UNIT - 3

S/w Architecture & Planning a S/w Project :-

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Role of S/w Architecture :-

Def^n :- S/w architecture of the system is a structure or structures of the system which consists of S/w elements and the externally visible properties of those elements and relationships among them.

The uses of S/w architecture description are as follows:

1) understanding and communication :-
The S/w architecture description is for communicating the architecture of the system to its users, developers and to its architects. This description helps stakeholders (users, developers, & architects) to understand the micro properties of system and how the system satisfies the functional and quality requirements.

2) Reuse :- S/w architecture helps in reusing the S/w. The S/w reuse help in increasing the Productivity and decreasing the cost of S/w.
If one wants to ~~build~~ ~~the~~

develop the S/w, then the architecture are chosen in such a manner that these components will be reused effectively.

3) Construction and evolution:-

As architecture partions the system into parts, some architecture-provided partitioning can naturally used for constructing the system, which also requires that the system be broken into parts such that different teams can seperately work on different parts. The parts specified in an architecture are relatively independent, and can be built independently.

4) Analysis:-

Before building the actual system some important properties of the system can be determined. The S/w engineers use the model to analyze the design of the product for its cost, reliability & performance. Architecture helps in determining such model.

Architecture views :-

For building the S/w systems different parts of the system are represented graphically. These graphical representations are called architectural views.

* A view represents the system which is composed of some types of elements and relationships between them.

Different views expose different properties & attributes.

There are 3 types of views
1) Module
2) component and connector
3) Allocation.

(*) Module view is a collection of code units each implementing some functionality. The main elements in this view are modules. Depending on the interaction between the modules the relationship between them is decided.

Various types of relationships are -

(i) "is-a-part" of relationship ⇒ means module 'A' is a part of module 'B'.

(ii) "uses or depends on" relationship ⇒ means module 'B' depends on module 'A'.

(iii) "generalization" or "specialization" relationship:- means module 'B' and 'C' are generalization of module 'A'.

Component and connector View (C&C):-

The system is used as collection of runtime entities. These entities are called components.

Eg:- Process, object as collection of objects

while executing, components need to interact with others to support the system services. connectors provides the means for communication.

Eg:- Pipes, and sockets.

Eg:- In distributed environment the middle ware acts as connectors for for distributed components.

Allocation View:-

The main focus is on allocation of resources. These resources can be H/w, S/w, file system & people.

In allocation view the relationship between S/w elements & elements of the environment in which the S/w system is executed is established.

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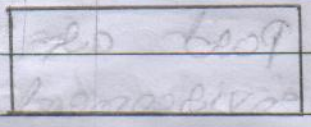
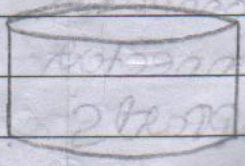
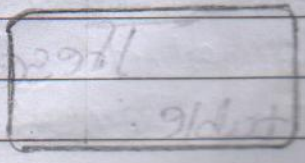
Components and connector view :-

The "C&C" architecture view of a system has 2 main elements
1) components
2) connectors.

* components are generaly the units of computation or data stores in the system.
* components has a name, which is generally chosen to represent the role of the componed or function it performs.
* There are various types of components for eg:- clients, servers, controller, sensors... etc.
* There are different representation for these components as shown below

Name of the component	Graphical Representation
Server	
client	
Data base	
Application.	

components use interfaces to communicate with other components. These Interfaces are called Ports.

Connectors :-

It defines the means of interaction between these components to Provide some services.

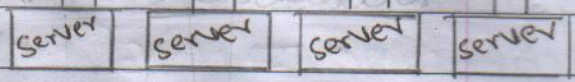
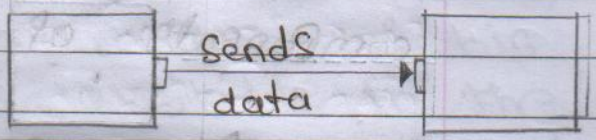
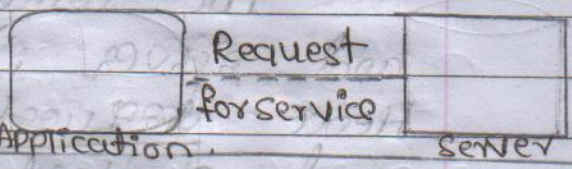
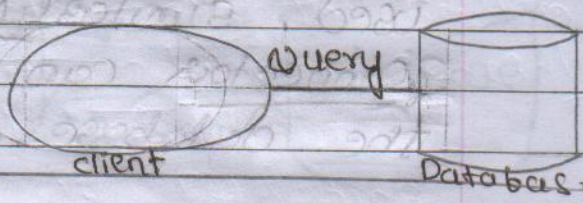
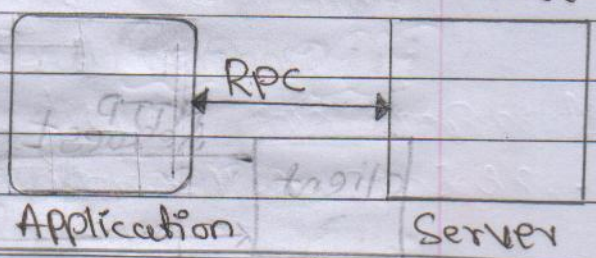
Thus there are group of components that interact with each other & Provide different functionalities.

