COURSE NAME

SOFTWARE ENGINEERING

CSC 3114

(UNDERGRADUATE)

CHAPTER 1

SOFTWARE & SOFTWARE ENGINEERING

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WHAT IS SOFTWARE ENGINEERING?

- Technologies that make it easier, faster, and less expensive to build high-quality computer programs
- A discipline aiming at producing fault-free software, delivered on time and within budget, that satisfies the users' needs.

- An engineering: A set of activities in software production
- The philosophy of established engineering disciplines to solve what are termed software crisis

SCOPE OF SOFTWARE ENGINEERING

- The aim of Software Engineering is to solve Software Crisis:
  - Late
  - Over budget
  - Low quality with lots of faults

- Software crisis is still present over 35 years later!

SOFTWARE CHARACTERISTICS

- A logical (intangible) rather than a physical system element
- Being developed or engineered but not being manufactured
- Software cost concentrating in engineering, not in materials
- Software does not "wearing out" but "deteriorating"(not destroyed after lifetime like hardware, but backdated by aging that needs to update)
- Software is a 'differentiator' (different sub-systems, e.g. cashier's workstation in a supermarket)
- Without "spare parts" in software maintenance (no extra useless features in software)
- Most software continues to be custom-built (based on the requirements)

SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

- A structured set of activities required to develop a software system
- The way we produce software, including:

1. Planning
2. Requirements Analysis
3. Design
4. Development
5. Testing
6. Final release / Deployment
7. Maintenance

SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

GOOD & BAD SOFTWARE

- Good software is maintained—bad software is discarded

- Different types of maintenance
  - Corrective maintenance [about 20%]
    - Modification to fix a problem
  - Enhancement [about 80%]
    - Perfective maintenance (modification to improve usability,…) [about 60%]
    - Adaptive maintenance (modification to keep up-to-date) [about 20%]
    - Preventive maintenance (modification to avoid any future error) [about 20%]

FAULTS IN SOFTWARE DEVELOPMENT PHASES

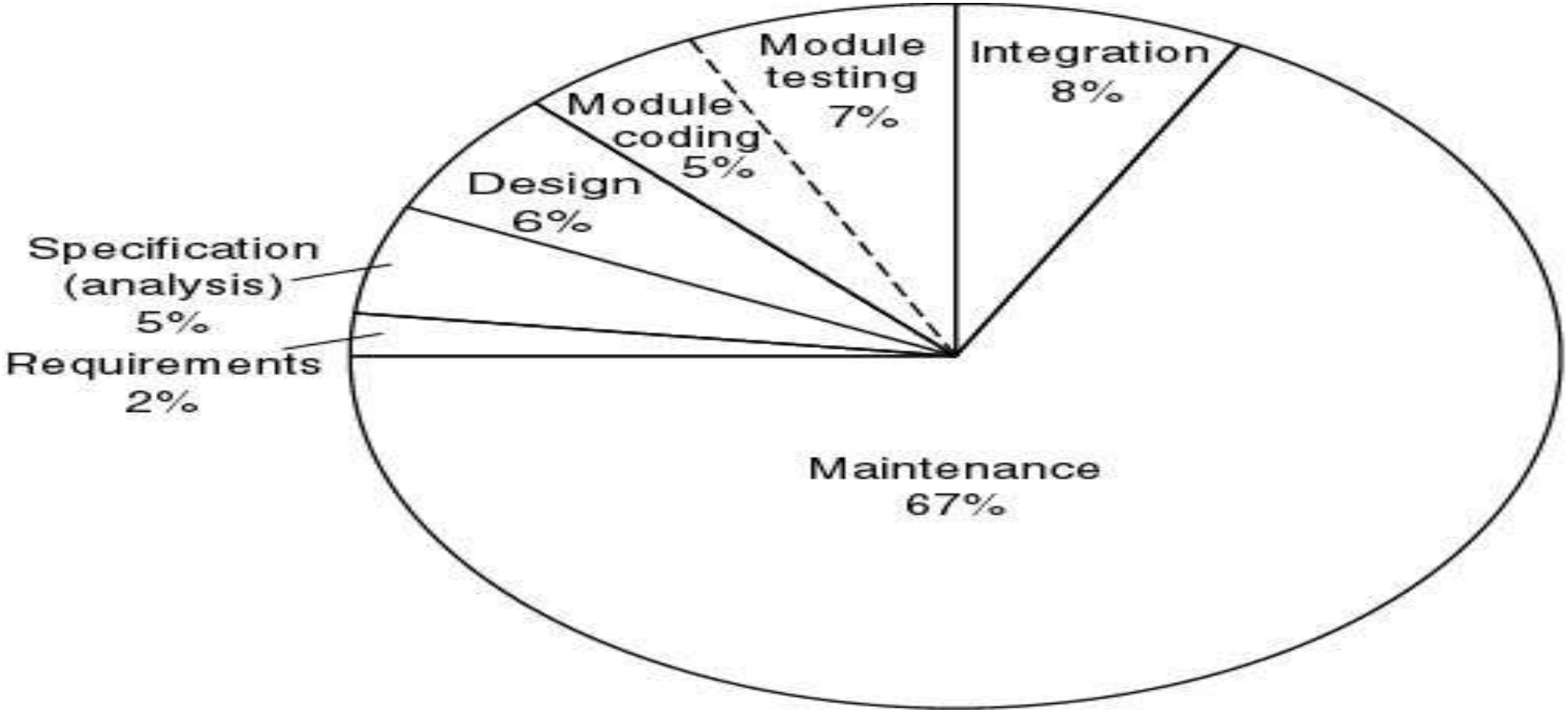
- 60 to 70 percent of faults are specification and design faults

- Data of Kelly, Sherif, and Hops [1992]
  - 1.9 faults per page of specification
  - 0.9 faults per page of design
  - 0.3 faults per page of code

- Data of Bhandari et al. [1994]

  Faults at end of the design phase of the new version of the product
  - 13% of faults from previous version of product
  - 16% of faults in new specifications
  - 71% of faults in new design

COST OF DETECTION & CORRECTION OF A FAULT



SOFTWARE APPLICATION

- System software (control computer hardware such as OS)
- Business software (commercial application for business users [SAP, ERP])
  - Systems, Applications, and Products
  - Enterprise Resource Planning
- Engineering and scientific software (e.g. statistical analysis-SPSS, Matlab)
- Embedded software (e.g. biometric device)
- Personal computer software (e.g. Microsoft Office)
- Web-based software (use over the internet with a browser, e.g. Gmail)
- Artificial intelligence software (e.g. HCI, Google AI)

SOFTWARE MYTHS (MANAGEMENT)

- Myth 1: We already have a book full of standards and procedures for building software. Wouldn't that provide my people with everything they need to know?
- Myth 2: My people have state-of-the-art software development tools; we buy them the newest computers.
- Myth 3: If we get behind schedule, we can add more programmers and catch up.
- Myth 4: If I outsource the software project to a third party, I can relax and let that firm build it.

SOFTWARE MYTHS (CLIENT)

- Myth 1: A general statement of objectives is sufficient to begin writing programs – we can fill in the details later.
- Myth 2: Project requirements continually change, but change can be easily accommodated because software is flexible.

SOFTWARE MYTHS (PROFESSIONAL)

- Myth 1: Our job is done once we write the program and get it to work.

  Fact: the sooner you begin writing code, the longer it will take you to get done.

- Myth 2: I cannot assess the program's quality until it is "running. "

- Myth 3: The working program is the only deliverable work product for a successful project.

- Myth 4: Software engineering will make us create very large and unnecessary documentation, invariably slowing us down.

WHY SYSTEM FAILS?

- The system fails to meet the business requirements for which it was developed. The system is either abandoned or expensive adaptive maintenance is undertaken.
- There are performance shortcomings in the system, which make it inadequate for the users' needs. Again, it is either abandoned or amended incurring extra costs.
- Errors appear in the developed system causing unexpected problems. Patches have to be applied at extra cost.
- Users reject the implemented system, lack of involvement in its development or lack of commitment to it.
- Systems are initially accepted but over time become un-maintainable and so pass into disuse.

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CHAPTER 2

SOFTWARE DEVELOPMENT PROCESS MODEL

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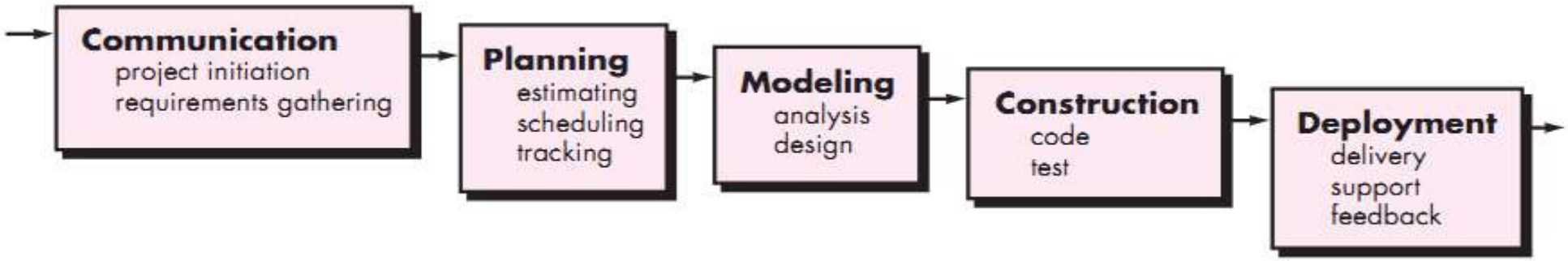
SOFTWARE PROCESS

- A structured set of activities required to develop a software system
- A software process model is an abstract representation of a process.
- It presents a description of a process from some particular perspective

WATERFALL MODEL



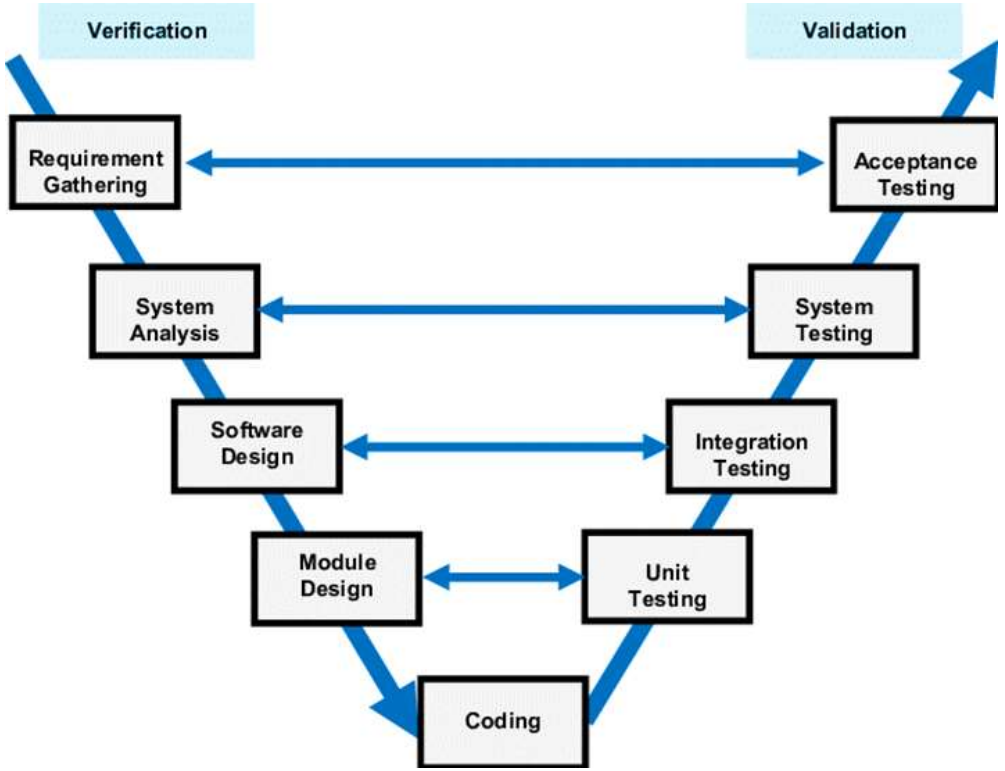
- **The waterfall or linear sequential model**

Problems of the Waterfall Model

- Inflexible partitioning of the project into distinct stages. The next phase starts only after the completion of the previous phase
- This makes it difficult to respond to changing customer requirements (no backtracking)
- Therefore, this model is only appropriate when the requirements are well-understood

