CS1530, Lectures 3 - 4: Software Development Methodologies

Definition

- Software Engineering Methodology: A system of dividing software development into distinct phases, responsibilities, and deliverables.
- There are many ways to do this!
- This allows better planning, management, and (arguably) better software.

Why Not Just Throw Coders At a Problem And Hope For The Best?

- Remember there are other aspects of development besides coding, and there needs to be communication with/from, and preparation for, these other aspects
- External constraints (e.g. deadlines, legislative or regulatory)
- Need for planning and estimation
- Interactions with others
- Guidelines for development (avoiding the “so... now what?” problem)

We've discovered a few things in software development; this is one!

- Projects get accomplished with higher quality and less surprise if the team follows some sort of structured methodology, as compared to none
- Now, what methodology to use, that is the question!
    - Domain-dependent
    - Team-dependent
    - Project-dependent
    - Schedule-dependent

Heavyweight vs Lightweight Methodologies

- One of the key dividing lines
- Lightweight = fewer rules, more flexibility, less documentation, less up-front work, less restrictive
- Heavyweight = more rules, less flexibility, more documentation, more up-front work, more restrictive

Heavyweight vs Lightweight

- Lightweight = pick-up game with your friends
- Heavyweight = Olympic sports
- Which is “better”? Depends on your goals!

Cowboy Coding

- The lightest of lightweight “processes”
- Lack of any sort of formal (or even informal) software project management
- Lack of estimation, testing, integration
- Think "hackathon" or “assignment due in two hours” work

Cowboy Coding

- You'd expect a Software Engineering professor to rail against this - and it IS overused - but it does have some benefits!
  - Fast
  - Flexible
  - Efficient for very small teams or projects
  - Efficient if correctness is not critical

Cowboy Coding

- Many, many drawbacks:
  - Tends to use "quick and dirty" solutions, a.k.a. kluges or hacks
  - Often leads to technical debt
  - Not good for writing code without defects
  - Very difficult to write non-trivial software systems in this style
  - Very difficult to converse with other stakeholders about system

The Culmination of the Manichaean Worldview in Software: Waterfall

- The closest to the “idealized” SDLC covered in the last class
- Understand and document all customer requirements first, then understand and document entire design, then understand and document all code before testing, etc.
- Stability before moving on, never moving back

Waterfall

- Very “wall-friendly” - easy to throw design “over the wall” to developers, or code “over the wall” to testers
- Why? Heavy documentation, software phase should be “complete” before moving on
- Communications can then be at a minimum
- This can be good - what if team is geographically disparate or very large?
- Helps eliminate the O(n^2) growth of comm pathways

Waterfall

- “Gates” between development phases
- Ensure correctness as much as possible before moving on
- Not meant to be flexible - you have specific goals you are trying to reach
- Change is minimized, but lots of work is done ahead to time when change should be “easier”
    - BDUF (“Big design up front”)

