



# SSW-555: Agile Methods for Software Development

*Introduction*  
*Extreme Programming/XP*

Prof. Zhongyuan Yu  
School of Systems and Enterprises  
Stevens Institute of Technology





# Course Basics

- Instructor: Zhongyuan Yu
  - Contact Info: zyu7@stevens.edu
  - Office Hours: Monday 3-4pm available on Zoom or by appointment
- Time: Tuesday 12:30-3pm
- Location: Gateway North 204
- Prerequisite(s): Programming experience, preferably Python
- Cross-listed with: CS 555

# What this course is about?

- This course examines agile methods to understand how rapid realization of software occurs most effectively.
- The agile development is contrasted with teams following more traditional methodologies that emphasize planning and documentation.
- Students will learn agile development principles and techniques covering the entire software development process.





# Course Schedule

Week	Date	Additional Comments	Assignment(s) Due	Topic	Reading(s)	Project
1	Tuesday, January 18, 2022		1/24/22	Course Overview, XP	[Boehm2002][RUP2003]	
2	Tuesday, January 25, 2022		1/31/22	User Story	[Ambler 2004][Grenning 2002]	
3	Tuesday, February 1, 2022			Scrum	[Schwaber 2013]	Preparation for project and group formation
4	Tuesday, February 8, 2022		2/14/22	Project Assignment from Industry Senior Executives		
5	Tuesday, February 15, 2022		2/21/22	Testing	[Gamma 1998]	Start of Sprint 1
6	Tuesday, February 22, 2022	Monday Class Schedule; No Classes				
7	Tuesday, March 1, 2022		3/7/22	Pair Programming	[Williams 2001]	Start of Sprint 2
8	Tuesday, March 8, 2022		3/21/22	Refactoring	[Fowler 1999] Chapter 2 -3	
9	Tuesday, March 15, 2022	Spring Recess; No Classes				
10	Tuesday, March 22, 2022		3/28/22	Lean	[Poppendieck 2012]	Start of Sprint 3
11	Tuesday, March 29, 2022		4/4/22	Feature-Driven Development (FDD)	[Palmer 2013]	
12	Tuesday, April 5, 2022			Debate/Guest Speaker		Start of Sprint 4
13	Tuesday, April 12, 2022		4/18/22	Crystal	[Wikiversity on Crystal]	
14	Tuesday, April 19, 2022		4/25/22	Scaled Agile Framework (SAF)	[Leffingwell 2009]	End of Project
15	Tuesday, April 26, 2022			Zoom Project Presentation		
16	Tuesday, May 3, 2022		5/8/22	Final Exam		

This schedule may subject to change



# Weekly assignments

1. Reading
2. Quiz
3. Project



- Due date of each week is on Monday 11:00 pm



# Readings and Quizzes

- Reading assignment each week
  - Suggested to be completed before attending lectures
  - See Canvas Modules for the weekly reading assignments
- Short online quiz covering the reading and lecture material
  - To help you retain the material
- Homework assignment each week (subject to change)
  - You may ask me questions about the homework before turning it in, but all work must be your own
  - Upload your homework answers to Canvas

***Be sure to answer all questions in your own words---don't copy from the lecture notes or other sources.***

***Copy and paste from lecture or web **is not acceptable*****



# Social Media

- How many hours do you spend on Social Media each day?
- Reallocate time for enhancing your career
  - New technologies
  - New approaches, tools, and techniques
  - Pulse of the industry
- Bi-weekly assignments to share an article of your choice





# Team project

- We will practice Extreme Programming and Scrum on a software project throughout the course
- The project will be released by Dr. Jie Zhao, Executive Vice President of Delos, Head of Delos Labs. (Delos is a global wellness technology company), tentatively scheduled on Feb.8th, 2022
- Midterm short feedback report & QA is expected after Sprint 2, and the final presentation is scheduled on Apr.26<sup>th</sup>, 2022
- How project is evaluated:
  - Software content 50%
  - XP and Scrum process 50%
  - Team member evaluation Adjusted (20%)
- All deliverables are team assignments:
  - Only one member of the team needs to submit the deliverable to the Canvas
  - We will use GitHub for Configuration Management
- Sign up for a GitHub account if you don't already have one





# Late Policy and Assignment Policy

- All assignments are due at the same time each week if any, **Monday 11:00 pm**, so you can plan your schedule
- Late assignments
  - Less than 24 hours: 5% deduction
  - 1-3 days: 10% deduction
  - 4-7 days, 30% deduction
  - Greater than a week, you will receive 0 for the corresponding assignment, if without written explanation **in advance** regarding a situation of unavoidable emergency
- The **lowest quiz grade will be dropped** for final homework calculation.



# Grading

Grades will be based on:

- **Assignments (35%)**
- **Project and Presentation (30%)**
- **Final Exam (25%)**
- **Bi-Weekly Social Media Participation and Bonus points (10%+)**

Grades will be posted on Canvas





# Cheating

- ***Cheating will NOT be tolerated***
- ALL work is expected to be in your own words
- all quiz answers
- all exam answers
- all programming
- Copying from any source is considered cheating
- providing a citation does not excuse this
- Consequences of cheating may include:
- receiving a grade of 0 for an assignment
- receiving a grade of "F" for the course
- expulsion from the university





# Acknowledgements

Lecture material comes from a variety of sources, including:

- [https://www.tutorialspoint.com/sdlc/sdlc\\_quick\\_guide.htm](https://www.tutorialspoint.com/sdlc/sdlc_quick_guide.htm)
- Software Engineering, 10th Edition, Ian Sommerville
- Scott W. Ambler [www.ambysoft.com/surveys/](http://www.ambysoft.com/surveys/)
- "Get ready for agile methods, with care" by Barry Boehm, *IEEE Computer*, January 2002.
- <http://agilemanifesto.org/>
- <http://www.extremeprogramming.org/>
- [http://www.tutorialspoint.com/extreme\\_programming/](http://www.tutorialspoint.com/extreme_programming/)
- <https://www.infoq.com/articles/reifer-agile-study-2017>



# Today's Topics

- Software development method comparison
- Motivations for agile methods
  - Rational Unified Process (RUP)
  - Boehm's risk exposure comparison
- Overview of Extreme Programming (XP)



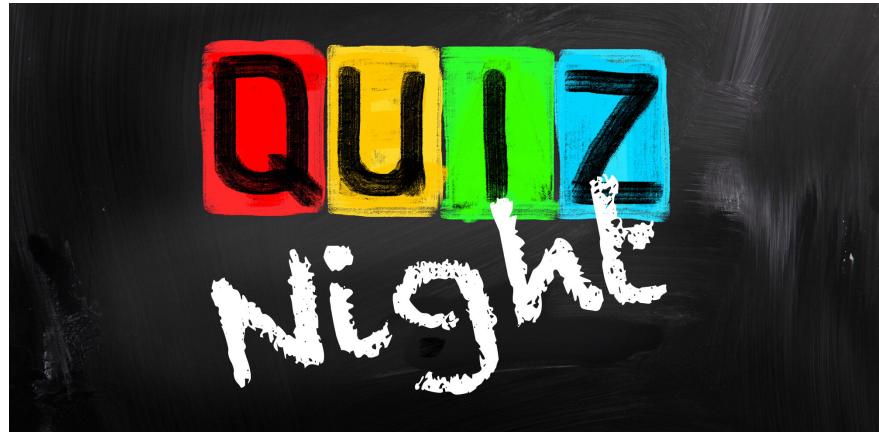
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# Software Development ? Coding



Programming (coding) of software is an important part of any software effort.

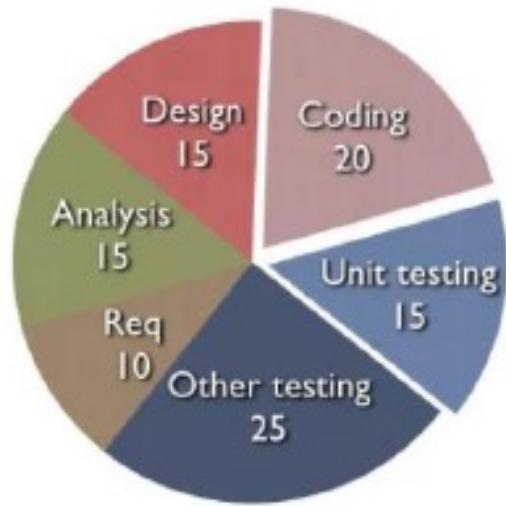


- 100% effort
- 80% effort
- 50% effort
- 25% effort
- 15% effort

# Software Development > Coding



Programming (coding) of software is an important part of any software effort.



- 100% effort
- 80% effort
- 50% effort
- **25% effort**
- **15% effort**

- It is usually less than **25%** of the total effort.
- On large projects, it is less than **15%** of the total effort.

# How much planning?

- What's the right level of planning for software projects?
  - It depends on the task!
- How should we decide?
  - What's the domain?
  - How complete are the requirements?
  - How stable are the requirements?
  - What's the cost of doing the wrong thing?
  - What's the cost of doing the right thing too slowly?
  - What are the risks?
  - What are the rewards?





# Software Development Life Cycle (SDLC)

Software specification

- What functionality must we support?

Software development

- How do we create the software that delivers the functionality?

Software validation

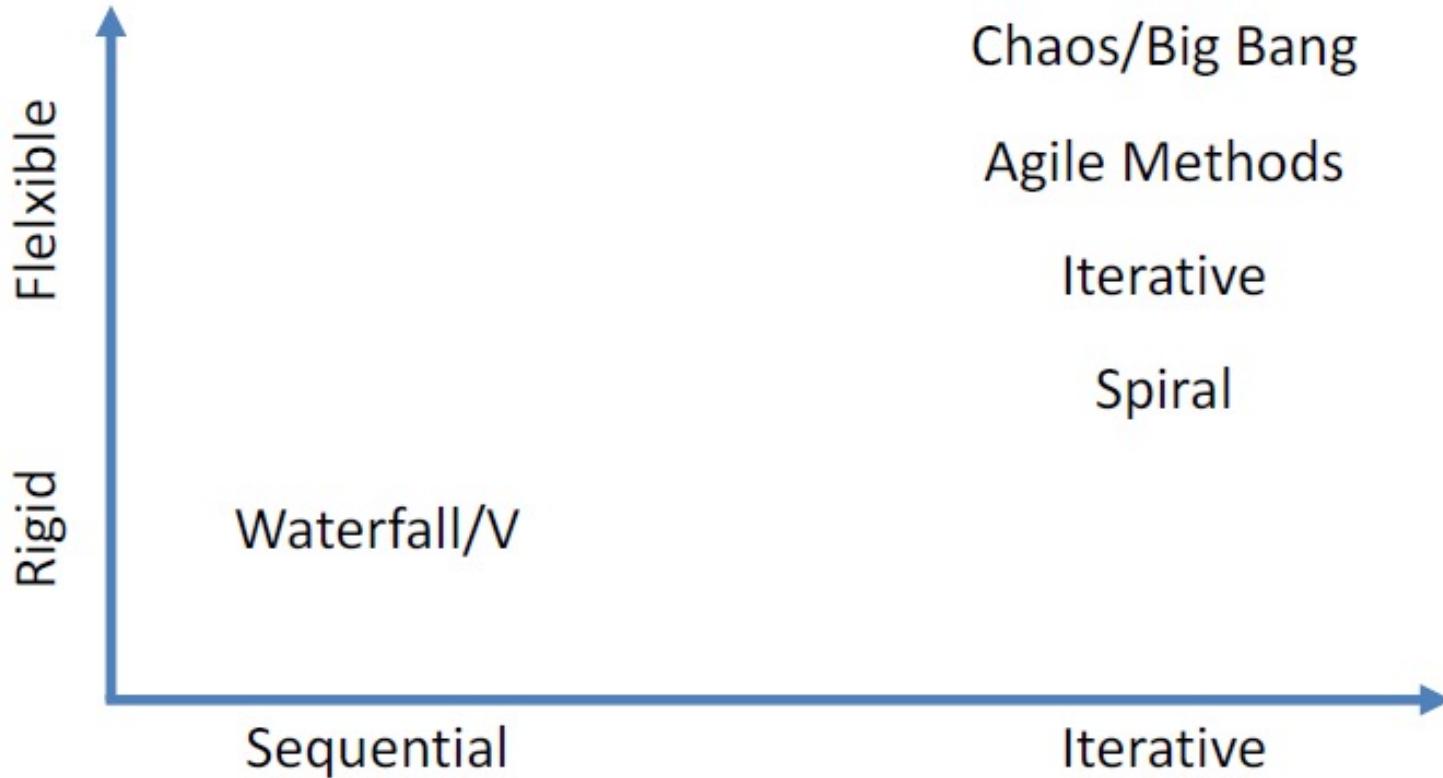
- How do we verify that the software does what it's supposed to do?

