CSED332: Software Design Methods

Lecture 3: Agile

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POSTECH

Last Lecture: Testing

- Software teting
  - test cases, test suites, test oracles, ...
  - JUnit and test automation
- Test coverage
  - equivalence partitioning, boundary analysis, combinatorial testing
  - structural coverage: method, statement, branch, condition

This Lecture: eXtreme Programming

- What is eXtreme Programming (XP)?
- How extremely does XP differ?
- When (not) to use XP?

Many Way to Develop Software

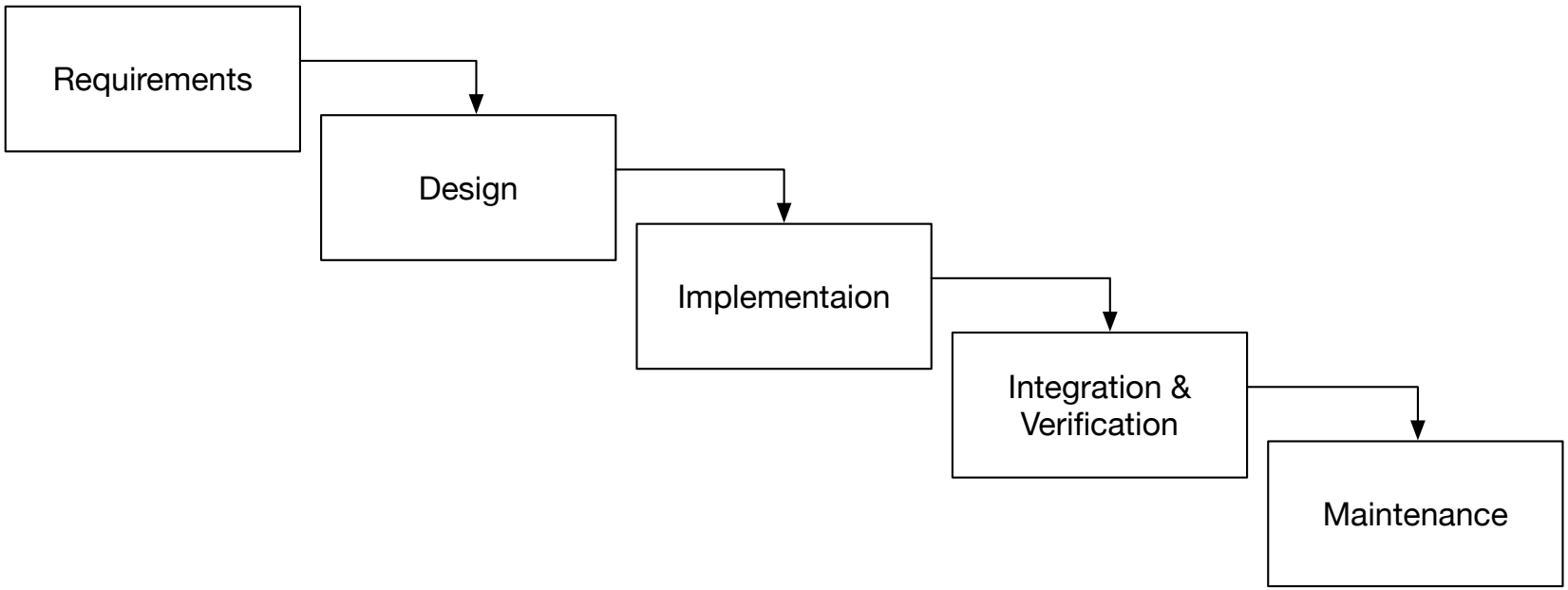
- Plan-driven / agile
- Centralized / distributed
- High math / low math
- Close / little interaction with customers
- Much testing / little testing
- Organize by architecture / features
- ...

Plan-Driven Process: Waterfall Process Activities

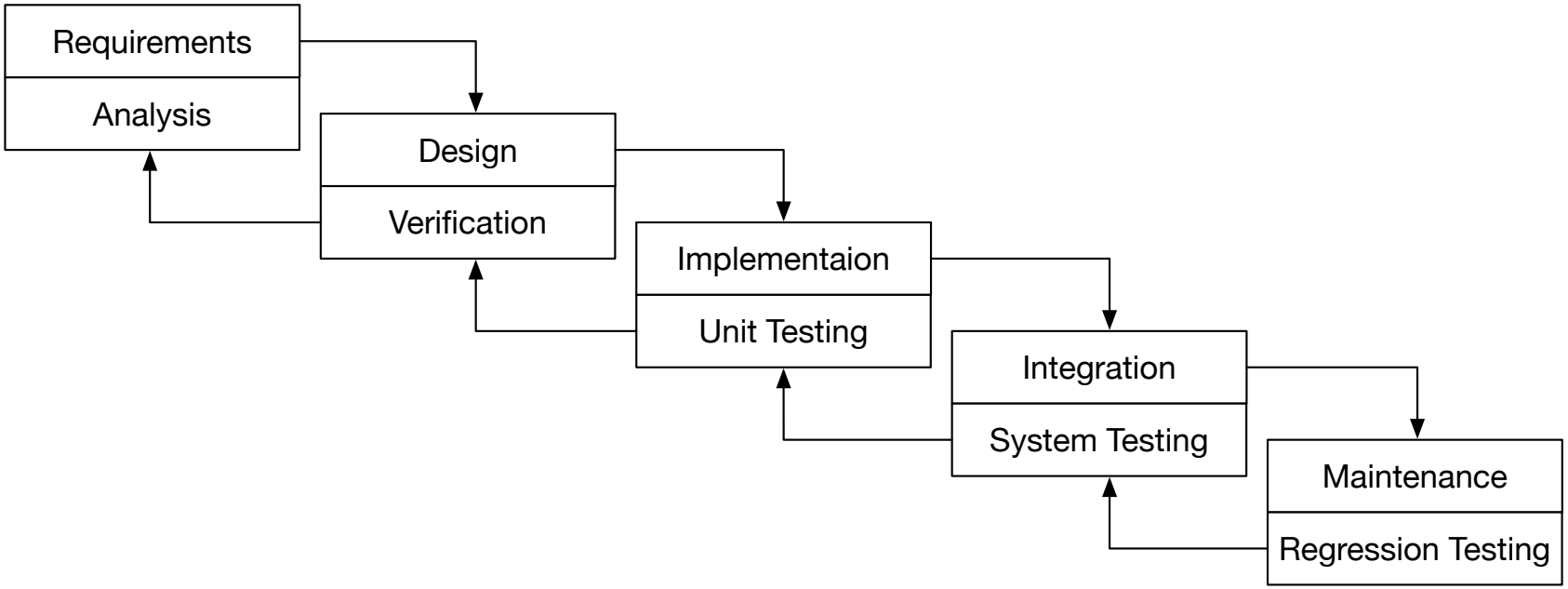
- Requirements: what software should do
- Design: structure code into modules
- Implementation: write code
- Integration: put modules together
- Testing: check if code works
- Maintenance: keep making changes