If all these components combined together then they will deliver the overall functionality of the system.

The interaction can be simple like a Procedure call or it can be very complex such as remote Procedure call in distributed environment, use of TCP/IP Port as communication in client/server environment using HTTP Protocol.

Every connector must have some name and type. The type of the connector describes the nature of the connector & the type of Interface it supports.

These notations are shown in the table.

Bus type connector	
Pipe	
Request-Response	
Database Access	
RPC	

① Example :-

Suppose we have to design an on-line examination system. This system can be implemented using three tier architecture.

Every student will act as a client. Student has to answer multiple choice questions. when the students answers all the questions then he will submit his question Paper to the server.

The server will be second component in this architecture. Server computes the marks for the submitted answers. ~~all questions then he will submit his question Paper to the server.~~

and these ~~answer~~ marks will be saved in the database.

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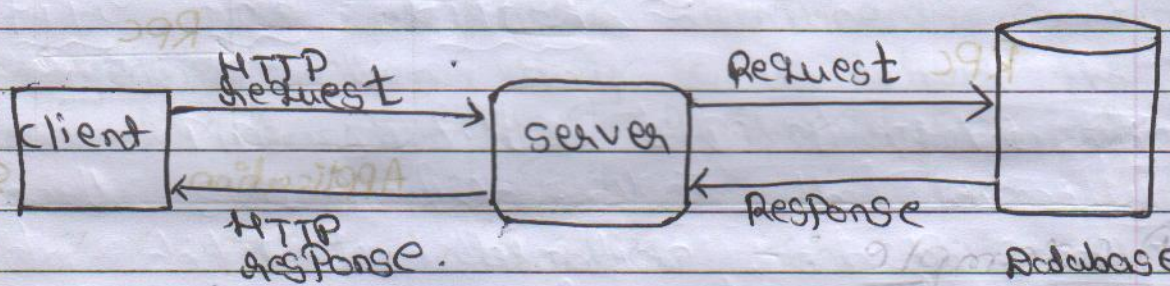
Database will be the third component

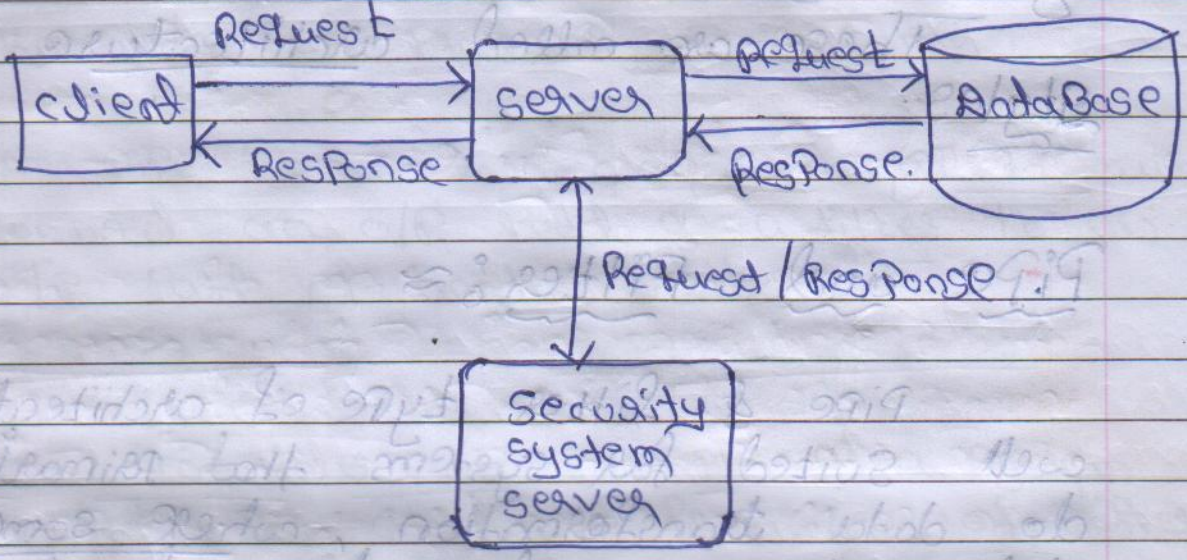
Thus client, server & Database are 3 components of this s/w architecture.

