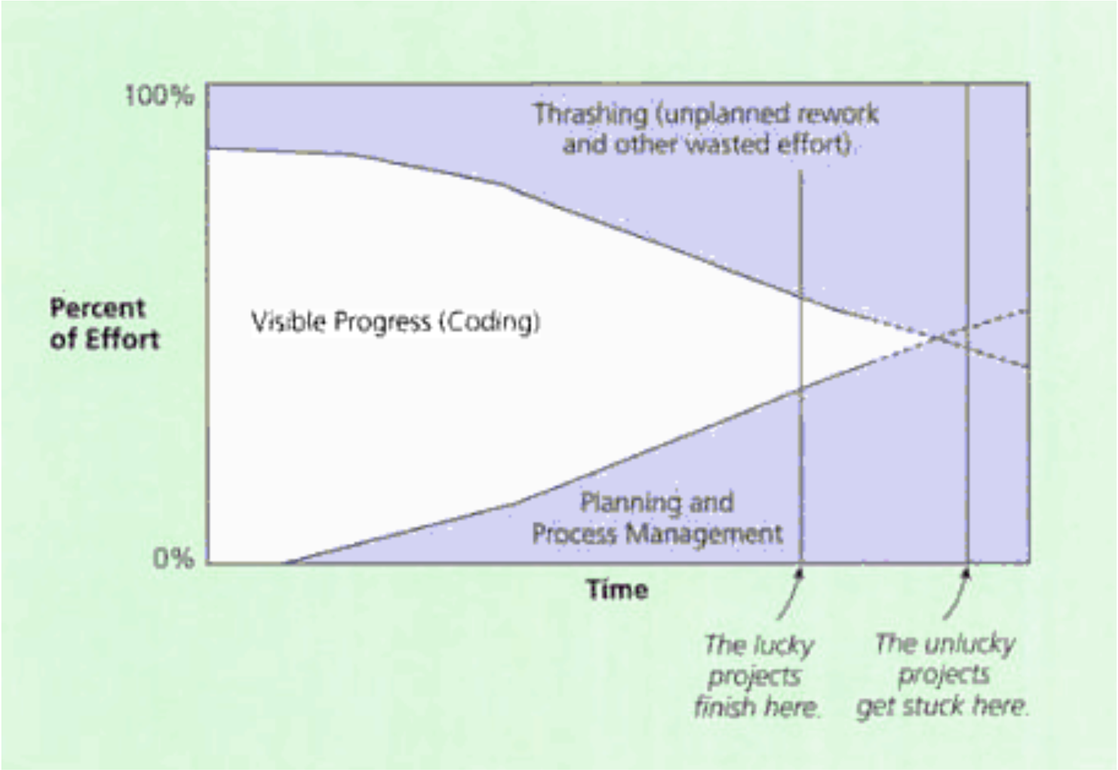
- nothing to learn or plan!
- work on whatever is interesting, ignore the rest.

Life Without Software Processes

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

Without Attention to Process



(Survival Guide, McConnell, p. 24)