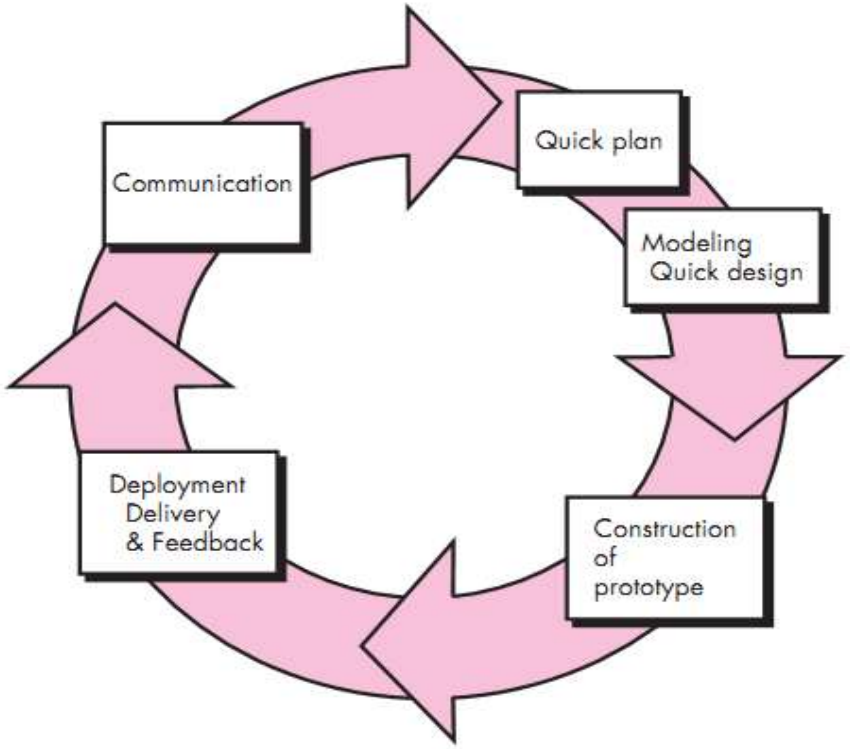
V - MODEL

- The V-model is an SDLC model in which process execution happens sequentially in a V-shape. It is also known as a Verification and Validation model.
- V-Model is an extension of the waterfall model and is based on an association of a testing phase for each corresponding development stage. This means that every single phase in the development cycle has a directly associated testing phase.
- This is a highly disciplined model, and the next phase starts only after the completion of the previous phase.



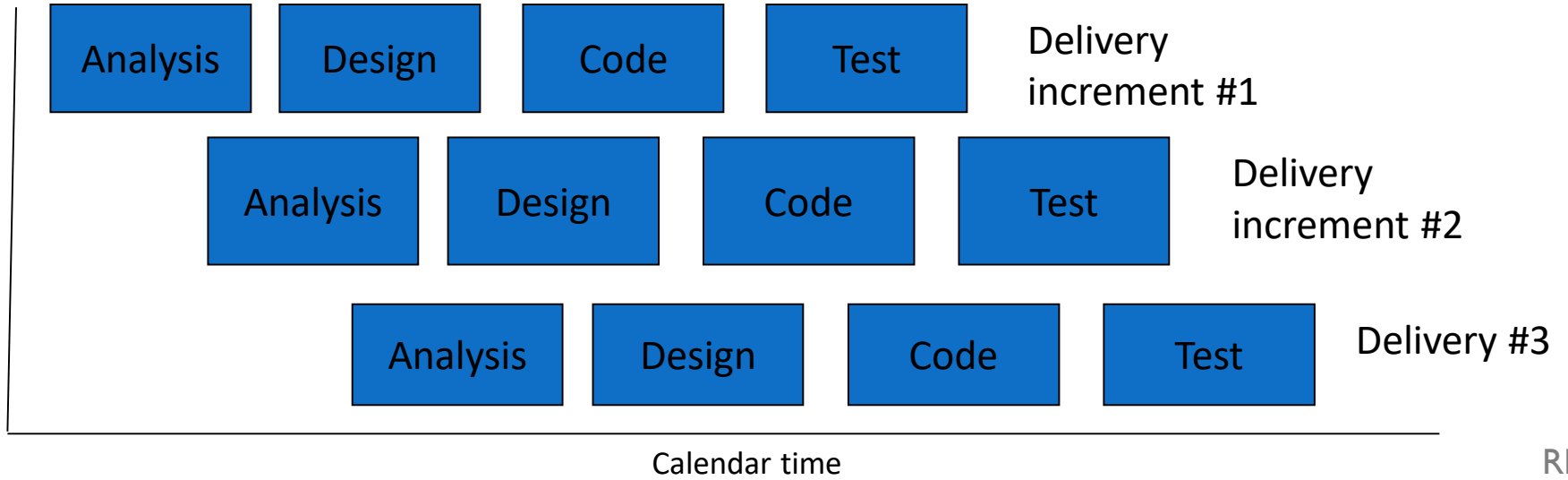
PROTOTYPING MODEL

- Requirements are not precise, and the prototype serves as a mechanism for identifying software requirements
- Iteration occurs as the prototype is tuned to satisfy the needs of the customer
- System requirements ALWAYS evolve during a project, so process iteration is proper where earlier stages are reworked and is always part of the process for large systems



INCREMENTAL DEVELOPMENT

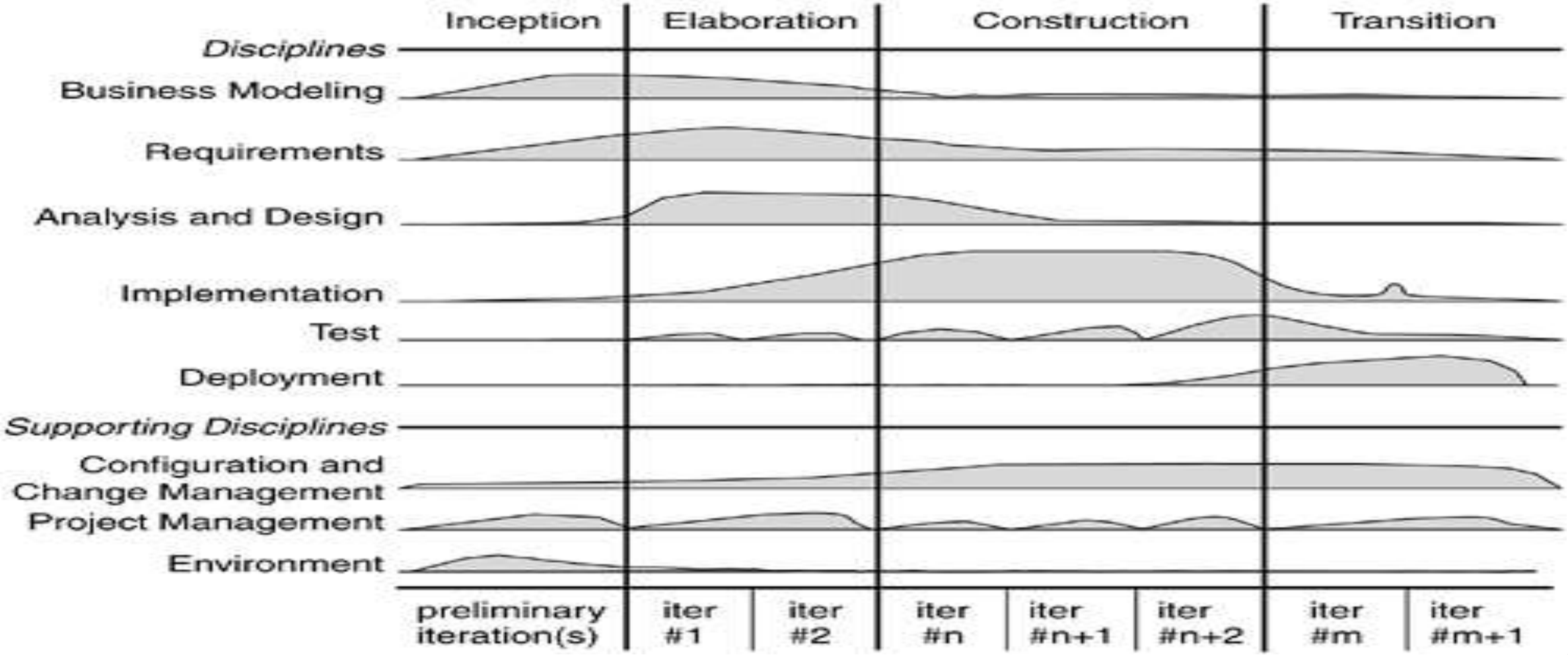
- Rather than delivering the system as a single delivery, development and delivery are broken down into increments, with each increment delivering part of the required functionality (SPIRAL).
- The requirements are relatively certain but there are many complexities that leads to frequent changes.
- User requirements are prioritized, and the highest priority requirements are included in early increments
- Once the development of an increment is started, the requirements are frozen though requirements for later increments can continue to evolve



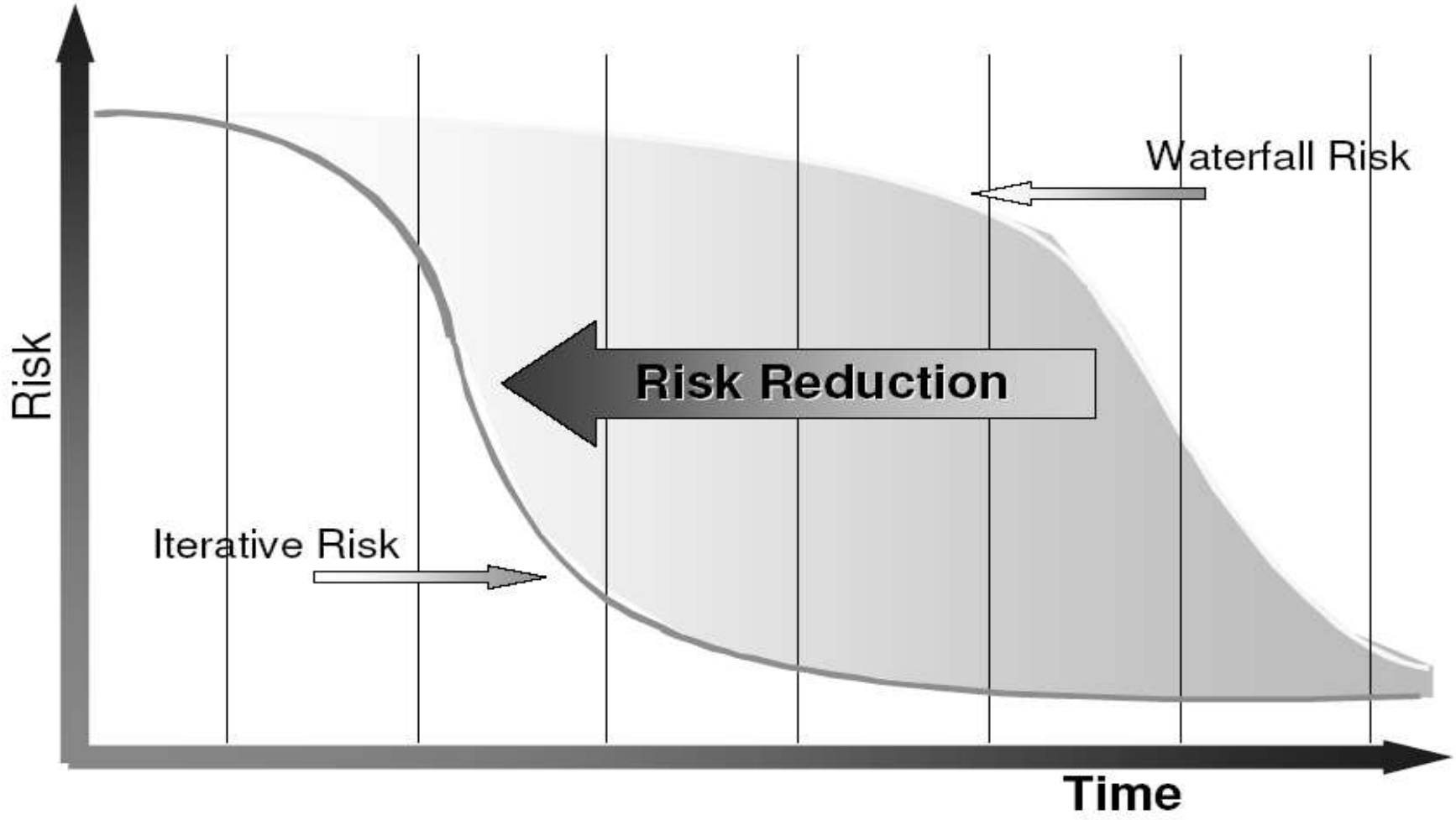
RAPID APPLICATION DEVELOPMENT (RAD)

- It is a type of incremental model. The developments are time-boxed, delivered, and then assembled into a working prototype
- In the RAD model, the components or functions are developed in parallel as if they were mini projects (frozen requirements in each increment)
- This can quickly give the customer something to see and use and to provide feedback
- Delivers a fully functional system in 90 days, give or take 30 days
- Phases of RAD are:
  - Requirements Planning
  - User Design (user interacts with the system analysts)
  - Construction (program and application development)
  - Cutover (testing, changeover to new system, user training)

RATIONAL UNIFIED PROCESS (RUP)



RISK PROFILE



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CHAPTER 3

REQUIREMENTS ENGINEERING

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Introduction to Requirements in SE

- The software requirements are description of features and functionalities of the target system.
- A condition or capability needed by a user to solve a problem or achieve an objective, or a condition or capability that must be met or possessed by a system or system component.
- Essentially, requirements specify what the software must do, how well it must perform and any constraints it must adhere to.
- For software projects to be successful, the Software Development Life Cycle (SDLC) is essential.

