UNIT - 1

Software Engineering Introduction

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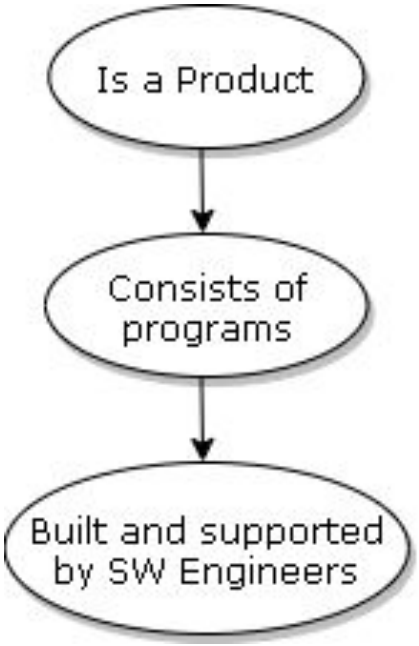
What is a Software?

What is a Software?



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Who SW is for?

Who SW is for?

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Literally for everyone in the industrialized world

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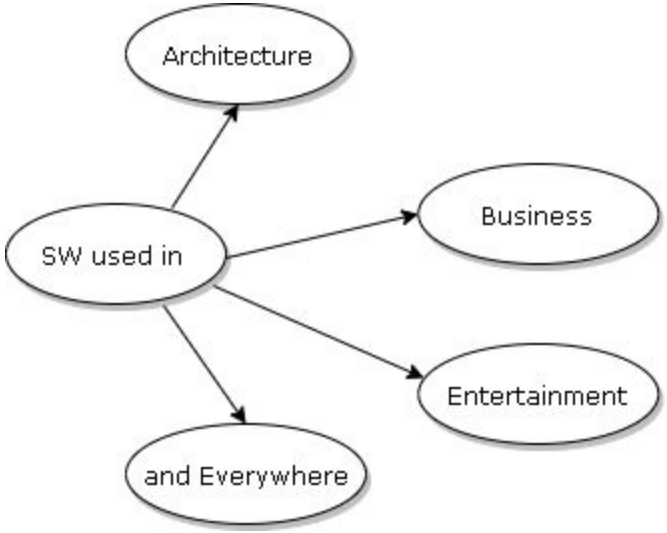
Why is it so important?

Why is it so important?



Software is inevitable

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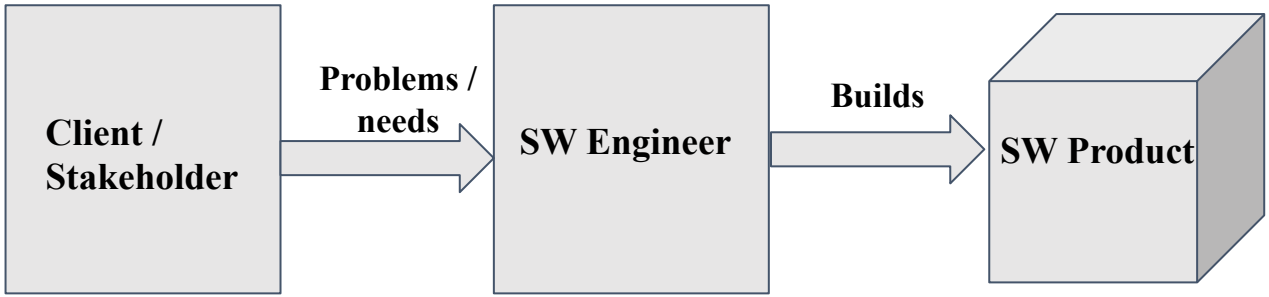
What are the steps for Software creation?

Steps for SW creation



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What is a work product?

What is work product?

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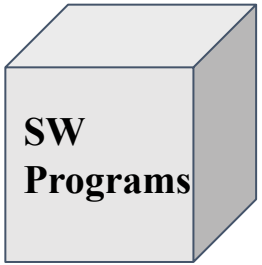

That runs in one computer and used by at least one user

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How to ensure everything is right?

How to ensure everything is right?

By making sure that the SW Engineer follows the **best practices** and and **frameworks** mentioned in the book

Impacts made by Computer SW

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- The SW emerged from a product to an on demand service
- Has grown very big
- New technologies are easier, faster, high quality and less expensive

Example of SW technologies

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- Web design and implementation
- Aspect Oriented Systems (Annotations)
- OS such as linux
- Object Oriented System

The different roles of SW

- Product
- A vehicle to transfer the product

The difference between Data and information?

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Let's discuss in detail with white board....

Don’t forget. The information is an important product of our age

The changes SW has undergone:

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Changes in...

Hardware performance

Architecture

Increased memory & storage

Range of input & output devices

Question:

What are the other improvements that are reason for the changes made in SW?

Questions for discussion and how can we solve them?

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Why does it take so long to get the sw finished?

Why are costs so high?

