Software Process

Department of Computing Science
University of Alberta

CMPUT 301 – Introduction to Software Engineering
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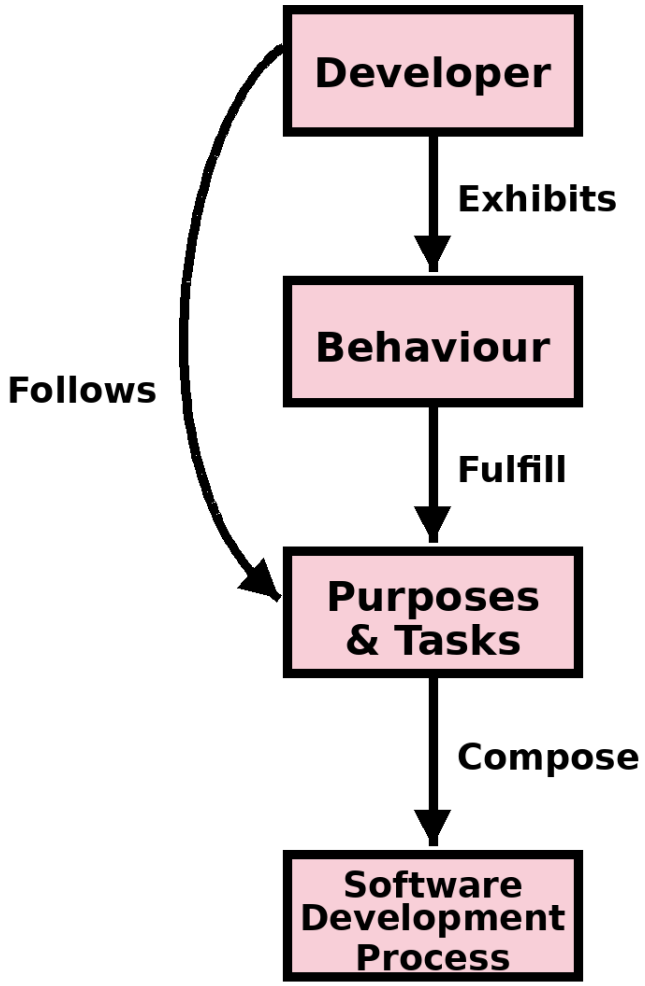
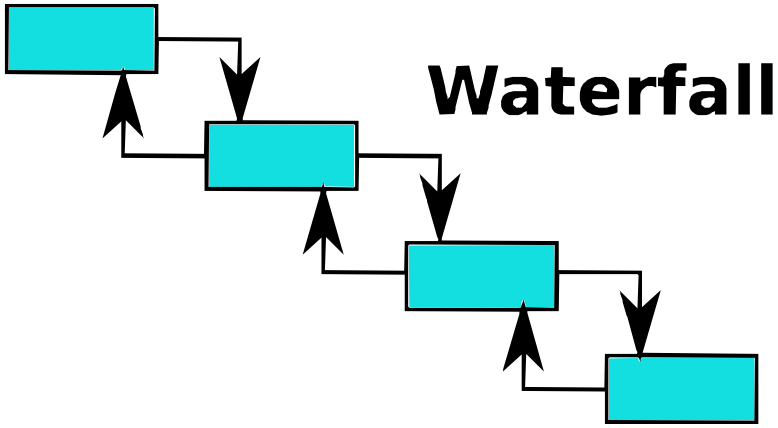
What Makes a Process?