The communication between the client and server is of type request & response Hence request response connector can be used. Similarly database access connector can used for interaction between the database & server.



⇒ In the above example ① the architecture has no security system. The student can given the examination for any number of times. and also it may happen like an unauthorized student can sit for exam. Here restriction has to be made, such that registered student can appear for exam and also he can take Part in exam for once only.

An additional component such as Security System will be required to serve the Purpose. In this System every student has an account & his account information is available to the Proxy server.



When the client logs correctly then only the Question Paper will be displayed to him. The login information will be submitted to server. The server then asks the Proxy server about the validity of the information. If the information is valid then only further Processing is done.

Architecture Styles for C & C View:-

It is clear that different system have different architecture. There are some general architectures that have been observed in many system & that seem to represent general structure that are useful for architecture & a class of problems. These are called architecture styles.

Pipe and Filter:-

Pipe & filter type of architecture is well suited for systems that primarily do data transformation, where some I/P data is received and goal of the system is to produce o/p data by suitably transforming by the I/P data.

Pipe & filter style has only one component type called filter. It also has only one connector type called Pipe

A filter performs a data transformation & sends the transformed data to other filters for further processing using the Pipe connectors.

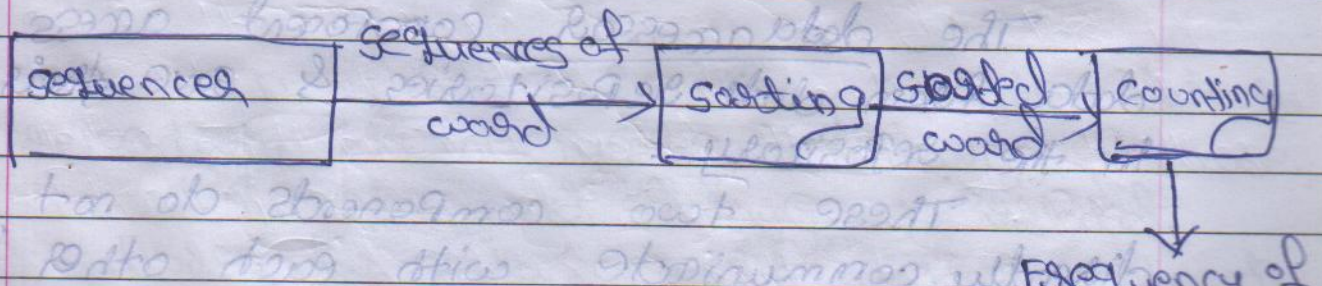
A filter may have more than one inputs & more than one o/p

These are some constraints on this architectural style -

1) The filter should work without the knowledge of Producer or consumer.

2) A pipe is a two-way connector. It must connect an o/p port of a filter to an I/P port of another filter.

Ex:- consider an example of a system needed to count the frequency of different words in a file. An architecture using the Pipes-and-filter style for a system to achieve this is given in the below fig.



This architecture Propose that the I/P data be first split into a sequence of words by a component sequencer.

This sequence of words is then sorted by the component sorting, which passes o/p of sorted words to another filter counting, that counts the no.of occurrences of the different words.