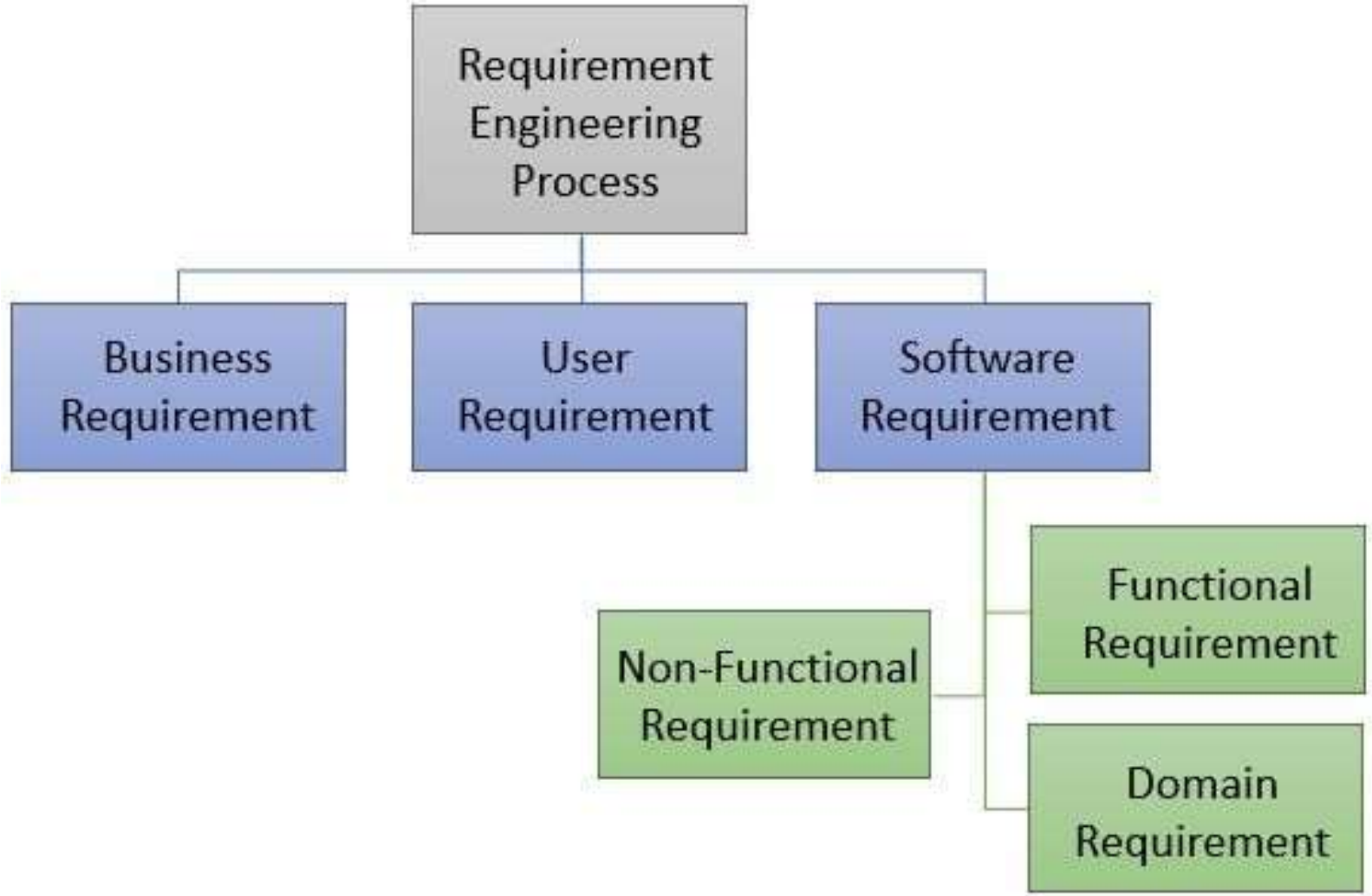


Figure 1: Types of requirements in RE

Role of Requirements in SDLC

- Initial phase of project planning.
- Basis for project estimation and planning.
- Guides design, implementation, testing and maintenance.
- SDLC offers an organized method that guarantees effectiveness, quality and risk reduction all the way through the development process.
- Teams may satisfy client expectations, manage projects more effectively and produce dependable software by conforming to a specified SDLC.

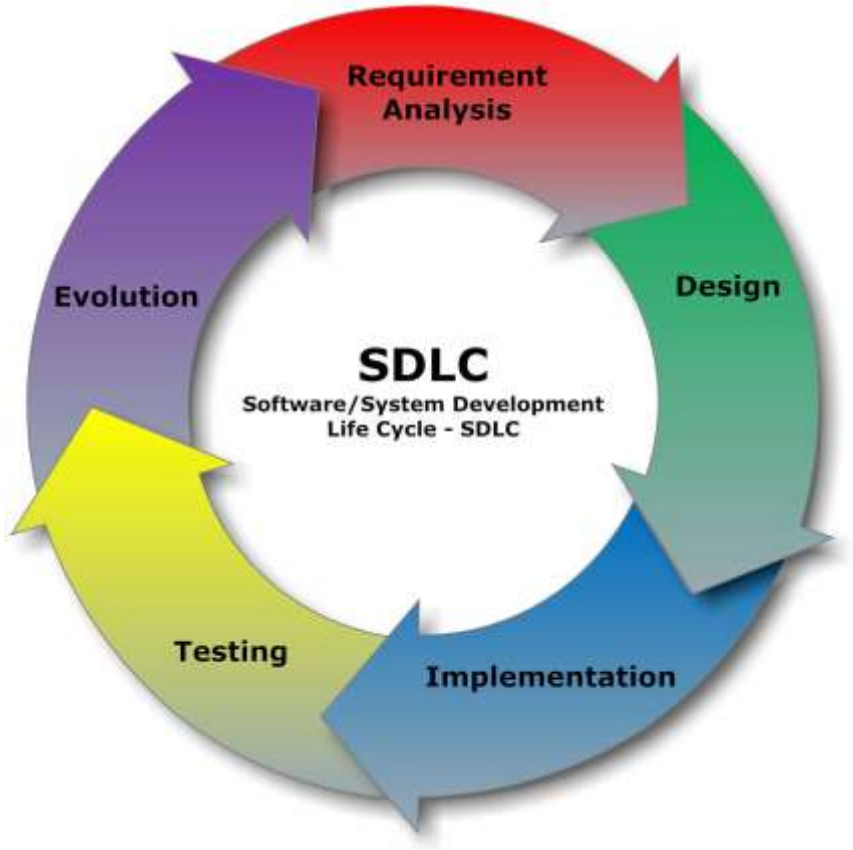


Figure 2: SDLC Phases

User Needs vs. System Requirements

User Needs	System Requirements
1. High-level goals or expectations of the user.	1. Detailed technical specifications the system must fulfill.
2. Described from the user's point of view.	2. Described from the developer's or system designer's perspective.
3. Broad and general.	3. Specific, measurable and testable.
4. To understand what users want or expect.	4. To guide system design, development and testing.

Business vs. Technical Requirements

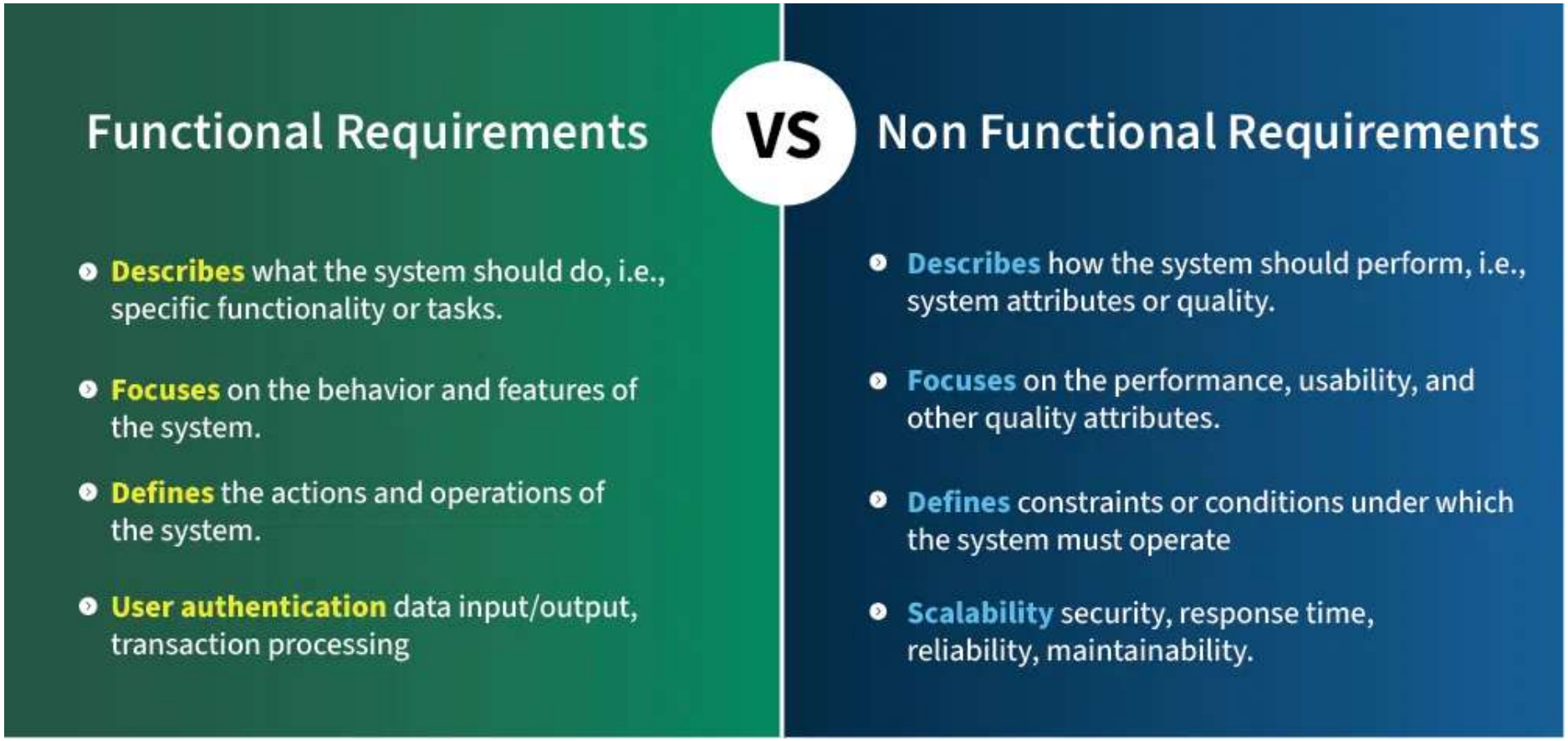
Business Requirements	Technical Requirements
1. High-level goals that the organization wants to achieve.	1. Specific technical solutions to meet business requirements.
2. What the business needs.	2. How the system will fulfill those needs.
3. Defined by business stakeholders (e.g., clients, managers).	3. Defined by technical team (e.g., developers, architects).
4. Increase online sales by 20%, reduce processing time.	4. Use of a secure payment gateway, implementation of necessary APIs.

Functional Requirements and Non-Functional Requirements

- FR defines system behavior and functions.