Life With Software Process

Advantages

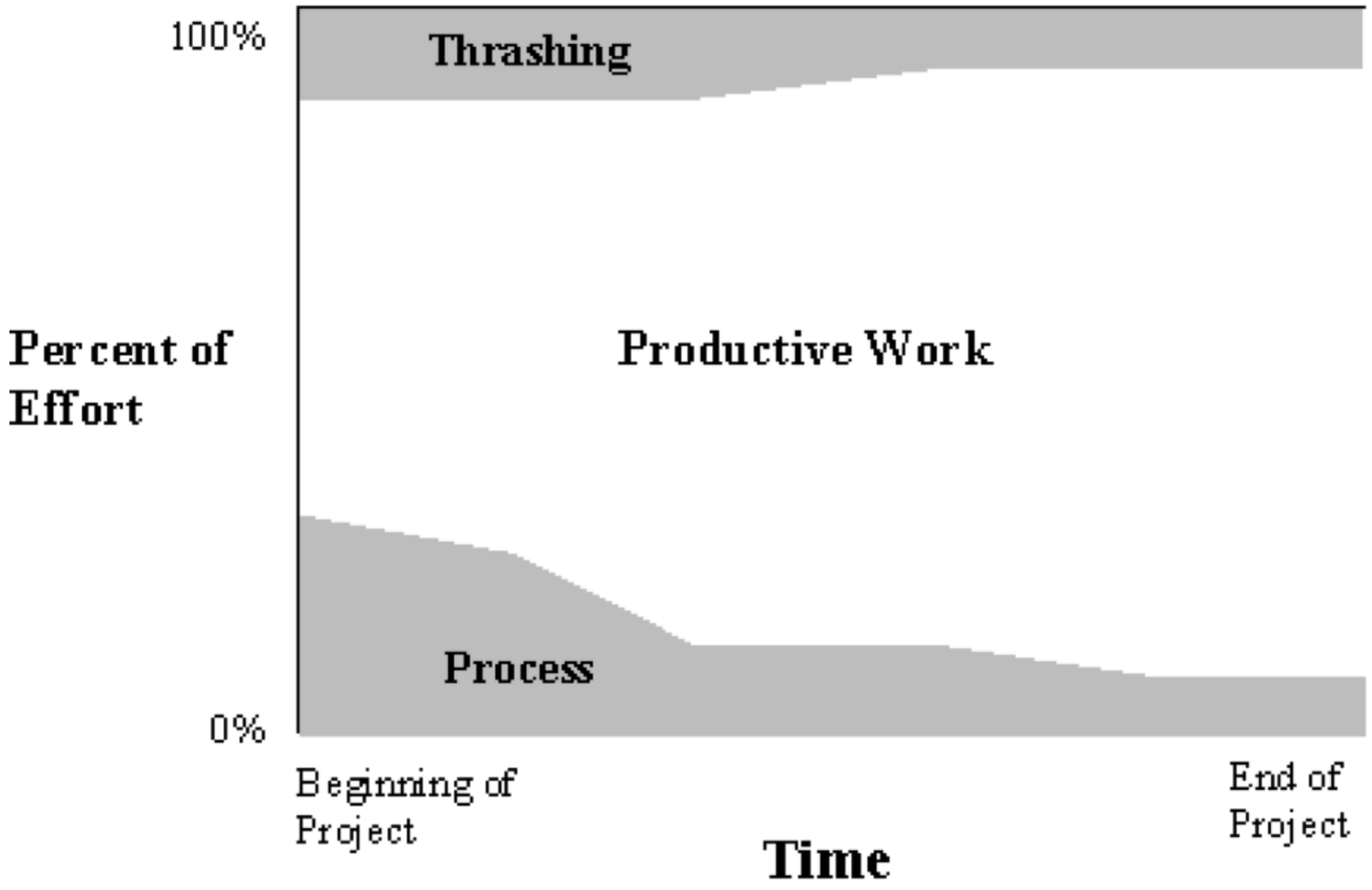
- Provides structure in which to work
- Forces you to think about the big picture and to follow steps to reach it
- Without it, you may make decisions that are locally optimal but globally misdirected
- It is a management tool

Life With Software Process

Disadvantages

- Can lead to compromises and artificial constraints
- Risk of over-emphasizing process rather than the product itself!

With Early Attention To Process



There are several software lifecycle models!