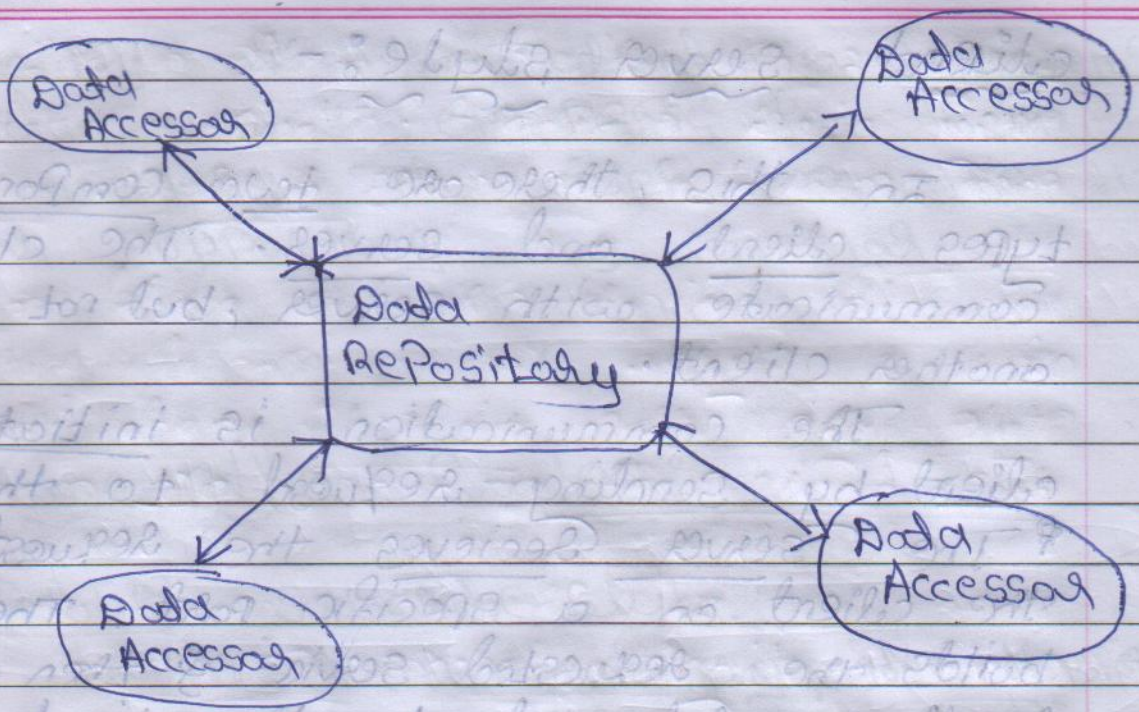
Shared - Data Style:-

There are two types of components- data repositories and data accessors. components of data repository type are where the system stores shared data. these could be files / databases.

These components provide a reliable and permanent storage. During concurrent access these components provide synchronized data access.

The data accessor component access the data from data repositories & save their data in the repository.

These two components do not directly communicate with each other instead they communicate ~~they communicate~~ through data repository components.



There are two variations of shared data style type & those are

1) Blackboard Repository
2) Passive Repository.

In Blackboard style if some data is Posted on the data repository, all the accessor components that need to know about it are informed.

In Passive Repository style data repository is a Passive Repository because. Provides permanent storage & related controls for data accessing. The components access the repository only when they want the data.

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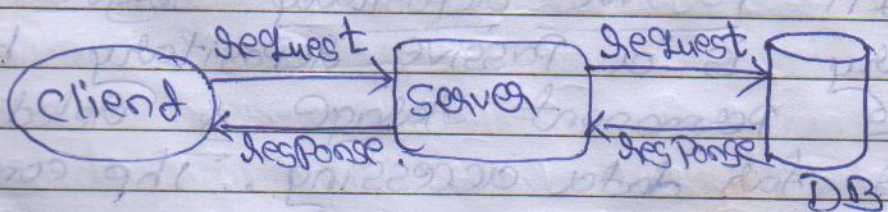
client - server style :-

In this, there are two components types client and server. The client can communicate with server, but not to another client.

The communication is initiated by client by sending request to the server. The server recieves the request from the client on a specific port. Then it builds the requested service & then the result is returned to the client.

There is one type of connector used in this style & is request and reply. The task of this connector is to connect the client to the server. This type of connector is asymmetric. The communication is synchronous in nature.

The most commonly used 3-tier architecture is shown below.



3-tier Architecture

Many of the client-server systems today use TCP ports for their connections. The web uses the HTTP for supporting this connection.

Some other Styles:

* Publish-Subscribe Style:

As the name suggests there are 2 components in this style & those are Publish and subscribe.

The Publish component generates the events & the subscribe component subscribes to the set of defined events.

Ex- In this type of architecture the events are generated using mouse clicks & there are components assigned to receive these events.

This style is considered as a special case of blackboard repository style.

* Peer-to-Peer Style:-

It is special type of client-server style in which every component can be client as well as server.

Every component can make a request to every other component. Thus in this style each component becomes a peer.

The object oriented model makes use of this style. The component of this style are the objects and the method invocation act as connectors.

* Communicating processes style :-

In this model Processes or threads communicate with each other by passing messages or through shared memory.

This style is used in the complex system in which multiple threads are supported for performing various task.

Documenting Architecture Design :-

S/w system Architecture can be prepared by drawing the diagrams by using various styles. But when designing is over, the architecture has to be properly communicated to all stakeholders for negotiation and agreement.

Hence it requires that architecture has to be documented. So that system

can be understood easily. The document describing the architecture should contain the following:

1) System & architecture views
2) Description of architecture views
3) Across views documentation.

=> System & architecture views:

* The first aspect that an architecture document should contain is identification of stakeholders and their objectives.

* A context diagram that establishes the scope of the system, & its boundaries. This is a diagram which shows the system at the center and connection with the people and other interacting elements of the system including sources & sinks of data.

