18CSC206J –SOFTWARE ENGINEERING & PROJECT MANAGEMENT

What is Software?

The product that software professionals build and then support over the long term.

Software encompasses:

(1) instructions (computer programs) that when executed provide desired features, function, and performance;

(2) data structures that enable the programs to adequately store and manipulate information and

(3) documentation that describes the ***operation and use of the programs.***

Features of Software?

- Its characteristics that make it different from other things human being build.

Features of such logical system:

- Software is developed or engineered, it is not manufactured in the classical sense which has quality problem.

- Software doesn't "wear out." but it deteriorates (due to change).

Features of Software?

- Hardware has bathtub curve of failure rate (high failure rate in the beginning, then drop to steady state, then cumulative effects of dust, vibration, abuse occurs).

- Although the industry is moving toward component-based construction (e.g. standard screws and off-the-shelf integrated circuits), most software continues to be custom-built.

- Modern reusable components encapsulate data and processing into software parts to be **reused by different programs**. E.g. graphical user interface, window, pull-down menus in library etc.

Software Applications

- 1. System software: such as compilers, editors, file management utilities
- 2. Application software**:** stand-alone programs for specific needs.
- 3. Engineering/scientific software: Characterized by “number crunching”algorithms. such as automotive stress analysis, molecular biology, orbital dynamics etc
- 4. Embedded software resides within a product or system. (key pad control of a microwave oven, digital function of dashboard display in a car)
- 5. Product-line software focus on a limited marketplace to address mass consumer market. (word processing, graphics, database management)
- 6. Web Apps (Web applications) network centric software. As web 2.0 emerges, more sophisticated computing environments is supported integrated with remote database and business applications.
- 7. AI software uses non-numerical algorithm to solve complex problem. Robotics, expert system, pattern recognition game playing

Software Process

- A process is a collection of activities, actions and tasks that are performed when some work product to be created

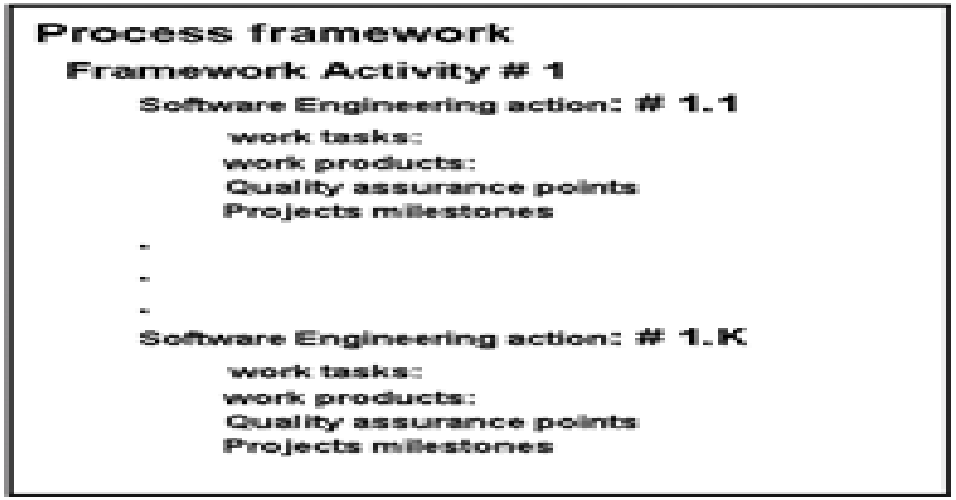
Process framework

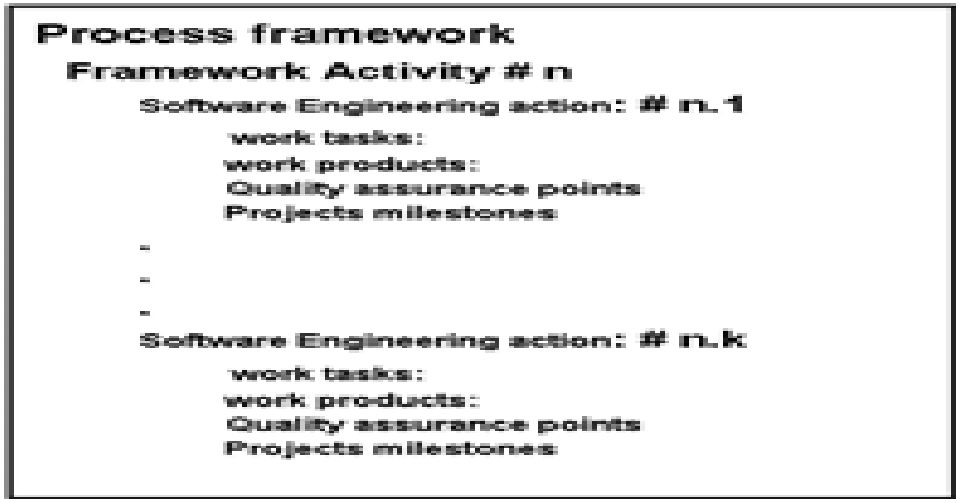
Why process :

A process defines who is doing what, when and how to reach a certain goal.

- To build complete software process.
- Identified a small number of framework activities that are applicable to all software projects, regardless of their size or complexity.
- It encompasses a set of **umbrella activities** that are applicable across the entire software process.

Process Framework





- Each framework activities is populated by a set **for *software engineering actions* – a collection of related tasks.**
- Each action has individual *work task*.

Generic Process Framework Activities

- **Communication:**
  - Heavy communication with customers, stakeholders, team
  - Encompasses requirements gathering and related activities
- **Planning:**
  - Workflow that is to follow
  - Describe technical task, likely risk, resources will require, work products to be produced and a work schedule.
- **Modeling:**
  - Help developer and customer to understand requirements (Analysis of requirements) & Design of software
- **Construction**
  - Code generation: either manual or automated or both
  - Testing – to uncover error in the code.
- **Deployment:**
  - Delivery to the customer for evaluation
  - Customer provide feedback

Umbrella Activities

- Software project tracking and control
  - **Assessing progress against the project plan**.
  - Take **adequate action to maintain schedule**.

- Formal technical reviews
  - Assessing software work products in an effort to uncover and remove errors before goes into next action or activity.
- Software quality assurance
  - Define and conducts the activities required to ensure software quality.

- Software configuration management

  - Manages the effects of change.

- Document preparation and production
  - Help to create work products such as models, documents, logs, form and list.

- Reusability management
  - Define criteria for work product reuse
  - Mechanisms to achieve reusable components.

- Measurement
  - Define and collects process, project, and product measures
  - Assist the team in delivering software that meets customer's needs.

- Risk management
  - Assesses risks that may effect that outcome of project or quality of product (i.e. software)

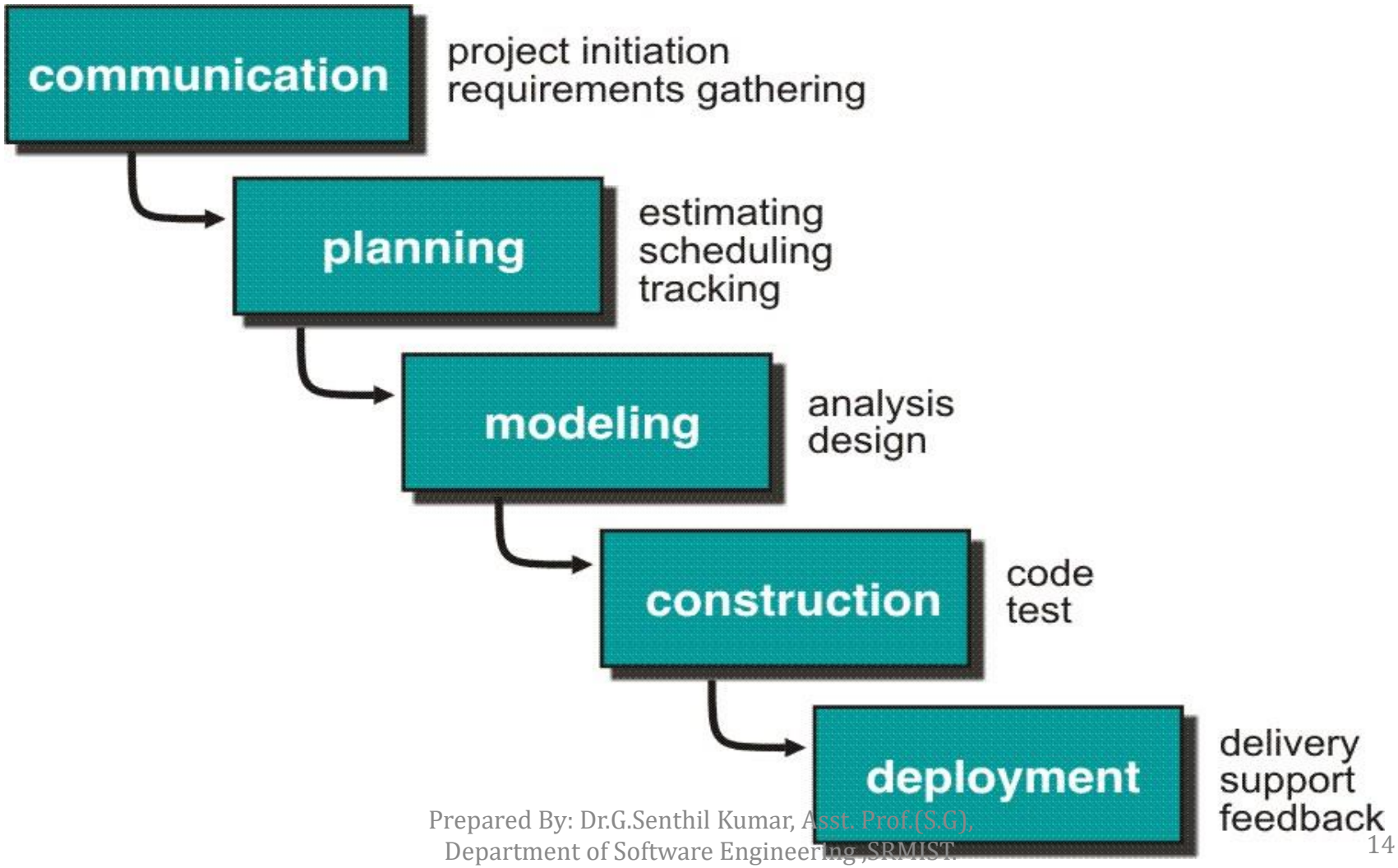
Software process model

- Process models prescribe a distinct set of activities, actions, tasks, milestones, and work products required to engineer high quality software.
- Process models are not perfect, but provide roadmap for software engineering work.
- Software process models are adapted to meet the needs of software engineers and managers for a specific project.