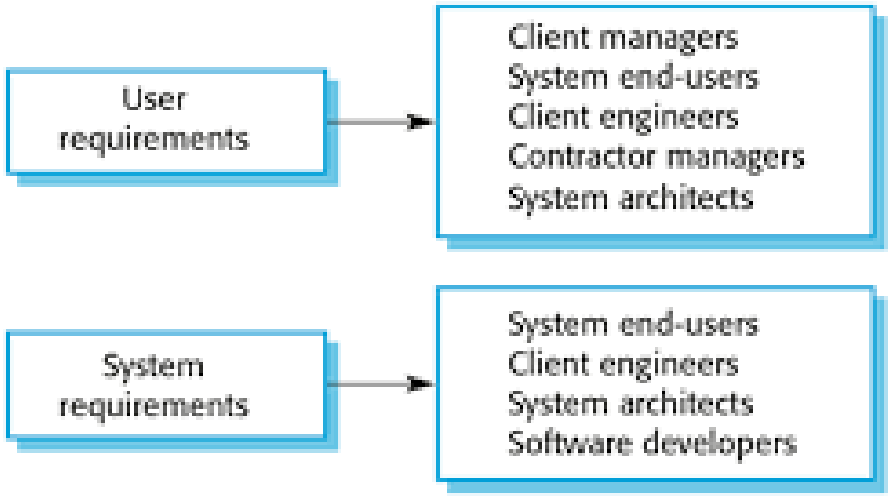
  Example: “System must allow users to log in”.
- NFR defines system attributes like performance, usability.
- Often affect user satisfaction.

Functional Requirements and Non-Functional Requirements [Cont.]



User, System and Business Requirements

- User: What users expect to do.
- System: Detailed technical description.
- Business: Alignment with business goals. From a business standpoint, business requirements specify what the software system must do in order for the company to reach its objectives.



Examples of Critical NFRs

NFR Category	Example
Performance	The system shall handle **1000 transactions per second**.
Reliability	The system shall have **99.99% uptime** over a 12-month period.
Scalability	The system shall support **up to 10,000 concurrent users** without failure.
Security	All user data shall be **encrypted using AES-256** during transmission.
Usability	New users shall be able to learn to use the system within **30 minutes**.

Requirements Engineering Phases

- The phases are:

1. Inception
2. Elicitation
3. Elaboration
4. Negotiation
5. Specification
6. Validation
7. Req. Management

Figure 3: RE Phases

- Cyclical and iterative process

1. Inception

- This phase involves identifying the initial idea and understanding the basic needs and scope of the project.
- It sets the foundation for further detailed analysis and planning.

2. Elicitation

- During elicitation, requirements are gathered from stakeholders using some techniques.
- Understanding stakeholders’ real needs.
- Techniques: Interviews, Surveys, Workshops.

3. Elaboration

- In this phase, requirements are analyzed and refined to resolve ambiguities, define detailed specifications and establish a clear understanding of functionalities of the system.

4. Negotiation

- Here, conflicting requirements are resolved through discussions with stakeholders, prioritizing needs and reaching an agreement on the most feasible and valuable features.

5. Specification

- Need to create a documentation based on requirements (like SRS, PRD).
- Clarity, consistency, completeness

6. Validation

- This phase verifies that the documented requirements accurately reflect stakeholder needs and are feasible, ensuring that the system will meet its intended purpose.
- Checking for correctness, feasibility.
- Techniques: Reviews, Prototyping

7. Requirements Management

- Throughout the project, requirements are managed to accommodate changes, track revisions and ensure that the evolving needs are properly incorporated and controlled.

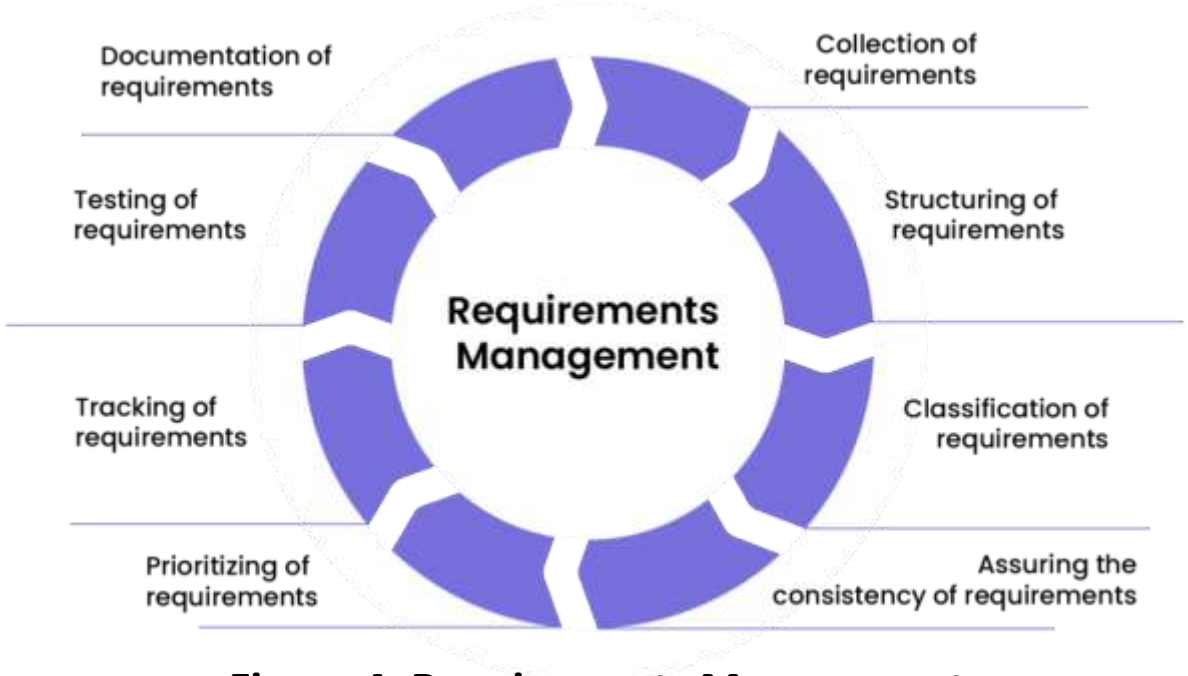


Figure 4: Requirements Management

Challenges in Requirements Engineering

Challenge	Description	Impact
Incomplete Requirements	Some requirements are missing or not well-defined.	Leads to system failures or unmet user expectations.
Changing Requirements	Requirements evolve due to business, market, or user changes.	Causes rework, delays, and increased cost.
Ambiguous Requirements	Requirements are vague or open to multiple interpretations.	Results in incorrect implementation.
Stakeholder Communication Gap	Misunderstandings between developers and non-technical stakeholders.	Misalignment between product and stakeholder needs.
Lack of Domain Knowledge	Development team lacks understanding of the user's environment or business.	Results in irrelevant or impractical system functionality.

Scope Creep

- Uncontrolled changes in requirements.
- Impact: Delays, budget overruns.
- Prevention: Clear documentation, approval processes.

Communication Gaps

- Between stakeholders and developers.
- Causes misunderstandings.
- Solutions: Prototypes, regular meetings.

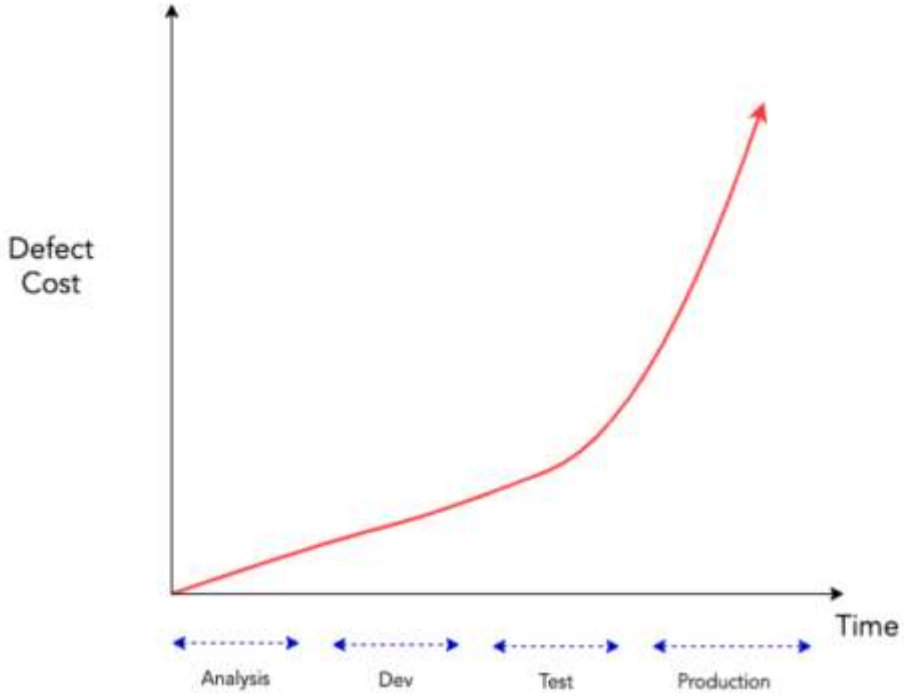
Impact of Poor Requirements in S/W Projects

- Inaccurate scope, budget issues.
- Failed projects due to misunderstood requirements.
- Cause misunderstandings and misaligned expectations.
- For example, the FBI Virtual Case File project failed because of vague and incomplete requirements, resulting in a significant budget overrun and eventual cancellation.
- Another case is the Denver International Airport's automated baggage handling system, which was plagued by unclear requirements, leading to extensive delays and cost overruns.

Boehm’s Law

- According to Boehm's Law, commonly referred to as the Law of Costly Errors, the later a software flaw is discovered in the development lifecycle, the more expensive it is to solution.
- To put it simply, it will cost significantly more to fix a bug during testing than it will to cure it during developing and it will cost even more to solve a bug after the software has been deployed.

Boehm's Law (Cont.)



User Stories vs Traditional SRS

- User stories: Simple, customer-focused statements.
- SRS: Software Requirements Specification.

User Stories	Traditional SRS
1. Simple, informal sentence: “As a [user], I want [feature]…”	1. Formal, structured document with detailed sections and specifications.
2. User needs and outcomes.	2. System functionalities and technical details.
3. Iterative, incremental development.	3. Upfront, comprehensive documentation.
4. Lightweight and minimal (Agile: Scrum, XP etc.).	4. Heavyweight, exhaustive documentation (Waterfall, V-model etc.).
5. Highly adaptable to change.	5. Difficult and costly to change once finalized.

The Requirements Baseline

- A requirements baseline is a set of requirements that has been reviewed and agreed upon and serves as the basis for further development.

- A meaningful baselining process gives all the major stakeholders confidence in the following ways:

- Customer management or marketing is confident that the project scope won't explode out of control, because customers manage the scope change decisions.
- User representatives have confidence that the development team will work with them to deliver the right solution, even if they didn't think of every requirement before construction began.
- Development management has confidence because the development team has a business partner who will keep the project focused on achieving its objectives and will work with development to balance schedule, cost, functionality, and quality.
- Business analysts and project managers are confident that they can manage changes to the project in a way that will keep chaos to a minimum.
- Quality assurance and test teams can confidently develop their test scripts and be fully prepared for their project activities.

Shift-Left Testing

- A software testing approach that involves performing testing activities early in the software development life cycle (SDLC), typically during the requirements, design or development phases, instead of waiting until after implementation.
- Shift-left testing: Test early; Test before implementation; Test often using requirements.

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CHAPTER 4

AGILE SOFTWARE DEVELOPMENT

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WHAT IS AN AGILE METHOD?