=> Description of architecture views

There are multiple views for representing architecture but the choice of the particular view depends on the need of the project and its stakeholders.

In architecture document there will be a Pictorial representation of the view, which is often the Primary Presentation view.

Along with the Pictorial representation there should be sufficient documentation. Following things must be present in this documentation.-

1) Element catalog:

It Provides the information about the elements shown in the Primary representation.

The purpose of the elements & their interfaces must be described in this catalog.

2) Architecture Rationale:-

Architecture rationale gives the reasons for selecting the different elements and composing them in the way it was done in the system architecture

3) Behaviour:

understanding the behaviour of the system helps in understanding how the system executes. Diagram like collaboration/sequence diagrams can be used

4) Other Information:

This section includes the info about those decisions that have not taken

during the design of the architecture.

=> Across views document :-

This document describes the relationship between different views. This the primary purpose of across view document.

If the relationship between different views is straight forward or strong then different structures will look similar and there will be repetition of the structure in the architecture. In such situation it is better to combine the different views. This eliminates the duplication of the structures & such a combined view will be help ful in performance analysis of the system.

The languages used in architecture description vary
1) Architectural description Language (ADL)
2) unified modelling Language (UML).

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Evaluating Architectures :-

Evaluating architecture means checking the impact of the architecture on non-functional quality attributes such as performance, reliability, portability, reusability, security etc.

There are two ways to evaluate the architecture.

1) Modelling Approach
2) Procedural Approach.

In Procedural approach sequence of steps are followed to evaluate these attributes.

1) In first step all the attributes that have significant impact on the architecture are identified. These attributes are identified by the stakeholders.

2) Then these attributes are listed in a table

3) Then for each attribute the analysis is done.

4) The analysed attributes are then rated with levels such as good, average, or poor.

5) Based on the outcome the architecture might be either accepted or rejected

:- Planning a S/w Project :-

Planning is the most important Project management activity. It has two basic objectives outputs

1) The overall Project management Plan document that establishes the Project goals on the cost, schedule, and quality and also defines Plans for managing risk, monitoring the Project etc.

2) The detailed Plan, often referred to as the detailed Project schedule, specifying the tasks that need to be performed to meet the goals, the resources required & their schedule.

The I/P to the Planning activity are the requirements specification & the architecture description.

Effort Estimation:

After gathering all the requirements of the Project and after analyzing them it is necessary to known two things about the Project -

1) The total time required to get completed
2) The overall cost of the Project.

The estimates are needed before the Project gets initiated. Such estimations help in controlling the Project.

For any S/w Project, effort estimation means estimating cost and schedule of the Project. The cost estimation is made in terms of Persons Per Month (PM)

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Top-Down Estimation Approach:-

Primary factor that controls the effort, is the size of the Project. That is larger the Project the greater is the effort requirement. The Top-down approach uses this and considers effort as a function of Project size

Commonly used function for estimating effort will be.

$$\text{Effort} = a * \text{SIZE}^{b}$$

where 'a' and 'b' are constants and Project SIZE is generally in KLOC.

Wolfson and Felix observed data of more than 60 projects done at IBM and estimated the values of the constants 'a' and 'b' as

$$\text{Effort} = 5.2 \times \text{SIZE}^{0.91}$$

The effort denoted in terms of Persons-Month (PM)

The disadvantage of the top-down approach is that the effort estimation in this approach is based on the size of Project. But if the size estimation of Project is inaccurate, then effort estimation will be wrong.

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COCOMO Model :- [Constructive Cost Model]

In COCOMO model after determining the initial estimate, some other factors are incorporated for obtaining the final estimate.

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To do this COCOMO uses a set of 15 different attributes of Project called cost driver attributes. Examples of the attributes are S/w reliability, Product complexity, analyst capability, ~~application~~ use of modern tools, ... etc.

Each cost driver has a rating scale and for each rating, multiplying factor is provided. For example, for reliability the rating scale is very low, low, nominal, high and very high, the multiplying factors for these ratings are 0.75, 0.88, 1.00, 1.15 and 1.40 respectively.

The multiplying factors for all 15 cost drivers are multiplied to get the effort adjustment factor (EAF). The final effort estimate, 'E' is obtained by multiplying the initial estimate by the 'EAF'.

ex:-

If the total size of the S/w is estimated to be "2 KLOC". If we want to use COCOMO for estimation, we should estimate the value of the different cost drivers.