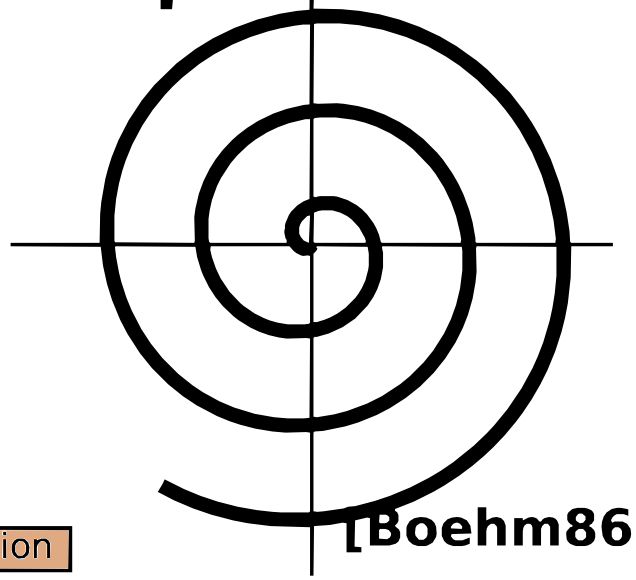
Software Development Processes



Waterfall

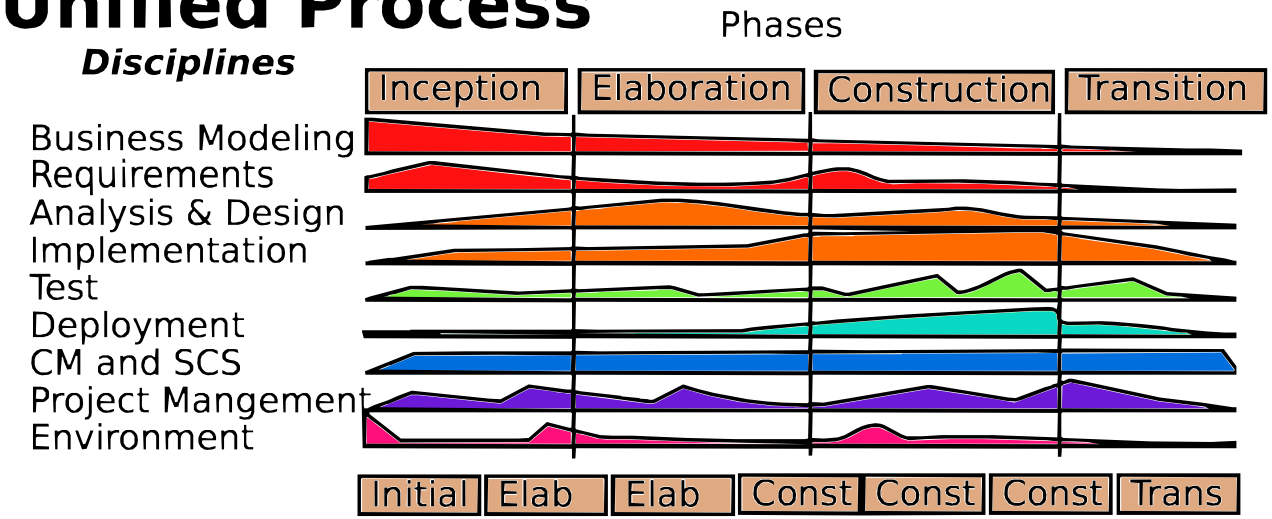
[Royce87]

Spiral



[Boehm86]

Unified Process



[Jacobson99]

Developer Perspective

- Software engineering:
  - Manage complexity, scale, lifetime
  - Increase quality
  - Reduce defects
  - Reduce maintenance and support costs
  - Reduce time-to-market
  - Reuse successful solutions
  - Apply methods and tools
  - Iterate and optimize

User Perspective

- Software usability:
  - Meets needs
  - Increase productivity
  - Easy to learn
  - Effective to use
  - Reduce errors
  - Safe to use