Software evolution

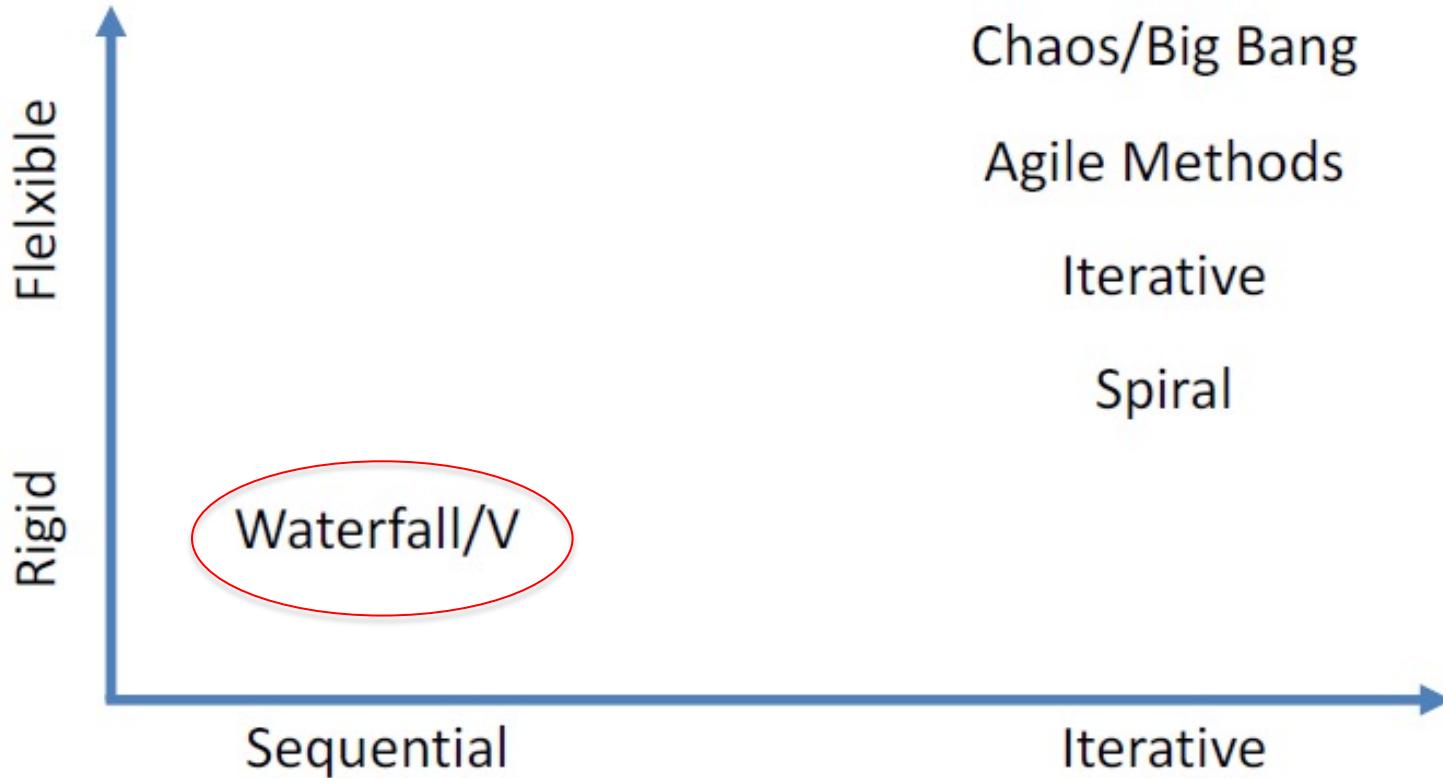
- How does the software evolve to meet customer needs?

Source: Software Engineering, 10th Edition, Ian Sommerville

# SDLC Methods



# SDLC Methods



# Meet the Famous Waterfall Model



A **sequential** (non-**iterative**) design process, seen as flowing steadily downwards (like a **waterfall**).

# Meet the Famous Waterfall model

**Requirements**

**Design**

**Implementation**

**Verification**

**Maintenance**

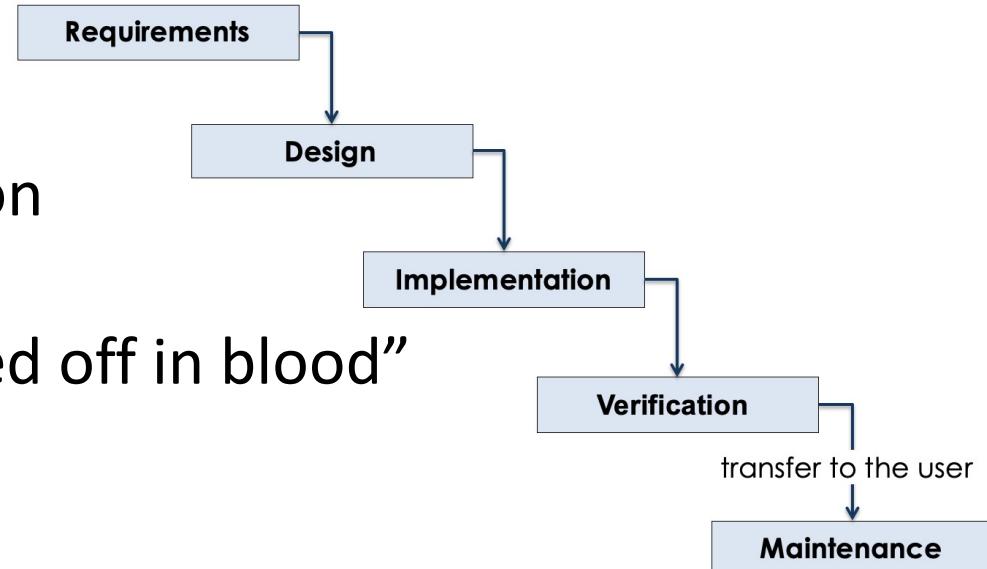
- Elaborate up-front activities
- Most of the “legacy” systems are still largely based on the waterfall

- **Requirements:** captured in a product requirements document
- **Design:** resulting in the software architecture
- **Implementation:** the development, proving, and integration of software
- **Verification:** systematic discovery and debugging of defects
- **Maintenance:** the installation, migration, support, and maintenance of complete systems

transfer to the user

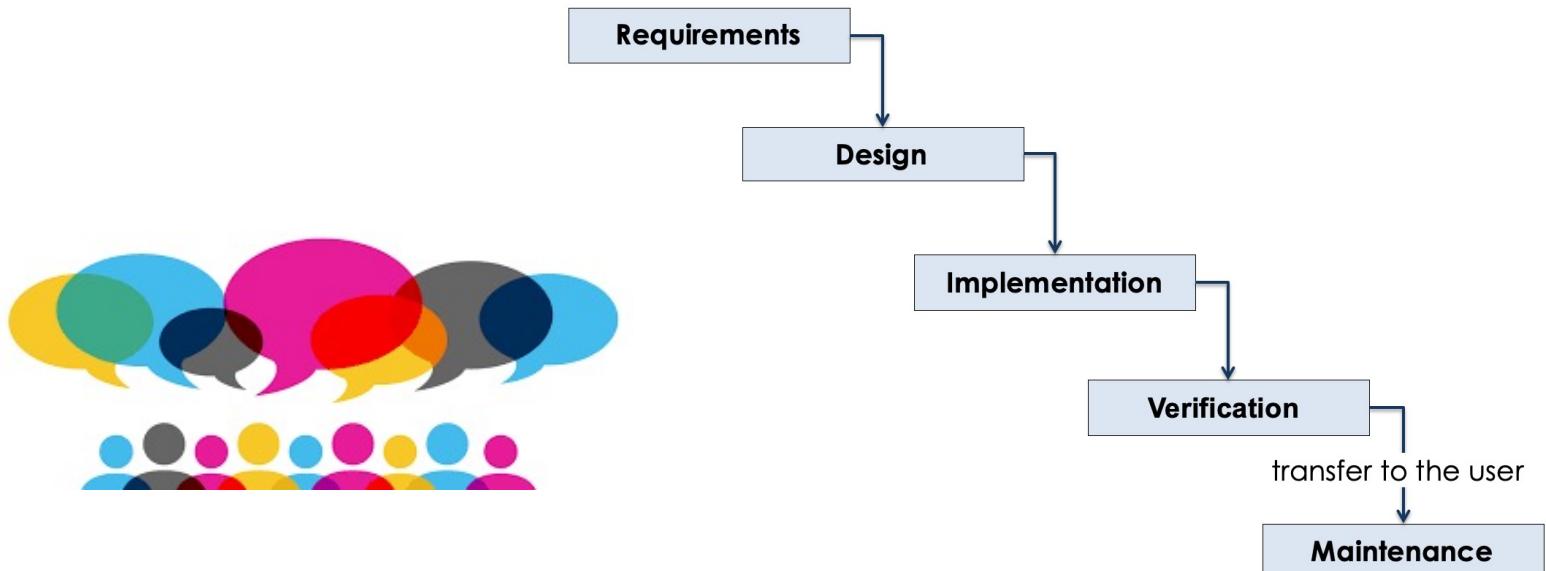
# Meet the Famous Waterfall Model

- Sufficient planning
- Popular with traditional engineering problems, e.g. building a bridge
- Very formal process
  - Extensive documentation
  - Serial execution
  - Strict paper work “signed off in blood”



# Meet the Famous Waterfall Model

- When is waterfall appropriate?





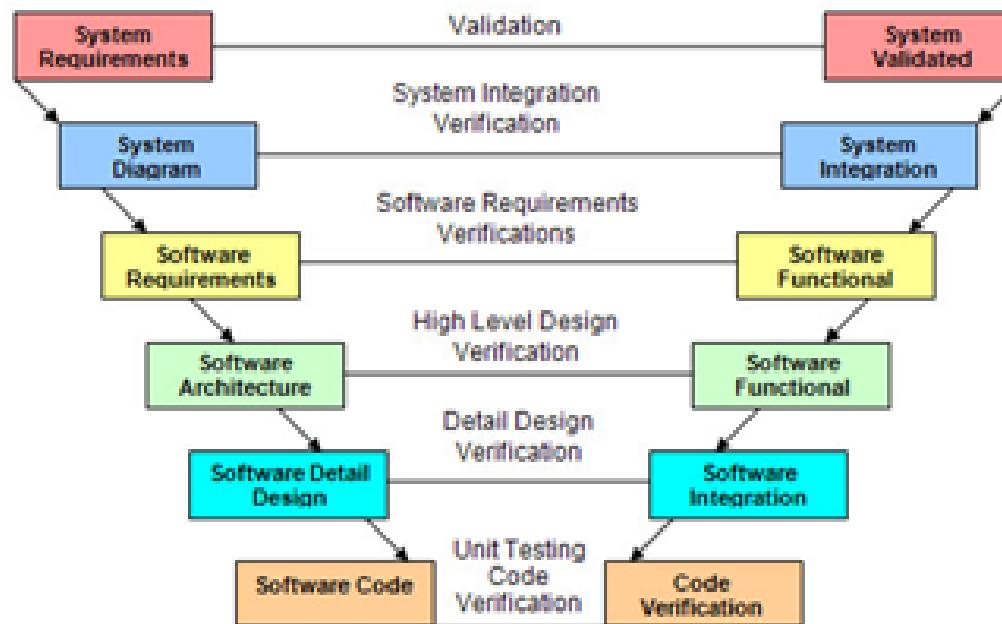
# Meet the Famous Waterfall Model

When is waterfall appropriate?