Suppose we expect that the

(1) complexity of the system is high
(2) The programmer capability is Low
(3) The application experience of the team is low

All the factors have nominal rating. From these effort adjustment factor (EAF) is

$$EAF = 1.15 * 1.17 * 1.13 = 1.52.$$

$$\boxed{EAF = 1.52}$$

The initial effort estimate for the Project is obtained from the equation,

$$E_i = 3.9 * 2^{0.91} = 7.3 \text{ PM}$$

The final effort 'E' is estimated as

$$\boxed{\begin{aligned} E &= E_i * EAF \\ \therefore E &= 1.52 * 7.3 = 11.1 \text{ PM} \end{aligned}}$$

Basic cocomo model is good for quick, early, rough, estimates of S/w Project.

Disadvantage :-

The accuracy of this model is limited because it does not consider certain factors for cost estimation of S/w, such as H/w constraints, Personal quality ... etc.

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Botlom-up estimation Approach :-

In this approach the project is first divided into tasks and then estimates for the different tasks of the project are obtained. From the estimates of the different tasks, the overall estimate is determined. That is, the overall estimate of the project is derived from estimates of its parts. This type of approach is also called activity-based estimation.

In this approach, the major modules of the system is identified. These modules are then categorized into simple, medium & complex based on certain criteria.

Following are the steps to estimate the effort using the botlom up approach in which past information is used -

1) Identify the modules in the project.
2. classify them as simple, medium and complex modules.
3. Get the coding effort for each module of different types.
4. using the effort distribution for the similar project estimate the efforts for other tasks. Then obtain the total effort required by the whole project.
5. Refine the estimate based on some factors.

This is a simple approach of estimating the effort.

Project Schedule and Staffing :-

After estimating the effort for overall project it becomes easy to estimate two thing

1) Duration / months / schedule
2) People / person / Resource

Generally the Product release are delayed and / or postponed because of lack of expertise and / or experience. Therefor Project schedule must continually be updated

The Duration of Project is estimated in terms of persons per month (PM). "Project duration can be reduced by doubling the no. of staff."

The above statement does not hold good because

1) communication and correspondence activities increases with doubling of staff.

2) Critical task may need more time to finish

Brook Law states — "increasing or adding man power to a late Project may further delay the Project and make it later

Average Duration Estimation :-

⇒ For instance, total duration 'm' in calender months, as is estimated by IBM can be given as

$$M = 4.1\ E^{3.06}$$

⇒ For COCOMO model can be given as.

$$M = 2.5\ E^{0.38}$$

⇒ Square Root check method for Project Schedule estimation :- This method is termed as rule of thumb for medium sized Projects.

$$M = \sqrt{\text{total effort in PM}}$$

Staffing :-

once the Project Schedule is estimate and effort estimate, then Project staff requirements can be computed easily. Accordingly, the average staff size for the Project can be computed as

$$\text{avg staff size} = \frac{\text{total effort}}{\text{Project duration (overall}}$$

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computed "avg staff size" may not be sufficient or may not be appropriate to meet the actual staff requirement.

It is observed that staff requirement for a given project remain small during requirement analysis and design. Further staff requirement increases during the coding.

The number of people called Peak time size (PTS) is required at the middle phase of the project.

We consider the following 3 major phases of a s/w development project.

1) Design
2) Build
3) Test. The man power requirement can be shown as below:

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Quality Planning :-

A Quality Planning is a step towards satisfying a final goal as to "deliver s/w with low defect density".

According rule of thumb "expect not more than 1 error / defect per thousand lines of code. (KLOC)"

However s/w development is highly people driven activity so is error appearance is quite natural. Hence these errors have to be removed before the shipment of the s/w product to the customer site.

To satisfy ultimate dreams of defect free s/w Release. a set of quality check / quality control (QC) activities have to be carried out.

Accordingly some of the QC activities for defect removal can be listed as a part of quality Planning they are as follows.

1) Requirement Reviews
2) Design Reviews
3) code Reviews
4) unit Testing
5) Integration Testing / System Testing
6) Acceptance Testing.