- Agile methods are considered
  - Lightweight (do not concentrate on the whole software development at once)
  - People-based rather than Plan-based
- Several agile methods
  - No single agile method
  - Different agile methods can be combined in software development (Hybrid)

AGILE DEVELOPMENT

"Plan-driven methods work best when developers can determine the requirements in advance . . . and when the requirements remain relatively stable, with change rates on the order of one percent per month."~ *Barry Boehm*

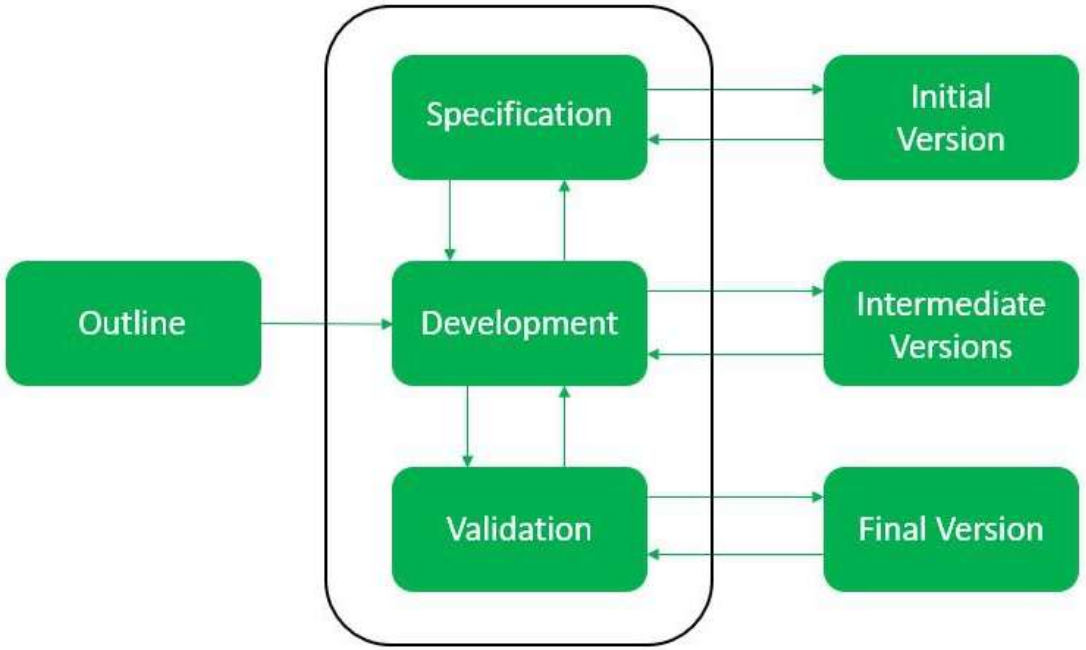
- Companies need to
  - innovate better and faster operations
  - respond quickly to
    - competitive initiatives
    - new technology
    - customer's requirements

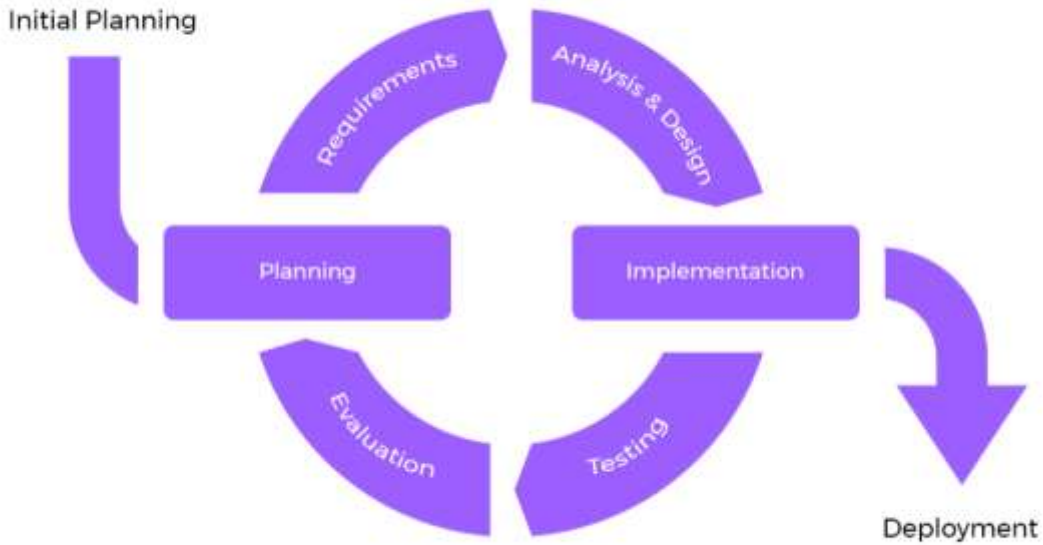
AGILE MODEL

- Subset of iterative and evolutionary methods

Iterative Products

- Each iteration is a self-contained, mini-project with activities that span requirements analysis, design, implementation, and test
- Leads to an iteration release (which may be only an internal release) that integrates all software across the team and is a growing and evolving subset of the final system
- The purpose of having short iterations is so that feedback from iterations N and earlier, and any other new information, can lead to refinement and requirements adaptation for iteration N + 1





EVOLUTIONARY + ITERATIVE MODEL = AGILE

AGILE METHODS VS. PAST ITERATIVE METHODS

- A key difference between agile methods and past iterative methods is the length of each iteration.

- In the past, iterations might have been three or six months long.
- In agile methods, iteration lengths vary between one to four weeks and intentionally do not exceed 30 days.
- Research has shown that shorter iterations have lower complexity and risk, better feedback, and higher productivity and success rates.

TIMEBOX & SCOPE

- The pre-determined iteration length serves as a timebox for the team.
- Scope (set of tasks) is chosen for each iteration to fill the iteration length.
- Rather than increase the iteration length to fit the chosen scope, the scope is reduced to fit the iteration length.

AGILE VS. PLAN DRIVEN PROCESS

Agile Process	Plan Driven Process
Small products and teams; scalability limited	Large products and teams; hard to scale down
Inappropriate for safety-critical products because of frequent changes	Handles highly critical products
Good for dynamic, but expensive for stable environments.	Good for stable, but expensive for dynamic environments
Require experienced Agile personnel throughout	Require experienced personnel only at start if stable environment
Personnel succeed on freedom and chaos	Personnel succeed on structure and order

AGILE ASSUMPTION

- It is difficult to predict in advance which software
  - requirements will persist and which will change
  - It is equally difficult to predict how customer priorities will change as the project proceeds

- Design and construction are interleaved in many types of software. That is, both activities should be performed tightly so that design models are proven as they are created. It is difficult to predict how much design is necessary before construction is used to prove the design.
- Analysis, design, construction, and testing are not as predictable (from a planning point of view) as we might like.

HUMAN FACTORS IN AGILE DEVELOPMENT

- Skill / Capability
- Common focus
- Collaboration
- Decision-making ability
- Fuzzy problem-solving ability
- Mutual trust and respect
- Self-organization

AGILE METHODS

- Extreme Programming (XP)
- Scrum
- Dynamic Systems Development Method (DSDM)
- Feature-Driven Development (FDD)
- Crystal Methods
- Lean Development (LD)
- Adaptive Software Development (ASD)

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CHAPTER 5

EXTREME PROGRAMMING (XP)

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EXTREME PROGRAMMING

- Evolved from the problems caused by the long development cycles of traditional development models (Beck 1999a).
- First started as 'simply an opportunity to get the job done' (Haungs 2001) with practices that had been found effective in software development processes during the preceding decades (Beck 1999b)

- Method is formed around common sense principles and simple to understand practices
  - No process fits every project, rather, simple practices should be tailored to suit an individual project

XP VALUES

- **Communication:** XP has a culture of oral communication and its practices are designed to encourage interaction.

  "Problems with projects can invariably be traced back to somebody not talking to somebody else about something important."

- **Simplicity:** Design the simplest product that meets the customer's needs. An important aspect of the value is to only design and code what is in the current requirements rather than to anticipate and plan for unstated requirements.

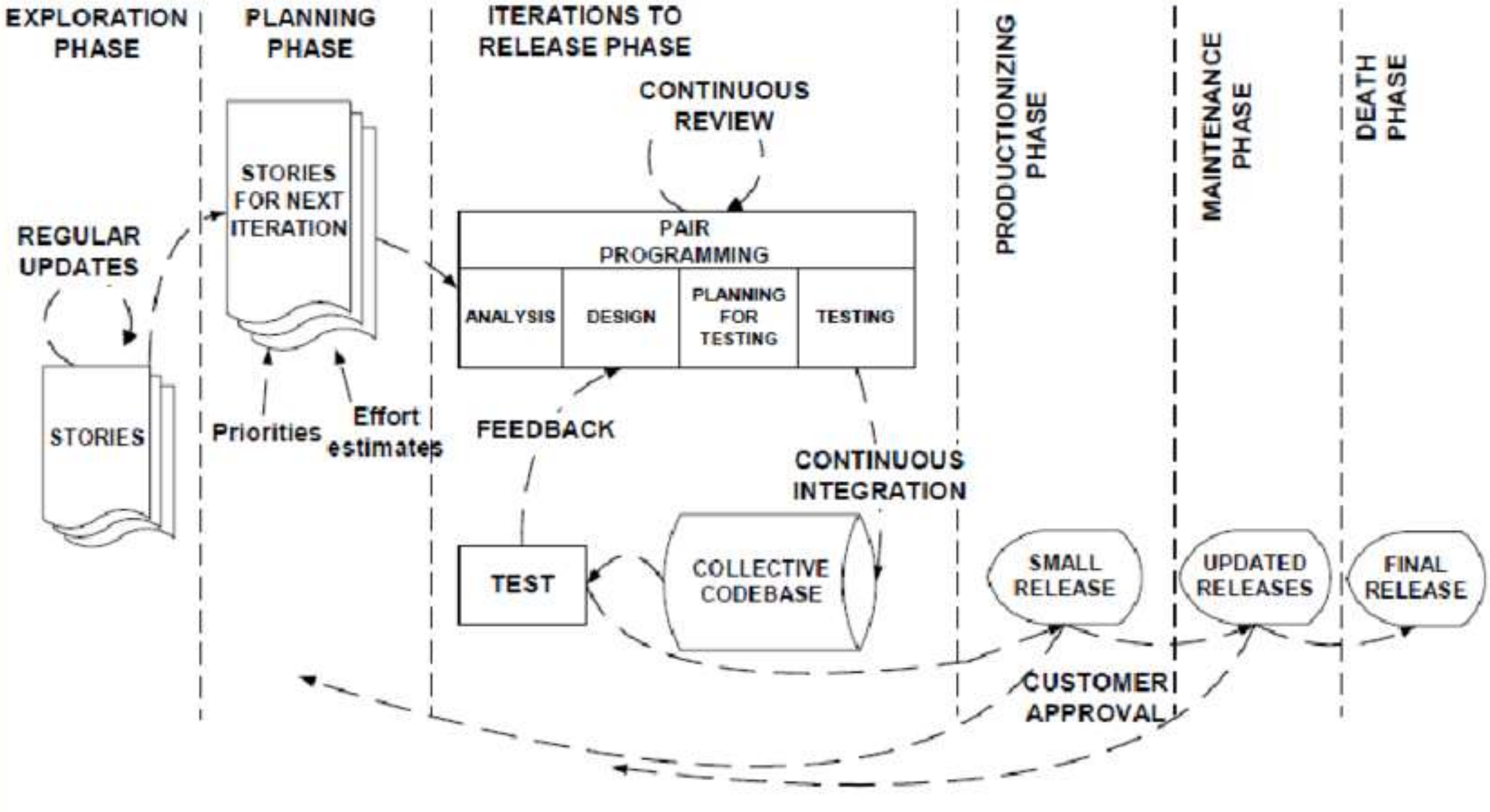
XP VALUES

- **Feedback:** The development team obtains feedback from the customers at the end of each iteration and external release. This feedback drives the next iteration.
- **Courage**: Allow the team to have courage in its actions and decision making. For example, the development team might have the courage to resist pressure to make unrealistic commitments.
- **Respect:** Team members need to care about each other and about the project.

XP PROCESS MODEL

- The life cycle of XP consists of six phases:

1. Exploration
2. Planning
3. Iterations to Release
4. Productionizing
5. Maintenance
6. Death


EXPLORATION PHASE
PLANNING PHASE
ITERATIONS TO RELEASE PHASE
PRODUCTIONIZING PHASE
MAINTENANCE PHASE
DEATH PHASE
CONTINUOUS REVIEW
STORIES FOR NEXT ITERATION
REGULAR UPDATES
PAIR PROGRAMMING
ANALYSIS
DESIGN
PLANNING FOR TESTING
TESTING
STORIES
Priorities
Effort estimates
FEEDBACK
CONTINUOUS INTEGRATION
TEST
COLLECTIVE CODEBASE
SMALL RELEASE
UPDATED RELEASES
FINAL RELEASE
CUSTOMER APPROVAL

XP PROCESS – EXPLORATION PHASE

- The customers write out the story cards that they wish to be included in the first release
- At the same time the project team familiarize themselves with the tools, technology and practices they will be using in the project
- The exploration phase takes between a few weeks to a few months, depending largely on how familiar the technology is to the programmers

XP PROCESS – PLANNING PHASE

- Users stories are written
- Estimate the effort of working with the user stories
- Priorities are given to the user stories to be implemented
- Release planning creates the release schedule

XP PROCESS – ITERATIONS TO RELEASE PHASE

- Includes several iterations of the systems before the first release
- Each takes one to four weeks to implement
- The first iteration creates a system with the architecture of the whole system. This is achieved by selecting the stories that will enforce building the structure for the whole system
- The customer decides the stories to be selected for each iteration
- At the end of the last iteration, the system is ready for production

XP PROCESS – PRODUCTIONIZING PHASE

- Requires extra testing and checking of the performance of the system before the system can be released to the customer
- New changes may still be found and the decision has to be made if they are included in the current release
- The iterations may need to be quickened from three weeks to one week
- The postponed ideas and suggestions are documented for later implementation

XP PROCESS – MAINTENANCE PHASE

- After the first release is productionized for customer use, the XP project must both keep the system in the production running while also producing new iterations
- Requires an effort also for customer support tasks
- Development velocity may decelerate after the system is in production
- May require incorporating new people into the team and changing the team structure

XP PROCESS – DEATH PHASE

- When the customer does no longer have any stories to be implemented
- System satisfies customer needs also in other respects (e.g., concerning performance and reliability)
- Necessary documentation of the system is finally written as no more changes to the architecture, design or code are made
- Death may also occur if the system is not delivering the desired outcomes, or if it becomes too expensive for further development

XP - ROLES AND RESPONSIBILITY

- **Customer:** writes the stories and functional tests, and decides when each requirement is satisfied. The customer sets the implementation priority for the requirements
- **Programmer:** keeps the program code as simple and definite as possible.
- **Tester:** helps the customer write functional tests, also run functional tests regularly, broadcast test results and maintain testing tools
- **Tracker:** gives feedback in XP. He traces the estimates made by the team (e.g. effort estimates) and gives feedback on how accurate they are in order to improve future estimations. He also traces the progress of each iteration and evaluates whether the goal is reachable within the given resource and time constraints or if any changes are needed in the process

XP - PRACTICES

- **Interaction:** Close interaction between the customer and the programmers. The programmers estimate the effort needed for the implementation of customer stories and the customer then decides about the scope and timing of releases.
- **Small/short releases:** A simple system is "productionized“ rapidly – at least once in every 2 to 3 months. New versions are then released even daily, but at least monthly.
- **Metaphor:** The system is defined by a metaphor/set of metaphors between the customer and the programmers. This "shared story" guides all development by describing how the system works.