User Perspective

- Experience:
  - Satisfying
  - Motivating
  - Looks nice
  - Enjoyable
  - Fun

Meeting Needs

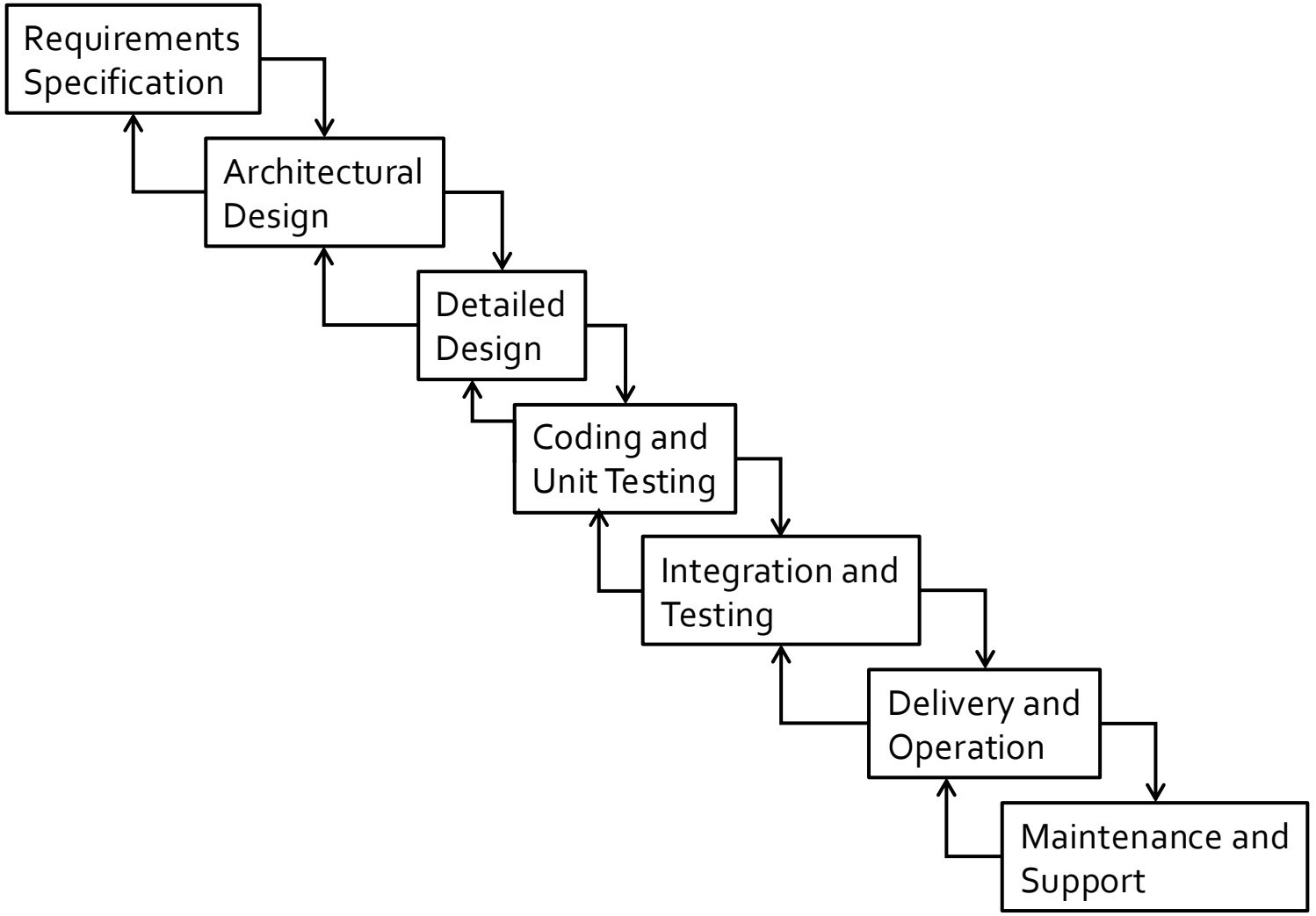
- Verification
  - Making sure you develop the *system right* (i.e., according to the requirements)

Discussion

- What are some major activities in developing software?
- Is there an effective order on these activities?

Waterfall

Waterfall Lifecycle Model



Discussion

- What are some pros and cons of the waterfall model?

Waterfall

- Pros:
  - Easily understood
  - Enforces discipline
  - Verification at every phase
  - Well-documented product

Waterfall

- Cons:
  - Uses a manufacturing view of software
    - Most software is not made as a “final” product
  - Customer must be patient
    - But time-to-market is critical
  - Customer sees the system only at the end
    - May not satisfy their real needs
    - No early feedback

Waterfall

- Cons:
  - Dependence on requirements being “right” at the start
    - This is almost never the case
    - Could end up building the wrong system
  - Requirements must all be known up front
    - But cannot always foresee all the necessary and changing requirements
- Summary
  - Need to be able to iterate – waterfall is not effective

Prototyping

Meeting Needs

- Validation
  - Making sure you develop the *right system* (i.e., what the customer really needed)

Prototyping

- Iterative design:
  - Cycling through several designs
  - Improving the product with each pass
- Various approaches (in combination):
  - Throwaway
  - Incremental
  - Evolutionary

Throwaway Prototyping

- Process:
  - Heavily involve real users
  - Build and test prototype
  - Gain knowledge for the real product
    - What is necessary
    - What works
    - What does not work
  - “Throw away” the prototype, then “develop” the product for real

Throwaway Prototyping

- Pros:
  - More communication between users and developers
  - Functionality is introduced earlier, which is good for morale

Throwaway Prototyping

- Cons:
  - Building the prototype must be rapid
  - Some qualities may be sacrificed, like security, reliability, etc.
  - Temptation to use the throwaway prototype in the final product

Incremental Prototyping

- Process:
  - Triage system into separate "increments"
    - I.e., "must do", "should do", "could do"
  - Develop and **add one increment at a time**
- Example: Accounting system
  - Prototype 1 – general ledger
  - Prototype 2 – accounts receivable/payable
  - Prototype 3 – payroll

