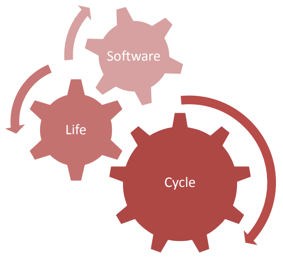

Software development lifecycle

The power of process

50MLOC = 50 million lines of code

- 50 lines/page-side ⇒ 1M page-sides
- 1K page-sides/ream ⇒ 1K reams
- 2 inches/ream ⇒ 2K inches
- 2K inches = 167 feet ≈ twice the height of the Allen Center
- 5 words/LOC @ 50 wpm ⇒ 50MLOC/5M min
- 5M min = 83,333 hr = 3,472 days ≈ 10 years

Just to type!
No breaks and
no thinking allowed!

2

Addressing software complexity

What are/is the …?
- Requirements
- Design
- Implementation
- Testing plan
- …

Who does the …?
- Requirements
- Design
- Implementation
- Testing
- …

- Two sides of the same coin
- Different approaches, representations, etc. are needed for the artifact-oriented components
- Different skill-sets, knowledge, etc. are needed for the human-oriented components

3

Outline

- What is a software development lifecycle?
- Why do we need a lifecycle process?
- Lifecycle models and their tradeoffs
  - "Code-and-fix"
  - Waterfall
  - Spiral
  - Evolutionary prototyping
  - Staged delivery

  …there are many others (XP, scrum, …)!
- Main recurring themes (Agile processes)

Ad-hoc development

- ad-hoc development: creating software without any formal guidelines or process
- Advantage: easy to learn and use!
- Disadvantages?

Ad-hoc development

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- Advantage: easy to learn and use!

- Some disadvantages of ad-hoc development:
  - some important actions (testing, design) may go ignored
  - not clear when to start or stop doing each task
  - does not scale well to multiple people
  - not easy to review or evaluate one's work

- A common observation: The later a problem is found in software, the more costly it is to fix.

Lifecycle stages

- Virtually all lifecycles share
  - Requirements
  - Design
  - Implementation
  - Testing
  - Maintenance
- Key question: how do you combine them, and in what order?

7

The software lifecycle

- Software lifecycle: series of steps / 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

Benefits of using a lifecycle

Benefits of using a lifecycle

- It provides us with a structure in which to work
- It forces us to think of the "big picture" and follow steps so that we reach it without glaring deficiencies
- Without it you may make decisions that are individually on target but collectively misdirected
- It is a management tool

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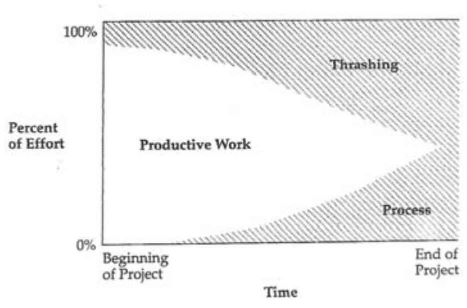
Drawbacks?

Are there analogies outside of SE?

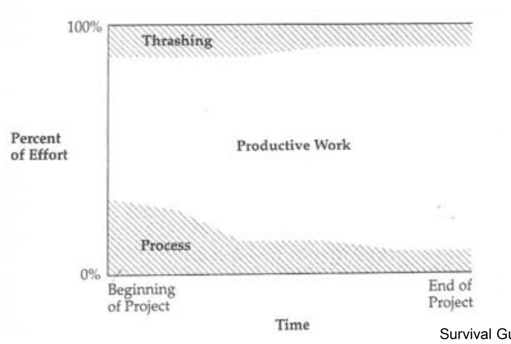
Consider the process of building the Paul Allen Center

Project with little attention on process



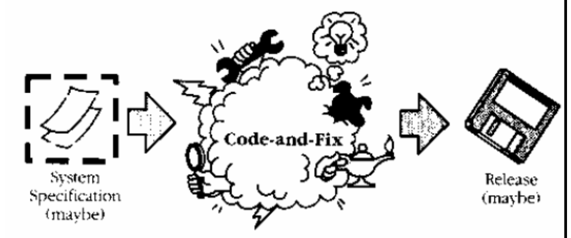
Survival Guide: McConnell p24

Project with early attention on process



Survival Guide: McConnell p25

"Code-and-fix" model



"Code-and-fix" model

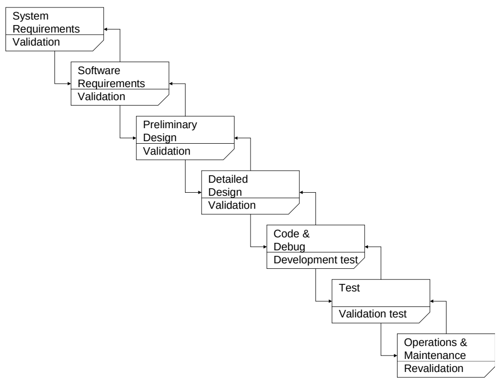
Advantages

- Little or no overhead - just dive in and develop, and see progress quickly
- Applicable *sometimes* for very small projects and short-lived prototypes

But DANGEROUS for most projects

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

Classic waterfall model


System Requirements Validation
Software Requirements Validation
Preliminary Design Validation
Detailed Design Validation
Code & Debug Development test
Test Validation test
Operations & Maintenance Revalidation