Prescriptive Model

- Prescriptive process models advocate an **orderly approach to software engineering**
  - Organize framework activities in a certain order
- Process framework activity with set of software engineering actions.
- Each action in terms of a task set that identifies the work to be accomplished to meet the goals.
- The resultant process model should be adapted to accommodate the nature of the specific project, people doing the work, and the work environment.
- Software engineer choose process framework that includes activities like;
  - **Communication**
  - **Planning**
  - **Modeling**
  - **Construction**
  - **Deployment**

Waterfall Model or Classic Life Cycle



Prescriptive Model

- Calling this model as “Prescribe” because it recommend a set of process elements, activities, action task, work product & quality.

- Each elements are inter related to one another (called workflow).

Waterfall Model or Classic Life Cycle

- Requirement Analysis and Definition: What - The systems services, constraints and goals are defined by customers with system users.

- Scheduling tracking -
  - Assessing progress against the project plan.
  - Require action to maintain schedule.

- System and Software Design: How –It establishes and overall system architecture. Software design involves fundamental system abstractions and their relationships.

- Integration and system testing: The individual program unit or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.

- Operation and Maintenance: Normally this is the longest phase of the software life cycle. The system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in earlier stages of the life-cycle.

Limitations of the waterfall model

- The nature of the requirements will not change very much During development; during evolution

- The model implies that you should attempt to complete a given stage before moving on to the next stage
  - Does not account for the fact that requirements constantly change.
  - It also means that customers can not use anything until the entire system is complete.

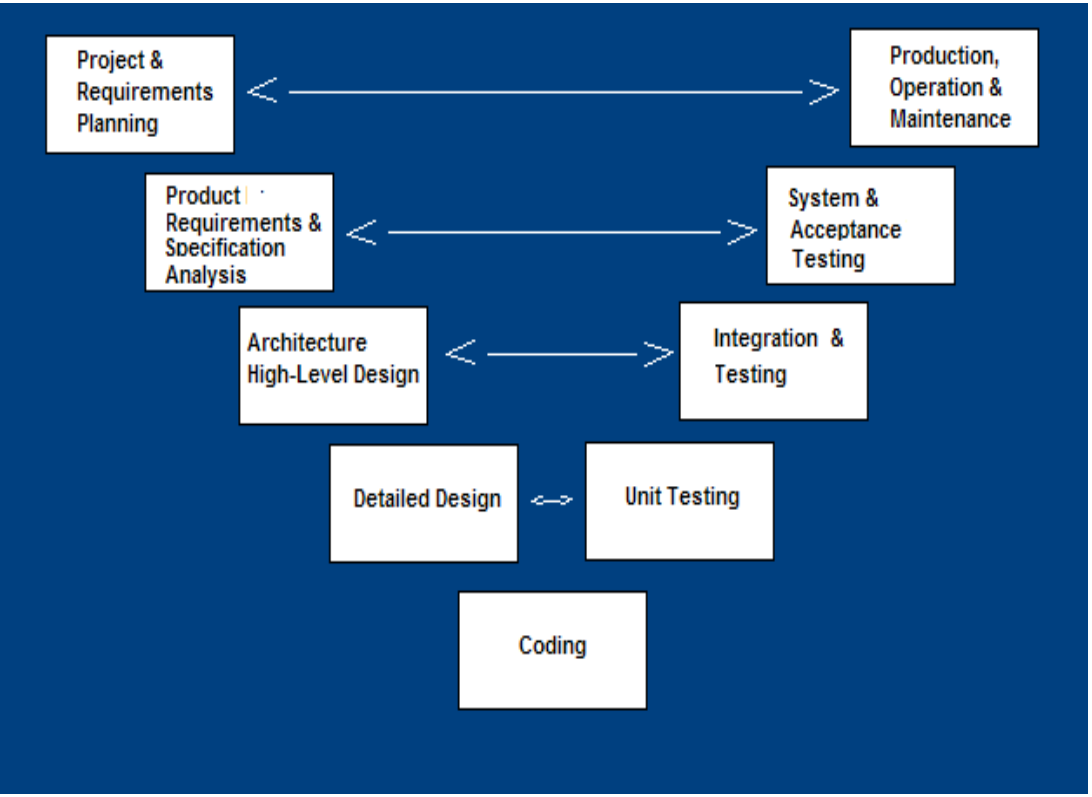
- The model implies that once the product is finished, everything else is maintenance.

- Surprises at the end are very expensive
- Some teams sit ideal for other teams to finish
- Therefore, this model is only appropriate when the requirements are well-understood and changes will be fairly limited during the design process.

- **Problems**:

1. Real projects are rarely follow the sequential model.
2. Difficult for the customer to state all the requirement explicitly.
3. Assumes patience from customer - working version of program will not available until programs not getting change fully.

V-Shaped SDLC Model



- A variant of the Waterfall that emphasizes the verification and validation of the product.
- Testing of the product is planned in parallel with a corresponding phase of development

V-Shaped Steps

- Project and Requirements Planning – allocate resources
- Product Requirements and Specification Analysis – complete specification of the software system
- Architecture or High-Level Design – defines how software functions fulfill the design
- Detailed Design – develop algorithms for each architectural component
- Production, operation and maintenance – provide for enhancement and corrections
- System and acceptance testing – check the entire software system in its environment
- Integration and Testing – check that modules interconnect correctly
- Unit testing – check that each module acts as expected
- Coding – transform algorithms into software

V-Shaped Strengths

- Emphasize planning for verification and validation of the product in early stages of product development
- Each deliverable must be testable
- Project management can track progress by milestones
- Easy to use

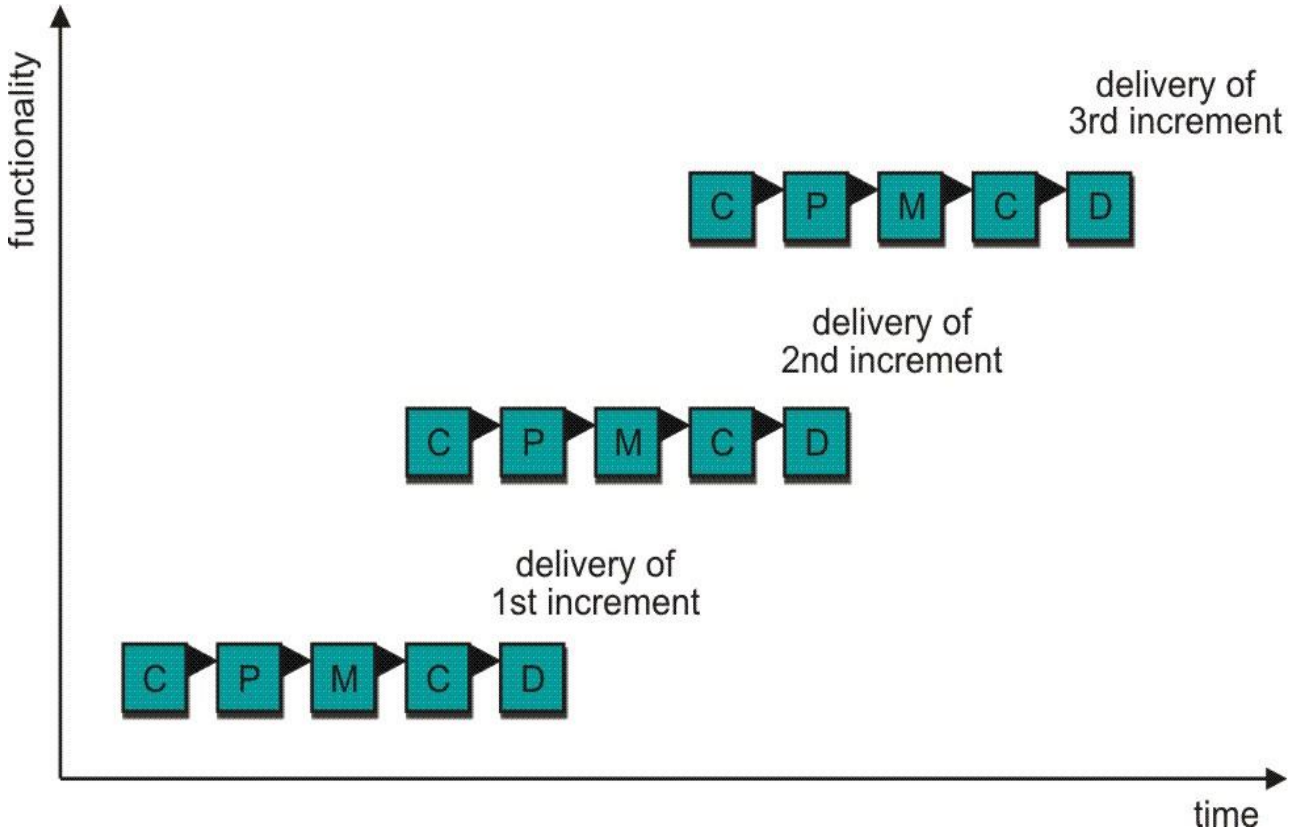
V-Shaped Weaknesses

- Does not easily handle concurrent events
- Does not handle iterations or phases
- Does not easily handle dynamic changes in requirements
- Does not contain risk analysis activities