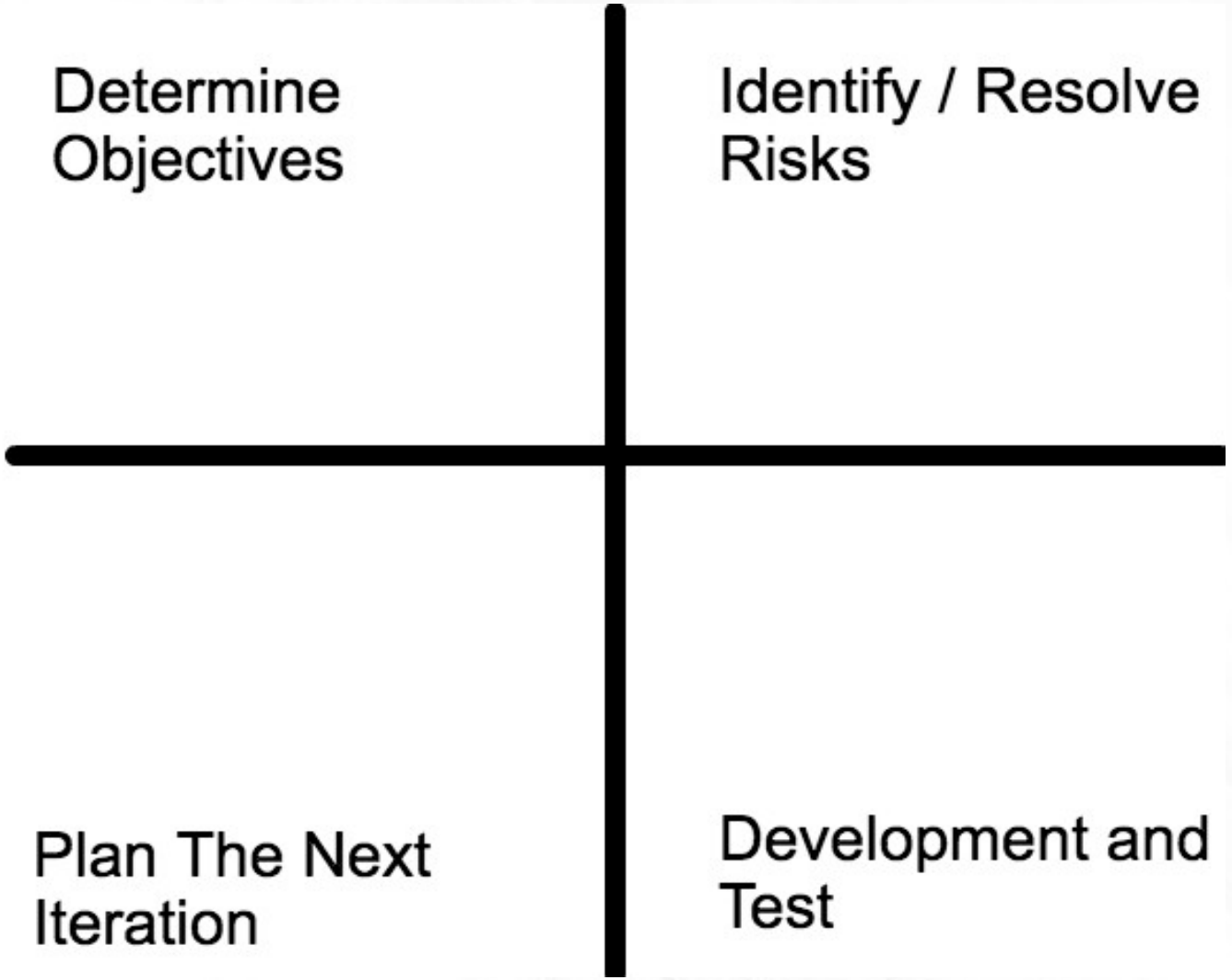
Benefits of Waterfall

- Often maligned, but it (or a variant like Incremental Development) actually can be good fit if requirements are stable and well-understood, and if developers understand the system and domain well
- I view it as a lumbering ogre - good if you want well-defined, well-understood tasks done
- Creates lots of documentation for others to be able to come on to team