- Must get it right the first time!
  - Interacting with hardware systems, which are difficult to change
- Cost of failure is very high
  - Critical systems with safety or security requirements, e.g. airplanes, self-driving cars...
- Complete and stable requirements
  - Very large, multi-organizational software projects

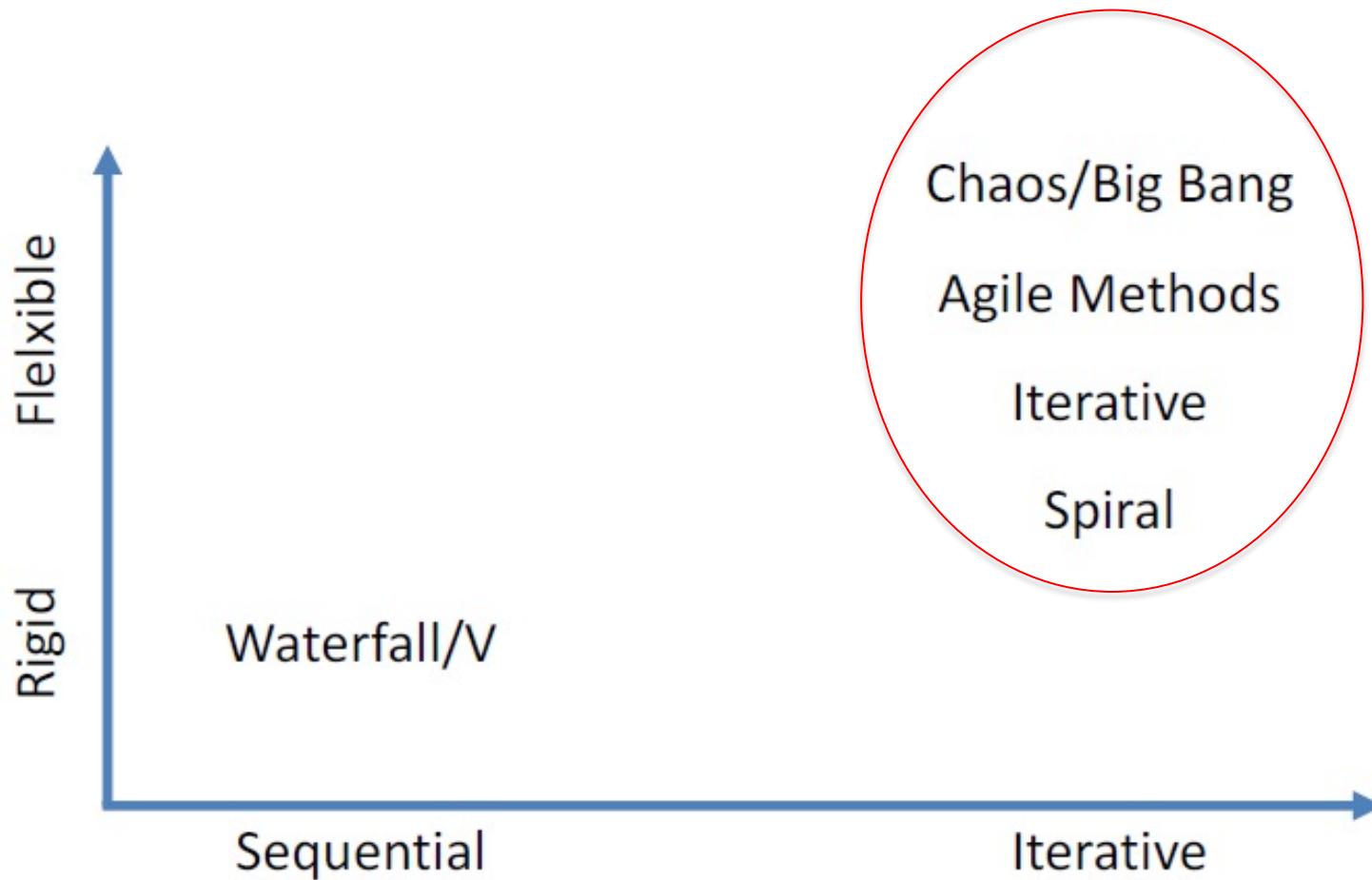
# V (Verification/Validation) SDLC Model

- Add verification/testing to each step of the Waterfall Model
- Must complete rigorous testing before proceeding to next step



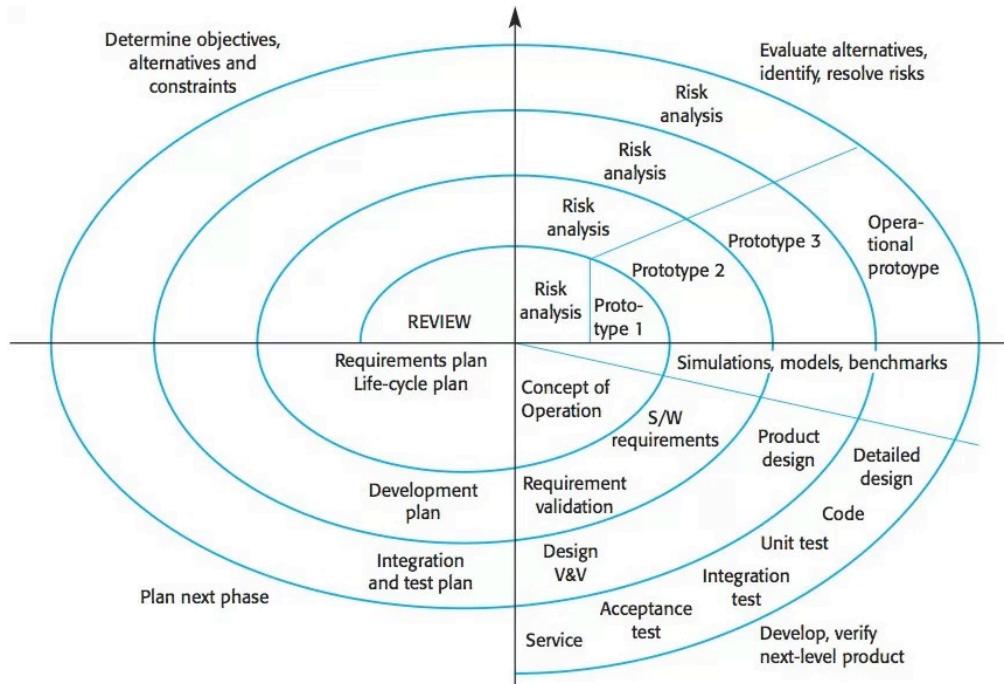
[https://sites.google.com/site/advancedsofteng/softwareacquisition/  
software-development-lifecycle-approaches](https://sites.google.com/site/advancedsofteng/softwareacquisition/software-development-lifecycle-approaches)

# SDLC Methods



# Boehm's Spiral Model

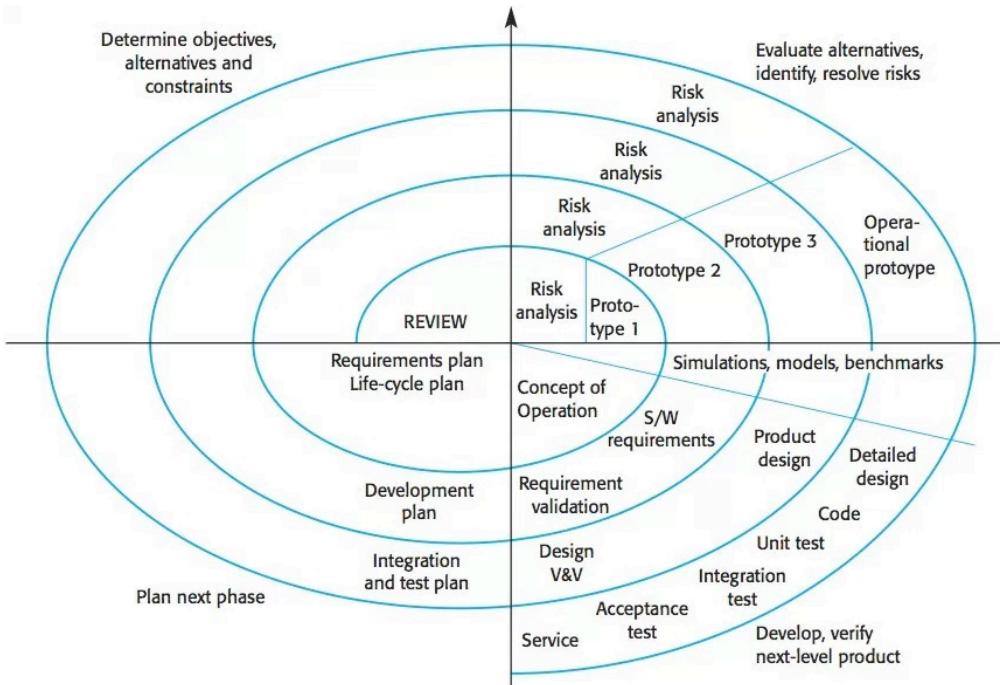
- Limitations of waterfall?



<http://iansommerville.com/software-engineeringbook/web/spiral-model/>

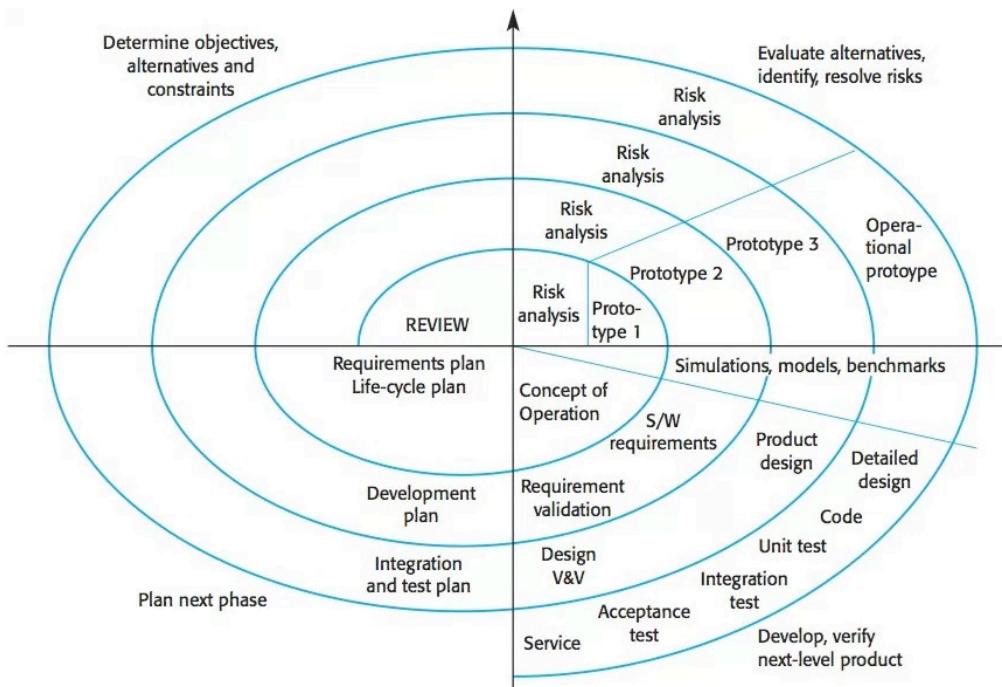
# Boehm's Spiral Model

- Limitations of waterfall?
- Hard to get it right the first time  
and changing requirements...