When to use the V-Shaped Model

- Excellent choice for systems requiring high reliability – hospital patient control applications
- All requirements are known up-front
- When it can be modified to handle changing requirements beyond analysis phase
- Solution and technology are known

Incremental Process Model



C- Communication
P - Planning
M – Modeling
C - Construction
D - Deployment

Delivers software in small but usable pieces, each piece builds on pieces already delivered

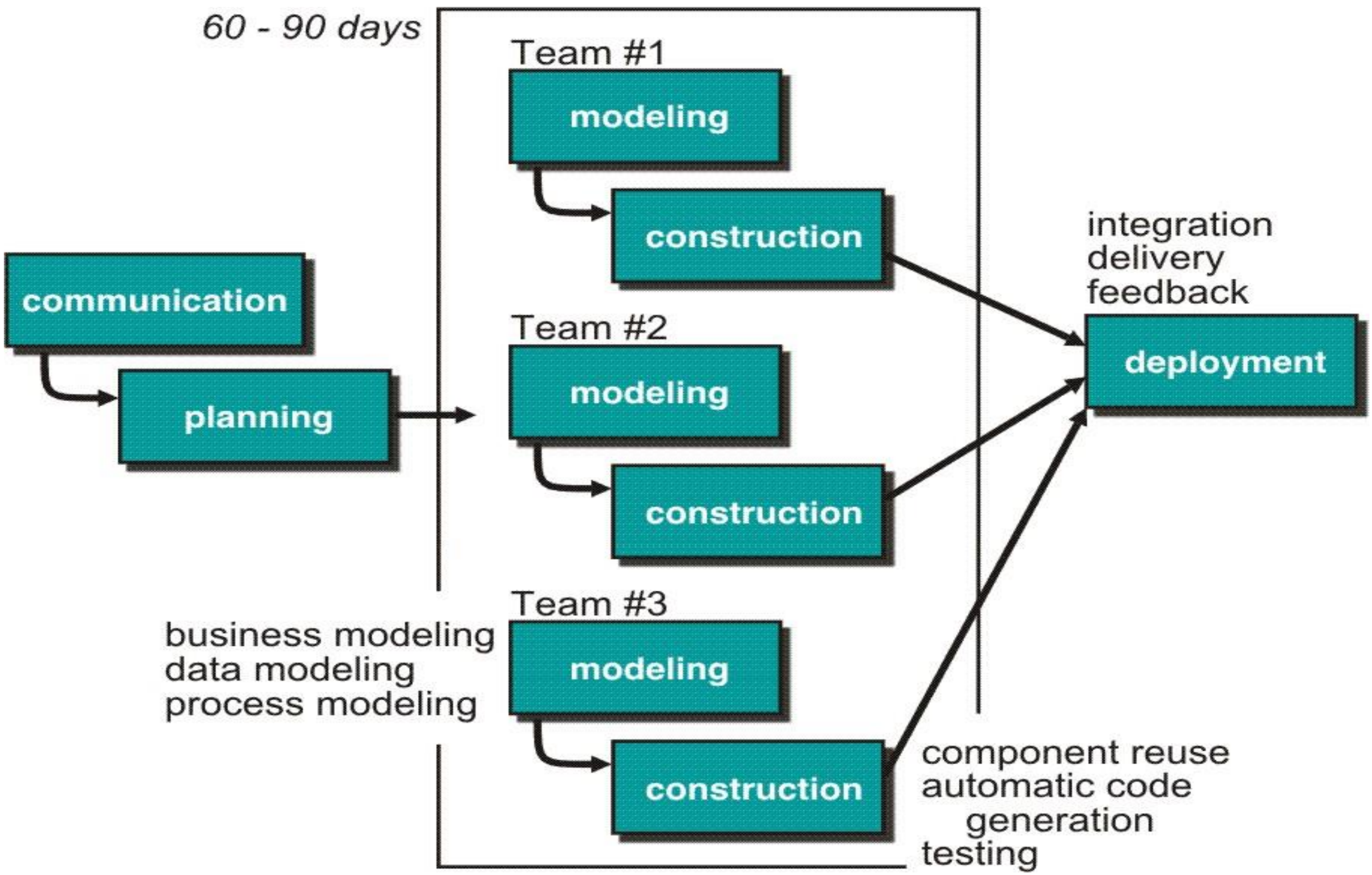
The Incremental Model

- Rather than deliver the system as a single delivery, the development and delivery is broken down into increments with each increment delivering part of the required functionality.
- First Increment is often core product
  - Includes basic requirement
  - Many supplementary features (known & unknown) remain undelivered
- A plan of next increment is prepared
  - Modifications of the first increment
  - Additional features of the first increment
- It is particularly useful when enough staffing is not available for the whole project
- Increment can be planned to manage technical risks.
- Incremental model focus more on delivery of operation product with each increment.

The Incremental Model

- User requirements are prioritised 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.
- Early increments act as a prototype to help elicit requirements for later increments.
- Lower risk of overall project failure.
- The highest priority system services tend to receive the most testing.

Rapid Application Development (RAD) Model



Makes heavy use of reusable software components with an extremely short development cycle

RAD model

- **Communication** – To understand business problem.
- **Planning** – multiple s/w teams works in parallel on diff. system.
- **Modeling** –
  - **Business modeling** – Information flow among business is working.

  Ex. What kind of information drives?

  Who is going to generate information?

  From where information comes and goes?

  - **Data modeling** – Information refine into set of data objects that are needed to support business.
  - **Process modeling** – Data object transforms to information flow necessary to implement business.

RAD Model

- If application is modularized ("Scalable Scope"), each major function to be completed in less than three months.
- Each major function can be addressed by a separate team and then integrated to form a whole.

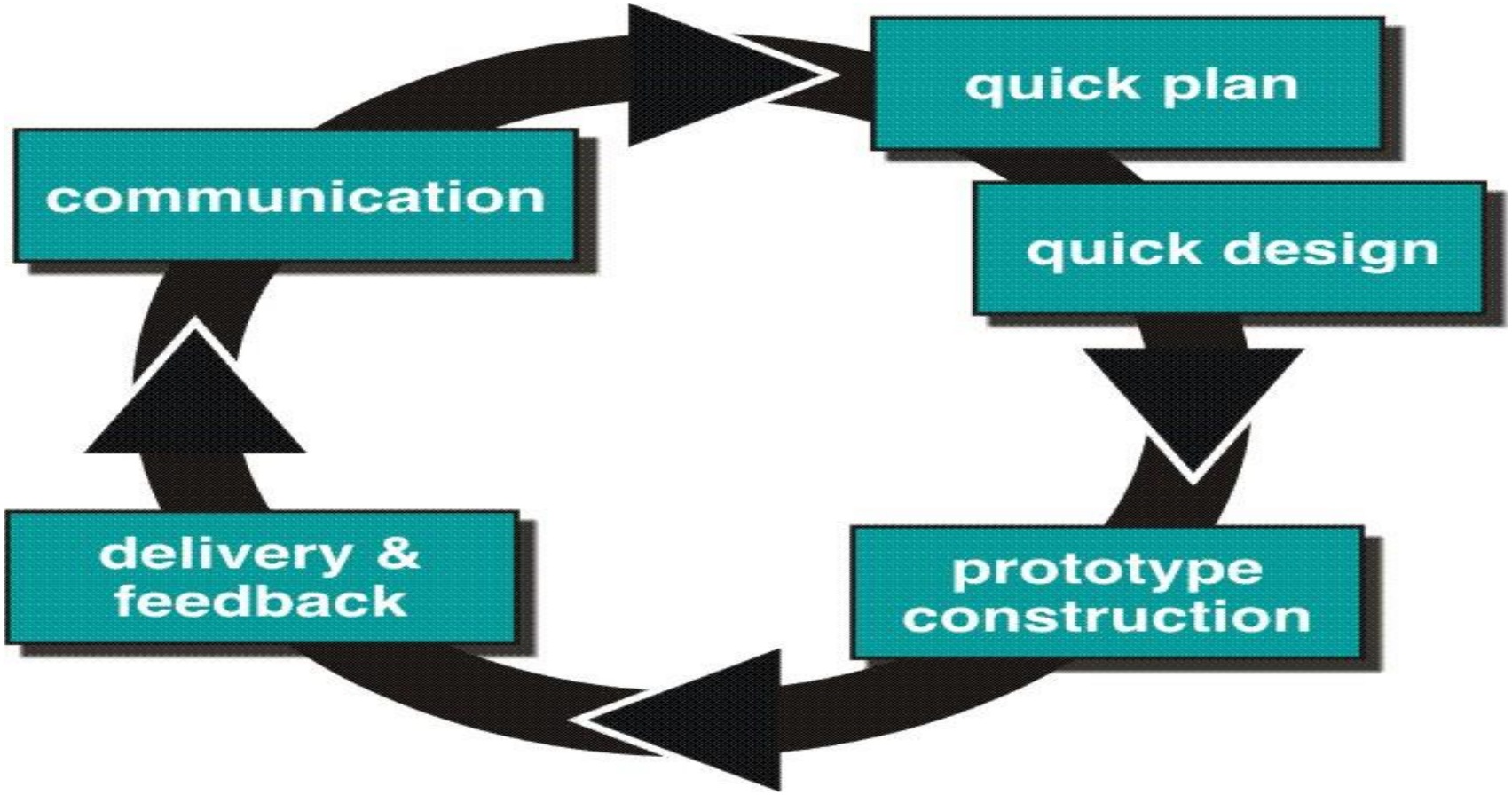
Drawback:

- For large but scalable projects
  - RAD requires sufficient human resources
- Projects fail if developers and customers are not committed in a much shortened time-frame
- Problematic if system can not be modularized
- Not appropriate when technical risks are high (heavy use of new technology)

Evolutionary Process Model

- Produce an increasingly more complete version of the software with each iteration.
- Evolutionary Models are iterative.
- Evolutionary models are:
  - Prototyping
  - Spiral Model
  - Concurrent Development Model
  - Fourth Generation Techniques (4GT)

Evolutionary Process Models :
Prototyping



Prototyping cohesive

- **Best approach when**:
  - Objectives defines by customer are general but does not have details like input, processing, or output requirement.
  - Developer may be unsure of the efficiency of an algorithm, O.S., or the form that human machine interaction should take.
- It can be used as standalone process model.
- Model assist software engineer and customer to better understand what is to be built when requirement are uncertain(Fuzzy).