XP - PRACTICES

- **Pair programming**
  - Two people write the code at one computer
  - One programmer, the driver, has control of the keyboard/mouse and actively implements the program. The other programmer, the observer, continuously observes the work of the driver to identify tactical defects (syntactic, spelling, etc.) and also thinks strategically about the direction of the work.
  - Two programmers can brainstorm any challenging problem. Because they periodically switch roles.
- **Continuous integration:** A new piece of code is integrated into the code-base as soon as it is ready.

XP - PRACTICES

- **40-hour week:** A maximum of 40-hour working week
- **On-site customer:** Customer has to be present and available full-time for the team
- **Coding standards:** Coding rules exist and are followed by the programmers (e.g. error message by exception handling). Communication through the code should be emphasized
- **Open workspace:** A large room with small cubicle (compartment) is preferred
- **Just rules:** Team has its own rules that are followed, but can also be changed at any time. The changes have to be agreed upon and their impact has to be assessed

XP - ARTEFACTS

- **User story cards**
  - Paper index cards which contain brief requirement (features, non-functional) descriptions
  - Not a full requirement statement
  - Commitment for further conversation between the developer and the customer
  - During this conversation, the two parties will come to an oral understanding of what is needed for the requirement to be fulfilled
  - Customer priority and developer resource estimate are added to the card
  - The resource estimate for a user story must not exceed the iteration duration

XP - ARTEFACTS

- **Task list**
  - A listing of the tasks (one-half to three days in duration) for the user stories that are to be completed for an iteration
  - Tasks represent concrete aspects of a user story
  - Programmers volunteer for tasks rather than are assigned to tasks

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CHAPTER 6

SCRUM

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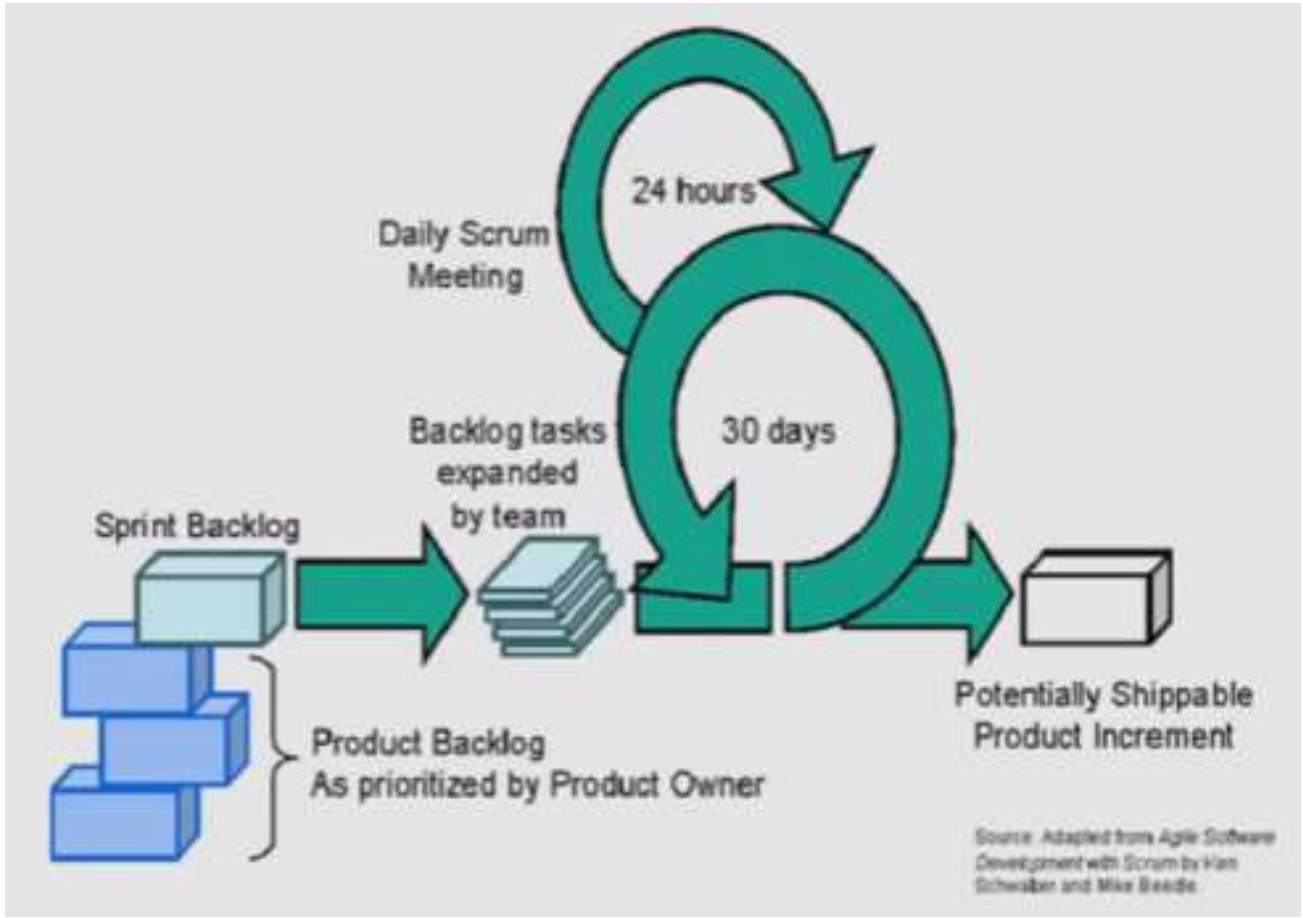
SCRUM

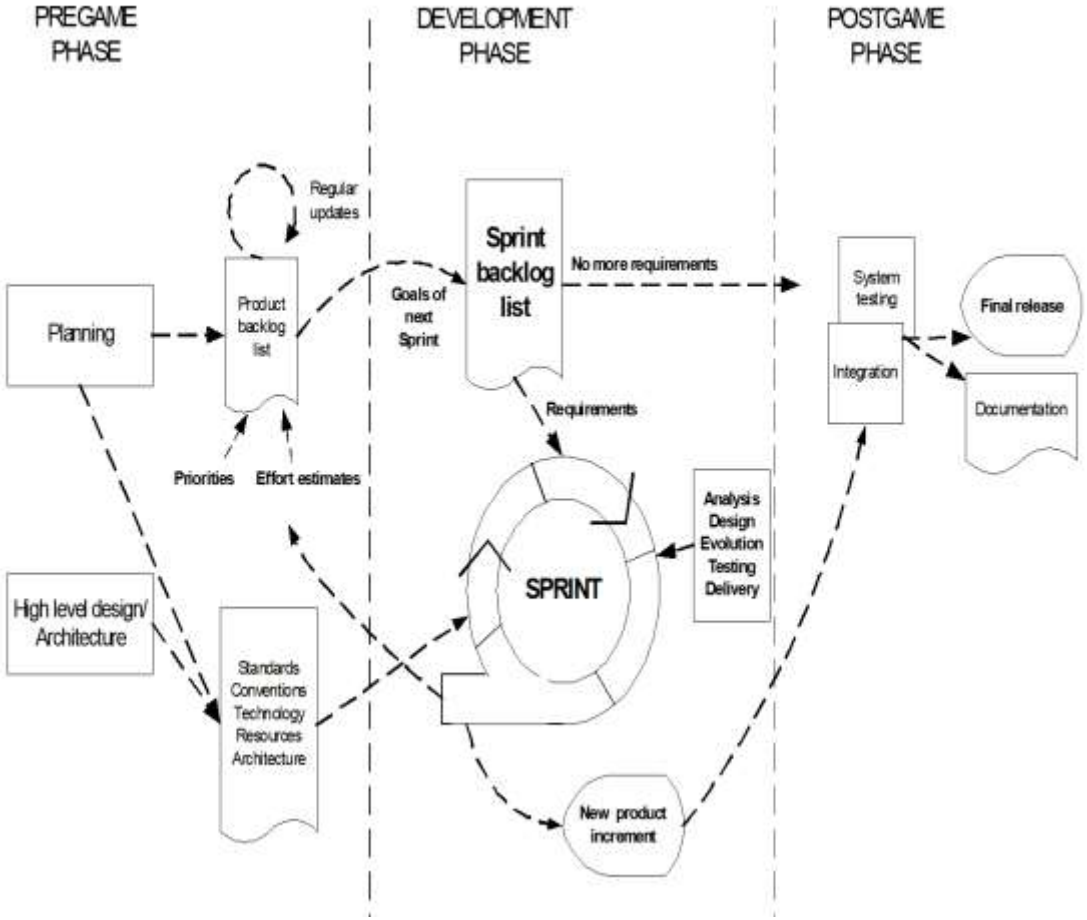
- The first references in the literature to the term 'Scrum‘ point to the article of Takeuchi and Nonaka (1986) in which an adaptive, quick, self-organizing product development process originating from Japan is presented (Schwaber and Beedle 2002).

- The term 'scrum' originally derives from a strategy in the game of rugby where it denotes "getting an out-of play ball back into the game" with teamwork (Schwaber and Beedle 2002).

- SCRUM process includes three phases
  - Pre-game
  - Game phase (development)
  - Post-game

SCRUM PROCESS





PRE-GAME PHASE

- The pre-game phase includes two sub-phases:

1. Planning:

- Definition of the system being developed
- A Product Backlog list is created containing all the requirements that are currently known
- The requirements are prioritized and the effort needed for their implementation is estimated
- The product Backlog list is constantly updated with new and more detailed items, as well as with more accurate estimations and new priority orders
- Planning also includes the definition of the project team, tools and other resources, risk assessment and controlling issues, training needs and verification management approval

PRE-GAME PHASE

2. Architecture

- The high level design of the system including the architecture is planned based on the current items in the Product Backlog
- In case of an enhancement to an existing system, the changes needed for implementing the Backlog items are identified along with the problems they may cause
- A design review meeting is held to go over the proposals for the implementation and decisions are made on the basis of this review

DEVELOPMENT (GAME) PHASE

- This phase is treated as a "black box" where the unpredictable is expected
- The system is developed in Sprints
  - Sprints are iterative cycles where the functionality is developed or enhanced to produce new increments.
  - Each Sprint includes the traditional phases of software development: requirements, analysis, design, evolution and delivery phases.
  - One Sprint is planned to last from one week to four week (not exceed one month).

POST-GAME PHASE

- This phase is entered when an **agreement** has been made such as the requirements are completed.
- In this case, **no more items and issues** can be found nor can any new ones be invented.
- The system is now ready for the **release** and the preparation for this is done during the post-game phase, including the tasks such as the integration, system testing and documentation.

ROLES AND RESPONSIBILITIES

Scrum Master

- Scrum Master is responsible for ensuring that the project is carried through according to the practices, values, and rules of Scrum and that it progresses as planned.
- Scrum Master interacts with the project team as well as with the customer and the management during the project.

Product Owner

- Product Owner is officially responsible for the project, managing, controlling, and making visible the Product Backlog list.
- He is selected by the Scrum Master, the customer, and the management.
- He makes the final decisions of the tasks related to product Backlog.

ROLES AND RESPONSIBILITIES

- **Scrum Team**
  - Scrum Team is the project team that has the authority to decide on the necessary actions and to organize itself in order to achieve the goals of each Sprint.
  - The scrum team is involved, for example, in effort estimation, creating the Sprint Backlog, reviewing the product Backlog list and suggesting impediments that need to be removed from the project.
- **Customer**
  - Customer participates in the tasks related to product Backlog items for the system being developed or enhanced.
- **Management**
  - Management is in charge of final decision making, along with the agreements, standards, and conventions to be followed in the project.
  - Management also participates in the setting of goals and requirements.