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# Boehm's Spiral Model



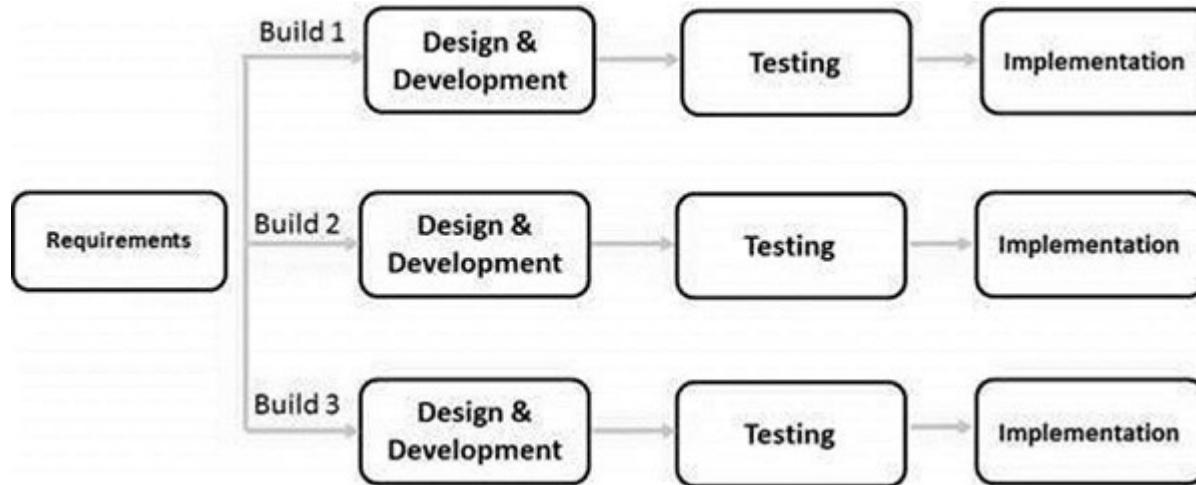
<http://iansommerville.com/software-engineeringbook/web/spiral-model/>

- Limitations of waterfall?

Hard to get it right the first time and changing requirements...

- Incremental development and interactions
  1. Objective setting
  2. Risk assessment and reduction
  3. Development and validation
  4. Planning for next iteration

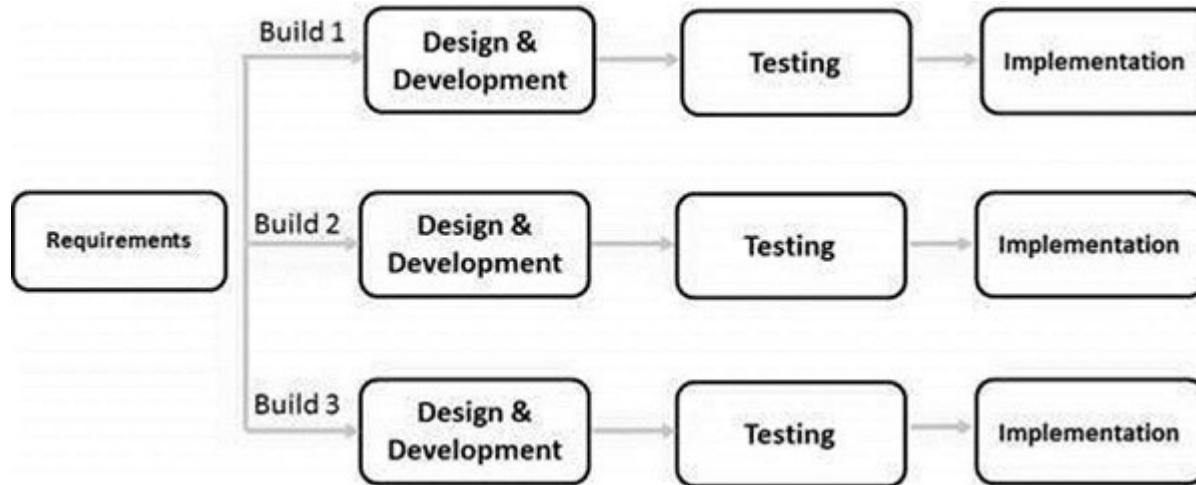
# Iterative models SDLC



[https://www.tutorialspoint.com/sdlc/sdlc\\_quick\\_guide.htm](https://www.tutorialspoint.com/sdlc/sdlc_quick_guide.htm)

- Identify requirements up front
  - Mostly stable but may change...
- Build subsets of requirements
  - Sequentially or in parallel with multiple groups of developers

# Iterative models SDLC



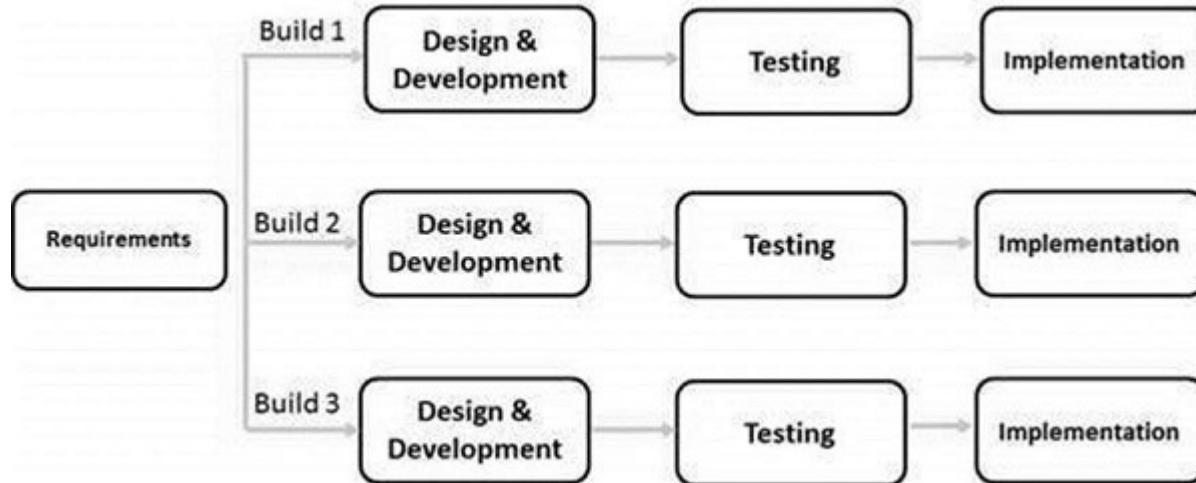
Benefits?



[https://www.tutorialspoint.com/sdlc/sdlc\\_quick\\_guide.htm](https://www.tutorialspoint.com/sdlc/sdlc_quick_guide.htm)

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# Iterative models SDLC



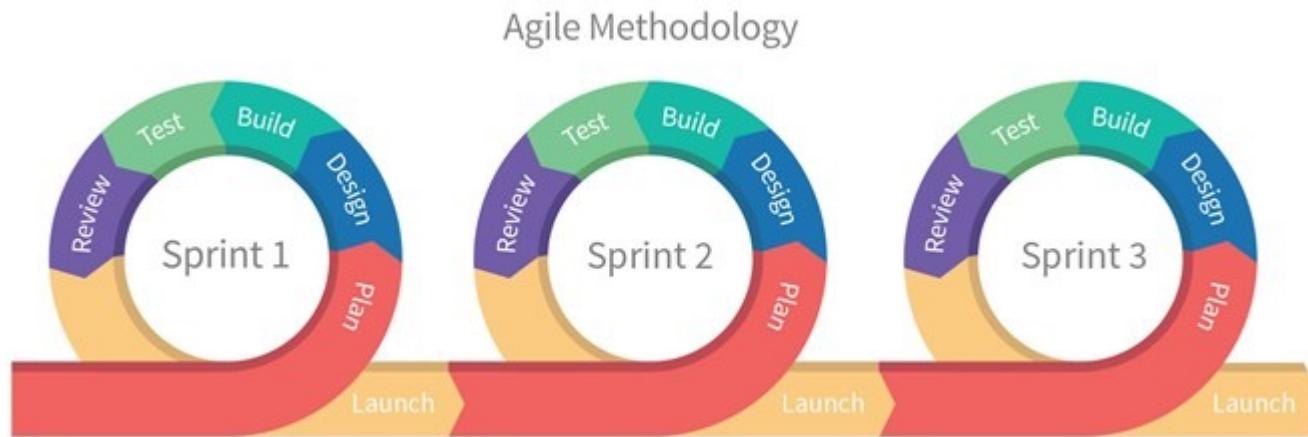
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- Identify requirements up front
  - Mostly stable but may change...
- Build subsets of requirements
  - Sequentially or in parallel with multiple groups of developers

## Benefits?

- Parallel effort supported by multiple teams
- Delivers early functionality to customers for review

# Agile Methods SDLC



<https://www.linkedin.com/pulse/what-agile-methodologydisadvantage-waterfall-model-bikesh-srivastava>

"Agile software Development" is an umbrella term for frequent iterative and incremental programming development approaches.

e.g. Extreme Programming (XP), Scrum, Crystal, DSDM, Lean, FDD

# Agile Methods SDLC



<https://www.linkedin.com/pulse/what-agile-methodologydisadvantage-waterfall-model-bikesh-srivastava>

- Frequent iterations and deliverables
- Close collaboration between developers and customers
- Support changing requirements
- Frequent retrospection: learn and improve from experience



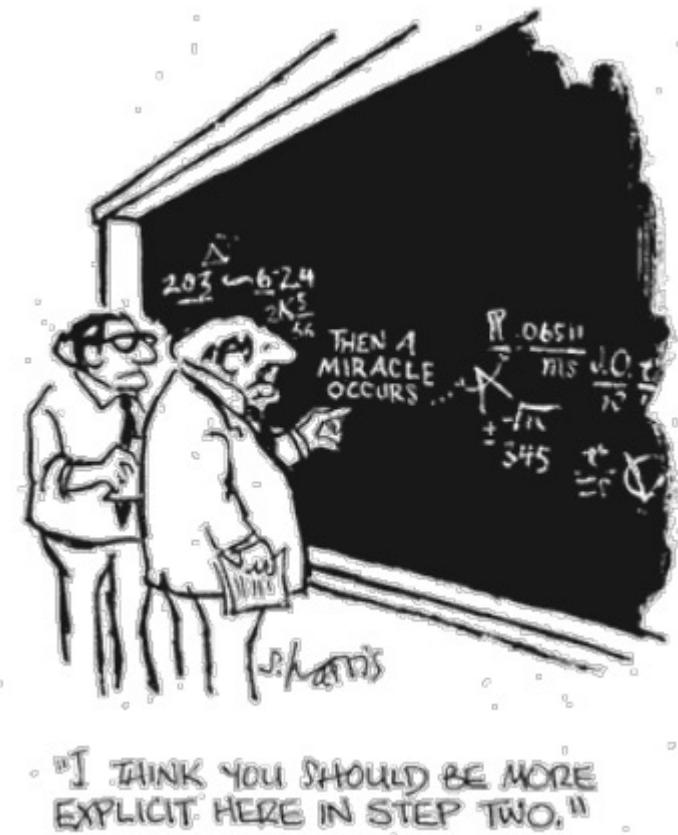
# Reasons to Use Agile Methods

- Big, upfront planning is not practical because of unstable (changing) and ambiguous requirements
- Delivery through small baby steps through iterative and incremental development to reduce the chances of risk.
- Visibility with customers: customers are part of the team instead of being purely observers.
- Frequent reflections by the project teams
  - What are we doing well?
  - What can we improve?