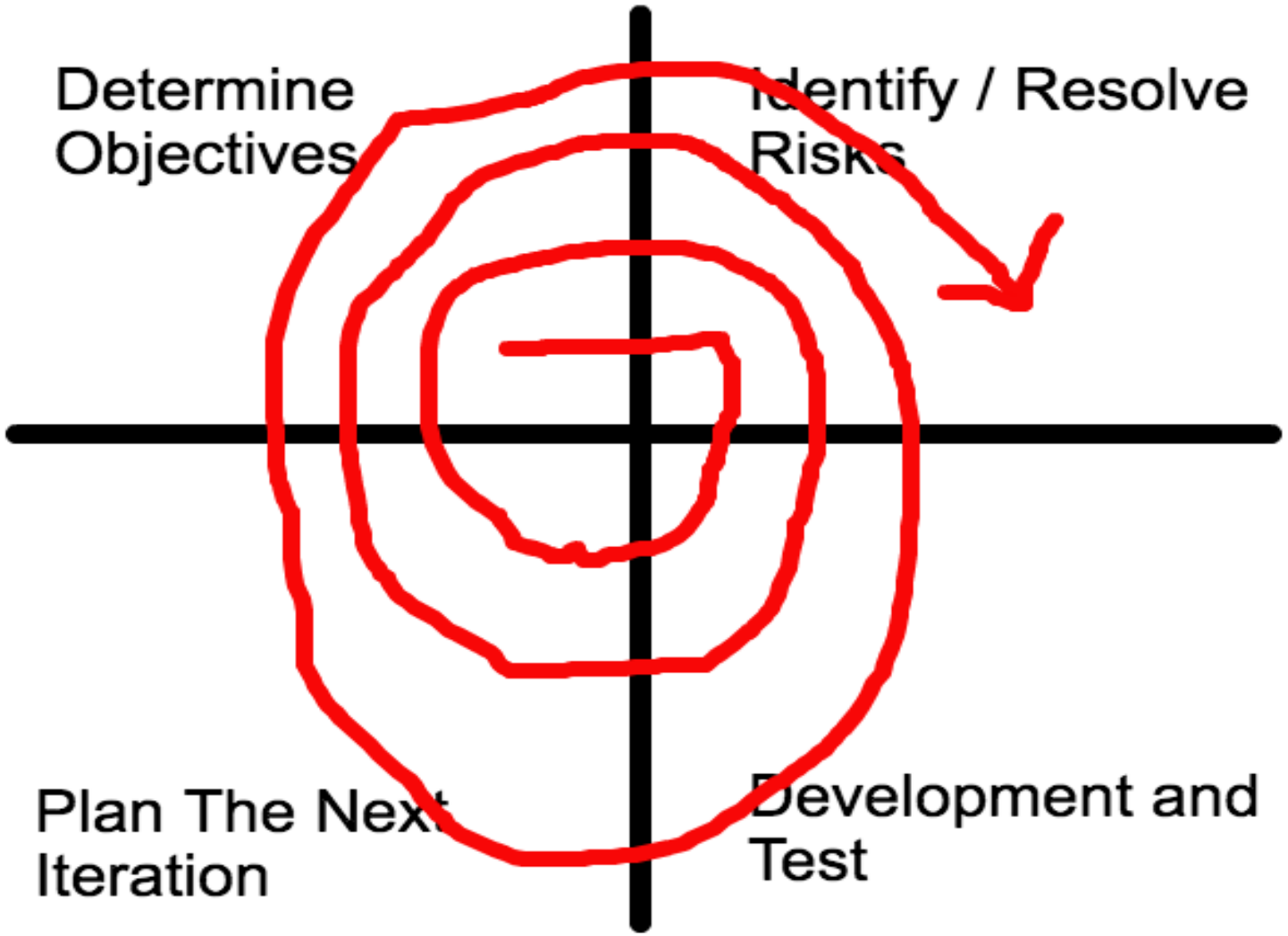
Drawbacks of Waterfall

- Very inflexible
- If problem domain is ill-defined or not well-understood, can end up with entirely the wrong product, or non-functional software
- Extremely slow
- Prone to failure - think “Christmas lights in sequence” as opposed to in parallel

Spiral


Determine Objectives
Identify / Resolve Risks
Plan The Next Iteration
Development and Test

Spiral


Determine
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Iteration

Benefits of Spiral Methodology

- Allows more precise estimation, albeit closer temporally
- More flexible than waterfall
- Allow focus on risk and trade-offs multiple times in the development process

Drawbacks of Spiral Metholodogy

- Still limits us in flexibility
- Not as detailed as some other methodologies; Barry Boehm described it as a meta-process which could be used for specific methodologies
    - In fact, most methodologies discussed in class are “special cases” of spiral development
- Focus is on risk reduction as opposed to feature development