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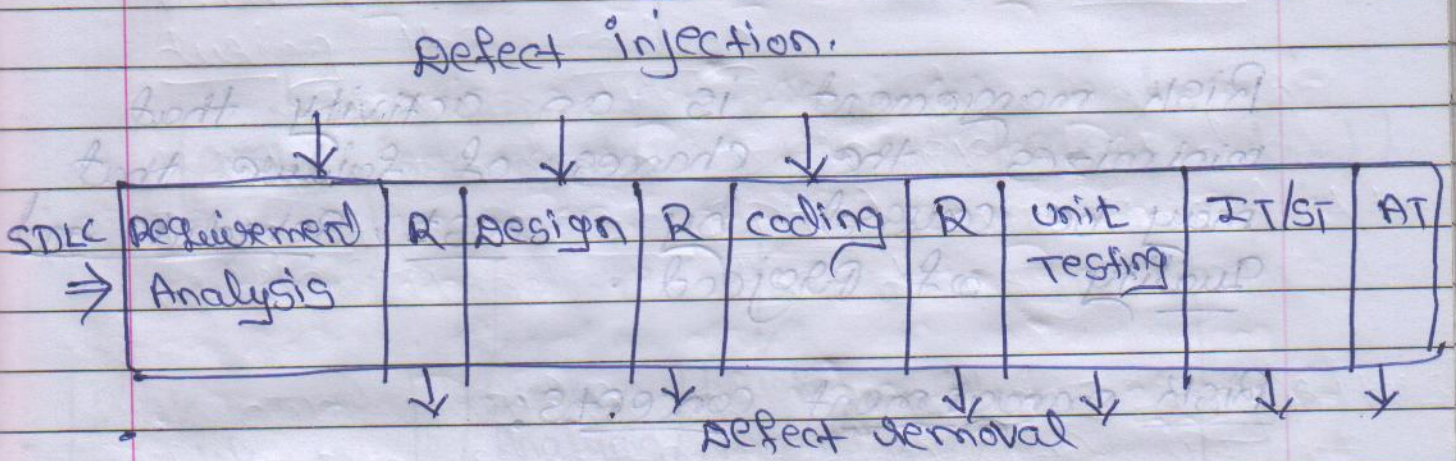
To have better understanding on - "how to get defect free S/w delivery?" - one must be familiar with a "defect injection and removal cycle".

as shown in the figure below.



where: IT → Integration Testing
ST → System testing
AT → Acceptance Testing
R → Removal.

To begin with - the assumption is the proposed S/w to be developed contains no error/defects.

During the transformation from the user needs to the S/w to satisfy the needs, defects are injected in the transformation activities. The injection stages are Requirement specification, detailed design and coding.

Thus the defect Removal (R) and QC will eliminate errors in order to

ensure defect free, high quality s/w delivery.

Risk Management Planning:-

Risk management is an activity that minimizes the chances of failure that may be caused by cost, schedule and quality of project.

Risk management concepts:

Risk is defined as an exposure to the chance of injury / loss.

Risk management: is the area that tries to ensure that impact of risk on cost, quality & schedule is minimal.

Risk manggement has to deal with:

* ~~Identification~~ Identifying undesirable events that can occur.
* The probability of their occuring and
* The loss if an undesirable event does occur.

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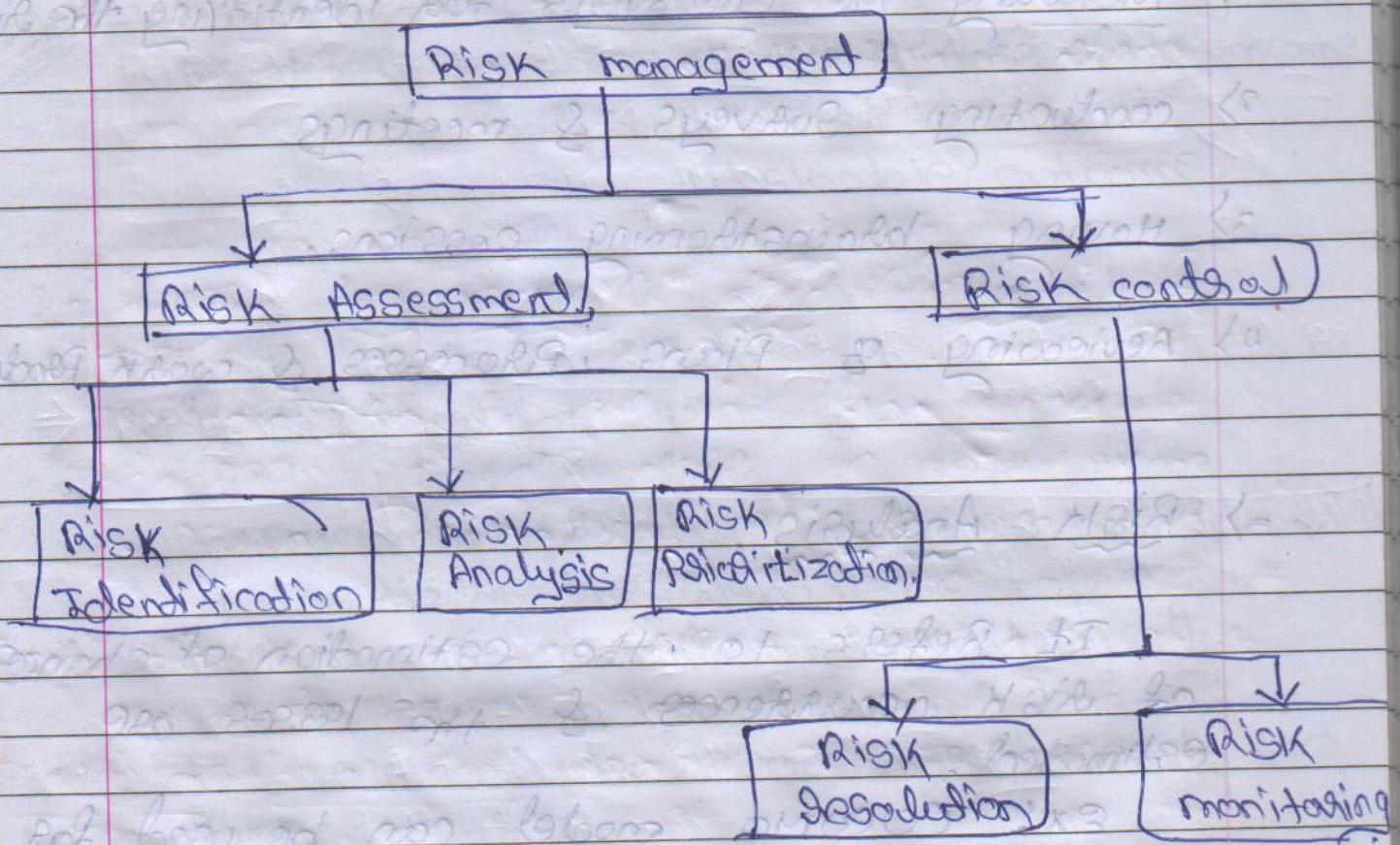
⇒ Risk management revolves around two things - Risk assessment and Risk control.