Evolutionary Prototyping

- Process:
  - Feature is refined or "evolved" over time
- Example: Text editor
  - Prototype 1 – keyboard Cut and Paste
  - Prototype 2 – touchscreen Cut and Paste
  - Prototype 3 – Cut and Paste works with Undo

Other Kinds of Prototypes

- User interface sketches
  - Hand-drawn or using drawing tool
- Storyboards
  - Graphical depiction of user interface
  - Like a comic strip, but only draw the UI

Other Kinds of Prototypes

- Index cards, Post-It® notes
  - E.g., tasks in a project plan
  - E.g., classes in an object-oriented analysis
  - E.g., pages in a web site structure

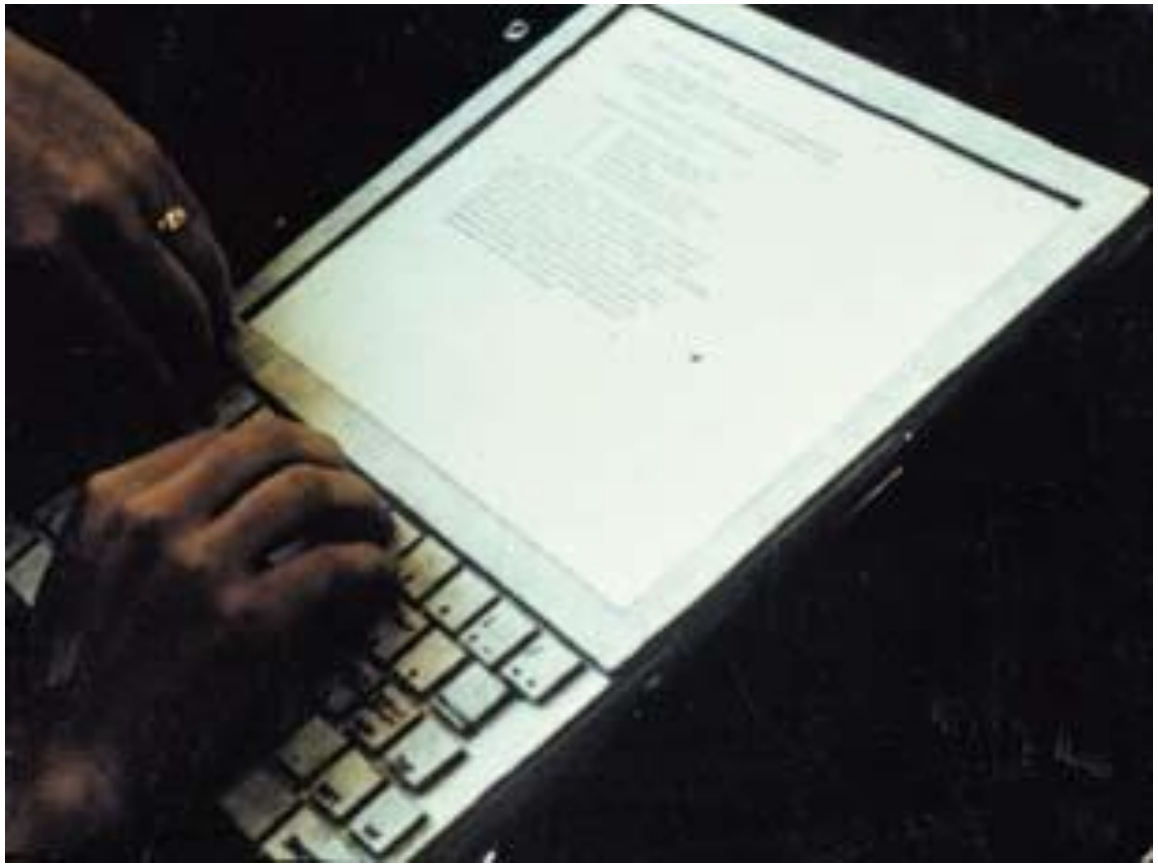
Other Kinds of Prototypes

- Physical mockups:
  - E.g., made from wood, clay, or foam

Balsa wood mock-up

Partial clay mock-up

Precision mock-up



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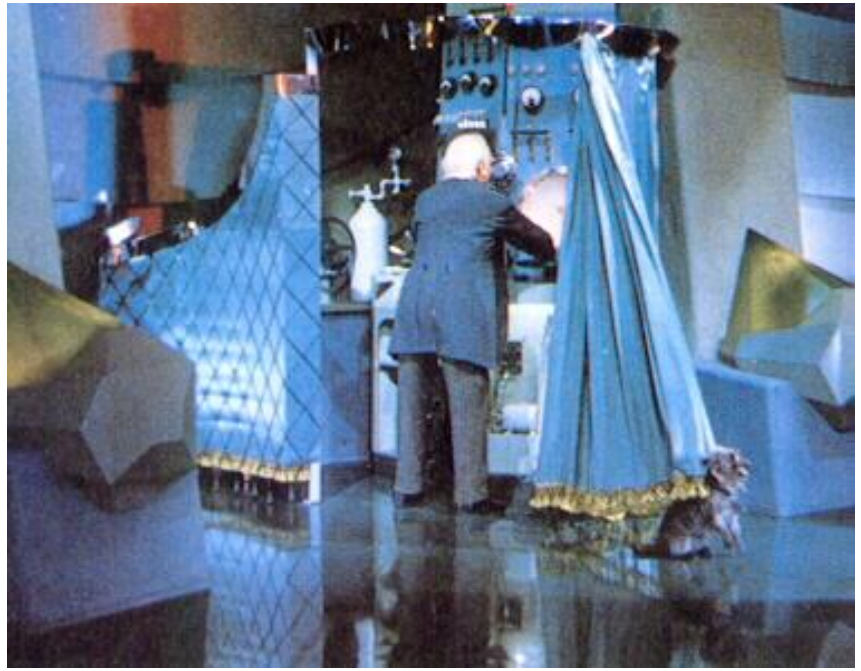
Other Kinds of Prototypes

- Wizard of Oz:
  - "Pay no attention to that man behind the curtain!"
  - Feature is "implemented" through human intervention behind the scenes