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

Code-and-Fix

Advantages

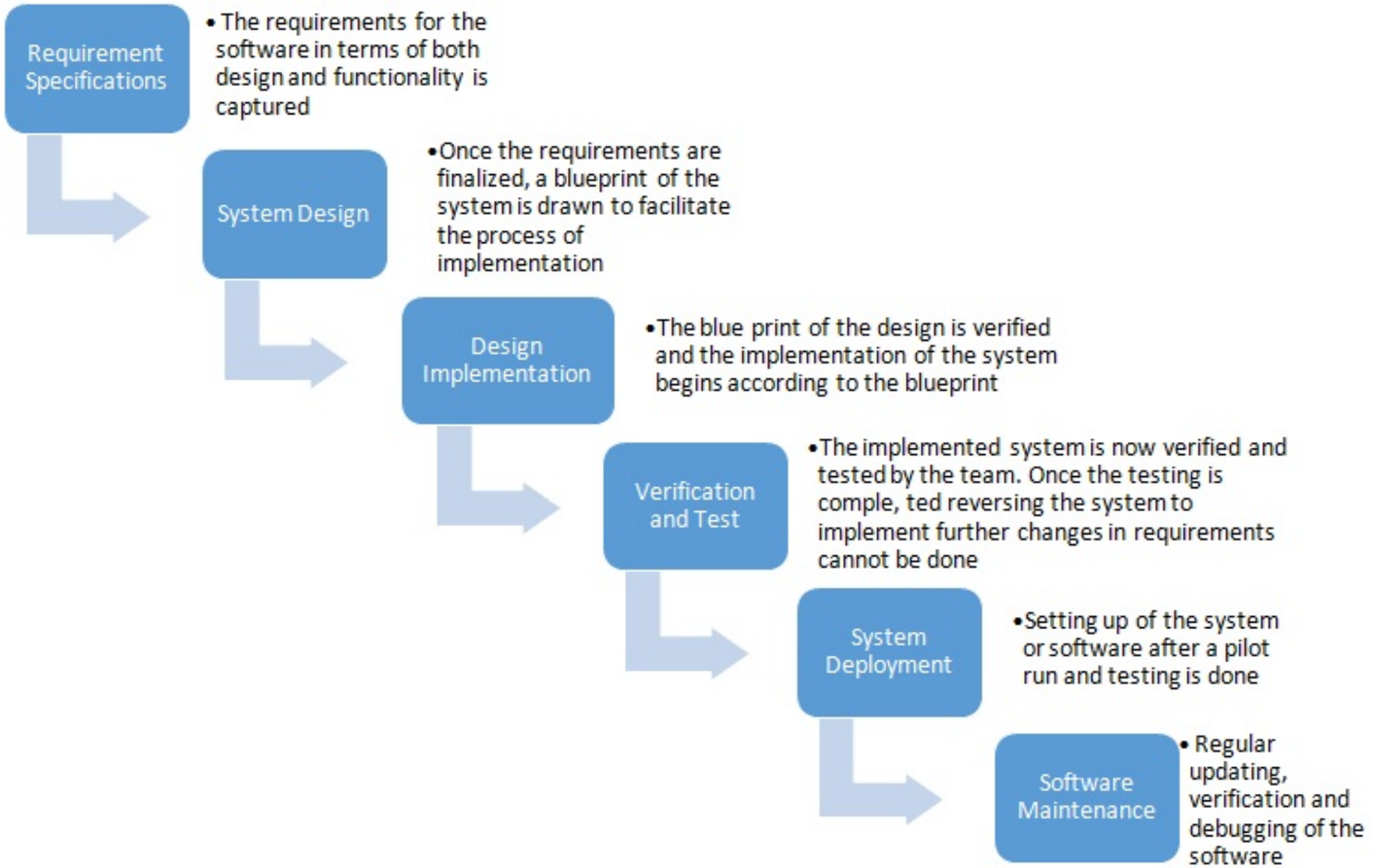
- Little to no overhead, see progress quickly
- Applicable for very small projects and short-lived prototypes

Code-and-Fix

Disadvantages

- No way to assess progress, quality, or risks
- Unlikely to accommodate changes without a major design overhaul
- Unclear delivery features (scope), timing, and support