Often merged together as Verification

Theoretical Waterfall Model



Real-Life Waterfall Model



Agile Process: eXtreme Programming (XP)

- Different from the rigid waterfall process
  - replace it with a collaborative and iterative design process
  - respond quickly to changing requirements
- Main figure: Kent Beck

Main Ideas of XP

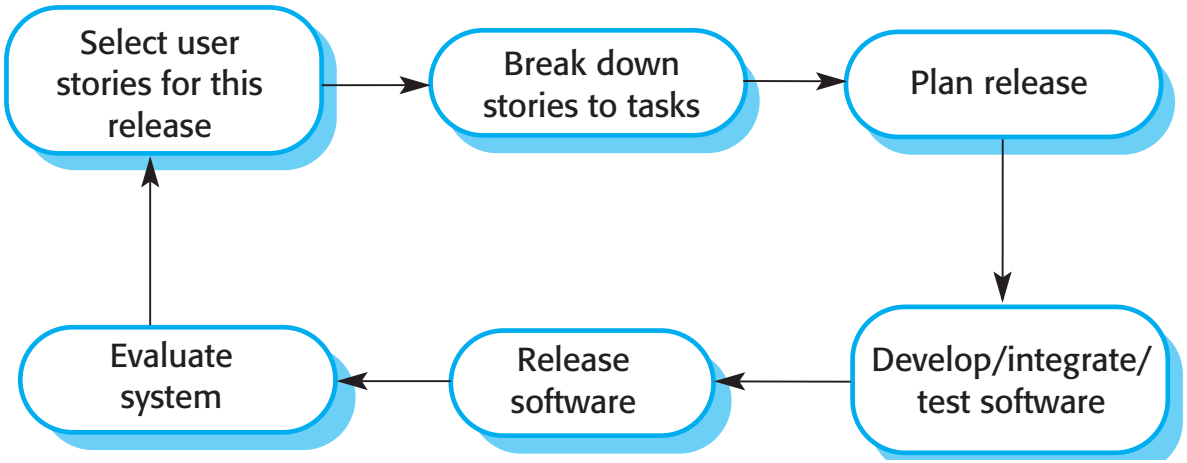
- Do not write excessive documentation
  - working code and tests are the main written product
- Implement features one by one
- Release code frequently
- Work closely with the customer
- Communicate a lot with team members

XP: Some Key Practices

- Planning game for requirements and user stories
- Test-driven development for design and testing
- Refactoring for design and implementation
- Pair programming for development
- Continuous integration for integration

XP is an Iterative Process

- Iteration = two week cycle (1-3 weeks)



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4. Each day, programmers work in pairs to finish tasks

Pair Programming

https://collaboration.csc.ncsu.edu/laurie/pair.html

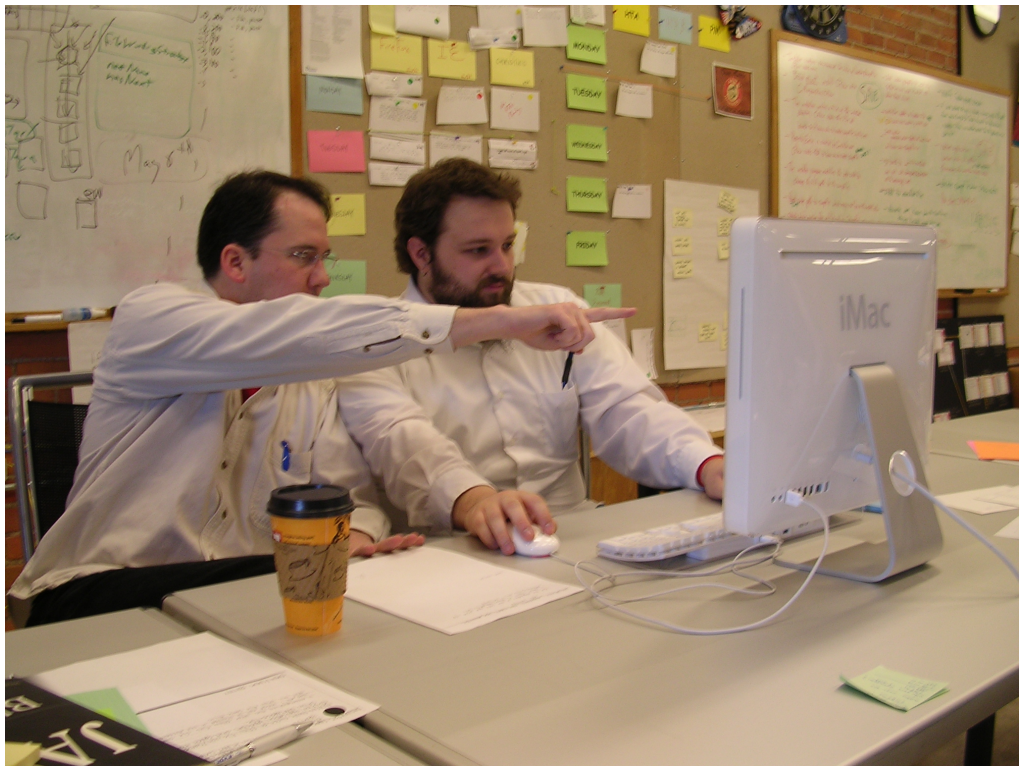
What Is Pair Programming?