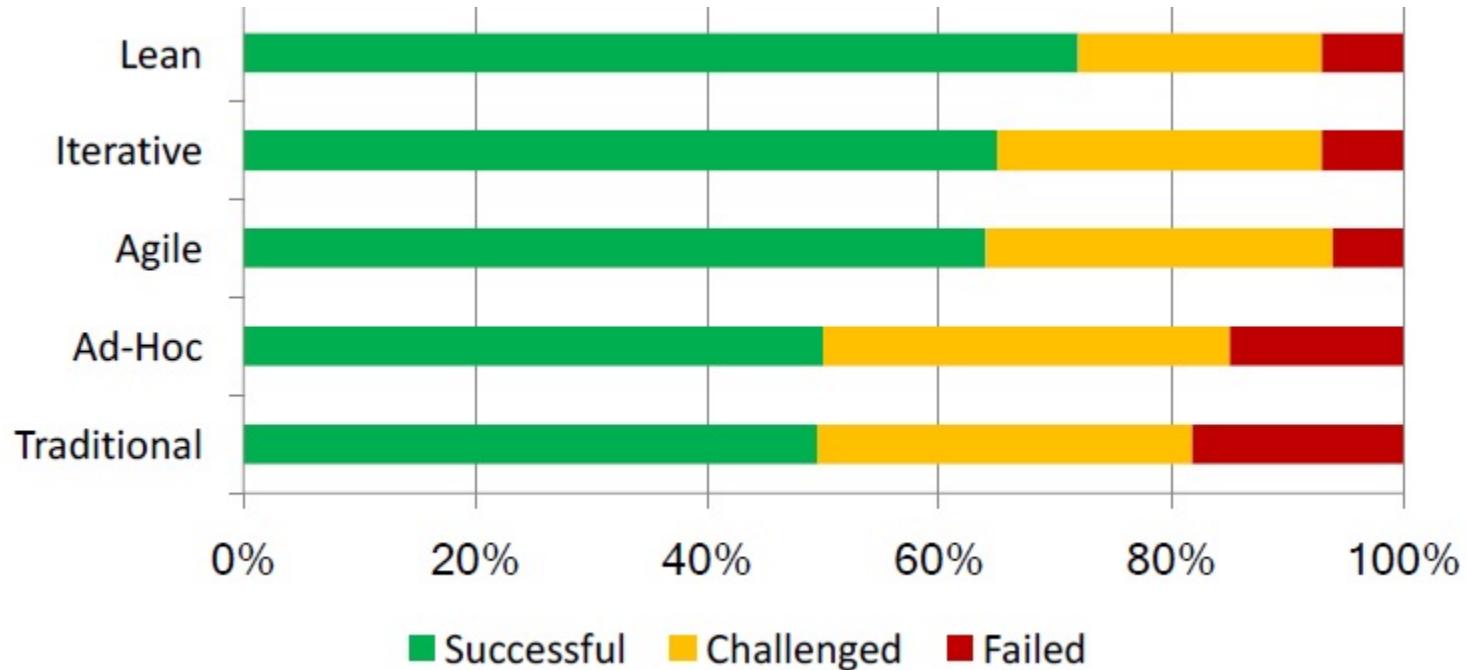
# Big Bang/Chaos SDLC

- Little to no planning
- Figure it out as you go
- Typically used for very small projects (e.g. course projects..., small start-ups)
- Not highly recommended...



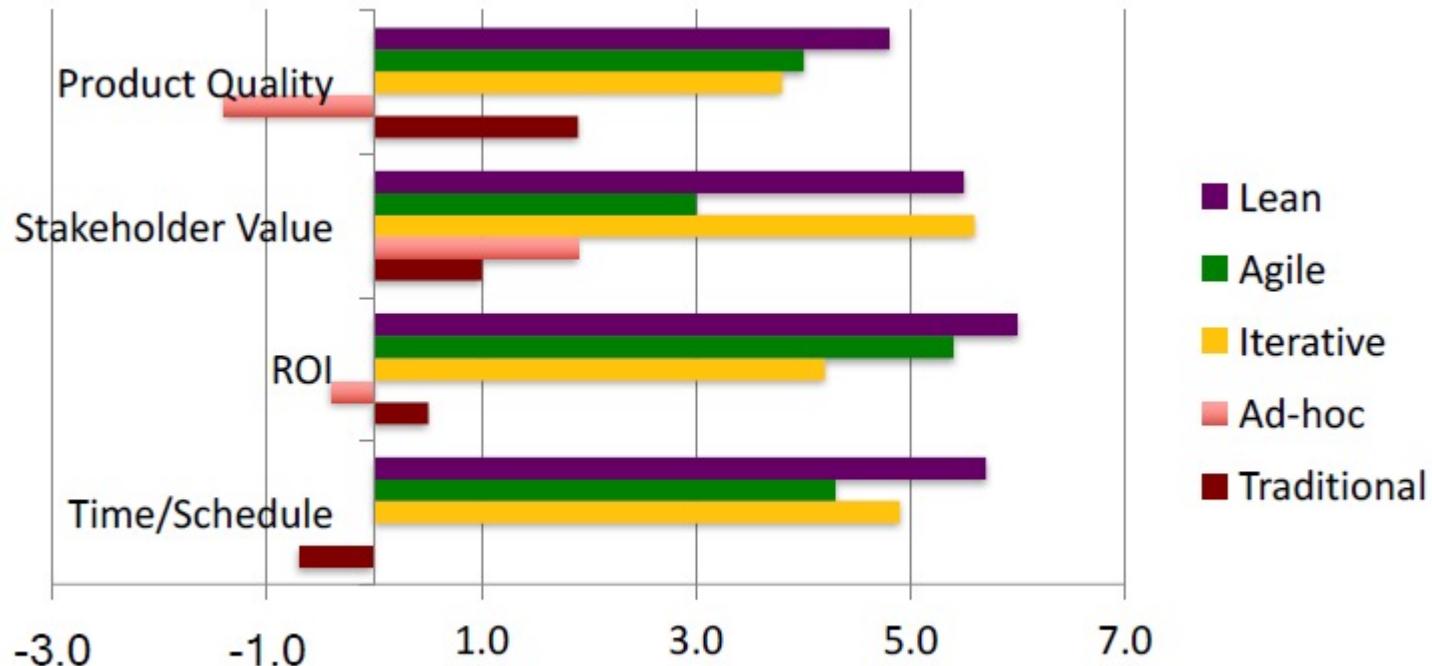


# Comparing Software Development Paradigms: 2013





# Comparing Delivery Paradigms

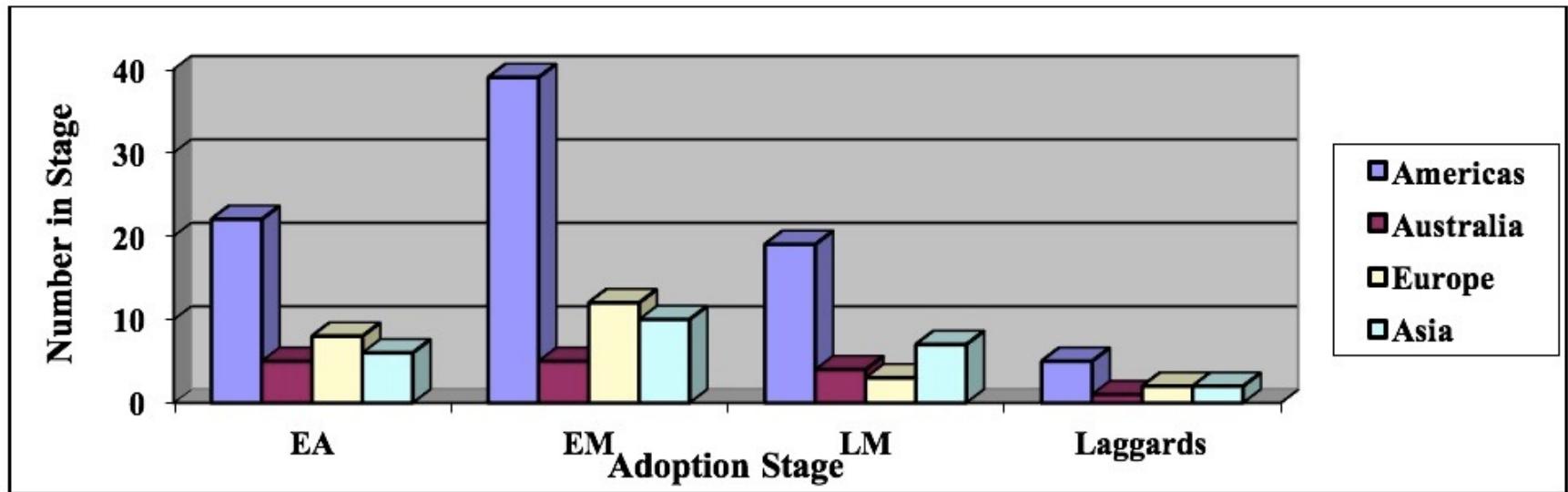




# Software Development in 1990s

- Large projects (> 40 people, > 1 year)
  - Used plan-based methods, such as RUP (Rational Unified Process)
  - More incremental than waterfall, but heavy process
  - Focus on quality, discipline, process improvement
- Medium-sized projects (7-40 people, 3-12 months)
  - Some used plan-based methods, some used ad hoc methods
  - Struggled to reduce process overhead while maintaining quality
- Small projects (< 7 people, < 3 months)
  - Many used ad hoc methods (or no methods)
  - Struggled to achieve greater speed

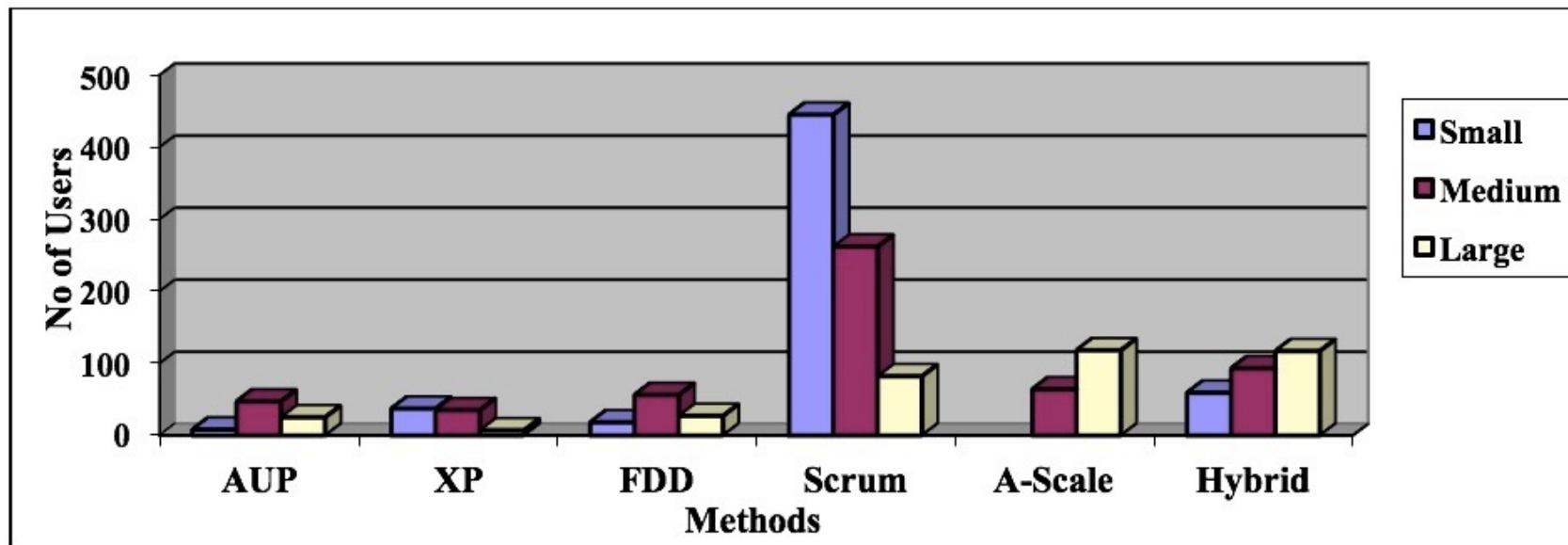
# Worldwide Agile Adoption Phase



- **EA:** Early Adopters (41) – introduced agile methods during period from 2004 to 2009.
- **EM:** Early Majority (66) – introduced agile methods during period from 2009 to 2014.
- **LM:** Late Majority (33) – introducing agile methods presently.
- **Laggards** (10) – considering, but not currently using agile methods.