Waterfall Model

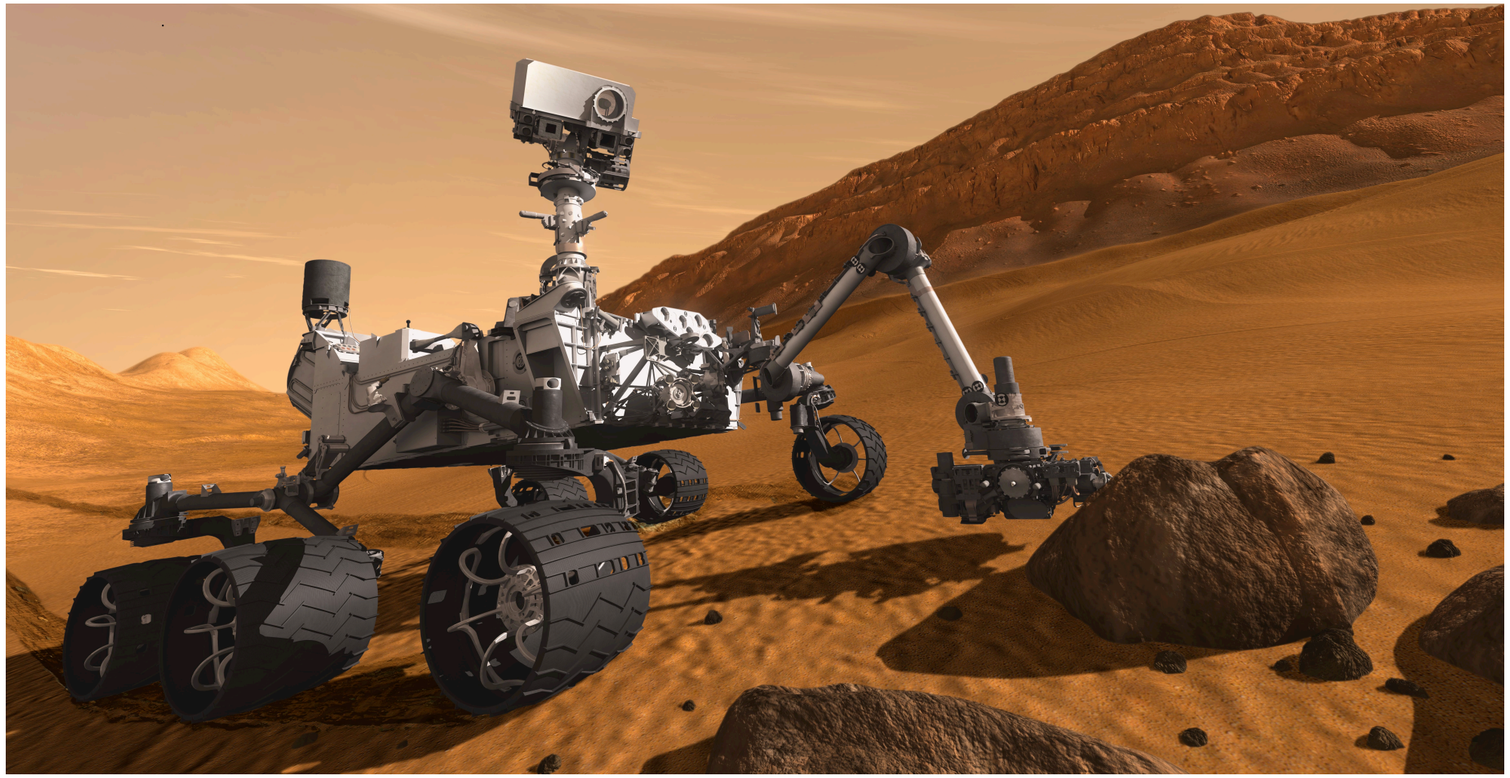


Waterfall Model

Used for long-term, expensive, critical projects

Waterfall Model

Used for long-term, expensive, critical projects



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

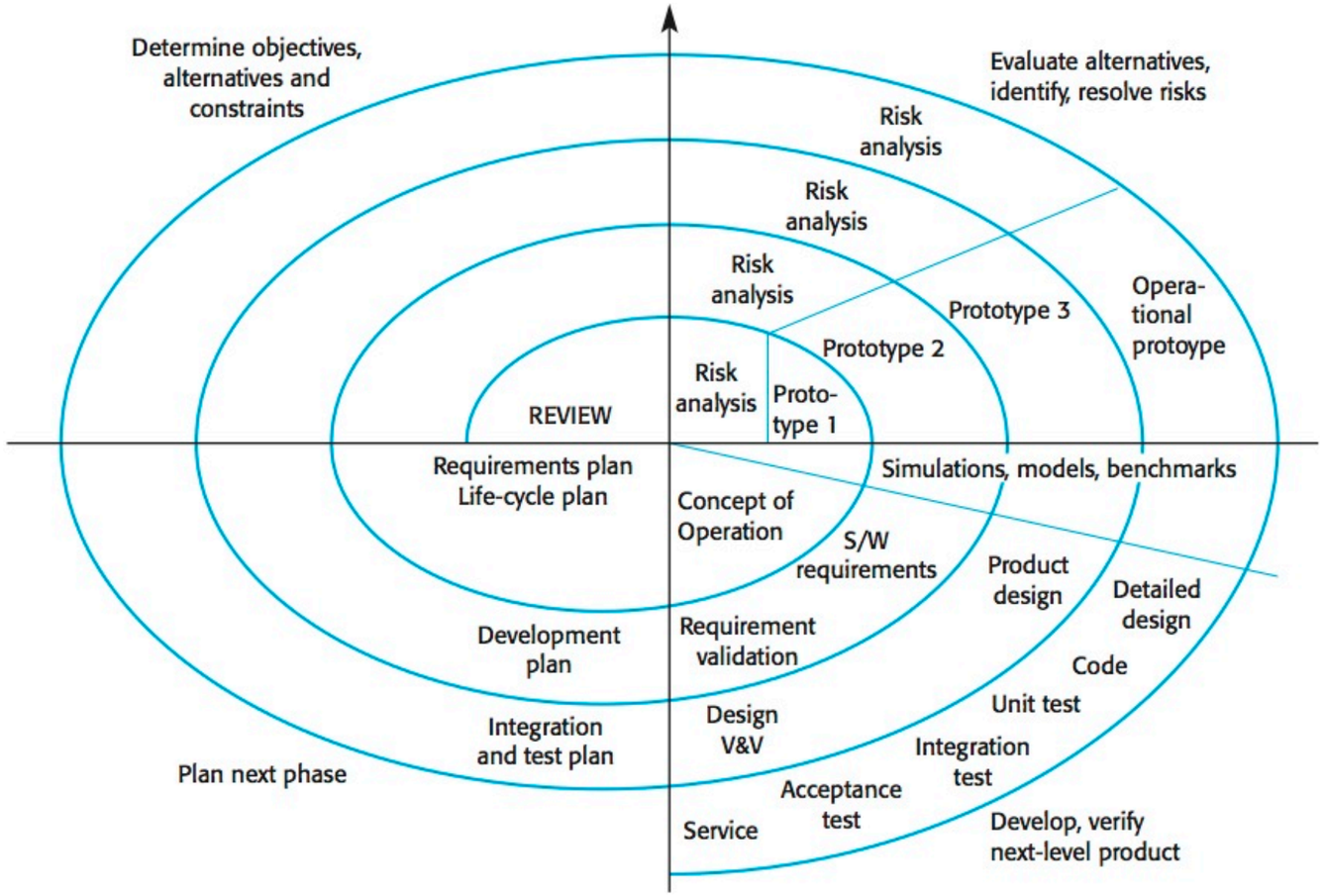
- Requires a lot of planning up front (not always easy)
  - assumes requirements will be clear and well-understood
- Rigid, linear; not adaptable to change in the product
  - costly to "swim upstream" back to a previous phase
- No sense of progress until the very end
  - no code to show until almost done