Why can't we find all errors before release?

Why do we have difficulty in measuring progress of software development?

Why do we need to spend time to improve the existing system?

The solution is:

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By using the proven process and frameworks

Comparing SW with HW

- Hardware system wear out (Become Useless) after time
- Can be fixed with changing that particular part

What are the reasons for Wearout???

SW doesn’t wear out instead deteriorate

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Let's discuss the bathtub curve of HW and compare the same for SW

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Types of SW

Let's discuss with white board

What are legacy SW?

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SW created decades ago

Continuously modified to meet the changes

Why not simply throw away the Legacy SW?

What are your answers?

Why not simply throw away the Legacy SW?

- In many companies the core business areas are handled by some legacy SW
- It’s almost impossible to change into a new system that may affect the entire business process

Issues with legacy

- Convoluted code [Unnecessarily complex code]
- Costly to maintain
- Poor performance
- Poor or non existent code change history
- Test cases were never archived
- Etc

What could be the solution?

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Let us think and discuss

What could be the solution?

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Few points:

- As long as the system supports the core operations it need not to be fixed
- Yet changes has to be made based on below reasons...

Reasons for changes

- To meet the needs computing requirements & Technology
- To meet new business requirements
- To make it interoperable with modern systems
- Re architected to make it relevant to the current needs

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The dominant SW domains in present days

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Lets ask the question again What is SE?

Lets ask the question again What is SE?

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- Collection of process
- Collection of methods
- Array of tools to implement

Purpose:

- To Create complex SW systems with ease
- in a timely manner
- With high quality
- Imposes discipline but adaptable and agile

What is a work product?

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Can be

- a set of programs
- Data
- Forms
- A software
- The outcome of any milestone of the project

The definition by IEEE IIEE93a of SE:

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The application of

- Systematic
- Disciplined
- Quantifiable

} Approaches

Used for

- Development
- Operations
- Maintenance

The Disciplined freedom:

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- The systematic, disciplined & quantifiable approach of one team may not be suitable for another team
- So the approaches have to be customized according to project nature and needs
- Process can provide flexible approaches

The different layers of SE

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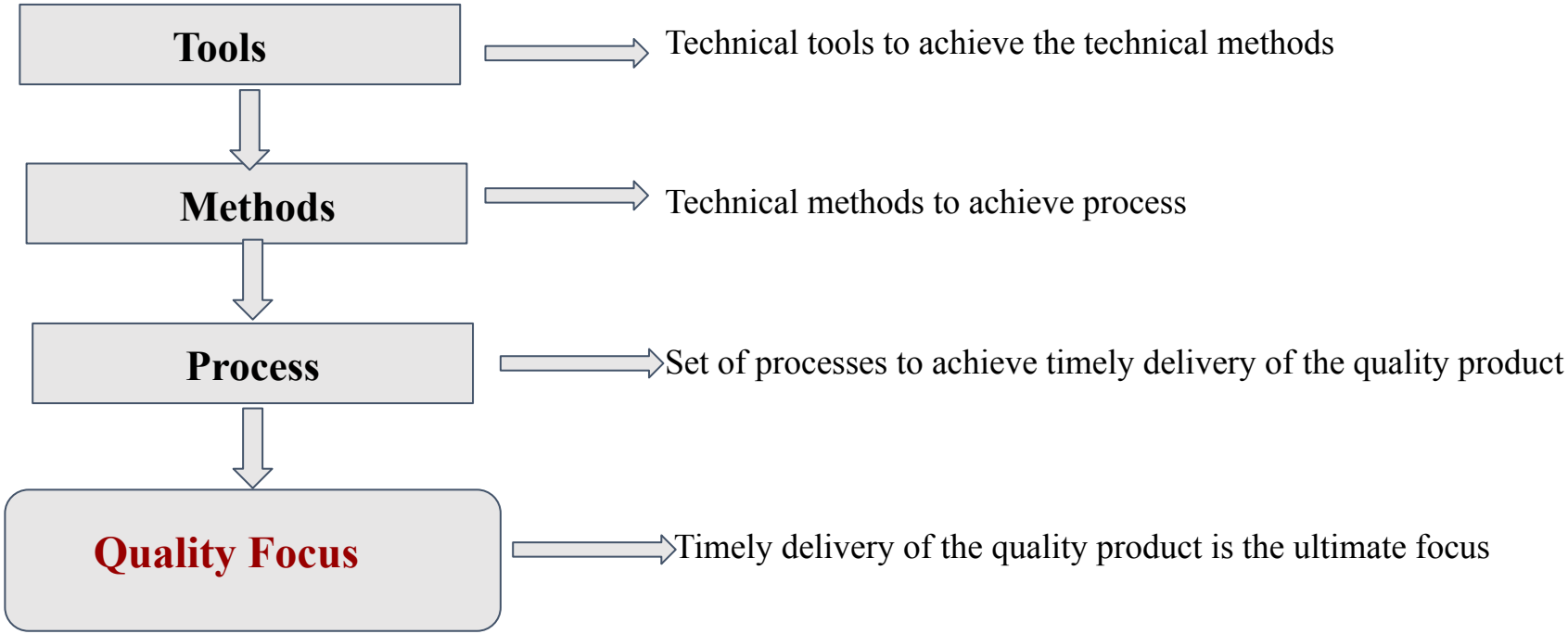
The SE is made up of different layers:

1. Processes
2. Methods
3. Tools

- The main focus is **"the quality product in a timely manner"**
- **Lean Six Sigma, TQM** are some examples philosophies that provides approaches to ensure quality
- Being used by leading companies for product development

The layers:


Tools
Technical tools to achieve the technical methods
Methods
Technical methods to achieve process
Process
Set of processes to achieve timely delivery of the quality product
Quality Focus
Timely delivery of the quality product is the ultimate focus

Software process:

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- Foundation of SW Engineering
- Glues each technology layers together
- Ensures timely development of SW products
- Defines framework
- Basis for “**Management control over the projects**”
- Defines the technical methods to be used
- Defines milestones (Work products)

Methods:

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- Are defined by Process layer
- Answers technical **“how to”** questions
- Consists of sub tasks
- Governs each area of technology

Tools:

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- Set of tools for implementing methods
- Can be automated or semi-automated

SW Process:

The process is a collection of activities, actions and tasks

Activities, Actions and tasks:

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Activity: Broad objective

Actions: Set of tasks to achieve the activity

Task: A small and well defined objective that produces outcome

The Process framework (SDLC):

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To ensure quality the process framework was defined:

Establishes foundation of a complete SW Engineering process:

- Communication - With customers/stakeholders
- Planning - Creating map of the process
- Modeling - Sketching / other modeling
- Construction - Coding / Implementing
- Deployment - Delivering the intended product to customer

Communication:

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- Communication between clients & stakeholders
- To understand the objective of the project
- Collecting requirements
- A very important phase
- Helps to identify roles

Planning:

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- Works like a map
- The journey is simplified with the plan
- Also Known As - **SOFTWARE PROJECT PLAN**

Defines the

- Technical tasks
- Risks
- Resources needed
- Deliverables (Milestones) - Work product

Modeling/Design:

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- Sketch/Model of the project in Big picture
- To analyze the system more in detail

Gives more info on:

- The overview of the architecture
- How individual parts fits and work together
- Characteristics
- Also reveals hidden requirements

Redesigning of models to provide a better solution

Construction:

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- Start coding/implementing based on the model prepared
- Yet to discover the errors in testing

Deployment:

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Delivering the product to the client

Customer shares feedback or request changes after use

Umbrella activities:

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- The process framework activities are completed by umbrella activities
- To manage & control progress, quality, change and risks

Umbrella activities:

1. SW Project tracking & control - Assess progress vs plan
2. Risk Management - Assessing the risks that affects the outcome
3. SW QA - Activities to maintain standards such as ISO, CMMI, SPICE etc… and ensure quality
4. Technical reviews - Code reviews, white box testing etc…
5. Measurement - Measures the requirement vs product
6. SW Configuration Management (SCM) - Change management (Ansible, Puppet)
7. Reusability Management - Reusable components (OOP)
8. Work product preparation & Production - Activities to Create the deliverables

Process adoption:

The process of one project is different from another due to the differences in:

Flow of Activities, Actions and Tasks

Actions and tasks defined within each framework activities

Work products (Outcome of achieving a milestone)

QA activities

Degree and rigor with which the process is described

Level of autonomy given to the SW team

Team organizations and roles are prescribed

SW Engineering practice:

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In the classic book *"How to solve It"* George Polya defines the Essence of SW Engineering practices

Lets see how how the practices mapped with the generic process framework:

1. Understand the problem (Communication and analysis)
2. Plan a solution (Planning & Modeling and SW design)
3. Carry out the plan (Code generation)
4. Examine the result for accuracy (Testing and QA)

1. Understand the problem (Communication and analysis)

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poor understanding of problem leads to **poor quality product**.

1. Don’t try to solve the problem unless understand it clearly
2. A non existent problem can’t be solved
3. Document the info collected from stakeholders

Sample questions you may ask:

To understand the problem clearly:

a. Who are the stakeholders?
b. What are the data, functions and features required to properly solve the problem?
c. Can the problem be compartmentalized?
d. Can the problem be represented graphically?

Plan the solution (Modeling & SW design):

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- After identifying the problem **don’t jump into coding immediately**.
- Find if a similar problem had been solved before.
- Recognize patterns to common problem and this exposes a potential solution, which in the end leads to effective implementation

What are the questions you will ask during **planning the solution**?

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What are the questions you would like to ask

“while planning for the solution”?

Carry out the plan : (Coding)

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- The plan created is the map
- Many issues will only be understood when you start implementing the code
- Having plan? - You won’t get lost

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What questions will you ask “**while coding**”?