Cleanroom Development

- Software Development based on formal methods (mathematical description of a system before coding)
- If a system fails QA, defects are not just fixed; system is moved back to design phase!
- Testing is done statistically, not haphazardly
- Not to be confused with “cleanroom” as in developing a workalike system without access to the underlying code

Benefits of Cleanroom Development

- Allows us to get close (never quite reaching, of course) defect-free software
- Confidence in software
- Reductions in cost of development compared to similar systems, according to the SEI

Drawbacks of Cleanroom Development

- Not as flexible - you need to understand a system very well to mathematically model it
- Lack of people with requisite skills in industry
- If not done properly (and see last point), can be slow

Iterative and Incremental

- Iterative - System is developed through repeated cycles
- Incremental - Small pieces of the software are done during each iteration
- Always have working software, just keep adding features

Kinds of Iterative and Incremental

- Unified Process
    - and its variants RUP, OpenUP, etc.
- Chaos model
- Various “incremental Waterfall” models
- XP
- “Agile” methodologies can be considered variants

Benefits of Iterative and Incremental

- Very flexible!
- Always have working software; can easily reduce scope by just stopping work
- Focus is on small pieces of the software and getting each part to work correctly - less risk of catastrophic failure

Drawbacks of Iterative and Incremental

- Less up-front design and analysis; could mean more technical debt later
- Difficult for products which are hard to split into feature sets
- Can be difficult to plan ahead

RAD (Rapid Application Development)

- Less emphasis on planning, less emphasis on design/architecture
- “Many projects fail because they did not meet the user's needs, and users have trouble verbalizing their needs, so let's focus on the UI and having a prototype first”
- Sometimes called “prototyping methodology”
- Prototypes get better - can evolve to the final product!

Benefits of RAD

- Higher quality software which more closely aligns with the user's needs
- Very, very flexible!
- Risk control - allows development team to focus on “what matters most”, cut features which won't be necessary, etc.

Drawbacks of RAD

- Poor design - as “prototypes” evolve into production systems, they can often degenerate into the “Big Ball of Mud” architecture anti-pattern
- Rarely works well for large, complex, or interdependent systems
- Focus is on user-facing systems, not back-end

Agile

- A broad term encompassing several different, but related, methodologies
- Focus is on communication - dev to dev, dev to customer, manager to customer, QA to dev..
- “Information radiators” - information on a system should be dynamic, not static documentation
- Goal is to meet the needs of the customer as opposed to meeting requirements

Agile

- Assumption is that software development is a “never-ending” process
- Features can be added or removed, defects fixed, etc.
- Relatively lightweight processes - focus is on development of the software, with enough process to “point people in the right direction”

Benefits of Agile Development

- Very flexible, very good for work on tight timelines without rigid deadlines
- Kaizen - "continuous improvement" baked into the system for the most part
- Focus on user means all stakeholders focus on end goal

Drawbacks of Agile Development

- Less up-front understanding of system, so development team can go down blind alleys or accumulate technical debt
- More heavyweight than some, although still very lightweight
- Adaptive vs prescriptive schedule estimation (often a problem when dealing with management)

CMMI

- Capability Maturity Model Integration (evolved from CMM, which was software-only)
- Developed at CMU! Now run by a spin-off company...
- NOT a software methodology, but a way to determine how well a software development group is aligned with the process
- That is, for whatever process you follow, how well do you follow it?

CMMI Levels

- Initial - Processes are unpredictable, ad hoc (where you start)
- Managed - Processes is defined and characterized for projects. The process is at least documented.
- Defined - Processes is defined and characterized for the entire organization.
- Quantitatively Defined - Processes are measured and controlled. There are metrics that can allow one to know how well the processes are working.
- Optimizing - Focus is on process improvement

Our Methodology: Agile / Scrum

- Perhaps the most popular version of “Agile development”
- We will see some of its drawbacks, benefits, and how it works next time!