> *Pair programming is a simple, straightforward concept. Two programmers work side-by-side at one computer, continuously collaborating on the same design, algorithm, code, and test. It allows two people to produce a higher quality of code than that produced by the summation of their solitary efforts.*
>
> — Laurie Williams

- Driver: types or writes
  - coding, design, debugging, testing, etc.
- Navigator: observes
  - looking for tactical and strategic defects
- Periodically switch roles of driver and navigator
  - possibly every 30 minutes or less

Example: Pair Programming

- Pair programming



- This is NOT Pair Programming
  - `https://www.youtube.com/watch?v=kE0O-Q5D1fw`

Research Findings to Date

- Strong anecdotal evidence from industry

  We can produce near defect-free code in less than half the time.

- Empirical Study
  - Pairs produced higher quality code (15% fewer defects)
  - Pairs completed their tasks in less time (58% of elapsed time)
  - Pairs enjoy their work more (92%)
  - Pairs feel more confident in their work products (96%)
- Measurements suggest
  - productivity of pair is similar to that of two working independently

Benefits of Pair Programming

- Higher product quality
- Improved cycle time
- Increased programmer satisfaction
- Enhanced learning
- Pair rotation
  - ease staff training and transition
  - sharing of knowledge (reduced risk when team members leave)
  - enhanced team building

Issue: Partner Work

Expert paired with an Expert

Expert paired with a Novice

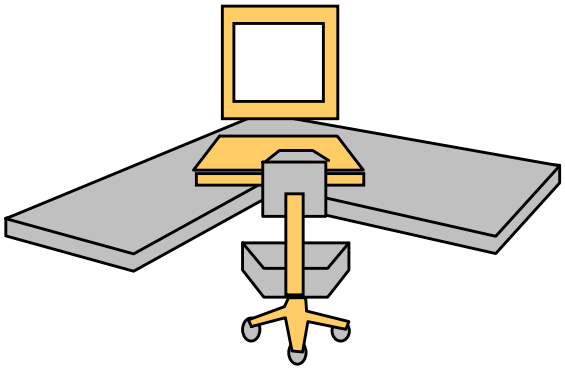
Novices paired together

Professional Driver Problem

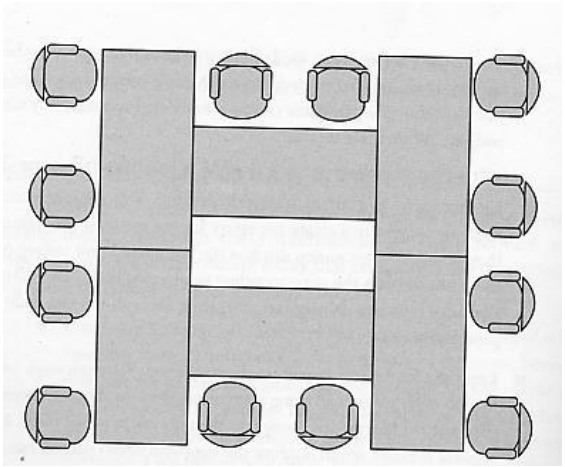
Culture

Issue: Pair Should Rotate

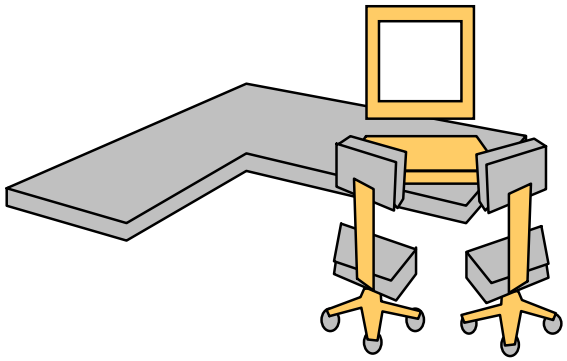
Issue: Workplace Layout



Bad



Best



Better

Issue: Process

- Pair programming is an old concept
  - since the beginning of programming (1950s)
- Used extensively in eXtreme Programming
  - collective code ownership: everyone is responsible for all the code
- But also in other development processes
  - pair programming can be added to any process

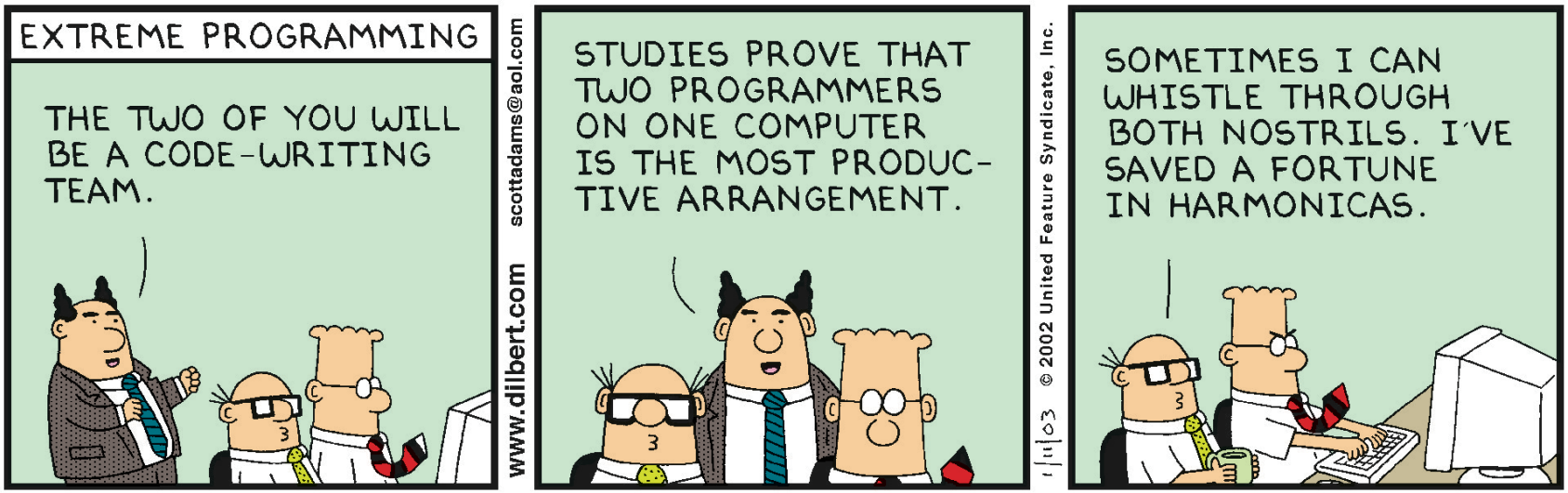
How Does This Work? (1)