Examining the result for accuracy (Testing & QA)

- Your solution may not be perfect
- Conduct as many as number of tests possible to get closer to perfection

The 7 Principles by David Hooker

David Hooker has defined 7 principles to follow for a successful SW system design

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What are principles?

What are principles?

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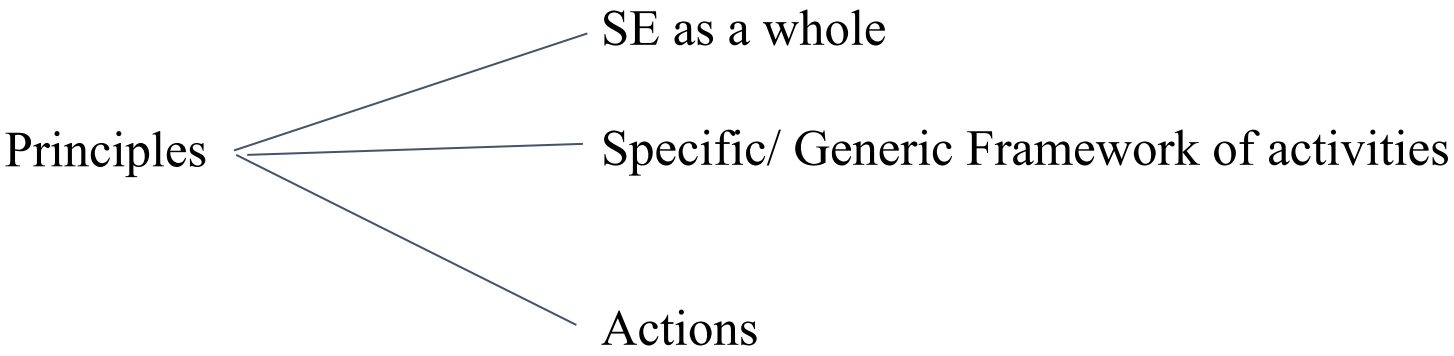
An important underlying law or assumption required in a system of thoughts

Establishes a solid mindset for SE practices



1. The Reason it all exists:

The reason for SW System? **“To Provide value to users”** Always keep in mind

Ask Question does this feature or approach add value to the system

2. KISS (Keep it Simple, Stupid)

Keep the system as Simple as Possible

A good system is easily understood and maintained

The above consideration will lead great success

Don’t avoid important sub parts in the name of simplicity

Successful systems are simple systems

Simple design Quick & Dirty

A lot of thoughts & Effort required to achieve simplicity

3. Maintain the Vision

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Clear vision = Success

Conceptual integrity is needed

Compromise architectural integrity = Break the system

The role of Architect

4. What you produce others will consume

SW are always, used, maintained and documented by others

Keep that in mind always

Design & implement the code accordingly

5. Be open to the future

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“Industrial strength” SW lasts long

More life span = More value

Think about longevity and adaptability from starting of design itself

6. Plan ahead for reuse

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Reuse:

- Saves time effort
- Harder to achieve
- Increased cost for developing
- OOP is an example
- Planning and thought process required
- Techniques are available to use in each level of dev. process

7. Think

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- Overlooked but essential
- Think before action = better result
- Even if there is a failure after thinking thats ok
- Indirect benefits
- Clear thought => System => Better results
- All the other principles requires thinking

SW Engineering Myths:

What are myths?

- Erroneous beliefs about SW & process
- May contain reasonable statement of fact

Myths can be of Management, Customers or Practitioners

Management Pressure:

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Pressure faced by Managers due to:

- Maintain budgets
- Keep schedule from slipping
- Improving quality

To get relief from the above reasons managers sometime believe in myths

Management Myths:

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Myth 1:

We already have a book that's full of standards and procedures for building SW. It will provide all info that my developers need.

Reality:

The book of standards exist:

- but often not used, SW practitioners unaware of its existence
- doesn’t reflect modern SW engineering practice
- incomplete
- not adaptable
- not streamlined to improve time-to-delivery while still maintaining a focus on quality

Management Myths:

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Myth 2:

If we get behind schedule, we can add more programmers and catch up (sometimes called the “Mongolian horde” concept).

Reality:

- unlike mechanical **“Adding more people later will delay the production”**
- New members have to be educated before contributing to the project
- But if well planned it is possible (Only experienced leaders can handle this situation)

Management Myths:

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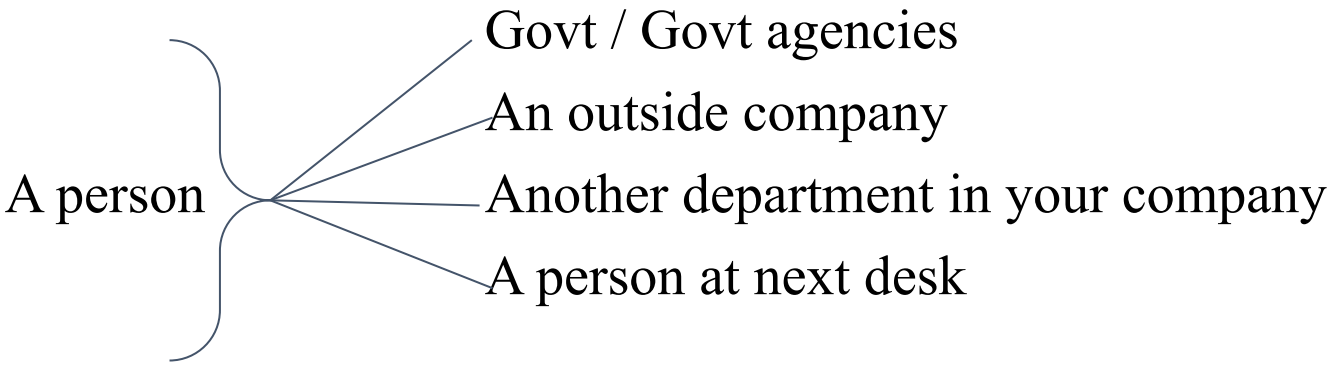
Myth 3:

If I decide to outsource the software project to a third party, I can just relax and let that firm build it.

Reality:

If an organization does not understand how to manage and control internal SW projects, it will also struggle with outsourcing

Who is Customer/client?



- Requested for SW under contract
- Myths of customer may lead to false info
- False info will lead to dissatisfaction with the company/developer

Customer Myths:

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Myth 1:

A general statement of objectives is sufficient to begin writing programs—we can fill in the details later.

Reality:

- comprehensive & stable statement of requirements is not always enough
- an ambiguous "statement of objectives" is a recipe for disaster
- unambiguous requirements **(derived iteratively)** are developed only through **effective and continuous communication**

Customer Myths:

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Myth 2:

Software requirements continually change, but change can be easily accommodated because software is flexible.

Reality:

- Changes made at initial stages (Design/modeling) = costs little
- Changes made at the later stages = costs much
- Changes made later may lead additional rework, resources, team etc...

Who is Practitioner?

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- The person involved in any of the phase of SW development
- Usually mentions the one who develops code

Practitioner Myths:

Myth 1:

Once we write the program and get it to work, our job is done.

Reality:

More work / effort will be needed once the SW is delivered to the client

Practitioner Myths:

Myth 2:

Until I get the program “running” I have no way of assessing its quality.

Reality:

- **“Technical Reviews” -** Are very effective
- Can be started from inception
- Better than testing the SW later

Practitioner Myths:

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Myth 3:

The only deliverable work product for a successful project is the working program.

Reality:

- SW config consists of many elements (Models, documents, reports etc...)
- Working program is one among them
- Work product means the outcome of any achieved milestone

Practitioner Myths:

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Myth 4:

Software engineering will make us create voluminous and unnecessary documentation and will invariably slow us down.

Reality:

- Focus of SW Engg is **"quality product"** not documents
- Documenting will reduce rework
- **Reduced rework = Faster delivery time**

The importance of understanding the Realities:

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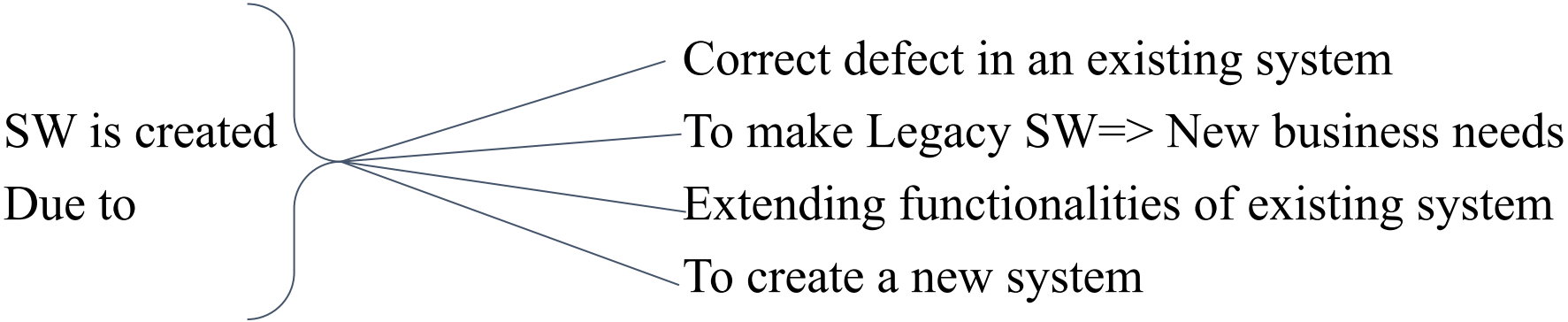
- Many SW Professionals believes in the myths
- Debunking the myths is very essential which will help you to formulate practical solutions

Why do we do SW projects?