- Prototyping start with communication, between a customer and software engineer to define overall objective, identify requirements and make a boundary

- Going ahead, planned quickly and modeling (software layout visible to the customers/end-user) occurs.

- Quick design leads to prototype construction.

- Prototype is deployed and evaluated by the customer/user.

- Feedback from customer/end user will refine requirement and that is how iteration occurs during prototype to satisfy the needs of the customer.

Prototyping (cont..)

- Prototype can be serve as “the first system”.
- Both customers and developers like the prototyping paradigm.
  - Customer/End user gets a feel for the actual system
  - Developer get to build something immediately.

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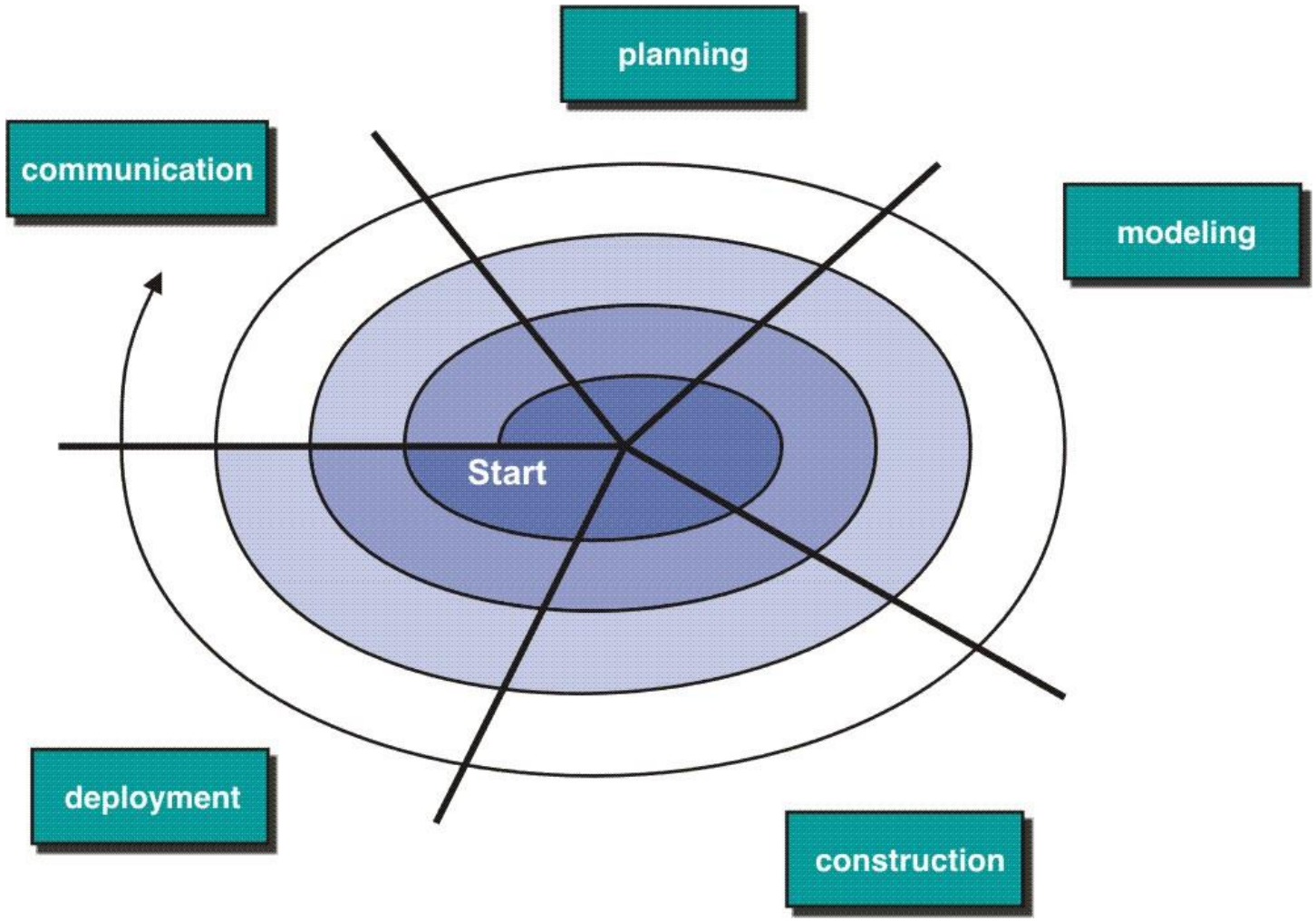
Problem Areas:

- Customer cries foul and demand that “a few fixes” be applied to make the prototype a working product, due to that software quality suffers as a result.
- Developer often makes implementation in order to get a prototype working quickly without considering other factors in mind like OS, Programming language, etc.
- Customer and developer both must be agree that the prototype is built to serve as a mechanism for defining requirement

Evolutionary Model: Spiral Model



Spiral Model

- Couples iterative nature of **prototyping** with the controlled and systematic aspects of the **linear sequential model**

- It provide potential for rapid development of increasingly more complete version of the software.

- Using spiral, software developed in as series of evolutionary release.

  – Early iteration, release might be on paper or prototype.
  – Later iteration, more complete version of software.

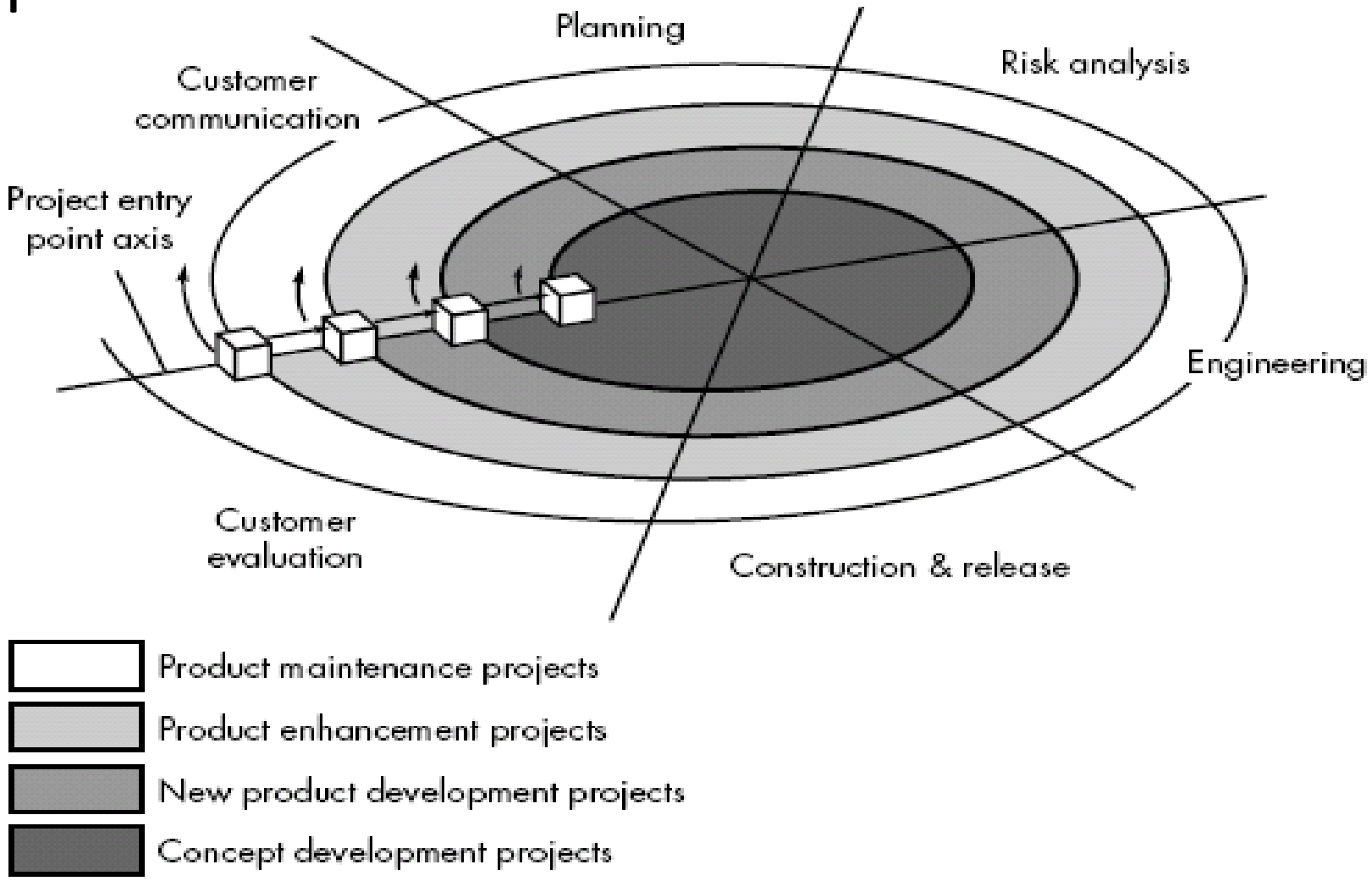
- Divided into framework activities (C,P,M,C,D). Each activity represent one segment.