<https://www.infoq.com/articles/reifer-agile-study-2017>

# Most Popular Agile Methodology



## Notes

- **Small Project (567)**: project that delivers a product can be developed by a single agile team.
- **Medium Projects (581)**: agile project that uses 2 to 5 teams at same locations to develop products.
- **Large Projects (352)**: large project that uses 5 or more teams often at different locations to develop products.

## Legend

- |  |   |   |
|--|---|---|
| • <b>AUP</b> – Agile Unified Process   | • <b>XP</b> – Extreme Programming         | • <b>FDD</b> – Feature-Driven Development |
| • <b>Scrum</b> – Scrum and derivatives | • <b>A-Scale</b> – Agile at scale methods | • <b>Hybrid</b> – Mix of methods          |

<https://www.infoq.com/articles/reifer-agile-study-2017>



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- Overview of Extreme Programming (XP)



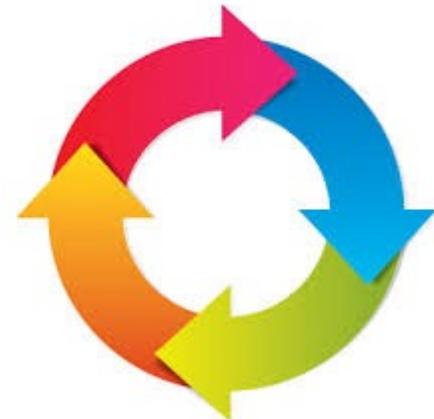
# Rational Unified Process (RUP)

- Developed at Rational Software in late 1990s after acquisition of several Object Oriented companies
- Based on 6 ***Best Practices*** of Software Engineering
  1. Develop iteratively
  2. Manage requirements
  3. Use component-based architectures
  4. Model software visually (UML)
  5. Continuously verify software quality
  6. Control changes



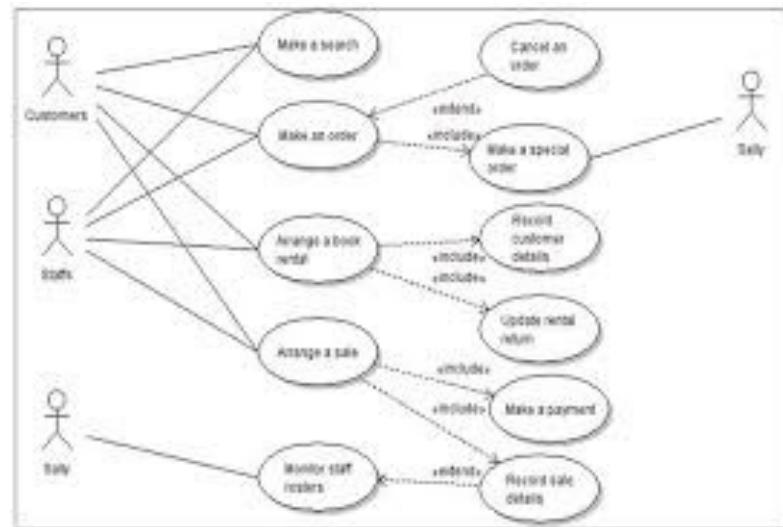
# Best RUP Practices (1)

- **Develop software iteratively**
  - Solutions are too complex to get right in one pass
  - Use an iterative approach and focus on the highest *risk* items in each pass
  - Customer involvement
  - Accommodate changes in requirements



# Best RUP Practices (2)

- **Manage Requirements**
  - Use cases and scenarios help to identify requirements
  - Requirements provide traceable thread from customer needs through development to end product



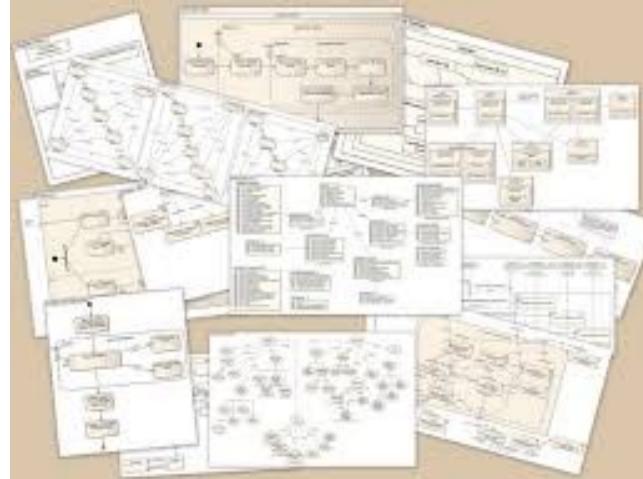
# Best RUP Practices (3)

- **Use component-based architecture**
  - Focusing on early development and baselining of a robust architecture prior to full-scale development
  - Architecture should be flexible to accommodate change
  - Focus on reusable, component-based software



# Best RUP Practices (4)

- **Visually model software**
  - Capture structure and behavior in Unified Modeling Language (UML)
  - UML helps to visualize the system and interactions



# Best RUP Practices (5)

- **Verify software quality**
  - Verification and Validation is part of the process, not an afterthought
  - Focus on reliability, functionality, and performance



# Best RUP Practices (6)

- **Control changes to software**
  - Change is inevitable
  - Actively manage the change request process
  - Control, track, and monitor changes



# RUP Phases

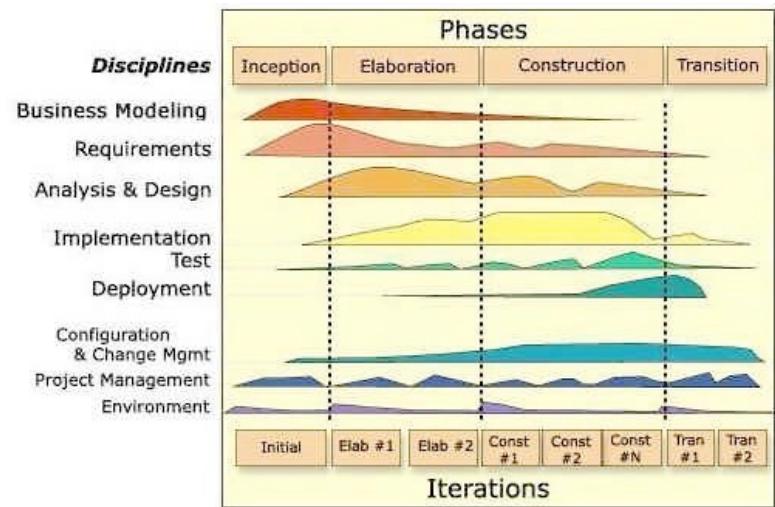
**Inception:** scope system for cost and budget, create basic use case model

**Elaboration:** mitigate risks by elaboration of use case model and design of software architecture

**Construction:** implement and test software

**Transition:** plan and execute delivery of system to customer

- Each phase ends with a milestone
- Stakeholders review progress and make go/no-go decisions



# RUP Disciplines

**Business Modeling:** create and maintain traceability between business and software modules

**Requirements:** describe what the system should do

**Analysis and Design:** show how the system will be realized in the implementation phase

**Implementation:** the system is realized through implementation of reusable components

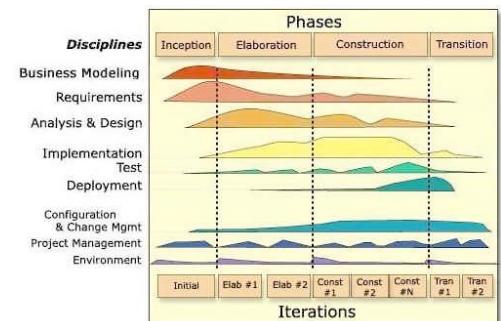
**Test:** find defects as early as possible

**Deployment:** produce product release and deliver to users

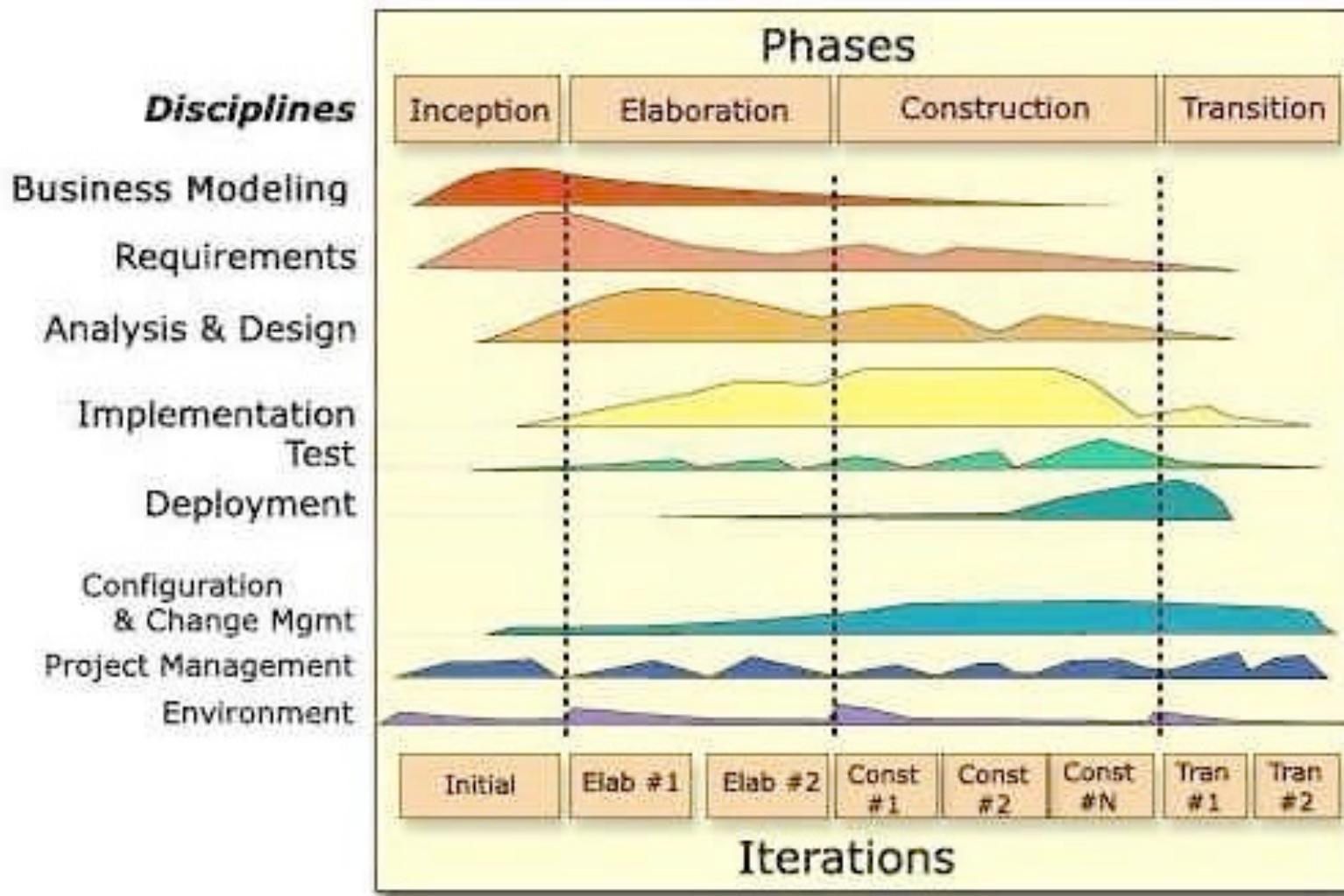
**Configuration and Change Management :** manage access to project work products