Classic waterfall advantages

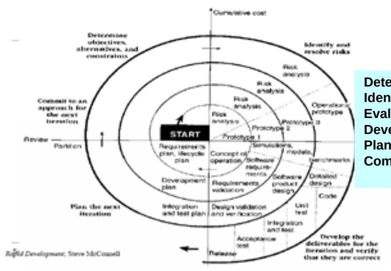
- Can work well for projects that are: very well understood but complex
  - Tackles all planning upfront
  - The ideal of no midstream changes equates to an efficient software development process
- Can provide support for an inexperienced team
  - Orderly sequential model that is easy to follow
  - Reviews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

Classic waterfall limitations

Classic waterfall limitations

- Difficult to specify all reqs of a stage completely and correctly upfront
- No sense of progress until the very end
- Integration occurs at the very end
  - Defies integrate early and often rule
  - Solutions are inflexible, no feedback until end
  - What is delivered may not match customer real needs
- Phase reviews are massive affairs
  - It takes a lot of inertia ($$) to make any change

Spiral model – risk oriented



Cumulative cost
Determine objectives, alternatives, and constraints
Identify and resolve risks
Risk analysis
Risk analysis
Risk analysis
Risk analysis
Operational prototype
Prototype 3
Prototype 2
Prototype 1
START
Commit to an approach for the next iteration
Review
Partition
Requirements plan, lifecycle plan
Concept of operation
Simulations, models, benchmarks
Software requirements
Development plan
Requirements validation
Software product design
Detailed design
Code
Plan the next iteration
Integration and test plan
Design validation and verification
Unit test
Integration and test
Acceptance test
Release
Develop the deliverables for the iteration and verify that they are correct
Rapid Development, Steve McConnell

Determine objectives
Identify and resolve risks
Evaluate alternatives
Develop and verify deliverables
Plan next spiral
Commit (or not) to next spiral

Spiral model

- Oriented towards phased reduction of risk
- Take on the big risks early and make some decisions
  - are we building the right product?
  - do we have any customers for this product?
  - is it possible to implement the product with the technology that exists today? tomorrow?
- Walks carefully to a result -- tasks can be more clear each spiral

Spiral model

Advantages

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

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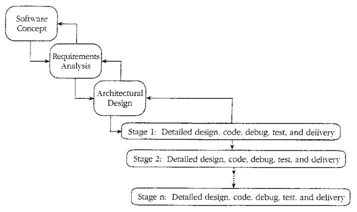
Limitations?

Lots of planning and management
Requires flexibility of the customer & contract
Relies on developers to have risk-assessment expertise

Staged delivery model


Software Concept
Requirements Analysis
Architectural Design
Stage 1: Detailed design, code, debug, test, and delivery
Stage 2: Detailed design, code, debug, test, and delivery
Stage n: Detailed design, code, debug, test, and delivery

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

Staged delivery model

Very practical in practice, widely used and successful

Advantages

- Can ship at the end of any release-cycle
- While not feature complete, intermediate deliveries show progress, satisfy customers, and provide opportunity for feedback
- Problems are visible early (ie. integration)
- Facilitates shorter, more predictable release cycles

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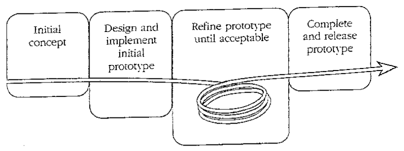
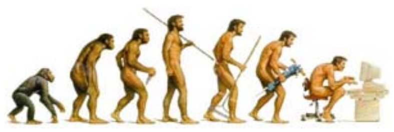
Limitations?
Requires tight coordination with documentation, mgmt, mktg
Must be decomposable
Extra "release" overhead

Evolutionary prototyping model


Initial concept
Design and implement initial prototype
Refine prototype until acceptable
Complete and release prototype

Develop a skeleton system and evolve it for delivery



Evolutionary prototyping model

Another popular and successful model, especially for custom products

Advantages
- Addresses risks early
- Produces steady signs of progress
- Useful when requirements are changing rapidly or customer is non-committal

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Advantages
- Addresses risks early
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- Useful when requirements are changing rapidly or customer is non-committal

Limitations

Requires close customer involvement
May spell trouble if the developers are inexperienced
Feature creep, major design decisions, use of time, etc.
Hard to estimate completion schedule or feature set

Why are there so many models?

Choices are good!

- 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

How do you evaluate models?

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

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

Model category matrix

- Rate each model 1-5 in each of the categories shown:

	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
design-to-schedule	4	3	5	3	2

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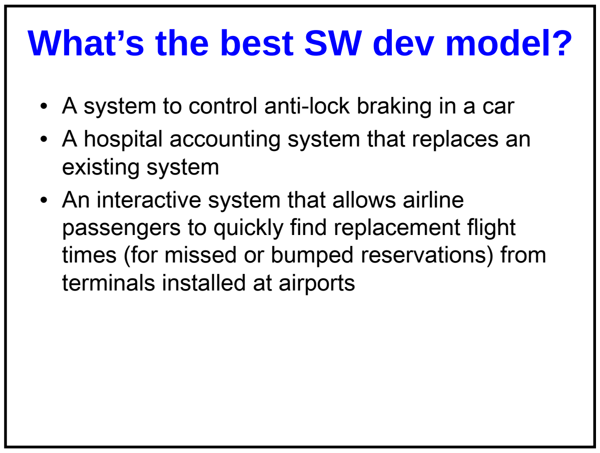

What’s the best SW dev model?

- 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