- Pair Pressure
  - keep each other on task and focused
  - don't want to let partner down
  - "embarrassed" to not follow the prescribed process
- Pair Negotiation
  - "searching through larger spaces of alternatives"
  - bring different prior experiences, while having shared goals
  - must negotiate how to approach the problem jointly
- Pair Courage
  - if it looks right to me and it looks right to you, ...
  - it's probably right!

How Does This Work? (2)

- Pair Reviews
  - "four eyeballs are better than two"
  - continuous design and code reviews
  - removes programmers' distaste for reviews
- Pair Debugging
  - explaining the problems to another person
  - "never mind; I see what's wrong. sorry to bother you."
- Pair Learning
  - learn from partners techniques, knowledge of language, domain, ...
  - take turns being the teacher and the student minute by minute

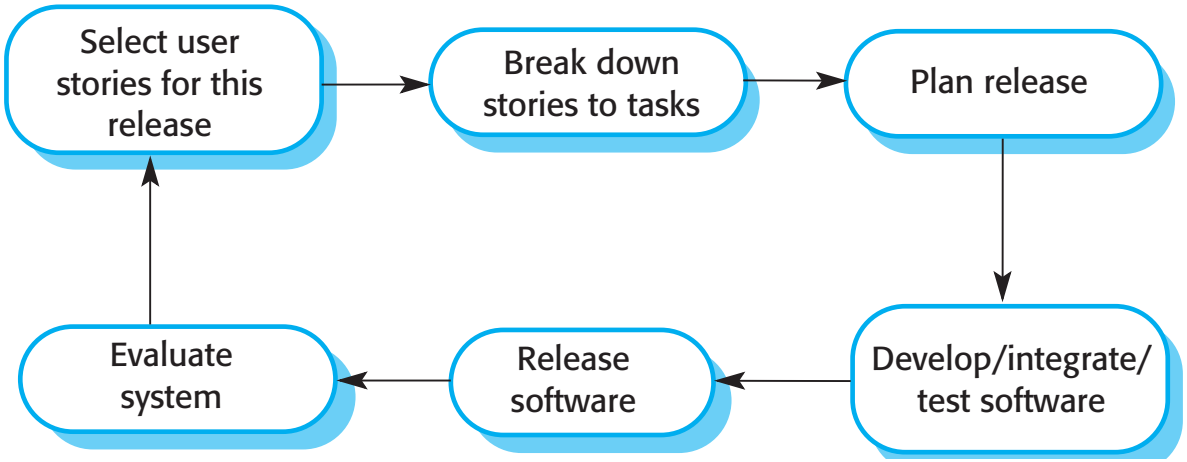
Pairs Means Working Together



User Stories

XP is an Iterative Process

- Iteration = two week cycle (1-3 weeks)



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What are User Stories?

A user story is the smallest amount of information (a step) necessary to allow the customer to define (and steer) a path through the system.

— David Astels, et al.

- A user story represents :
  - a feature customers want in the software
- Written by our customers (communication with developers)
  - and not by developers (?)
- Typically written on index cards

Writing User Stories

- Materials
  - a stack of blank index cards, pens or pencils, rubber bands
- Start with a goal of the system
  - e.g., applicant submits a loan application
- Think about the steps that the user takes
  - as the user does the activity
- Write no more than one step on each card
  - do not make it too complex

Format of a User Story

- Title: 2–3 words
- Acceptance test
- Priority: 1–2–3 (1 most important)
- Story points (e.g., the number of days of ideal development time)
- Description: 1–2 sentences (a single step towards achieving goal)

Title: Enter Player Info		
Acceptance Test: enterPlayerInfo1	Priority: 1	Story Points: 1
Right after the game starts, the Player Information dialog will prompt the players to enter the number of players (between 2 and 8). Each player will then be prompted for their name, which may not be an empty string. If Cancel is pressed the game exits gracefully.		

Example: Acceptance Test for a Story

- Create Receipt

  Keep a running receipt with a short description of each scanned item and its price.

- Test

  Setup: The cashier has a new customer

  Operation: The cashier scans three cans of beans ($0.99 each), two pounds of spinach ($0.59/lb), and a toothbrush ($2.00)

  Verify: The receipt has all of the scanned items and their correctly listed prices.

Priorities

- High
  - "Give us these stories to provide a minimal working system."
- Medium
  - "We need these stories to complete this system."
- Low
  - "Bells and whistles? Which stories can come later?"