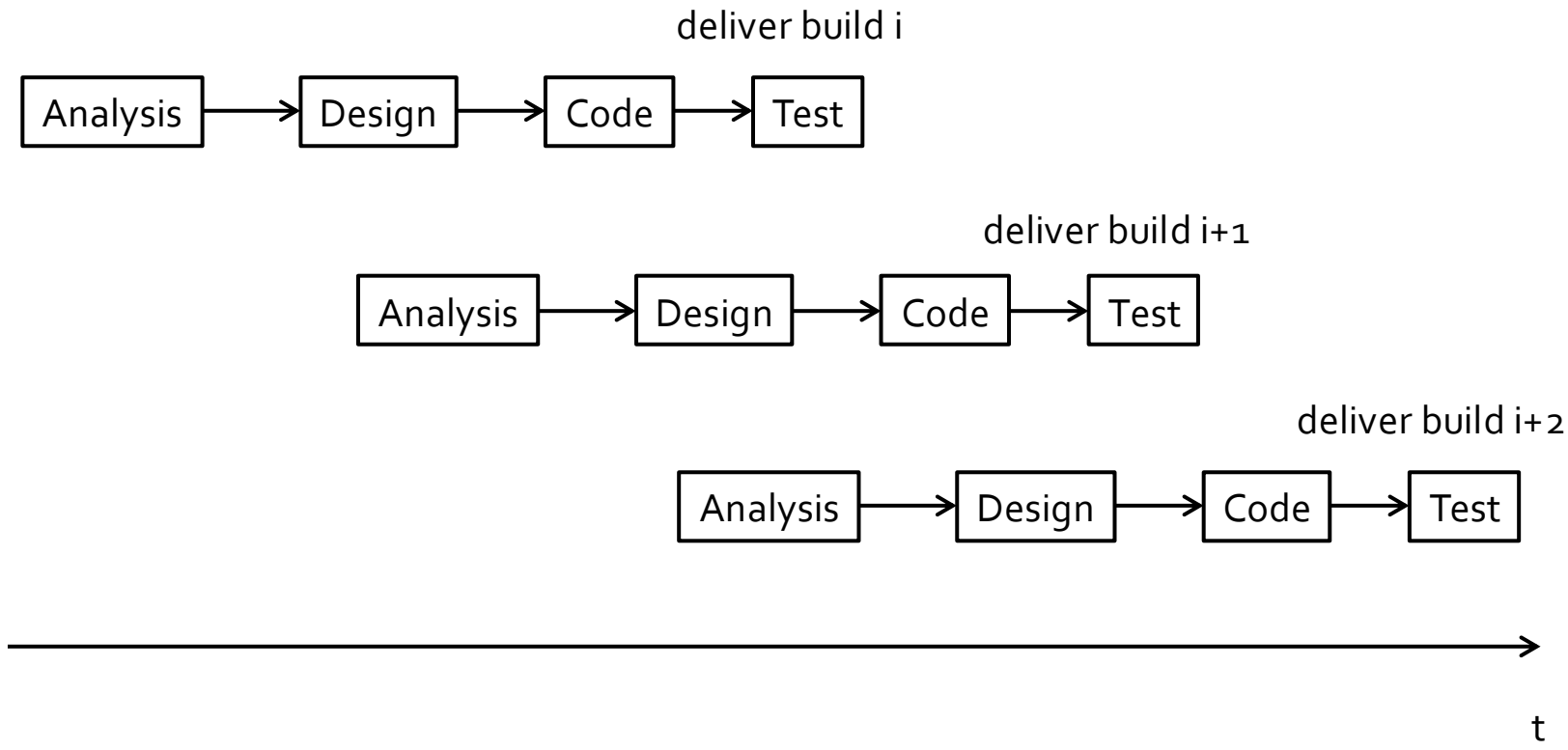


Staged Delivery

Staged Delivery

- Developers:
  - Deliver the system in a series of working releases or builds
- Users:
  - Use some functionality while the rest continues to be developed
- Possible parallelism:
  - Production and development systems
  - Staggered development streams

Staggered Builds



Staged Delivery

- Pros:
  - Provides more options
  - Different builds focus on specific features
  - Reduces estimation errors
  - Risks are reduced earlier

Staged Delivery

- Cons:
  - Overhead needed to plan and drive the product toward staged releases
  - Extra complexity of supporting multiple versions in the field

Agile Practices

“Agile Manifesto”

- A short set of values for building software in a flexible, iterative way
- http://agilemanifesto.org/

Agile Principles

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

Agile Principles

- Individuals and interactions:
  - Trust motivated individuals
  - Face-to-face conversation
  - Best work emerges from self-organizing teams
  - Team reflects on and adjusts their behavior
  - Promote constant, sustainable pace

Agile Principles

- Working software:
  - The main measure of progress
  - Continuous, frequent delivery of value

Agile Principles

- Customer collaboration:
  - Customers and developers work together
  - Satisfy customer early

Agile Principles

- Responding to change:
  - Welcome changing requirements, even if late
  - Technical excellence and good design
  - Simplicity – art of maximizing work not done

Prioritizing Stories (Features)

- High priority
  - **Must** be done
  - Complete first
  - Risk level:
    - Will cause big problems if not done (first)
    - Will cause big problems if it breaks

Prioritizing Stories (Features)

- Medium priority
  - **Should** be done
  - Complete second
  - Risk level:
    - Will cause some problems if not done (before other user stories)
    - Will cause some problems if it breaks

Prioritizing Stories (Features)

- Low priority
  - **Could** be done
  - Complete third
  - Risk level:
    - Only minor problems if not done (before other user stories)
    - Only minor problems if it breaks

Prioritizing Stories (Features)

- No priority
  - Nice to have but not needed
  - Do it last
  - Risk level:
    - No problems if not done (before other user stories)

Estimating Cost

- A story's cost is estimated by the effort required to complete it
- Effort depends on:
  - Amount of work involved
  - Complexity of the work
  - Uncertainty and technical risk involved
- Development team should participate in estimation
  - Individual estimates carry bias
  - Team discussion uncovers hidden complexities

eXtreme Programming (XP)

- http://www.extremeprogramming.org/
- Predecessor to Agile

XP

- Philosophy:
  - **Communication**
  - **Feedback**
  - **Simplicity**
  - **Programmer friendly**
  - **For small teams (up to about 20)**
  - Code-centric
  - Requires courage

Same as Agile

XP

- 12 practices:
  1. 40-hour week
  2. Metaphor
  3. Simple design
  4. Collective ownership
  5. Coding standards
  6. Small releases
  7. Continuous Integration
  8. Refactoring
  9. Planning game
  10. Testing
  11. On-site customer
  12. Pair programming

XP

- For programmer welfare:
  - 40-hour week
    - Work no more than 40 hours a week
    - Never work overtime a second week in a row

XP

- For shared understanding:
  - Metaphor
    - Guide development with a shared story of how the system works
  - Simple design
    - Design the system as simply as possible; remove extra complexity when discovered

XP

- For shared development:
  - Collective ownership
    - Anyone can change any code anywhere in the system at any time
  - Coding standards
    - Write all code according to rules that enhance communication and understanding through code

XP

- For continuity:
  - Small releases
    - Put simple system into production quickly, then release new versions on a very short cycle
  - Continuous integration
    - Integrate and build the system many times a day
  - Refactoring
    - Restructure the system to improve its design, simplicity, or flexibility