SCRUM PRACTICES

❑ Product Backlog & Sprint

- Sprint is the procedure of adapting to the changing environmental variables (requirements, time, resources, knowledge, technology etc.).
- The working tools of the team are Sprint Planning Meetings, Sprint Backlog, and Daily Scrum meetings.

❑ Effort Estimation & Sprint Backlog

- Sprint Backlog is the starting point for each Sprint. It is a list of Product Backlog items selected to be implemented in the next Sprint.
- The items are selected by the Scrum Team together with the Scrum Master and the Product Owner in the Sprint Planning meeting, on the basis of the prioritized items and goals set for the Sprint.
- Unlike the Product Backlog, the Sprint Backlog is stable until the Sprint (i.e. 30 days) is completed. When all the items in the Sprint Backlog are completed, a new iteration of the system is delivered.

SCRUM PRACTICES

- **Sprint Planning meeting**
  - A Sprint Planning Meeting is a two-phase meeting organized by the Scrum Master.
  - The Scrum Master, Management, Product Owner, and Scrum Team participate in the first phase of the meeting to decide upon the goals and the functionality of the next Sprint.
  - The second phase of the meeting is held by the Scrum Master and the Scrum Team focusing on how the product increment is implemented during the Sprint.
- **Daily Scrum meeting**
  - Daily Scrum meetings are organized to keep track of the **progress** of the Scrum Team continuously and they also serve as planning meetings: what has been done since the last meeting and what is to be done before the next one.
- **Sprint Review meeting**
  - On the **last day** of the Sprint, the Scrum Team and the Scrum Master present the results (i.e. working product increment) of the Sprint to the management, customers, users, and the Product Owner in an informal meeting.

REFERENCES

- R.S. Pressman & Associates, Inc. (2010). *Software Engineering: A Practitioner's Approach*.
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CHAPTER 7

THE DYNAMIC SYSTEMS DEVELOPMENT METHOD (DSDM)

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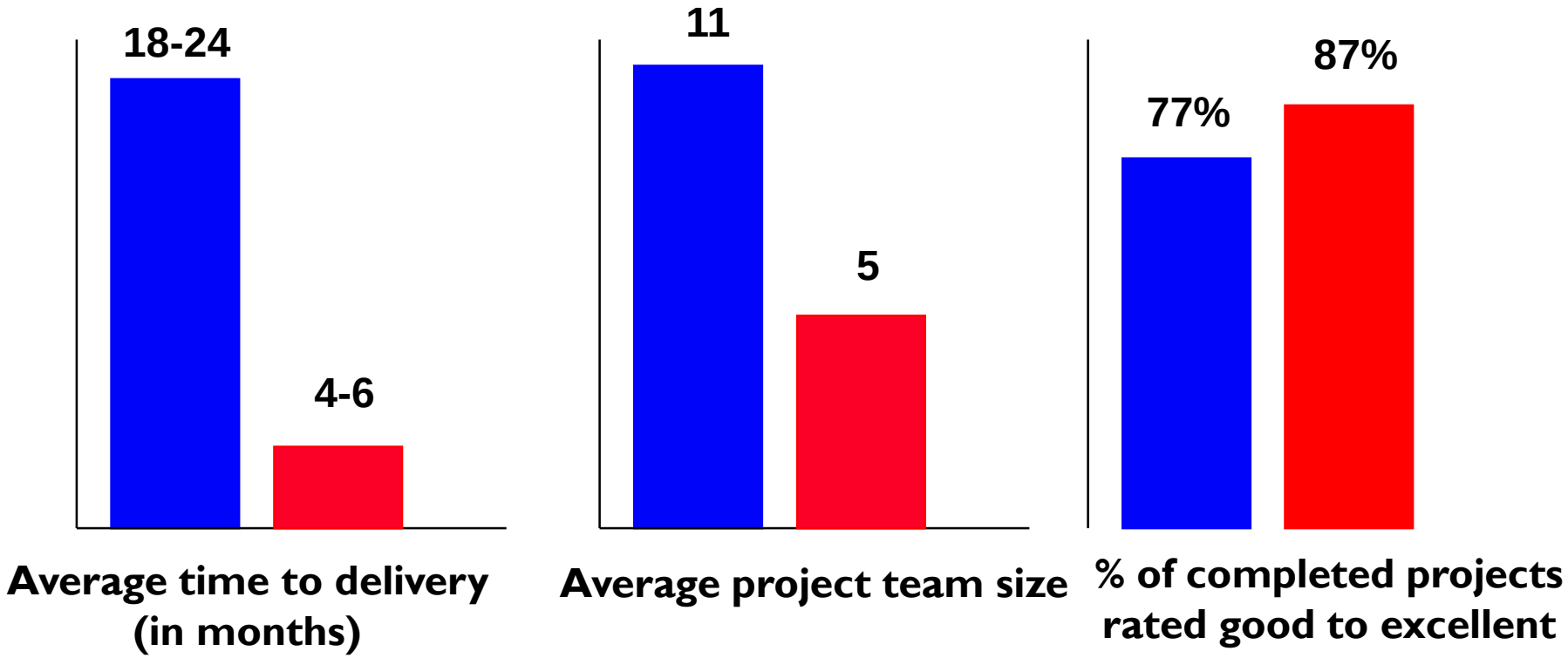
DSDM

- **The Dynamic Systems Development Method (DSDM)** is a public domain Rapid Application Development method which has been developed through capturing the experience of a large group of vendor and user organisations.
- **It is now considered to be the UK's de-facto standard for RAD.**

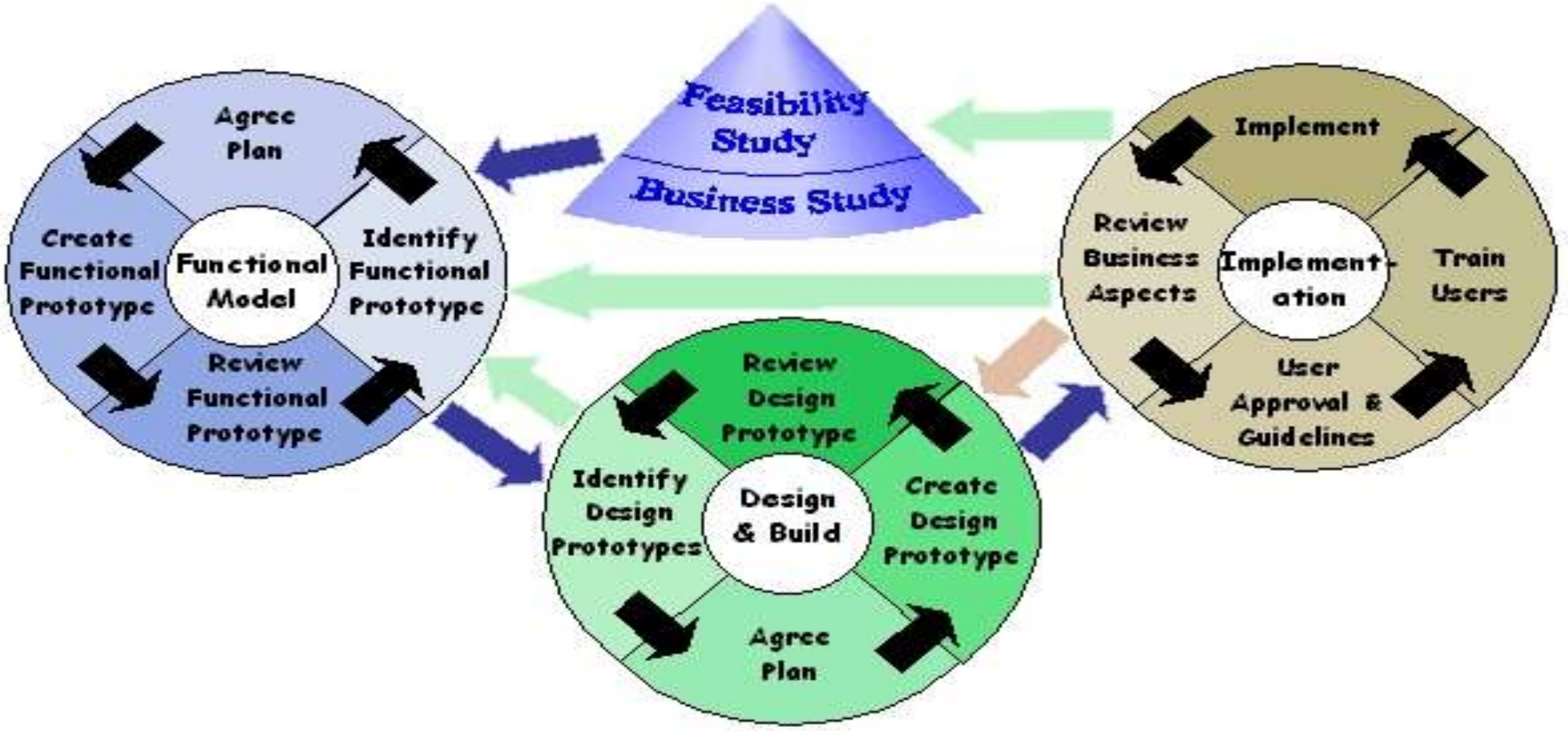
- The key to DSDM is to deliver **what** business needs **when** it needs.
  - Achieved by using the various techniques in the framework and flexing requirements
  - The aim is always to address the current and imminent needs of the business rather than to attack all the perceived possibilities

TRADITIONAL METHOD VS. DSDM



Source: British Airways IM Department, Newcastle

DSDM PROCESS VIEW



DSDM PROCESS

Activity	Sub activity	Description
Study	**Feasibility Study**	Stage where the suitability of DSDM is assessed. Judging by the type of project, organizational and people issues, the decision is made, whether to use DSDM or not. Therefore it will generate a FEASIBILITY REPORT, a FEASIBILITY PROTOTYPE, and a GLOBAL OUTLINE PLAN which includes a DEVELOPMENT PLAN and a RISK LOG.
	Business Study	Stage where the essential characteristics of business and technology are analyzed. Approach to organize workshops, where a sufficient number of the customer's experts are gathered to be able to consider all relevant facts of the system, and to be able to agree on development priorities. In this stage, a PRIORITIZED REQUIREMENTS LIST, a BUSINESS AREA DEFINITION, a SYSTEM ARCHITECTURE DEFINITION, and an OUTLINE PROTOTYPING PLAN are developed.

DSDM PROCESS

Activity	Sub activity	Description
Functional Model Iteration	Identify functional prototype	Determine the functionalities to be implemented in the prototype that results from this iteration. In this sub-stage, a FUNCTIONAL MODEL is developed according to the deliverables result of business study stage.
	Agree schedule	Agree on how and when to develop these functionalities.
	Create functional prototype	Develop the FUNCTIONAL PROTOTYPE, according to the agreed schedule and FUNCTIONAL MODEL.
	Review functional prototype	Check correctness of the developed prototype. This can be done via testing by end-user and/or reviewing documentation. The deliverable is a FUNCTIONAL PROTOTYPING REVIEW DOCUMENT.