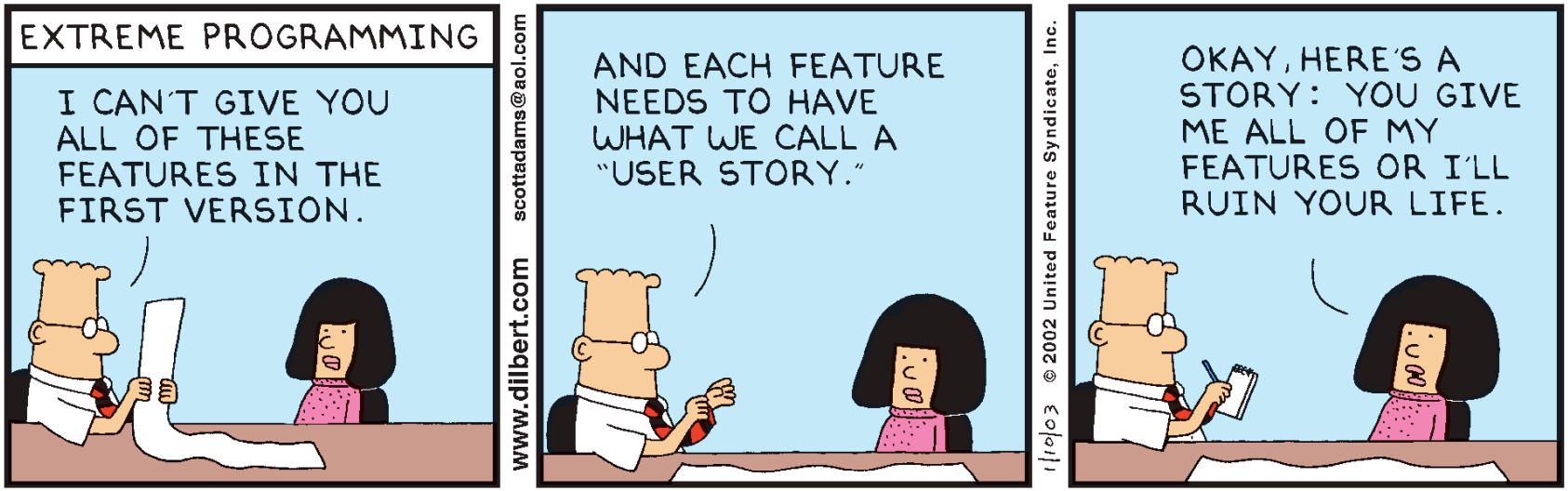
Story Points

- Unit of measure
  - the overall size of a user story, feature, or other piece of work.
  - NOT amount of time or the number of people
- Relative values
  - raw value of a story point is unimportant
- Estimating story points
  - choose a medium-size story and assign it, e.g., 5
  - estimate other stories relative to that

Criteria for User Stories

- Independent: of each other as much as possible
- Negotiable: understandable to the customer, not a contract
- Valuable: must provide value to the customer
- Estimable: to a good approximation
- Small: so as to fit within an iteration
- Testable: in principle, even if there isn't a test for it yet

Need Educated Customer



Planning Game[1]

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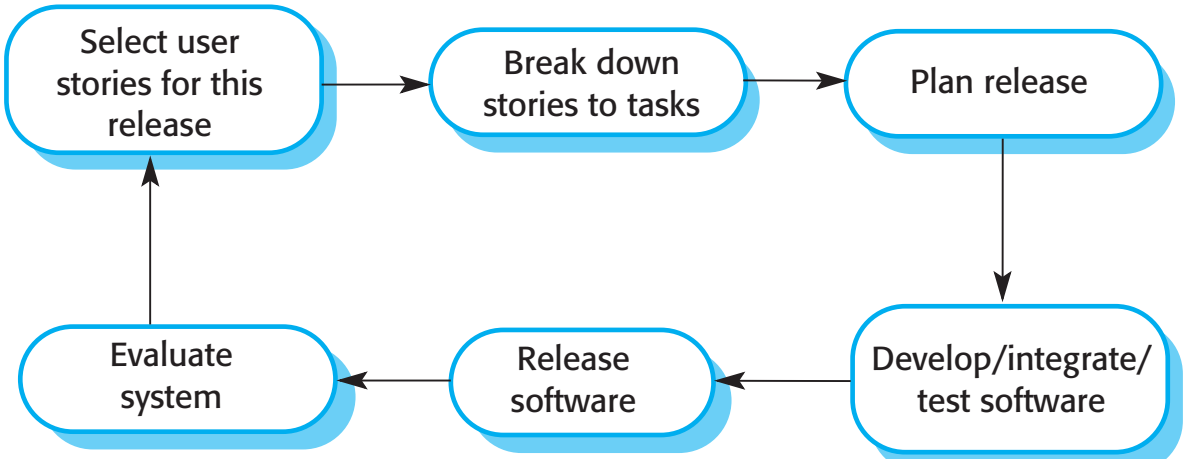

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How to Plan

- Make a list
  - everything you have to do
- Decide when you will do each thing
  - How long will it take?
- Make sure you have what you need for each task
  - e.g., dependencies between different tasks

How Long Will It Take?

- Compare with other tasks
  - you have previously done
- Break into smaller steps
  - when too hard to estimate
- Get several people to estimate
  - to consider different aspects

Planning Game

- Customer writes user stories.
  - only provide enough detail to estimate time to implement the story
- Programmers estimate time to do each story.
  - If story is too big, customer splits it
- Customer chooses stories to be implemented that match velocity.
  - project velocity is amount of work done in the previous iteration(s)

Example: Coming up with the Plan

- Desired Features: a user story is given by a customer
- Estimate Size: 30 story points
- Divide by Velocity: 5 story points / two week iteration
- Derive Duration: 6 iterations
- Iteration/Release Plan: 3 months

Estimating Size

- Story point: unit of measure
  - the overall size of a user story, feature, or other piece of work.
  - NOT amount of time or the number of people
- Ideal time:
  - the amount of time, stripped of all peripheral activities
  - E.g., soccer game = 90 minutes
- Elapsed time:
  - the amount of time that passes on the clock
  - E.g., soccer game = 2 hours
- Velocity
  - a measure of how much work is getting done on your project.
  - sum of the estimates of the user stories finished during the iteration

Estimating Story Points

- Choose a medium-size story and assign it a "5"
  - based on how hard to implement it
  - not relate to actual hours; only relative
- Estimate other stories relative to that
  - twice as big
  - half as big
  - almost but not quite as big
  - a little bit bigger
- Only values

0 1 2 3 5 8 | 13 20 40 100

← Near-term iteration "stories" a few iterations away "epic" →

Estimating Ideal Days

- Ideal days vs. elapsed time
  - supporting current release
  - meetings, demonstrations
  - sick time, phone calls, personal issues
  - ...
- When estimating ideal days, assume
  - the story being estimated is the only thing you will work on
  - everything you need will be on hand when you start
  - there will be no interruptions

Ideal Days vs. Story Points

- Both are units of predicted effort
- Story points:
  - pure measure of size (focus on feature, not person)
  - helps drive cross-functional behavior
  - estimation is typically faster in the long run
- Ideal days:
  - my ideal days are not your ideal days (focus on person)
  - easier to explain outside of team
  - estimation is typically faster at first