- Evolutionary process begins in a clockwise direction, beginning at the center risk.

- First circuit around the spiral might result in development of a product specification.

- Subsequently, develop a prototype and then progressively more sophisticated version of software.

Spiral Model



Spiral Model (cont.)

Concept Development Project:

- Start at the core and continues for multiple iterations until it is complete.
- If concept is developed into an actual product, the process proceeds outward on the spiral.

New Product Development Project:

- New product will evolve through a number of iterations around the spiral.
- Later, a circuit around spiral might be used to represent a "Product Enhancement Project"

Product Enhancement Project:

- There are times when process is undeveloped or software team not developing new things but change is initiated, process start at appropriate entry point.

- Spiral models uses prototyping as a risk reduction mechanism but, more important, enables the developer to apply the prototyping approach at each stage in the evolution of the product.

- It maintains the systematic stepwise approach suggested by the classic life cycle but also incorporates it into an iterative framework activity.

- If risks cannot be resolved, project is immediately terminated

The 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**

What is “Agility”?

- Effective (rapid and adaptive) response to change (team members, new technology, requirements)
- Effective communication in structure and attitudes among all team members, technological and business people, software engineers and managers。
- Drawing the customer into the team. Planning in an uncertain world has its limits and plan must be flexible.
- Organizing a team so that it is in control of the work performed
- Eliminate all but the most essential work products and keep them lean.
- Emphasize an incremental delivery strategy as opposed to intermediate products that gets working software to the customer as rapidly as feasible.

What is “Agility”?

- Rapid, incremental delivery of software
- The development guidelines stress delivery over analysis and design although these activates are not discouraged, and active and continuous communication between developers and customers.

An Agile Process

- Is driven by customer descriptions of what is required (scenarios). Some assumptions:
  - Recognizes that plans are short-lived (some requirements will persist, some will change. Customer priorities will change)
  - Develops software iteratively with a heavy emphasis on construction activities (design and construction are interleaved, hard to say how much design is necessary before construction. Design models are proven as they are created.)
  - Analysis, design, construction and testing are not predictable.
- Thus has to Adapt as changes occur due to unpredictability
- Delivers multiple 'software increments', deliver an operational prototype or portion of an OS to collect customer feedback for adaption.

Agility Principles - I

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face–to–face conversation.

Agility Principles - II

7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity – the art of maximizing the amount of work not done – is essential.
11. The best architectures, requirements, and designs emerge from self–organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Extreme Programming (XP)

- The most widely used agile process, originally proposed by Kent Beck in 2004. It uses an object-oriented approach.

- XP Planning
  - Begins with the listening, leads to creation of "user stories" that describes required output, features, and functionality. Customer assigns a value(i.e., a priority) to each story.
  - Agile team assesses each story and assigns a cost (development weeks. If more than 3 weeks, customer asked to split into smaller stories)
  - Working together, stories are grouped for a deliverable increment next release.

- A commitment (stories to be included, delivery date and other project matters) is made.
- Three ways:
- 1. Either all stories will be implemented in a few weeks,
- 2. high priority stories first, or
- 3. the riskiest stories will be implemented first.

- After the first increment "project velocity", namely number of stories implemented during the first release is used to help define subsequent delivery dates for other increments.

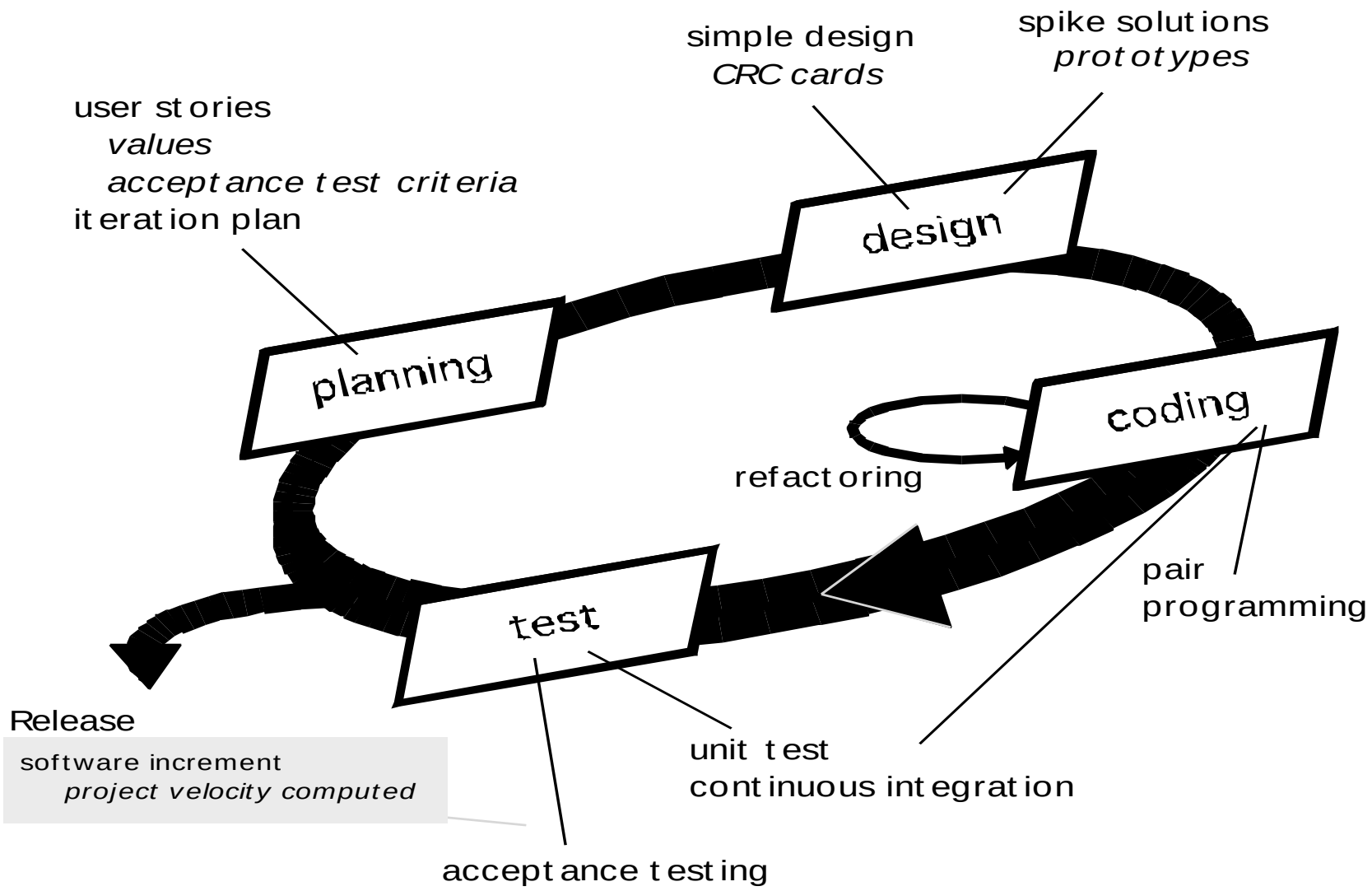
- Customers can add stories, delete existing stories, change values of an existing story, split stories as development work proceeds.

Extreme Programming (XP)

- XP Design (occurs both before and after coding as refactoring is encouraged)
  - Follows the KIS principle (keep it simple) Nothing more nothing less than the story.
  - Encourage the use of CRC (class-responsibility-collaborator) cards in an object-oriented context. The only design work product of XP.
  - For difficult design problems, suggests the creation of "spike solutions"—a design prototype for that portion is implemented and evaluated.
  - Encourages "refactoring"—an iterative refinement of the internal program design. Does not alter the external behavior yet improve the internal structure. Minimize chances of bugs. More efficient, easy to read.

- XP Coding
  - Recommends the construction of a unit test for a story *before* coding commences. So implementer can focus on what must be implemented to pass the test.
  - Encourages "pair programming". Two people work together at one workstation. Real time problem solving, real time review for quality assurance. Take slightly different roles.
- XP Testing
  - All unit tests are executed daily and ideally should be automated. Regression tests are conducted to test current and previous components.
  - "Acceptance tests" are defined by the customer and executed to assess customer visible functionality

Extreme Programming (XP)



SCRUM

- Scrum's unique importance among the methods its **strong promotion of self-directed teams**
- Daily team measurement
- Avoidance of prescriptive process
- Demo to external stakeholders at end of each iteration
- each iteration, client-driven adaptive planning

Some key practices include:

- self-directed and self-organizing team
- no external addition of work to an iteration, once chosen
- daily stand-up meeting with special questions
- usually 30-calendar day iterations

Scrum has been used by:

- Microsoft
- Yahoo
- Google
- Electronic Arts
- Lockheed Martin
- Philips
- Siemens
- Nokia
- IBM
- Capital One
- BBC
- Intuit
- Nielsen Media
- First American Real Estate
- BMC Software
- Ipswitch
- John Deere
- Lexis Nexis
- Sabre
- Salesforce.com
- Time Warner
- Turner Broadcasting
- Oce

Scrum has been used for:

- Commercial software
- In-house development
- Contract development
- Fixed-price projects
- Financial applications
- ISO 9001-certified applications
- Embedded systems
- 24x7 systems with 99.999% uptime requirements
- the Joint Strike Fighter
- Video game development
- FDA-approved, life-critical systems
- Satellite-control software
- Websites
- Handheld software
- Mobile phones
- Network switching applications
- ISV applications
- Some of the largest applications in use

REQUIREMENT ENGINEERING

INTRODUCTION

What is Requirement?