**Project Management:** manage risks, direct people, coordinate with other stakeholders

**Environment:** ensure that process, guidance and tools are available



# RUP Phases, Iterations and Disciplines

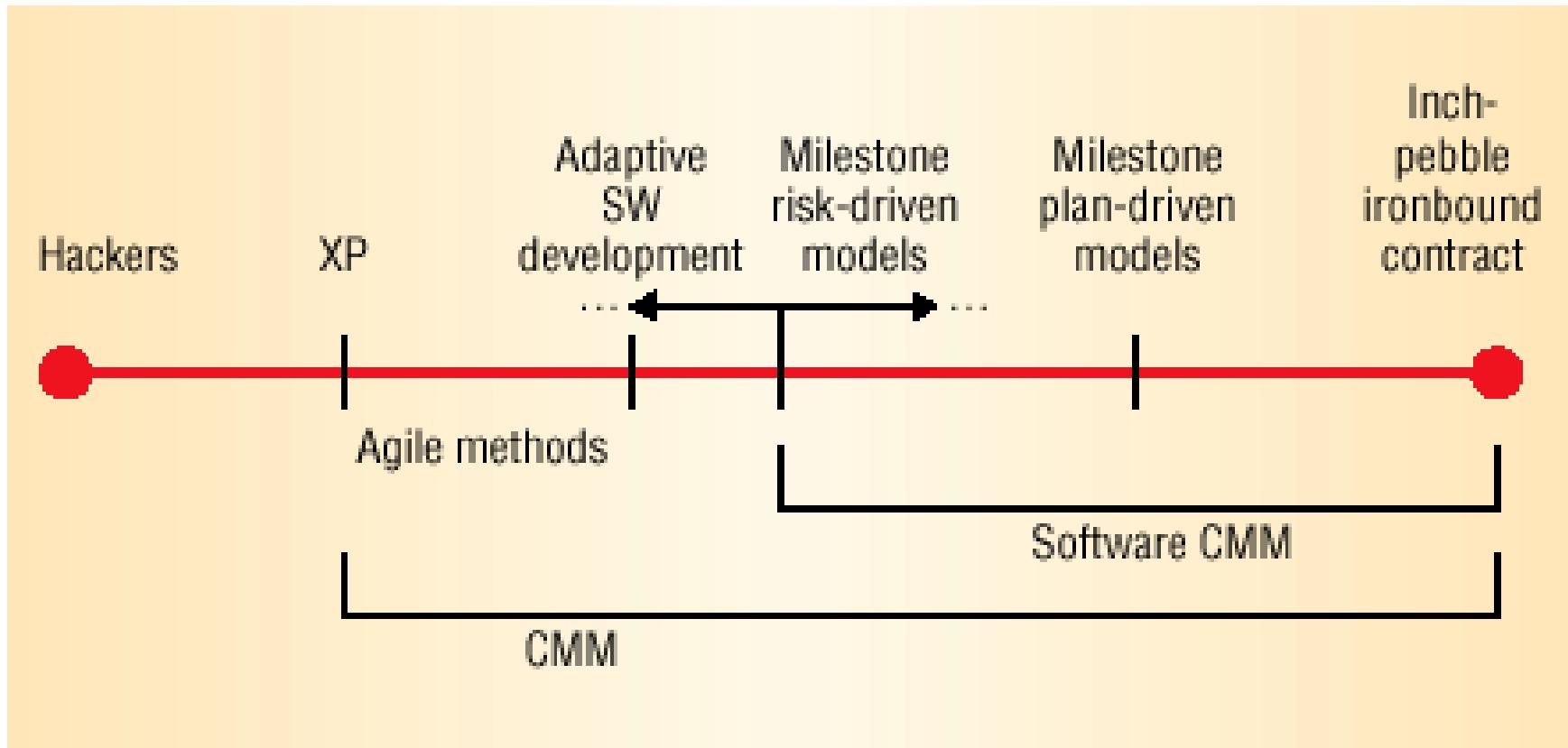




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# Spectrum of methods to meet different project needs



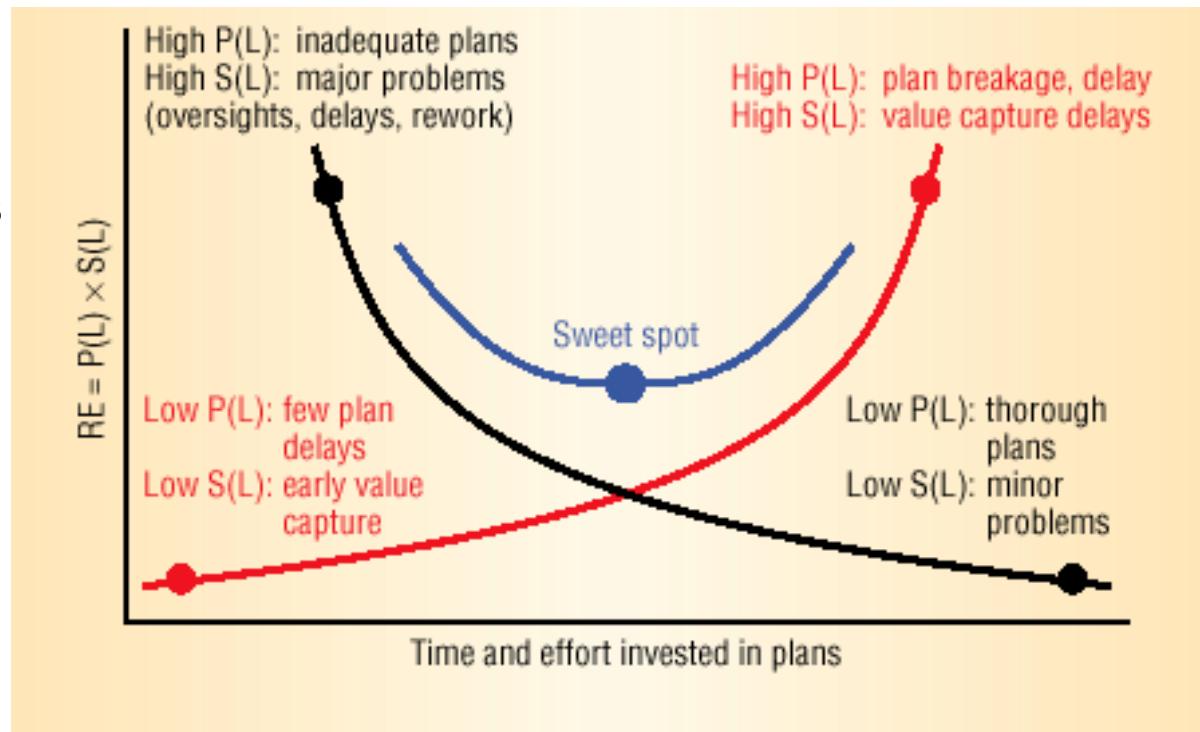
Source: "Get ready for agile methods, with care" by Barry Boehm, *IEEE Computer*, January 2002.

# Boehm's risk exposure profile:

**RE**: Risk Exposure  
**P(L)**: Probability of Loss  
**S(L)**: Size of Loss

Black curve:  
Inadequate plans

Red curve:  
Loss of market share



**Figure 2. Risk exposure (RE) profile. This planning detail for a sample e-services company shows the probability of loss P(L) and size of loss S(L) for several significant factors.**

Source: "Get ready for agile methods, with care" by Barry Boehm, *IEEE Computer*, January 2002.

# Safety Critical Profile

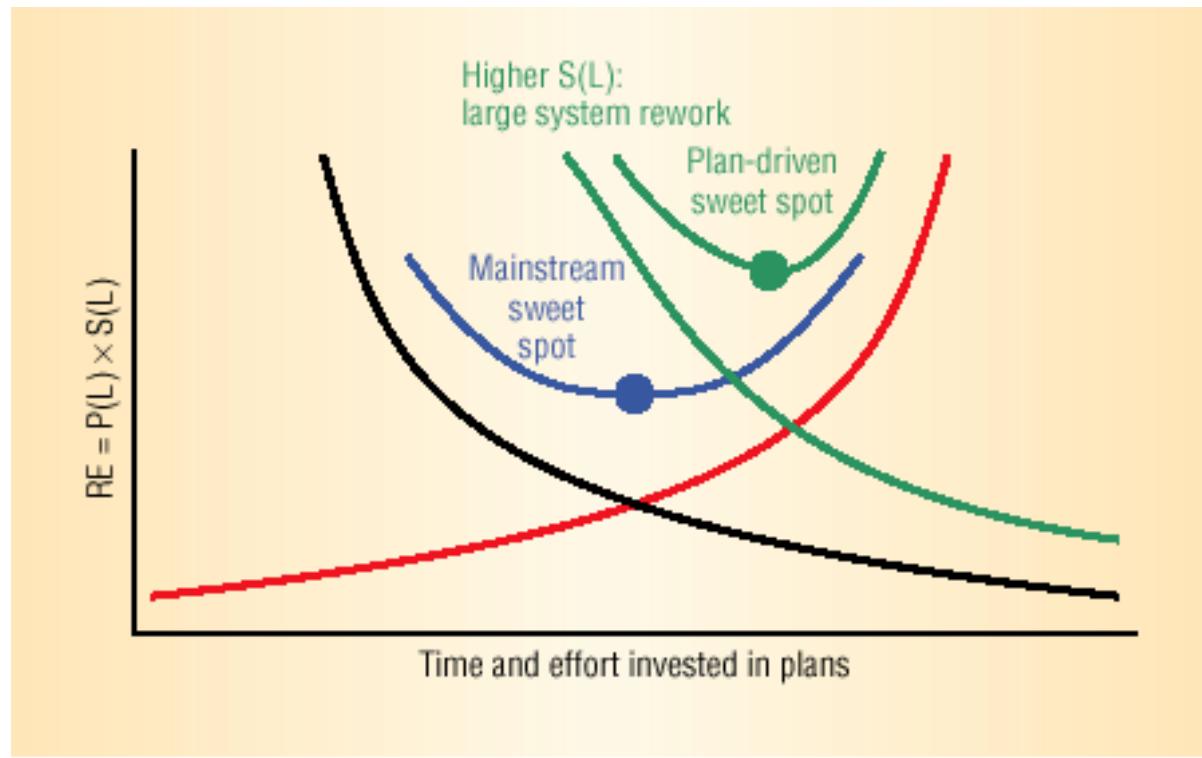
**RE:** Risk Exposure

**P(L):** Probability of Loss

**S(L):** Size of Loss

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Red curve:  
Loss of market share



**Figure 4. Comparative RE profile for a plan-driven home-ground company that produces large, safety-critical systems.**

Source: "Get ready for agile methods, with care" by Barry Boehm, *IEEE Computer*, January 2002.