XP

- For feedback:
  - Planning game
    - Determine scope of the next iteration and overall release together with customer
  - Testing
    - Write automated unit tests first before the code; customer writes tests in requirements
  - On-site customer
    - Include a real, live user on the team, available full-time to answer questions quickly

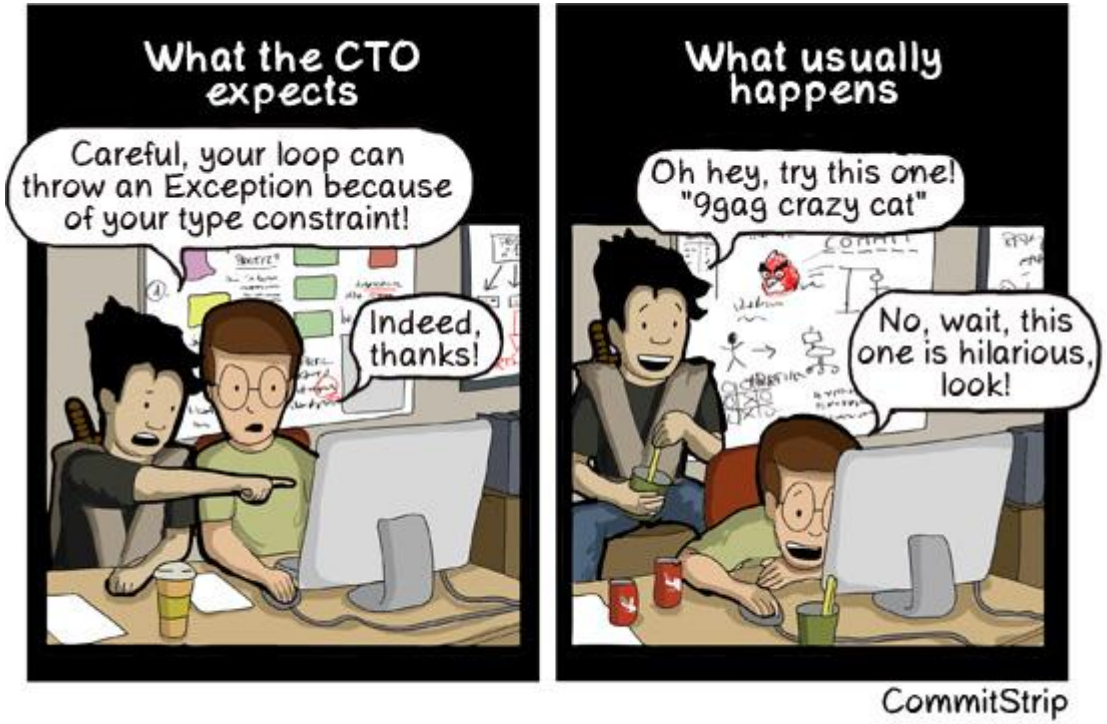
XP

- For synergy:
  - Pair programming
    - Have all production code written with two programmers actively at one machine
    - Prevents individual code ownership