Deriving an Estimate for a User Story

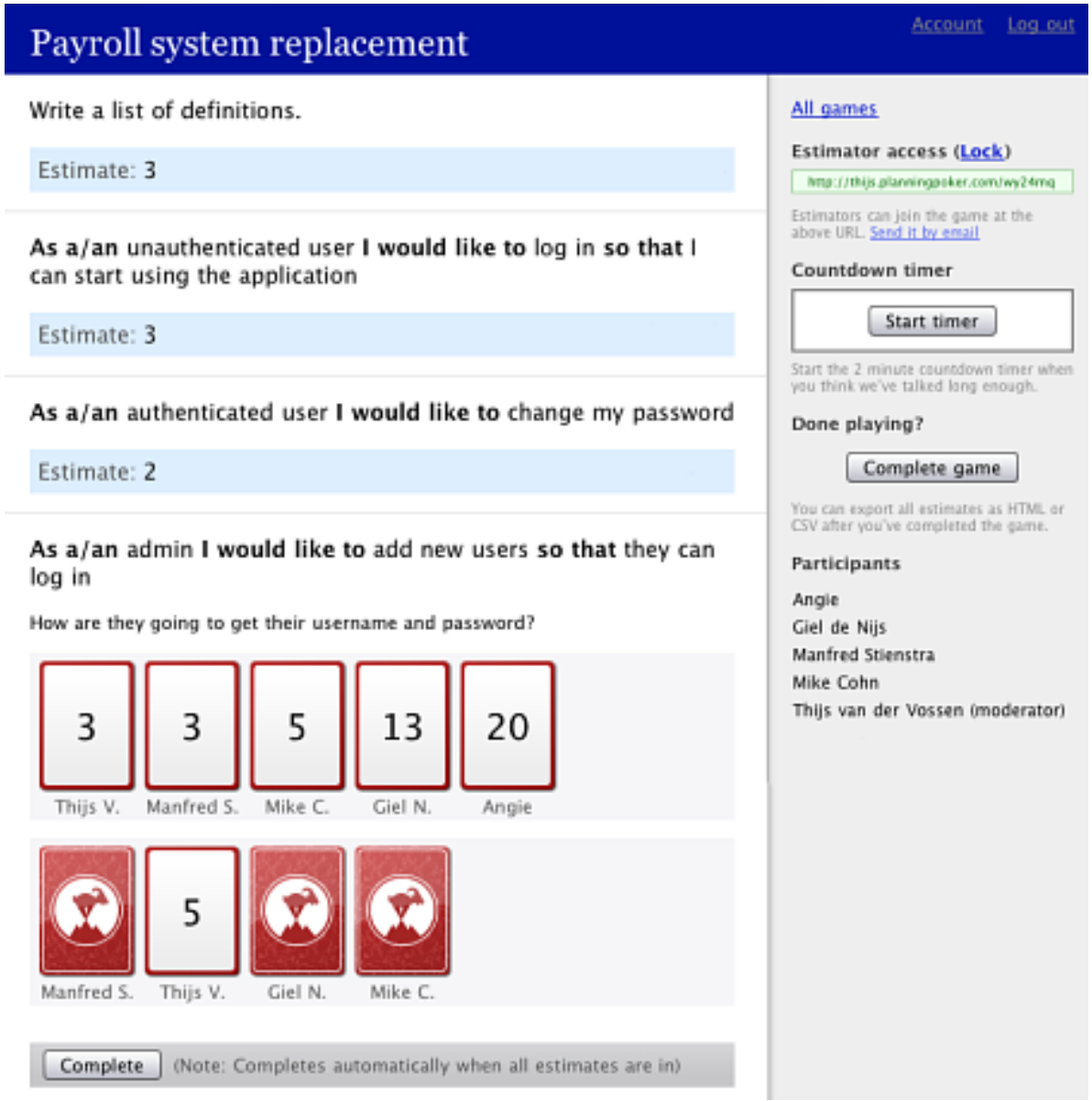
- Expert opinion
  - based on (extensive) experience
  - one expert not be enough (need to consider all aspects)
- Analogy
  - relative to (several) other user stories
  - triangulation: little bigger than “3” and a little smaller than “8”
- Disaggregation
  - break up into smaller, easier-to-estimate pieces or tasks.
  - need to make sure you do not miss any tasks.
- Planning poker
  - combines expert opinion, analogy, disaggregation
  - avoids the cognitive bias of anchoring

Planning Poker Deck

Playing Planning Poker

- Include all players on the development team:
  - but less than 10 people overall
  - programmers, testers, requirements analysts, UI designers, . . .
- Moderator (usually the product owner or analyst)
  - read the description (e.g., user stories) and answer any questions
- Each estimator privately selects a card with their estimate
- All cards simultaneously turned over
- Re-estimate
- Repeat until converge

Planning Poker: http://planningpoker.com



Velocity

- A measure of a team's rate of progress.
  - how much work is getting done on your project
- Summing up the story points assigned to the user stories
  - that the team completed during the iteration
- Assumption
  - team produces in future iterations at the rate of past velocity
- If velocity changes dramatically for more than one iteration
  - need to re-estimate and re-negotiate the release plan

Example: Release Plan

- Desired Features: a user story given
- Estimate Size: 30 story points
- Divide by Velocity: 5 story points / 2 week iteration
- Derive Duration: 6 iterations
- Release Plan: 3 months

Example: Not Working as Fast as Planned?

- Desired Features: a user story given
- Estimate Size: 30 story points
- Divide by Velocity: 3 story points / 2 week iteration
- Derive Duration: 10 iterations
- Release Plan: 5 months

Example: Not Working as Fast as Planned?