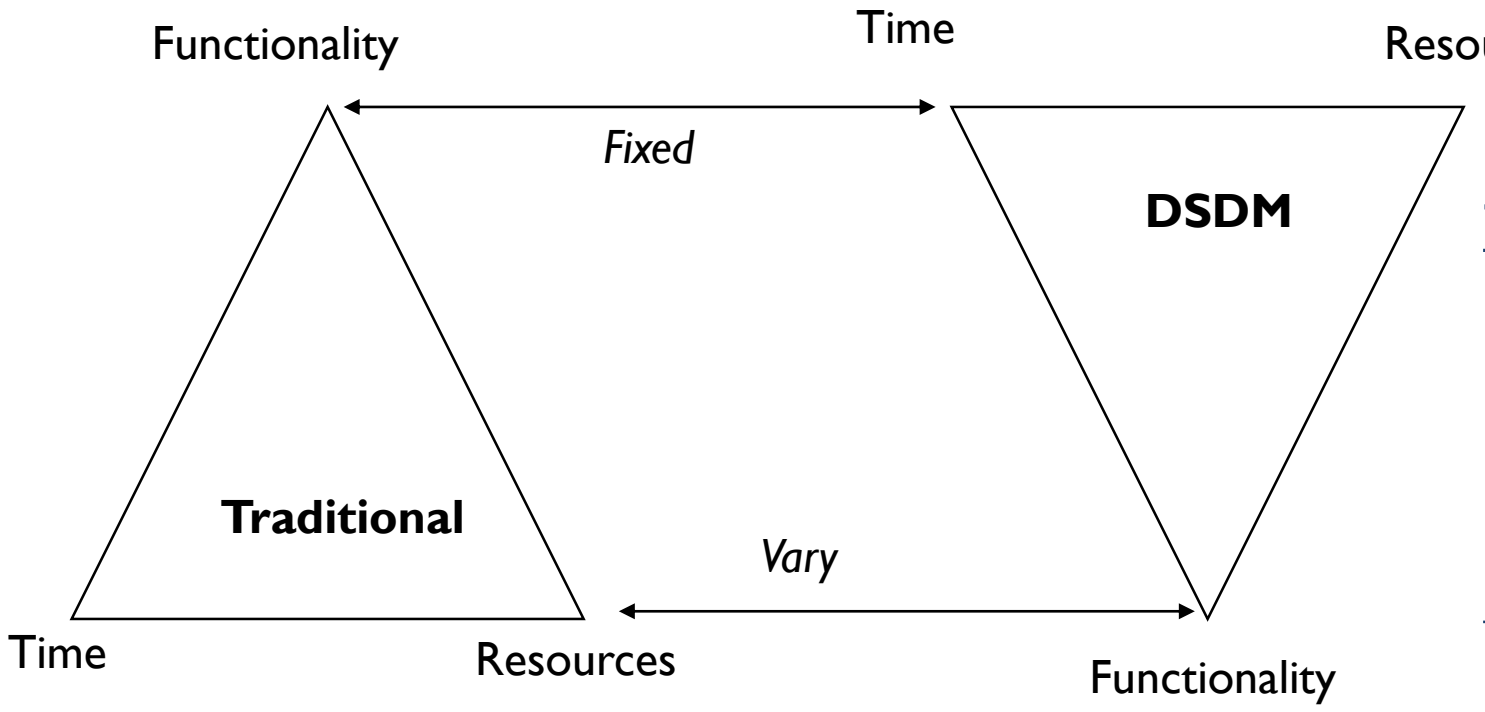
DSDM PROCESS

Activity	Sub activity	Description
Design and Build Iteration	Identify design prototype	Identify functional and **non-functiona**l requirements that need to be in the tested system. And based on these identifications, an IMPLEMENTATION STRATEGY is involved. If there is a TEST RECORD from the previous iteration, then it will be also used to determine the IMPLEMENTATION STRATEGY.
	Agree schedule	Agree on how and when to realize these requirements.
	Create design prototype	Create a system (DESIGN PROTOTYPE) that can safely be handed to end-users for daily use, also for testing purposes.
	Review design prototype	Check the correctness of the designed system. Again, testing and reviewing are the main techniques used. A USER DOCUMENTATION and a TEST RECORD will be developed.

DSDM PROCESS

Activity	Sub activity	Description
Implementation	User approval and guidelines	End users approve the tested system (APPROVAL) for implementation and guidelines with respect to the implementation and use of the system are created.
	Train users	Train future end user in the use of the system. TRAINED USER POPULATION is the deliverable of this sub-stage.
	Implement	Implement the tested system at the location of the end users, called as DELIVERED SYSTEM.
	Review business	Review the impact of the implemented system on the business, a central issue will be whether the system meets the goals set at the beginning of the project. Depending on this the project goes to the next stage, the post-project or loops back to one of the preceding stages for further development. This review is will be documented in a PROJECT REVIEW DOCUMENT.

DIFFERENCE BETWEEN TRADITIONAL DEVELOPMENT VS. DSDM



Traditional Method

- Functional/requirements are fixed
- Time & resources can vary

DSDM/Agile Methods

- Functional/requirement varies
- Time & resources are fixed

TECHNIQUES TO CONSIDER IN DSDM

- Flexibility [80:20 Rule]
- Timeboxing
- MoSCoW Rules
- Prototyping

DSDM TECHNIQUES: FLEXIBILITY

- A fundamental assumption of DSDM is that nothing is built perfectly first time.
- 80:20 Rule: The 80/20 rule says that you can get 80% of the value from a project by focusing on the 20% of needs that are the most important.

DSDM assumes that all previous steps can be revisited as part of its iterative approach.

Therefore, the current step need be completed only enough to move to the next step, since it can be finished in a later iteration.

DSDM TECHNIQUES: TIMEBOXING

- Without effective timeboxing, prototyping teams can lose their focus and run out of control.
- Timeboxing works by concentrating on when a business objective will be met as opposed to the tasks which contribute to its delivery.
- **Timeboxing Basics**
  - Time between start and end of an activity
  - DSDM uses nested timeboxes, giving a series of fixed deadlines
  - Ideally **2 - 4 weeks** in length
  - Objective is to have easiest 80% produced in each timebox
  - Remaining 20% potentially carried forward subsequent timeboxes
  - Focus on the essentials
  - Helps in estimating and providing resources

DSDM TECHNIQUES: MOSCOW RULES

- **MoSCoW** rules formalised in DSDM version 3
  - **Must have** – fundamental to project success
  - **Should have** – important but project does not rely on
  - **Could have** – left out without impacting on project
  - **Want to have but Won't have** this time for those valuable requirements that can wait till later development takes place; in other words, the Waiting List.

Category	Meaning	Example
Must-have	**Essential requirements** that are critical for system success.	User login functionality; data encryption; payment processing.
Should-have	**Important features**, but not vital for initial delivery.	Password reset option; mobile responsiveness; role-based access.
Could-have	**Nice-to-have enhancements** that have little impact if left out.	Dark mode; advanced analytics dashboard; chatbot.
Won't-have (this time)	**Least priority**, out of scope for now, but may be considered in future.	Third-party integrations; multilingual support; gamification.

DSDM TECHNIQUES: PROTOTYPING

Prototypes are necessary in DSDM because

- Facilitated workshops define the high-level requirements and strategy
- Prototypes provide the mechanism through which users can ensure that the detail of the requirements is correct
- Demonstration of a prototype broadens the users awareness of the possibilities and assists them in giving feedback to the developers
- Speeds up the development process and increases confidence that the right solution will be delivered

REFERENCES

- R.S. Pressman & Associates, Inc. (2010). *Software Engineering: A Practitioner's Approach*.
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CHAPTER 8

FEATURE DRIVEN DEVELOPMENT (FDD)

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WHAT IS FDD?

- Feature Driven Development (FDD)
- FDD is an agile software development process
- FDD uses a short-iteration model
- FDD combines key advantages of other popular agile approaches along with other industry-recognized best practices
- FDD was created to easily scale to much larger projects and teams

WHAT IS A FEATURE?

- FDD delivers the system feature by feature
- Feature is a small function expressed in client-valued terms which presents the customer requirements to be developed in software using small iteration
- Features are to be "small" in the sense they will take no more than two weeks to complete Features that appear to take longer are to be broken up into a set of smaller features. Two weeks is the maximum, most features take less time (1 - 5 days)
- Feature naming template:

<action> the <result> <by|for|of|to> a(n) <object> **Calculate the vote of a national election**

- Examples: Calculate the total of a sale
  Validate the password of a user
  Authorize the sales transaction of a customer

FDD ROLES

- FDD Primary Roles

Project Manager	Chief Architect
Class Owners	Domain Experts
	Chief Programmers

- FDD Supporting Roles

Language Guru (shared vocabulary)	
Toolsmith (making tools for application)	
Tester	
Technical Writer (documentation)	

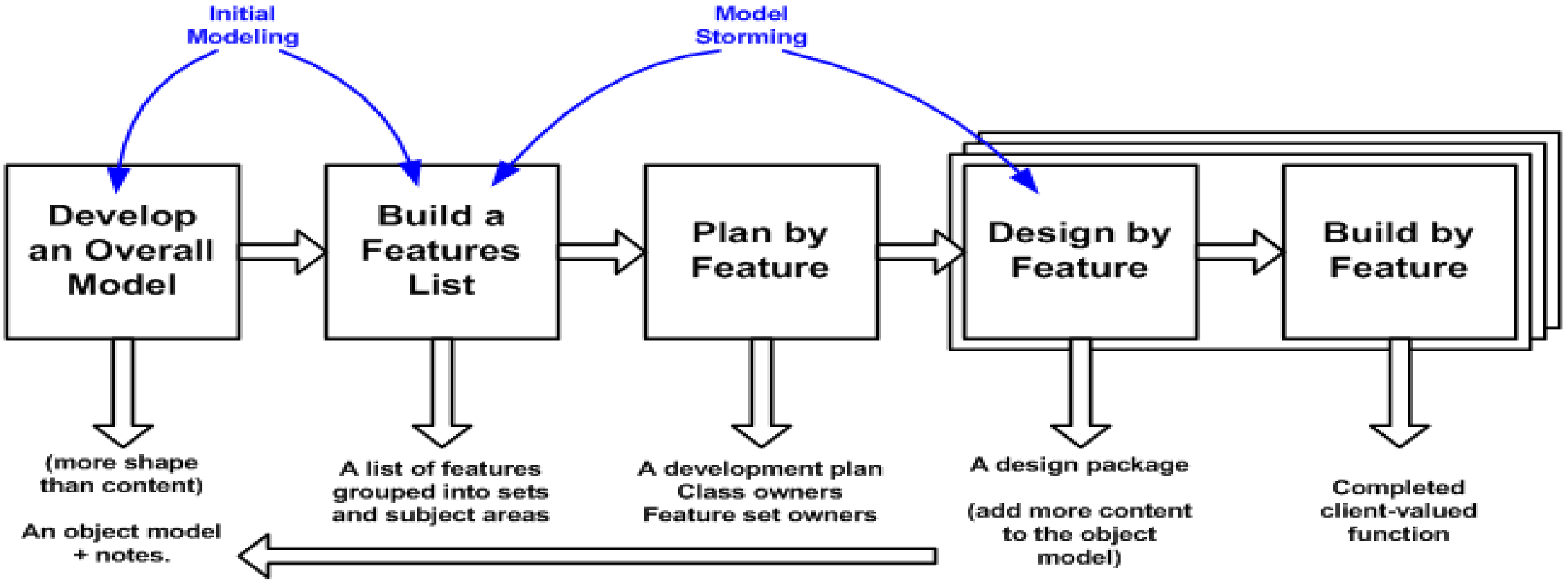
FDD PROCESS

- Process #1: Develop an Overall Model
- Process #2: Build a Features List
- Process #3: Plan By Feature
- Process #4: Design By Feature
- Process #5: Build By Feature

FDD PROCESS

- Project wide upfront design activities:
  - Process #1: Develop an Overall Model
  - Process #2: Build a Features List
  - Process #3: Plan By Feature
  - Goal: not to design the system in its entirety but instead is to do just enough initial design that you are able to build on
- Deliver the system feature by feature:
  - Process #4: Design By Feature
  - Process #5: Build By Feature
  - Goal: Deliver real, completed, client-valued function as often as possible

FDD PROCESS



FDD PROCESS

- **Process #1: Develop an Overall Model**
  - Form a modeling team
  - Domain walk-through
  - Build High-level object model
  - Record Notes
  - **Goal** - for team members to gain a good, shared understanding of the problem domain and build a foundation

- **Process #2: Build a Features List**
  - All Features are organized in a three level hierarchy :

Domain Subject Area
Business Activity
Features

FDD PROCESS

- **Process #3: Plan by Feature**
  - Construct initial schedule
    - Formed on level of individual features
      - Prioritize by business value
      - Also consider dependencies, difficulty, and risks
  - Assign responsibilities to team members
    - Determine Class Owners
    - Assign feature sets to chief programmers

FDD PROCESS

- **Process #4: Design by Feature**
  - Form Feature Teams
  - Team members collaborate on the full low level analysis and design
  - Certain features may require teams to bring in domain experts
  - Teams need to update the model artifact to support their changes

Feature Team

- Chief Programmers pick teams based on the current feature in development
- Chief Programmers lead picked team (usually 3 to 5 people)
- Upon completion of the current feature the team diRMands
- Each team will concurrently work on their own independent iteration
- Possible to be on multiple teams at once

FDD PROCESS

- **Process #5: Build by Feature**
  - Implement designed feature
  - Test feature
    - Unit-level
    - Feature-level
  - Mandated Code Inspections (formal review with checklist)
  - Integrate with regular build

FDD PROCESS

- **Mandated Code Inspections** for Two Main Reasons
  - Research has shown that when it is done properly, inspections find more bugs as well as different types of bugs than any other form of testing.
  - It is also a great learning experience

- **Reporting**
  - FDD emphasizes the ability to provide accurate, meaningful, and timely progress information to all stakeholders within and outside the project
  - Feature Milestones

REFERENCES

- R.S. Pressman & Associates, Inc. (2010). *Software Engineering: A Practitioner's Approach*.
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