It is a statement describing either

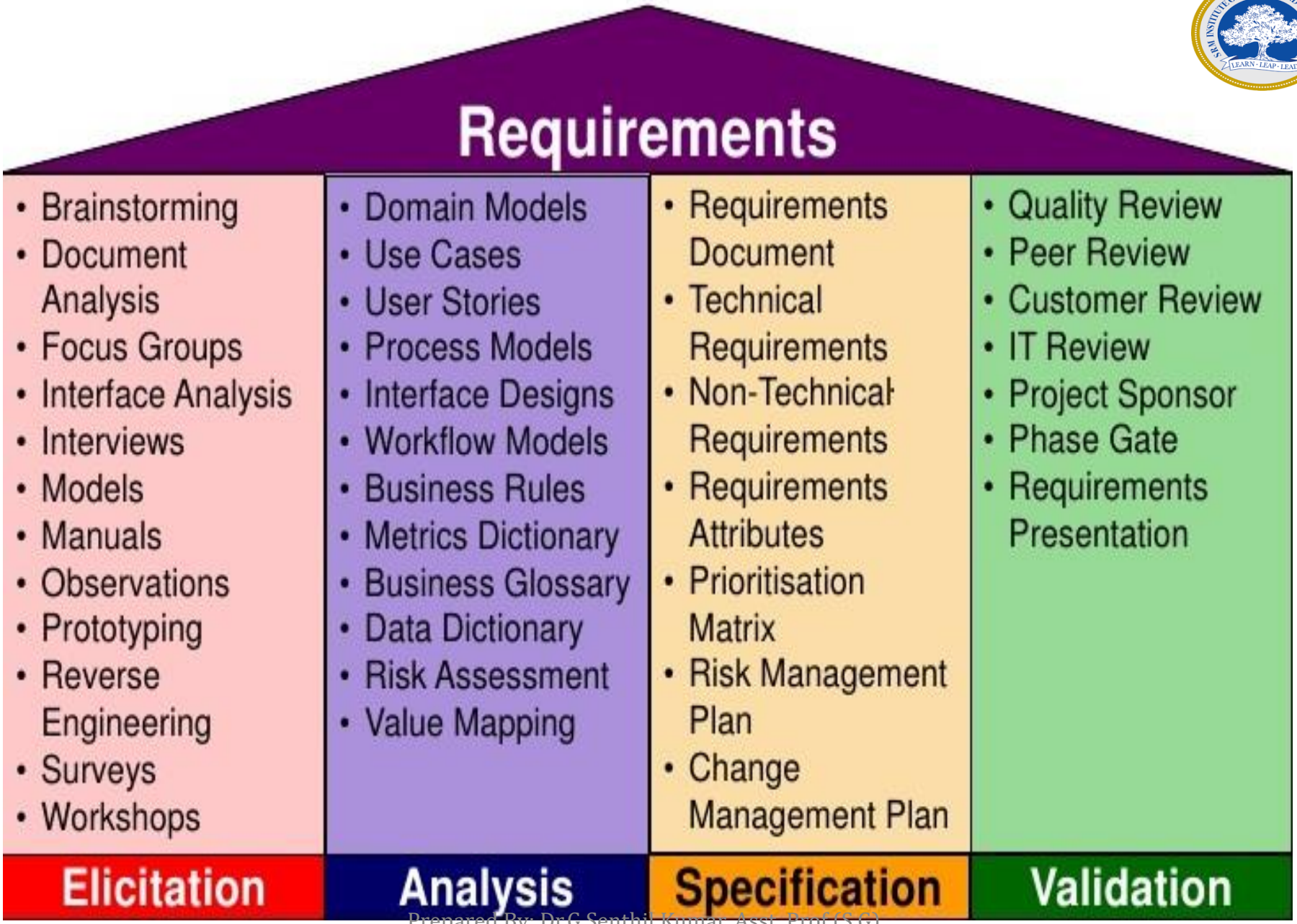
- an aspect of what the proposed system must do, or
- a constraint on the system's development.

  In either case it must contribute in some way towards adequately solving the customer's problem;

- the set of requirements as a whole represents a negotiated agreement among the stakeholders.
- A collection of requirements is a *requirements document.*

What are Requirements?

- Requirements are defined during the early stages of a system development as a **specification** of what should be implemented or as a constraint of some kind on the system.
- They may be:
  - a user-level facility description,
  - a detailed specification of expected system behaviour,
  - a general system property,
  - a specific constraint on the system,
  - information on how to carry out some computation,
  - a constraint on the development of the system.


Requirements
• Brainstorming
• Document Analysis
• Focus Groups
• Interface Analysis
• Interviews
• Models
• Manuals
• Observations
• Prototyping
• Reverse Engineering
• Surveys
• Workshops
• Domain Models
• Use Cases
• User Stories
• Process Models
• Interface Designs
• Workflow Models
• Business Rules
• Metrics Dictionary
• Business Glossary
• Data Dictionary
• Risk Assessment
• Value Mapping
• Requirements Document
• Technical Requirements
• Non-Technical Requirements
• Requirements Attributes
• Prioritisation Matrix
• Risk Management Plan
• Change Management Plan
• Quality Review
• Peer Review
• Customer Review
• IT Review
• Project Sponsor
• Phase Gate
• Requirements Presentation
Elicitation
Analysis
Specification
Validation

Types of Requirement

User requirements

- Statements in natural language plus diagrams of the services the system provides and its operational constraints. Written for customers. provides and its operational constraints. Written for customers.

System requirements

- A structured document setting out detailed descriptions of the system's functions, services and operational constraints. Defines what should be implemented so may be part of a contract between client and contractor.

Types of Requirement

- **Functional requirements:**
  - Services the system should provide
  - What the system should do or not in reaction to particular situations
  - Example: “If a patient is known to be allergic to a particular medication, then prescription of that medication shall result in a warning message being issued to the prescriber”
- **Non-functional requirements:**
  - Constraints on the services or functions offered by the system
  - Example: “The system shall be available to all clinics during normal working hours (Mon-Fri, 0830-1730). Downtime during normal working hours shall not exceed 5 seconds in any one day”
- **Domain requirements:**
  - From the application domain of the system
  - Example: “The system shall implement patient privacy provisions as set out in the 1998 Data Protection Act”

Functional vs. Non-Functional Requirements

Functional Requirements	Non-functional Requirements
• **Products** The system **shall display** a list of all products offered by the shop. *MustHave* The system **shall organise** the list of products by product category. *MustHave* The system **shall display** detailed product descriptions consisting of name, photograph, price and text of description on demand. *MustHave* The system shall allow the items in the catalogue to be **searched**. *ShouldHave*. The system **shall display** the number of items currently in the shopping basket on each page of the catalogue. *CouldHave* • **Payment** The system **shall accept** all major credit cards. *MustHave* The system **shall validate** payment with the credit card processing company. *MustHave*	• **Capacity** The system shall support 1000 transactions per day. *ShouldHave* The system shall support a peak transaction rate of 10 transactions per second. *ShouldHave* The system shall support 5000 concurrent sessions. *MustHave* • **Availability** The system shall be available 24 hours per day, 360 days per year. *MustHave* The system shall not lose any transaction data. *MustHave* The system shall accept payment and raise an order within 5 seconds in 95% of the cases. *ShouldHave* The system shall log in a customer within 5 seconds. *ShouldHave*

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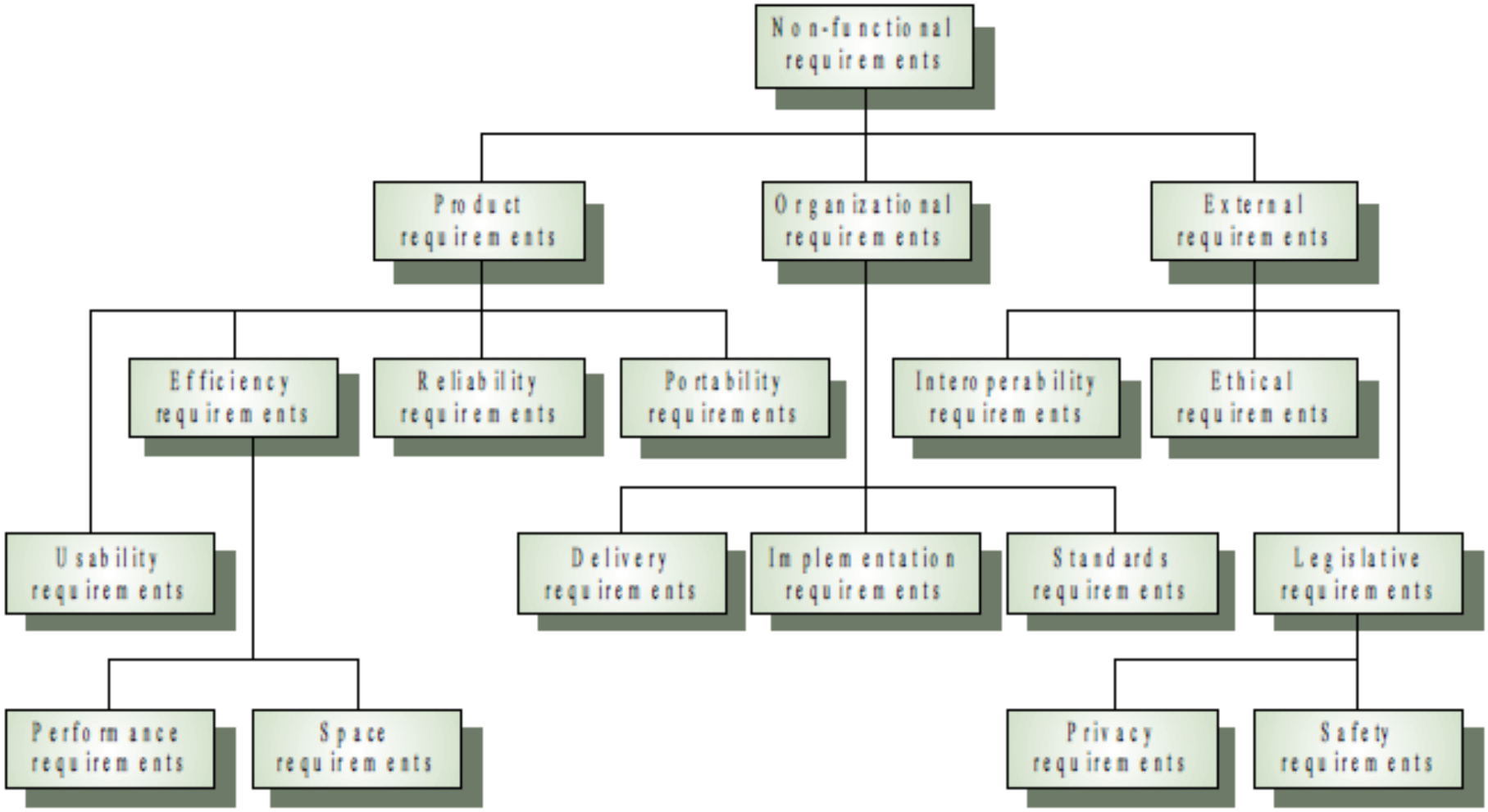
Types of Non- functional Requirements