- Desired Features: a user story given
- Estimate Size: 18 story points
- Divide by Velocity: 3 story points / 2 week iteration
- Derive Duration: 6 iterations
- Release Plan: 3 months

Velocity Corrects Estimation Errors

- The velocity should change, not each story point estimate
  - to re-estimate and re-negotiate the release plan for future releases
- Since all user stories are estimated relative to each other

Prioritization

- Driven by customer, in conjunction with developer
  - which user stories to be implemented?
- Choose features to fill up velocity of iteration
  - a feature to a broad base of customers or users
  - a feature to a small number of important customers or users
  - the cohesiveness of the story in relation to other stories
- Cohesiveness example
  - "Zoom in" a high priority feature
  - "Zoom out" not a high priority feature but relative to "Zoom in"

Priorities (Revisited)

- High
  - "Give us these stories to provide a minimal working system."
- Medium
  - "We need these stories to complete this system."
- Low
  - "Bells and whistles? Which stories can come later?"

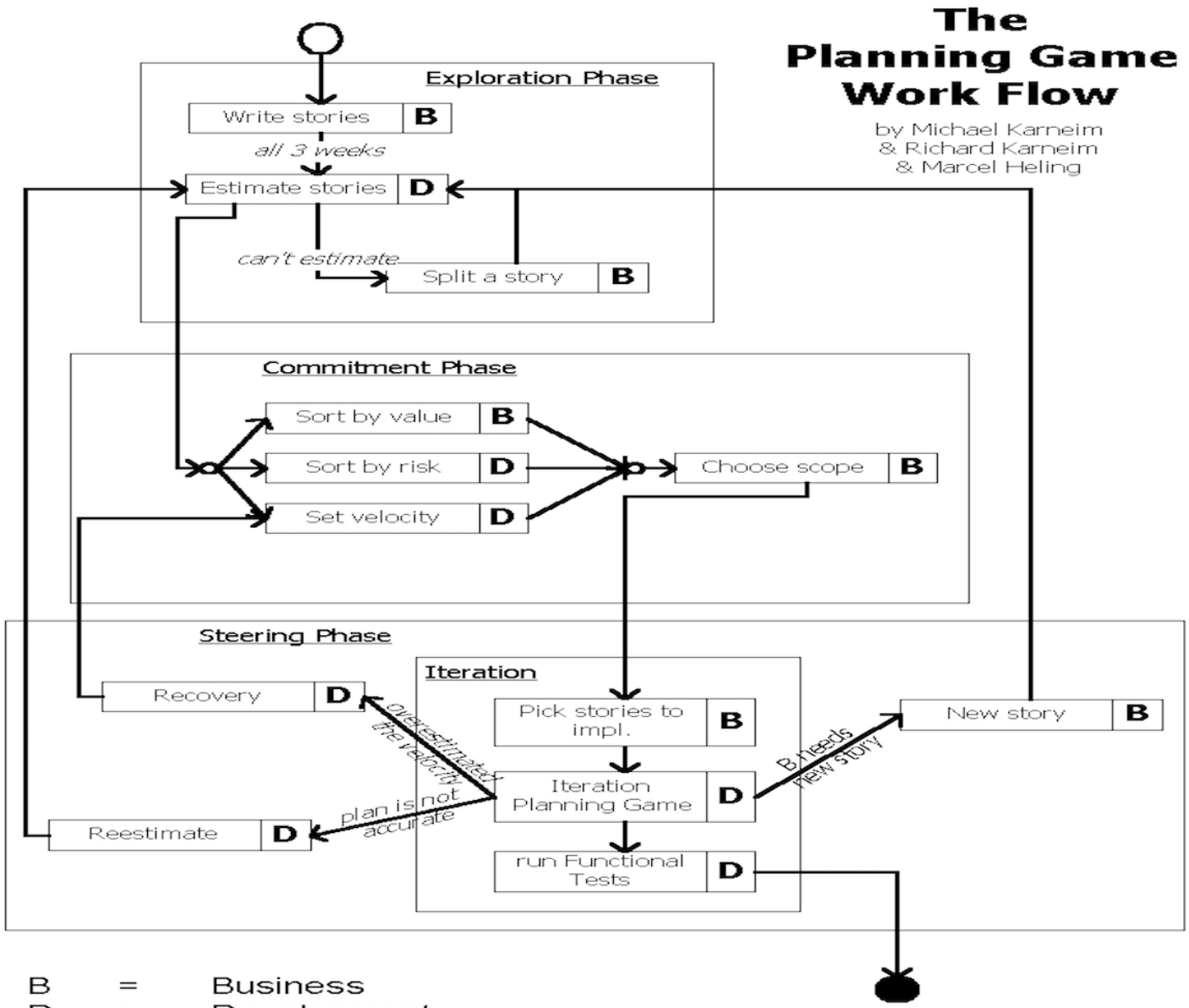
Example: Planning Game (2)

Customer	Desired Features:	a user story given
Developer	Estimate size (too big)	100 story points
Customer	Split the user story	8 user stories
Developer	Estimate Size:	20 story point each
	Divide by Velocity:	5 story points / 2 week iteration
	Derive Duration:	8 * 4 iterations
	Release Plan (small releases):	8 * 2 months
Customer	Choose stories to be implemented first	

Iteration Planning

At the beginning of each iteration

- Customer selects user stories
  - with estimates that total up to the velocity from the last iteration.
- User stories are broken down into the programming tasks
  - developers sign up to do the tasks
- Developers estimate how long their tasks will take to complete
  - ideal days or story points
- Velocity used to determine if the iteration is overbooked or not
  - too much: the customer must choose user stories to be put off
  - too little: another story can be accepted


The Planning Game Work Flow
by Michael Karneim & Richard Karneim & Marcel Heling
Exploration Phase
Write stories
B
all 3 weeks
Estimate stories
D
can't estimate
Split a story
B
Commitment Phase
Sort by value
B
Sort by risk
D
Set velocity
D
Choose scope
B
Steering Phase
Iteration
Recovery
D
Pick stories to impl.
B
New story
B
Overestimated the velocity
Iteration Planning Game
D
B needs new story
plan is not accurate
Reestimate
D
run Functional Tests
D
B = Business
D = Development