# Agile Profile

**RE:** Risk Exposure

**P(L):** Probability of Loss

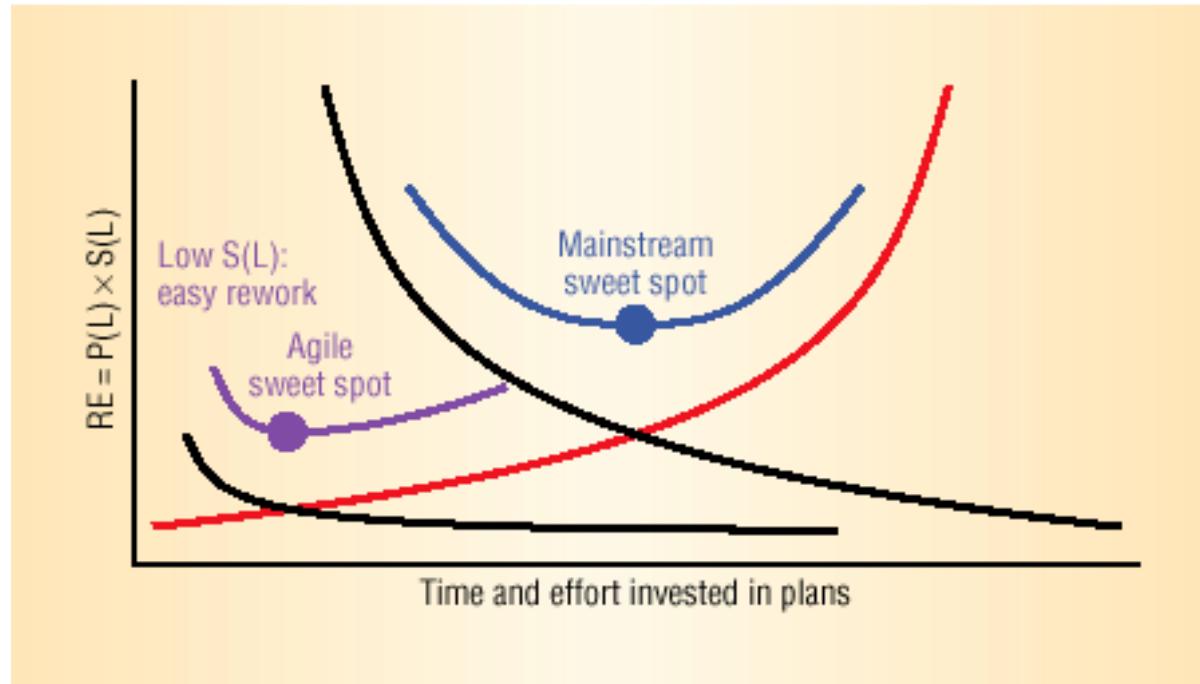
**S(L):** Size of Loss

Black curve:

Inadequate plans

Red curve:

Loss of market share



**Figure 3. Comparative RE profile for an agile home-ground company with a small installed base and less need for high assurance.**

Source: "Get ready for agile methods, with care" by Barry Boehm, *IEEE Computer*, January 2002.



# Agile Manifesto (2001)

## Manifesto for Agile Software Development

We are uncovering better ways of developing software by doing it and helping others do it.

Through this work we have come to value:

**Individuals and interactions** over processes and tools

**Working software** over comprehensive documentation

**Customer collaboration** over contract negotiation

**Responding to change** over following a plan

That is, while there is value in the items on the right, we value the items on the left more.

12 Principles behind the Agile Manifesto

<http://agilemanifesto.org/>



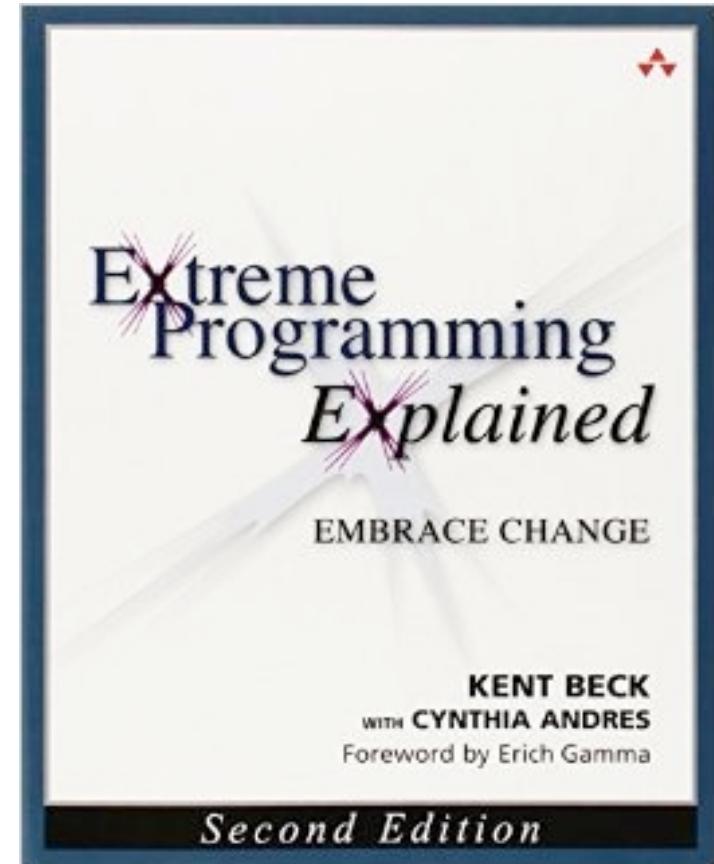
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  - Boehm's risk exposure comparison
- Overview of Extreme Programming (XP)



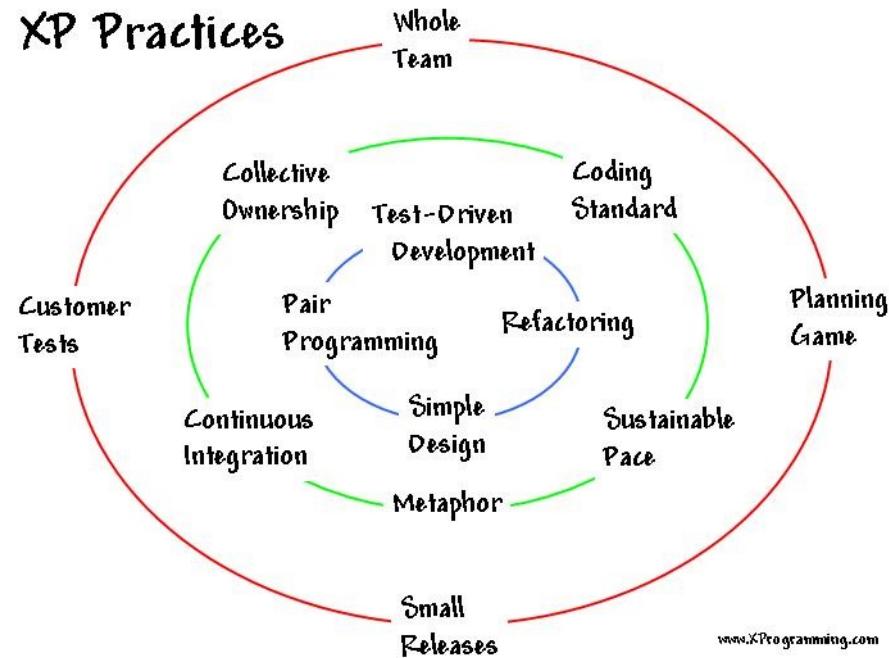
# Extreme Programming (XP)

- Created by Kent Beck while working on a project for Chrysler in the late 1990s with collaborators: Ward Cunningham and Ron Jeffries
- One of the most well-known agile methods
- Takes best practices to extreme levels
- <http://www.extremeprogramming.org/>



# 12 Extreme Programming Practices

1. The Planning Game
2. Small releases
3. Metaphor
4. Simple design
5. Testing
6. Refactoring
7. Pair programming
8. Collective ownership
9. Continuous integration
10. Sustainable pace
11. Whole team
12. Coding standards



[www.XProgramming.com](http://www.XProgramming.com)



# 1. The Planning Game

The main planning process within extreme programming is called the Planning Game. The game is a meeting that occurs once per iteration, typically once a week.

Business people decide:

- scope
- priority
- release dates

Technical people decide:

- estimates of effort
- technical consequences
- process
- detailed scheduling

The Planning Game has the following advantages:

- ✓ Reduction in time wasted on useless features
- ✓ Greater customer appreciation of the cost of a feature
- ✓ Less guesswork in planning



## 2. Small Releases

- Every release should be as small as possible
- Every release must completely implement its new features
- Every release should contain the ***most valuable business features***
  - Contrast with RUP where you focus on the biggest risk first

The advantages of Short Releases are:

- ✓ Frequent feedback
- ✓ Tracking
- ✓ Reduce chance of overall project slippage



### 3. Metaphor

- Metaphor is a simple explanation of the project
  - Agreed upon by all members of the team
  - Simple enough for customers to understand
  - Detailed enough to drive the architecture

The advantages of Metaphor are:

- ✓ Encourages a common set of terms for the system
- ✓ Reduction of buzz words and jargon
- ✓ A quick and easy way to explain the system



## 4. Simple Design

- Runs all the tests
- Has no duplicated logic like parallel class hierarchies
- States every intention important to the developers
- Has the fewest possible classes and methods

The advantages of Simple Design are:

- ✓ Time is not wasted adding superfluous functionality
- ✓ Easier to understand what is going on
- ✓ Refactoring and collective ownership is made possible
- ✓ Helps keep the programmers on track



## 5. Testing

- The developers continually write unit tests, which need to pass for the development to continue.
- The customers write tests to verify that the features are implemented.
- The tests are automated so that they become a part of the system and can be continuously run to ensure the working of the system.

The advantages of testing are:

- ✓ Unit testing promotes testing completeness
- ✓ Test-first gives developers a goal
- ✓ Automation gives a suite of regression tests



# 6. Refactoring

Developers restructure the system without changing its behavior to remove duplication, improve communication, simplify, or add flexibility. This is called Refactoring.

- The developers ask if they can see how to make the code simpler, while still running all of the tests.

The advantages of Refactoring are:

- ✓ It become easier to make the next changes
- ✓ Increases the developer knowledge of the system



# 7. Pair Programming

- All code written with two people at one machine
  - Driver:
    - thinks about best way to implement
  - Navigator:
    - thinks about viability of whole approach
    - thinks of new tests
    - thinks of simpler ways
    - Switch roles frequently
- ✓ Two heads are better than one



## 8. Collective Ownership

- The entire team takes responsibility for the whole of the system.
- Not everyone knows every part equally well, but everyone knows something about every part.
- If developers see an opportunity to improve the code, they go ahead and improve it.

The advantages:

- ✓ Helps mitigate the loss of a team member who is leaving.
- ✓ Promotes the developers to take responsibility for the system as a whole rather than parts of the system.



# 9. Continuous Integration

- Integrate and test every few hours, at least once per day
  - Don't wait until the very end to begin integration
- All tests must pass
- Easy to tell who broke the code
  - Problem is likely to be in code that was most recently changed

The advantages:

- ✓ Reduces the duration, which is otherwise lengthy.
- ✓ Enables the short releases practice as the time required before release is minimal.



# 10. Sustainable Pace

- 40 hours per week: most developers lose effectiveness past 40 hours.
- Overtime is a symptom of a serious problem
- XP only allows one week of overtime

The advantages:

- ✓ People should be fresh and eager every morning
- ✓ Value is placed on the developers' well-being.
- ✓ Management is forced to find real solutions.



# 11. Whole Team

- Customer is a member of the team
  - ✓ Real customer will use the finished system
- Programmers need to ask questions of a real customer
  - ✓ Clarify requirements or explain what's needed
- Customer sits with the team
  - ✓ Customer can get some other work done while sitting with programmers



## 12. Coding Standard

- Communication through the code.
- The least amount of overhead.
- Voluntary adoption by the whole team.

The advantages :

- ✓ Supports collective ownership
- ✓ Reduces the amount of time developers spend reformatting other peoples' code
- ✓ Reduces the need for internal commenting
- ✓ Calls for clear, unambiguous code

# Workspace



<http://study.com/cimages/multimages/16/openworkspace.png>



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Thank You