Elicitation Techniques

Elicitation techniques

- Stakeholder analysis
- Analysis of existing systems or documentation, background reading
- Discourse analysis
- Task observation, ethnography
- Questionnaires
- Interviewing
- Brainstorming
- Joint Application Design (JAD)
- Prototyping
- Pilot system
- Use cases and scenarios
- Risk analysis

Data-Gathering Techniques[1]

Technique	Good for	Kind of data	Plus	Minus
Questionnaires	Answering specific questions	Quantitative and qualitative data	Can reach many people with low resource	The design is crucial. Response rate may be low. Responses may not be what you want
Interviews	Exploring issues	Some quantitative but mostly qualitative data	Interviewer can guide interviewee. Encourages contact between developers and users	Time consuming. Artificial environment may intimidate interviewee
Focus groups and workshops	Collecting multiple viewpoints	Some quantitative but mostly qualitative data	Highlights areas of consensus and conflict. Encourages contact between developers and users	Possibility of dominant characters
Naturalistic observation	Understanding context of user activity	Qualitative	Observing actual work gives insight that other techniques cannot give	Very time consuming. Huge amounts of data
Studying documentation	Learning about procedures, regulations, and standards	Quantitative	No time commitment from users required	Day-to-day work will differ from documented procedures

[1] Preece, Rogers, and Sharp "Interaction Design: Beyond human-computer interaction", p214

Software Project Effort and Cost estimation & Project Planning

The key parameters which define the quality of any software products, which are also an outcome of the Cocomo are primarily Effort & Schedule:

Effort: Amount of labor that will be required to complete a task. It is measured in person-months units.

Schedule: Simply means the **amount of time required for the completion of the job**

Boehm's definition of **organic, semidetached, and embedded systems:**

Organic – A software project is said to be an organic type if the team size required is **adequately small, the problem is well understood and has been solved in the past** and also the team members have a nominal experience the problem

Semi Detached

The projects classified as Semi-Detached are comparatively **less familiar and difficult to develop** compared to the organic ones and **require more experience and better guidance and creativity**. E.g.: Compilers or different Embedded Systems can be considered of Semi-Detached type.

Embedded – A software project with requiring the highest level of complexity, creativity, and experience requirement fall under this category. Such **software requires a larger team size** than the other two models and also the **developers need to be sufficiently experienced and creative to develop such complex models.**

All the above system types utilize different values of the constants used in Effort Calculations.

Types of Models: COCOMO consists of a hierarchy of three increasingly detailed and accurate forms. Any of the three forms can be adopted according to our requirements.

These are types of COCOMO model:

1.Basic COCOMO Model

2.Intermediate COCOMO Model

- The first level, **Basic COCOMO** can be used for quick and slightly rough calculations of Software Costs. Its accuracy is somewhat restricted due to the absence of sufficient factor considerations.

- **Intermediate COCOMO** takes these Cost Drivers into account and **Detailed COCOMO** additionally accounts for the influence of individual project phases

Estimation of Effort: Calculations –

1. **Basic Model –**

$$E = a(KLOC)^b$$

The above formula is used for the cost estimation of for the basic COCOMO model, and also is used in the subsequent models. The constant values a and b for the Basic Model for the different categories of system:

SOFTWARE PROJECTS	A	B
Organic	2.4	1.05
Semi Detached	3.0	1.12
Embedded	3.6	1.20

- The **effort is measured in Person-Months** and as evident from the formula is dependent on Kilo-Lines of code.

- These formulas are used as such in the Basic Model calculations, as not much consideration of different factors such as reliability, expertise is taken into account, henceforth the estimate is rough.

Intermediate Model –The basic Cocomo model assumes that the effort is only a function of the number of lines of code and some constants evaluated according to the different software system.

However, in reality, no system's effort and schedule can be solely calculated on the basis of Lines of Code. For that, various other factors such as reliability, experience, Capability. These factors are known as Cost Drivers and the **Intermediate Model utilizes 15 such drivers for cost estimation.**

Classification of Cost Drivers and their attributes:

(i) Product attributes –

Required software reliability extent

Size of the application database

The complexity of the product

(ii) Hardware attributes –

Run-time performance constraints

Memory constraints

The volatility of the virtual machine environment

Required turnabout time

(iii) Personnel attributes –

Analyst capability

Software engineering capability

Applications experience

Virtual machine experience

Programming language experience

(iv) Project attributes –

Use of software tools

Application of software engineering methods

Required development schedule

(iii) Personnel attributes –

Analyst capability

Software engineering capability

Applications experience

Virtual machine experience

Programming language experience

(iv) Project attributes –

Use of software tools

Application of software engineering methods

Required development schedule

COST DRIVERS	VERY LOW	LOW	NOMINAL	HIGH	VERY HIGH
Product Attributes					
Required Software Reliability	0.75	0.88	1.00	1.15	1.40
Size of Application Database		0.94	1.00	1.08	1.16
Complexity of The Product	0.70	0.85	1.00	1.15	1.30
Hardware Attributes					
Runtime Performance Constraints			1.00	1.11	1.30
Memory Constraints			1.00	1.06	1.21
Volatility of the virtual machine environment		0.87	1.00	1.15	1.30
Required turnabout time		0.94	1.00	1.07	1.15

Personnel attributes					
Analyst capability	1.46	1.19	1.00	0.86	0.71
Applications experience	1.29	1.13	1.00	0.91	0.82
Software engineer capability	1.42	1.17	1.00	0.86	0.70
Virtual machine experience	1.21	1.10	1.00	0.90	
Programming language experience	1.14	1.07	1.00	0.95	
Project Attributes					
Application of software engineering methods	1.24	1.10	1.00	0.91	0.82
Use of software tools	1.24	1.10	1.00	0.91	0.83
Required development schedule	1.23	1.08	1.00	1.04	1.10

- The project manager is to rate these 15 different parameters for a particular project on a scale of one to three.

  Then, depending on these ratings, appropriate cost driver values are taken from the above table.

  These 15 values are then multiplied to calculate the EAF (Effort Adjustment Factor). The Intermediate COCOMO formula now takes the form:

$$E = (a(KLOC)^b) * EAF$$

The values of a and b in case of the intermediate model are as follows:

SOFTWARE PROJECTS	A	B
Organic	3.2	1.05
Semi Detached	3.0	1.12
Embeddedc	2.8	1.20

Software Project Planning

The overall goal of project planning is to establish a pragmatic strategy for controlling, tracking, and monitoring a complex technical project.

Why?

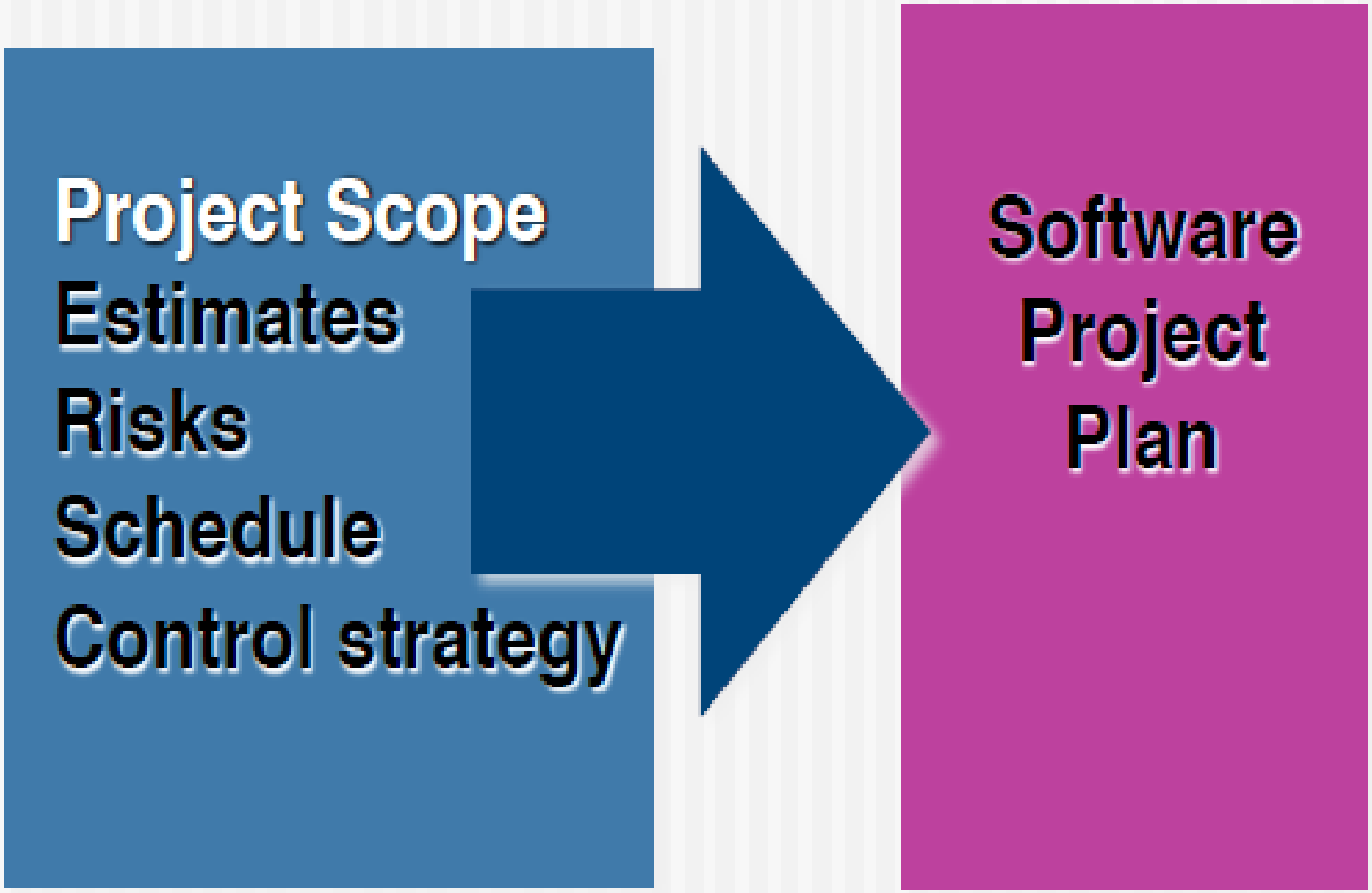
So the end result gets done on time, with quality!