Waterfall Model

Disadvantages

- 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



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

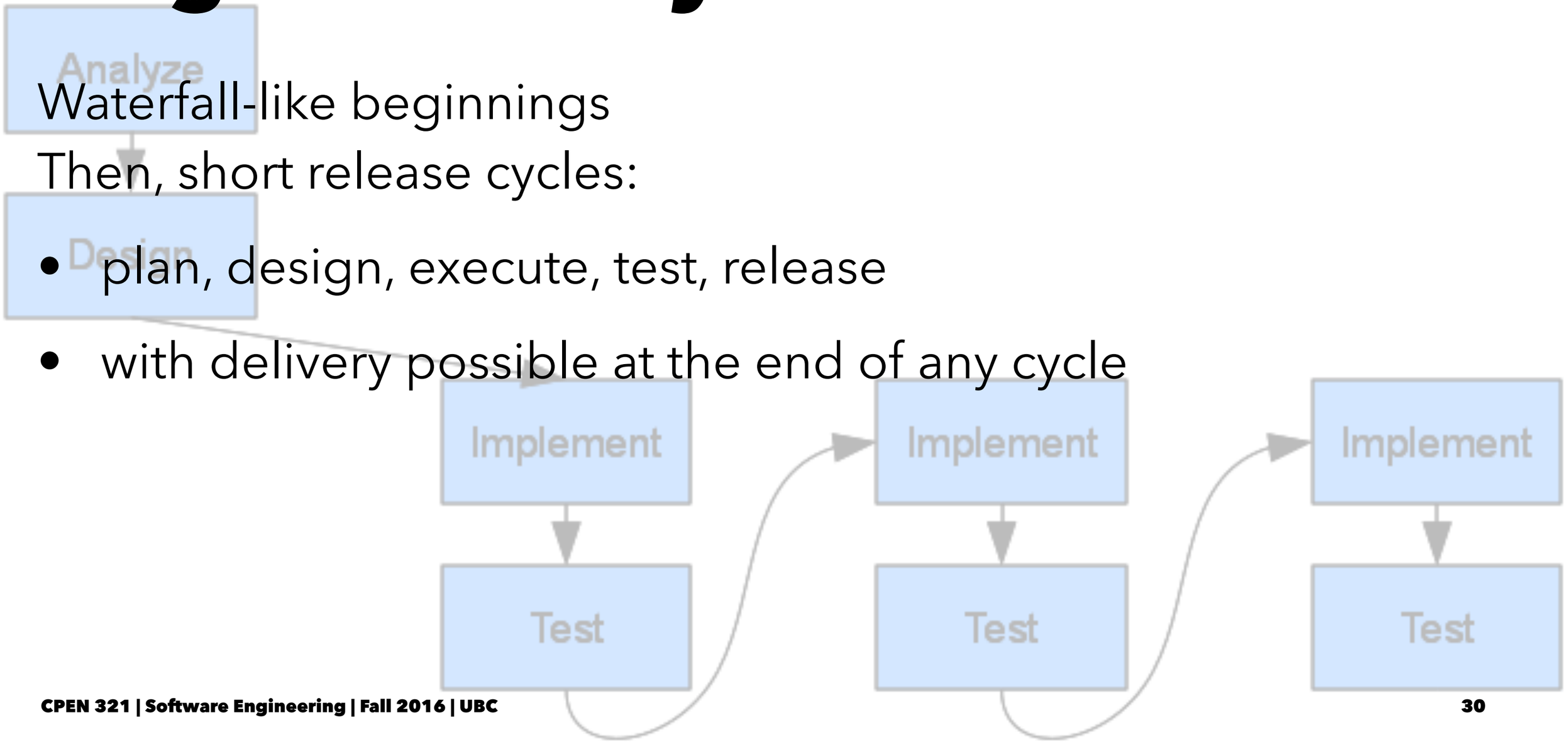
- A lot of planning and management
- Frequent changes of task
- But, get to stick with one product feature/goal
- Requires customer and contract flexibility
- Developers must be able to assess risk
- Must address most important issues

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

Practical; widely used

Staged Delivery Model

Disadvantages

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

EVOLUTIONARY PROTOTYPING

IMMEDIATE FEEDBACK

Evolutionary Prototyping

- Develop a skeleton system early 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
- Temporary fixes become permanent constraints
- Requires low friction deployment and experimentation

Evolutionary Prototyping

Disadvantages

- 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

Evolutionary Prototyping

Disadvantages

- Integration problems
  - fails for separate pieces that must then be integrated
  - bridging; new software trying to gradually replace old

More Models

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

More Models

embracing or fighting timelines

- 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

What's the best model?

Aim for good, fast, and cheap.

But you can't have all three at the same time.

Model Scorecards

1: lowest / bad; 5: highest / very good

Code-and-Fix

Risk management: 1
Quality/cost control: 1
Predictability: 1
Progress visibility: 3
Customer involvement: 2

Model Scorecards

1: lowest / bad; 5: highest / very good

Waterfall

Risk management: 2
Quality/cost control: 4
Predictability: 3
Progress visibility: 1
Customer involvement: 2

Model Scorecards

1: lowest / bad; 5: highest / very good

Spiral

Risk management: 5
Quality/cost control: 5
Predictability: 3
Progress visibility: 3
Customer involvement: 3

Model Scorecards

1: lowest / bad; 5: highest / very good

Evolutionary Prototyping

Risk management: 3
Quality/cost control: 3
Predictability: 2
Progress visibility: 5
Customer involvement: 5

Model Scorecards

1: lowest / bad; 5: highest / very good

Staged Delivery

Risk management: 3
Quality/cost control: 5
Predictability: 3
Progress visibility: 3
Customer involvement: 4

Model Scorecards

1: lowest / bad; 5: highest / very good

Fit-to-Schedule

Risk management: 4
Quality/cost control: 3
Predictability: 5
Progress visibility: 3
Customer involvement: 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

Summary

- Limitations of lifecycle models
  - Can lead to artificial design constraints
  - Risk of overemphasizing process over results
  - Models only approximate actual practices