- Any SW related product starts with an informal conversation

What is discussed during the Kickoff meeting (The first meeting)

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- Mostly technical informations are not discussed during that meeting
- Feasibility, customer needs, opportunity will be discussed
- More technical details will be discussed in the next phase

Summary:

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SW Engg: => Process, methods and tools

Focus => Quality product in a timely manner

SW Process => Process framework + Umbrella activities

Process FW=> Communication, planning, modeling, construction & deployment

Umbrella act => Refer to the slide 53

Process adoption => Refer to the slide 54

SW Engg practices:

SW Engg Principles:

SW Engg Myths: Management, customer and practitioner

How SW project starts

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Software Process Structure

SW Process structure introduction

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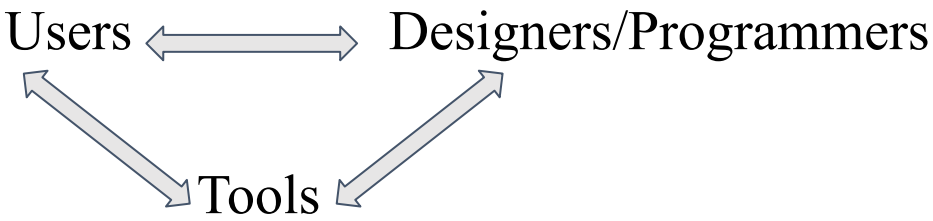
- SW like other capitals
- It is Embodied knowledge

  (Initially Dispersed, Tactic, Latent and incomplete in large measures)
- Process binds the dispersed ideas into a single system
- Process provides interaction between Users, Designers and tools



- Iterative Social learning process

What is SW Capital?

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SW capital : Embodied knowledge collected, distilled (Purified) and organized process

What is SW Process?

- Series of predictable steps to build SW Systems
- Goal: Quality, Timely delivery of SW Product

Who Does it?

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- SW Engineers/SW Practitioners, their managers and also clients together creates it

Why is it important?

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- Predict stability, control & organize activities
- To keep everything Agile - A modern approach
- Helps identify appropriate Activities, actions and tasks

How to choose process?

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- Type of process is defined after identifying the type of product
- Same process not suitable for all the SW projects

How to measure is everything right?

- SW process can be assessed with available mechanisms eg. CMMI
- The maturity of the process can be assessed

What is maturity of the process?

SW Process in short

- Collection of activities, actions and tasks
- Also Known As Software Development Life Cycle SDLC
- Goal: To achieve HQ SW in a timely manner
- SW Engineering is not SW Process
- SW process defines the approach to build the SW System (Split the tasks)
- SW Engineering is performed by Creative, knowledgeable people who practiced and mastered matured SW process

Generic process model/Framework

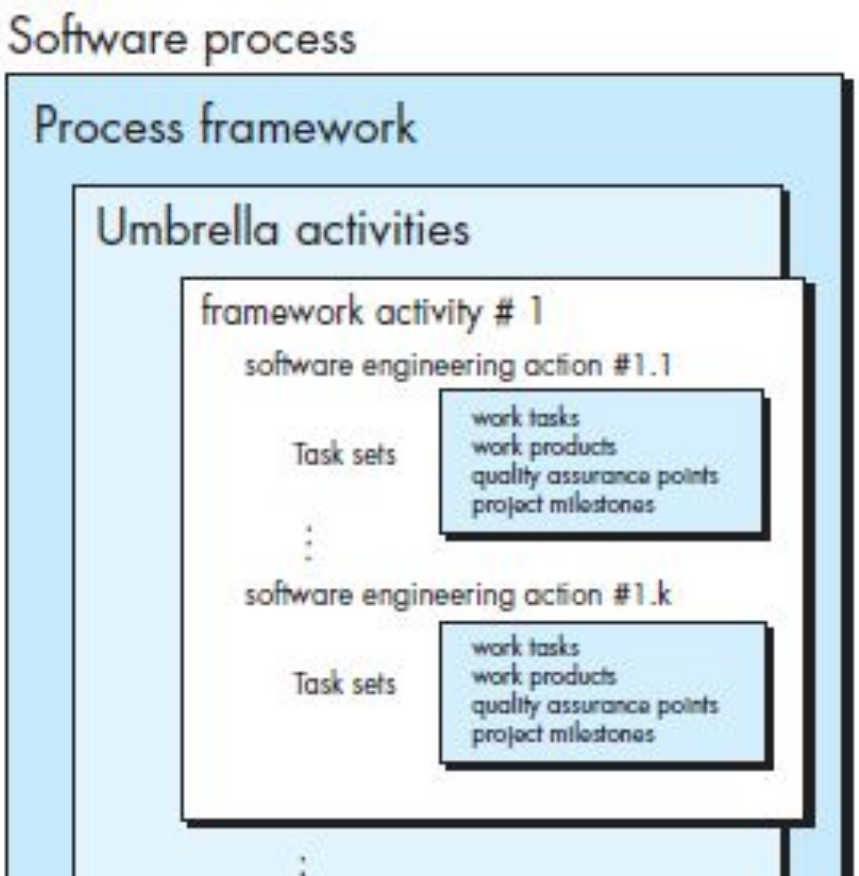
- Process defines: Collection of activities, actions and tasks with in a framework activity
- FW defines relationship between Framework activities
- Framework activities consists of Actions
- Action consists of TaskSet