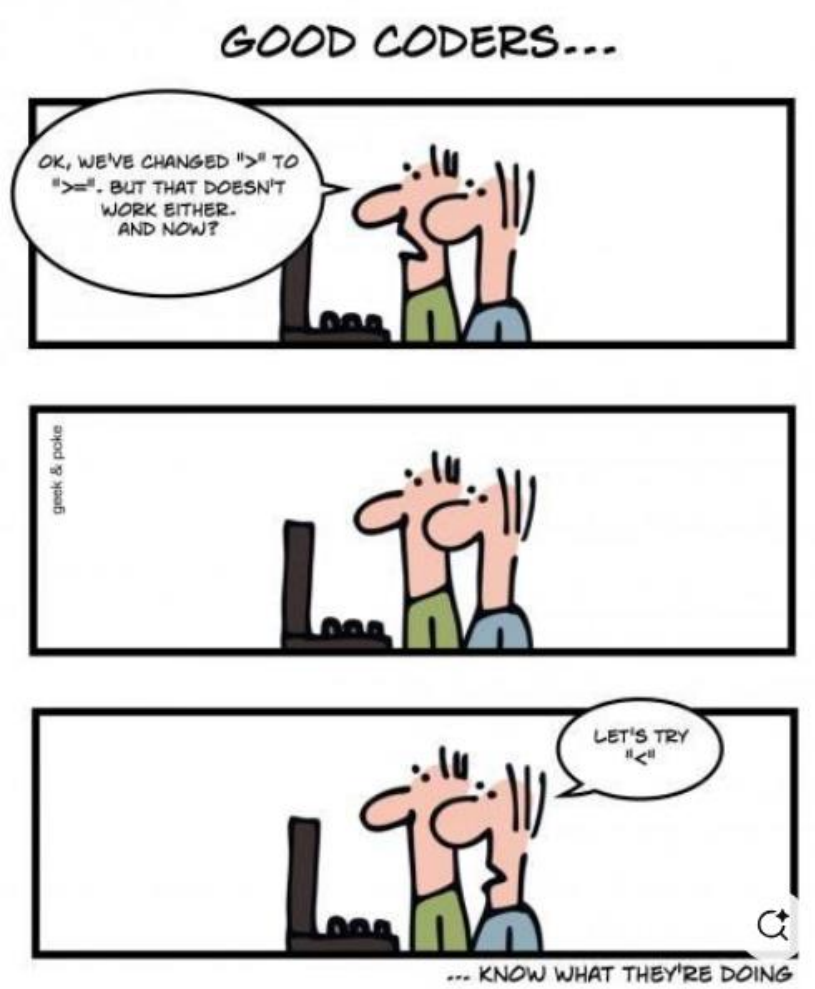
XP

- So why is it called “extreme”?
  - If short iterations are good, make them as short as possible
  - If simplicity is good, make the simplest thing that works
  - If design is good, do it all the time (refactoring)
  - If testing is good, write tests first, and do it all the time (test-driven development)
  - If code reviews are good, do it all the time (pair programming)

“Pair Programming”



https://www.commitstrip.com/en/2012/08/14/pair-programming/?



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Discussion

- What are reasons for having programmers working in pairs?
- What are reasons they shouldn't?

Pair Programming

- Synergies:
  - More ideas
    - Complementary skills
    - Better consideration of alternative solutions
  - Learning
    - Expert/student apprenticeship
    - Continuous critique to learn new things

Pair Programming

- Synergies:
  - Pressure
    - They do not want to let each other down, or waste each other's time
  - Courage
    - They give each other confidence to do things they might avoid if alone

Pair Programming

- Synergies:
  - Reviews
    - Better able to reveal defects with more eyes looking at the code
  - Debugging
    - Bugs reveal themselves when one explains the misbehaving code to the other

Scrum

- One part of the Agile development process
- Based on:
  - Feedback, roles, transparency, meetings, prioritization and planning
- Like classic engineering management, and is often used onsite in civil engineering and software development

Scrum

- Roles:
  - Scrum master
    - Acts as a coach, meeting facilitator, and administrator
    - Knows the process (Agile, XP, etc.)
    - Protects the team from distractions and helps them follow Scrum
  - Product owner
    - Represents the customer
    - Defines product backlog
  - Team members
    - Write code

Scrum

- Meetings:
  - Many per iteration
    - Daily scrum
  - Once per iteration
    - Planning meeting
    - Review
    - Retrospective

Scrum

- Daily scrum:
  - AKA daily "standup"
    - Time limited
    - Everyone is standing, so they are more uncomfortable and want to finish soon
  - Each team member answers 3 questions:
    - What did you do?
    - What are you going to do?
    - What is blocking you?

Scrum

- Planning meeting:
  - First meeting of the iteration (only on first day)
  - Input: requirements and user stories
  - Output: choose appropriate stories to work on next
    - Estimate their cost in time
    - Prioritize them
    - Fit them into the time left for the iteration

Scrum

- Review:
  - Review work completed
  - Review work not completed
  - Adjust and prioritize
  - Demonstrate current system

Scrum

- Retrospective:
  - Review issues faced with quality and personnel
  - Try to improve the process
  - What went well?
  - What could be improved?
  - Stay calm

More Information

- Articles:
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    - IEEE TSE, 12(2), 1986
  - "Software Development Worldwide: The State of the Practice"
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    - IEEE Software, November/December 2003
  - "How Microsoft Builds Software"
    - M.A. Cusumano and R.W. Selby
    - Comm. ACM, 4(6), 1997

More Information

- Books:
  - Software Project Survival Guide
    - S. McConnell
    - Microsoft Press, 1998
  - The Build Master
    - V. Maraia
    - Addison-Wesley, 2005
  - Extreme Programming Explained
    - K. Beck
    - Addison-Wesley, 2004
  - Pair Programming Illuminated
    - L. Williams and R. Kessler
    - Addison-Wesley, 2002