Project Planning Task Set-I

- Establish project scope
- Determine feasibility
- Analyze risks
  - Risk analysis is considered in detail in Chapter 25.
- Define required resources
  - Determine require human resources
  - Define reusable software resources
  - Identify environmental resources

Estimation

- Estimation of resources, cost, and schedule for a software engineering effort requires
  - experience
  - access to good historical information (metrics)
  - the courage to commit to quantitative predictions when qualitative information is all that exists
- Estimation carries inherent risk and this risk leads to uncertainty


Project Scope
Estimates
Risks
Schedule
Control strategy
Software
Project
Plan

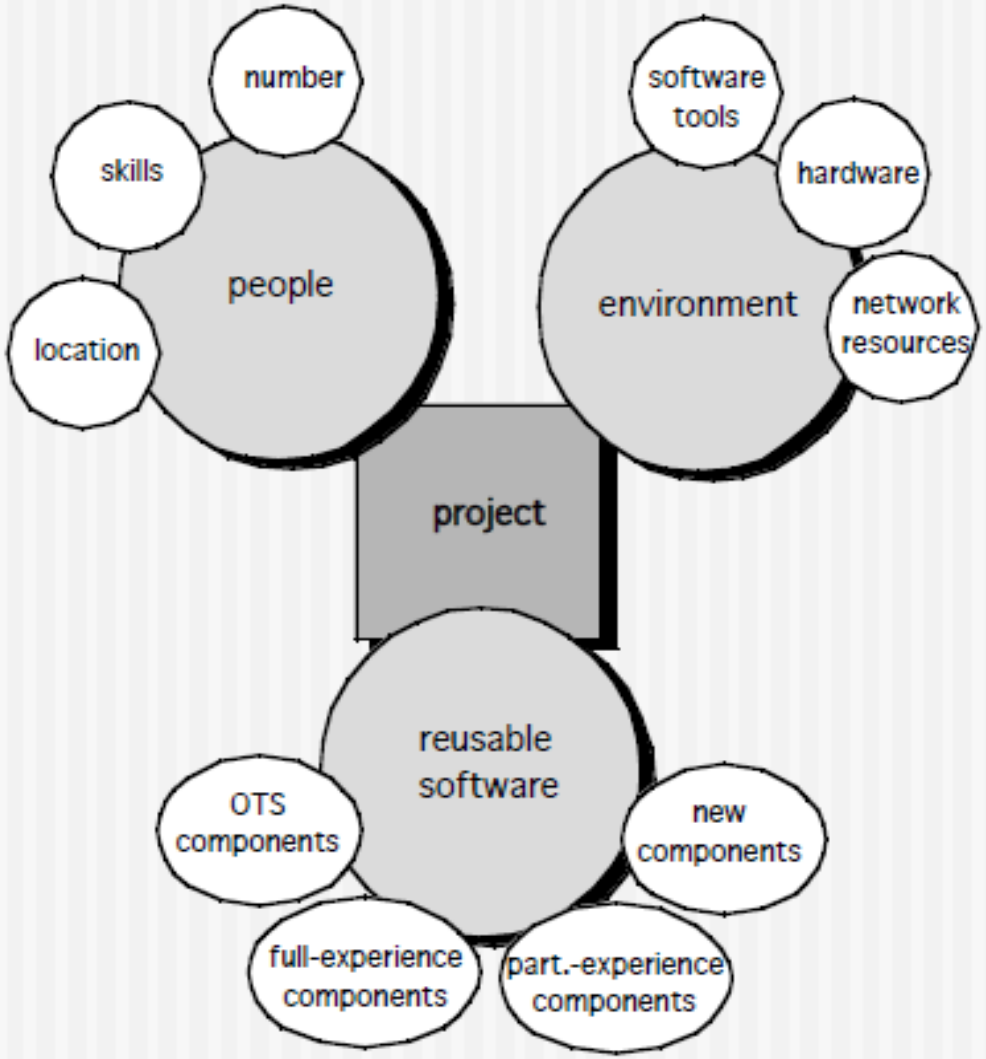
To Understand Scope ...

- Understand the customers needs
- understand the business context
- understand the project boundaries
- understand the customer's motivation
- understand the likely paths for change

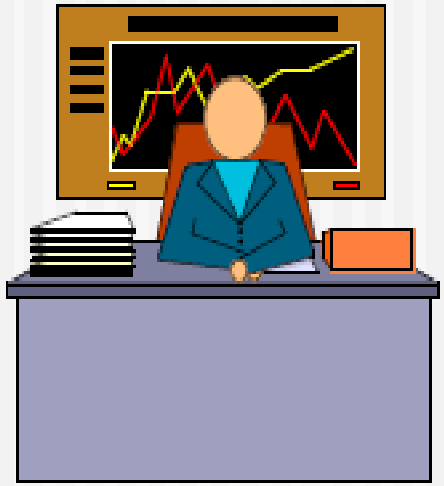
What is Scope?

- *Software scope* describes
  - the functions and features that are to be delivered to end-users
  - the data that are input and output
  - the "content" that is presented to users as a consequence of using the software
  - the performance, constraints, interfaces, and reliability that *bound* the system.
- Scope is defined using one of two techniques:
  - A narrative description of software scope is developed after communication with all stakeholders.
  - A set of use-cases is developed by end-users.

Resources


number
skills
people
location
software tools
hardware
environment
network resources
project
reusable software
OTS components
new components
full-experience components
part.-experience components

Project Estimation



- Project scope must be understood
- Elaboration (decomposition) is necessary
- Historical metrics are very helpful
- At least two different techniques should be used
- Uncertainty is inherent in the process

Work Breakdown Structures

Work Breakdown Structures

- The development of a work breakdown structure is dependent on the project management style, organizational culture, customer preference, financial constraints and several other hard-to-define parameters.

- A WBS is simply a hierarchy of elements that decomposes the project plan into the discrete work tasks.
- A WBS provides the following information structure:
  - A delineation of all significant work
  - A clear task decomposition for assignment of responsibilities
  - A framework for scheduling, budgeting, and expenditure tracking

- Two simple planning guidelines should be considered when a project plan is being initiated or assessed.

FIRST-LEVEL WBS ELEMENT	DEFAULT BUDGET
Management	10%
Environment	10%
Requirements	10%
Design	15%
Implementation	25%
Assessment	25%
Deployment	5%
Total	100%

The first guideline prescribes a default allocation of costs among the first-level WBS elements

DOMAIN	INCEPTION	ELABORATION	CONSTRUCTION	TRANSITION
Effort	5%	20%	65%	10%
Schedule	10%	30%	50%	10%

The second guideline prescribes the allocation of effort and schedule across the life-cycle phases

The Cost and Schedule Estimating Process

- Project plans need to be derived from two perspectives.
- *Forward-looking:*

1. The software project manager develops a characterization of the overall size, process, environment, people,
and quality required for the project

2. A macro-level estimate of the total effort and schedule is developed using a software cost estimation model

3. The software project manager partitions the estimate for the effort into a top-level WBS, also partitions the schedule into major milestone dates and partitions the effort into a staffing profile

4. At this point, subproject managers are given the responsibility for decomposing each of the WBS elements into lower levels using their top-level allocation, staffing profile, and major milestone dates as constraints.

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- *Backward-looking:*

1. The lowest level WBS elements are elaborated into detailed tasks, for which budgets and schedules are estimated by the responsible WBS element manager.

2. Estimates are combined and integrated into higher level budgets and milestones.

3. Comparisons are made with the top-down budgets and schedule milestones. Gross differences are assessed and adjustments are made in order to converge on agreement between the top-down and the bottom-up estimates.

REFERENCES:

- Roger S. Pressman, Software Engineering – A Practitioner Approach, 6th ed., McGraw Hill, 2005
- Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010
- Walker Royce, Software Project Management, Pearson Education, 1999
- Jim Smith Agile Project Management: Creating Innovative Products, Pearson