  [Communication, Planning, Design, Implementation and Deployment]

- TaskSet defines:

  1. TaskList / Work Tasks
  2. Work Product to be produced
  3. Milestones
  4. QA points to be taken care

SW Process Framework



SW Process Flow:

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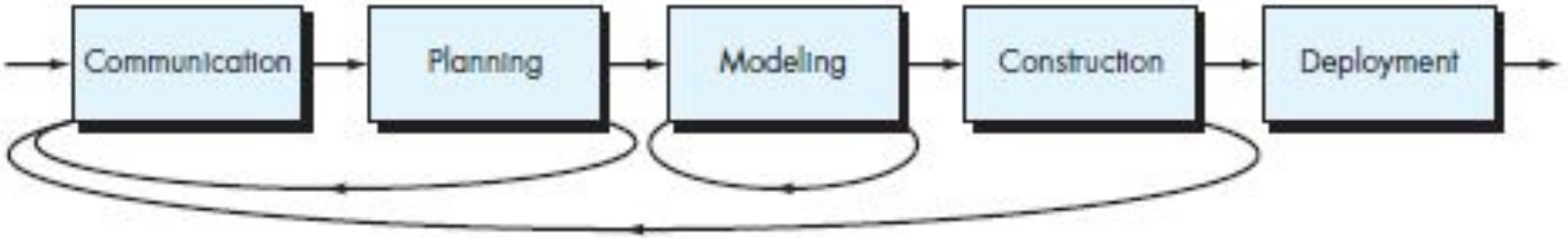
- SE consists of Process FW and Umbrella activities
- But **“Process Flow”** is another important aspect of SW process
- Types of Process flow:

1. Linear Process flow
2. Iterative Process flow
3. Evolutionary Process flow
4. Parallel process flow

1. Linear Process Flow

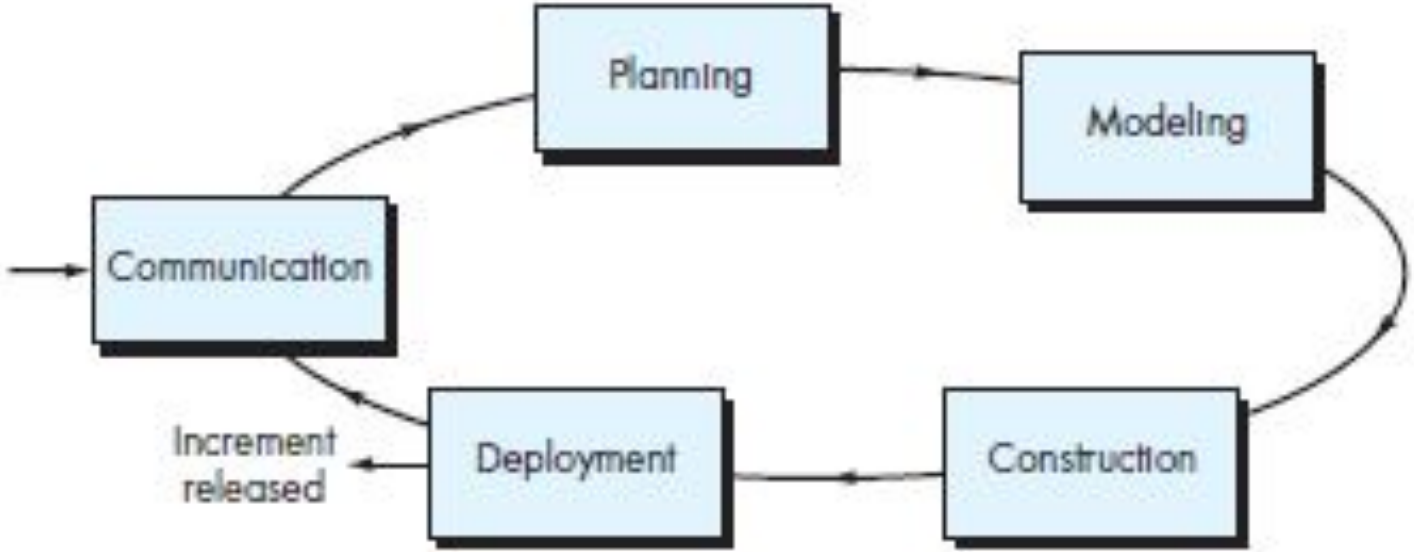
(a) Linear process flow

2. Iterative Process Flow



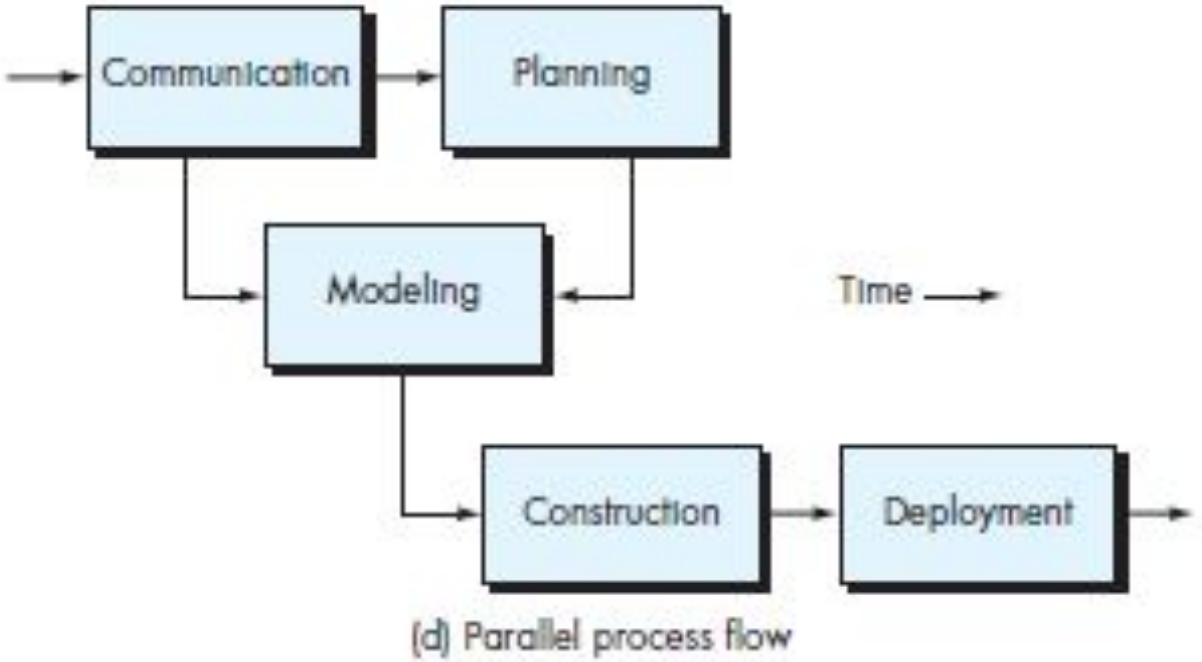
(b) Iterative process flow

3. Evolutionary Process Flow



(c) Evolutionary process flow

4. Parallel Process Flow



(d) Parallel process flow

Defining Framework Activities

Before defining FW activities ask the following questions:

1. What actions are required for a Framework activity?
2. What is the nature of the problem you are trying to solve?
3. Characteristics of people doing the work.
4. Stakeholder (Client) sponsoring the product.

What is a Task Set?

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- A task set defines the actual work to be done to accomplish the objectives of a software engineering action

- Task Set consists of (Work Task, Work Product, Milestone and QA Points)
- Task sets are created according to **the needs** of the project & **characteristics of the team**

Example Scenario:

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Scope of project: Small

FW Activity: Communication

Action: Elicitation or Requirement gathering

What are the possible **“task set”**? Think & answer

Possible Work Task:

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- Identify list of stakeholders
- Invite them for an informal meeting
- Ask stakeholder to list functions and features required
- Discuss on requirement to build the final list
- Prioritize requirement to build a final list
- Note area for uncertainty

Based on above points list down the work products to be produced

Process Pattern

What are process patterns?

- Each team faces a common SW process problem
- Patterns are proven solutions for the common SW process problems

Why do we need them?

- To address the issues very quickly and efficiently

What process pattern describes?

- Issues / Problems related to process
- Environment that caused the problem
- Suggests one or more solution for a problem

Classification of Process patterns:

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- One or many patterns can be combined
- Patterns can be applied at any level of abstraction

Patterns can be used to address the problems with a complete process model

(or)

Can be used to address the issue with FW activities

(or)

Can be used to address the issue with an action or Taskset within a FW activity

Types of Process patterns: Contd

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Pattern Name:

- Patterns are given a meaningful name describing the problem it solves

  Eg. Technical Reviews

Pattern Types:

1. Task Pattern
2. Stage Pattern
3. Phase pattern

Task pattern:

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- Depicts the problem in action and tasks
- The detailed steps to perform a specific task such as Technical Review
- The low level process pattern

Stage pattern:

- Problems associated with framework activity of a process
- Consists of multiple Task Patterns because FW activity is a collection of actions and tasks
- Stage = FW activity
- Stage pattern Eg. establishing communication
- Task Pattern Eg. Requirement gathering (Action)

Phase pattern

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- Identifies problems associated with the sequence of FW activities
- Mostly iterative in nature
- Eg. Spiral model or prototyping