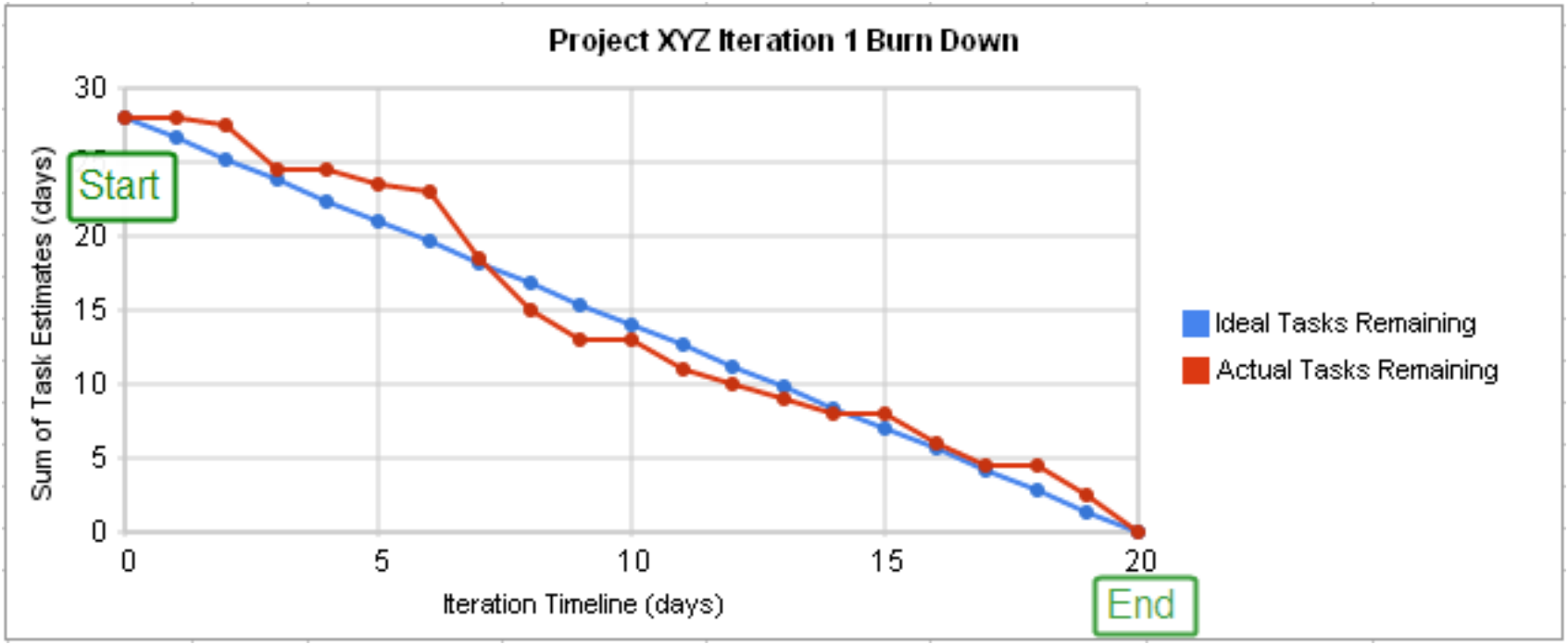
Project Tracking

- Keep track of when each task is finished
  - must be objective (e.g., "wrote a program" not "learned language")
  - different tasks are evaluated differently
- Compare plan to reality
  - estimated vs. actual completion date
- Tasks are either finished or not
  - forbid "90% finished" – decompose tasks
  - in XP, programming task is not finished until all tests run correctly

Your project

Update documents on GitLab to reflect completion dates.

Burn Down Chart



- Shows the amount of work remaining at the start of each iteration

  Vertical axis: number of story points or hours remaining
  Horizontal axis: iterations (or days)

- Visual indicator of how quickly a team is moving toward its goal

Difficulties in Scheduling

- Productivity is not proportional to the number of people
  - tasks cannot be fully partitioned to individuals in practice
  - require communication among subtasks
- Adding manpower to a late software project makes it later
  - called Brooks' law
  - communication overheads and training
- The unexpected always happens
  - always allow contingency in planning

Unit Tests and Refactoring

Simplicity

- Add one feature (user story) at a time
  - Programmers only worry about one iteration at a time
- Do not worry about future stories
  - Customer can change future iterations
- Make program as simple as possible
  - The simplest thing that could possibly work

Recover Simplicity

- Adding a new feature
  - tends to make the code less simple
- Refactoring the code
  - recover simplicity back
- Safe refactoring
  - requires to have a rigorous set of unit tests

Refactoring

- Changing the structure of program without changing its behavior
  - make code easier to understand
  - make code cheaper to modify
- Some refactoring
  - rename, rename, rename
  - extract method and local variable
  - encapsulate field
  - ...
- Automated refactoring support (e.g., Eclipse)

Working Software

- All software has automated (unit) tests
- All tests pass, all the time
- Never check in broken code to the repository

How to Work on a Task

- Get latest version of the code. All tests pass.
- Write test first. It fails.
- Write code to make test pass. Now all tests pass.
- Refactoring (clean up)
- Check in your code (plus smoke testing)

One Key Practice

- Write tests first, then write code
  - tests will initially fails
- Various names
  - Test-first programming
  - Test-driven development
- Is it testing or designing?
  - does not find bugs, but prevents them
  - does not measure quality, but improves it

Why Test?

- Improve quality: find faults
- Measure quality
  - Prove there are no bugs? (Is it possible?)
  - Determine if software is ready to be released
  - Determine what to work on
  - See if you made a mistake
- Learn the software

XP Specification and Testing

- Talk about specification when writing unit tests
  - write tests and then code
  - document code
- Customer (team) writes functional tests (acceptance test)
  - tests are derived from user stories
  - tests need to be documented to ensure traceability to user stories

XP and Test Coverage

- Measure coverage periodically
  - at end of iteration?
  - use automated tools
- Use as feedback
  - To write more tests
  - To improve how you write tests

Summary

- Core XP practices
  - pair programming, user stories, planning game, testing, refactoring
- Homework 3 (Due 10/2):
  - More Java, JUnit, and Maven
- Reading
  - `https://en.wikipedia.org/wiki/Agile_software_development`
  - `http://www.extremeprogramming.org`

Questions?