⇒ Risk assessment is done during Project Planning

⇒ In this Phase the risks are identified, analysed, & then Prioritized

⇒ The goal of risk assessment is to Prioritize the risk.

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⇒ Risk Identification:

various methods can be used to identify the risk are.

1) Preparing the checklists for identifying the risk

2) conducting surveys & meetings

3) Having brainstorming sessions.

4) Reviewing of Plans, Processes & work Products

⇒ Risk Analysis:

. It Refers to the estimation of chances of risk occurrences & the losses are estimated.

ex: COCOMO model can be used for do analyse the cost & schedule risks.

Risk analysis can be done by estimating the worst case value of size and all the cost drivers.

⇒ Risk Prioritization:

After risk analysis, the impact of each risk on the project can be analysed. Based on the impact risk can be prioritised.

Risk exposure computing is done for Prioritising the risk. Risk exposure is calculated by following formula.

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Risk Exposure = Probability of undesirable outcome * Loss due to undesirable outcome.

Risk control:

Once the Project manager has identified & Prioritized the risks, the top few risks are focused and controlled.

The Risk control activities include the following

1) Risk Avoidance
2) Risk Mitigation
2) Risk monitoring

Risk Avoidance: where in the Project Manager tries to avoid the risk

Risk Mitigation:

In Risk avoidance, certain actions are performed which will either reduce the Probability of the major risk or reduce the loss due to the major risk.

These are called risk mitigation steps.

Risk monitoring: is the activity of monitoring the status of various risks & their control activities.

A Practical Risk Management Approach:

Many s/w development organizations make use of risk Planning approaches that are simple & practical in use.

In this approach the risk Prioritization is done, based on chances of risk occurrences such as low, medium & High

The following step can be applied for Prioritising the risks-

1) List few identified risks.
2) For each risk, rank the impact of the risks as low, medium, and high.
3) Rank or Arrange the risk items based on Probability (chance) and Impact.
4) Select the top few risk for mitigation and monitoring.

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Project Management Plan :-

It is a document that defines how the Project is executed, monitored & controlled.

The Project monitoring Plan comprise two key componets

1) Measurements
2) tracking.

Measurements :

The basic purpose of measurement in a Project is to provide data to Project management about schedule (1), size (2), effort (3) and defects (4).

Monitoring the schedule will access if the Project is on time or there will be some delay in its completion.

Entire Effort is the main resource consumed in a S/w Project. It is essential to measure the number of people who are working on the Project and the amount of time spent. This computes the cost of the Project in terms of Persons-Per-month (PM).

Defects are closely related with the quality of the S/w. It is always better to keep track of defects.

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Size of the Project:

It can be measured in terms of LOC or function Points. This is useful in managing the Project.

Project tracking:-

The goal of the Project monitoring is to get the visibility of the Project execution. There are three levels of monitoring

1) activity level monitoring (2) status reporting (3) milestone analysis.

⇒ Activity level Monitoring:

In this kind of monitoring, each activity is enlisted and its time for execution and completion is mentioned.

This kind of monitoring can be done daily during the Project Meetings.

If the task gets fully completed then it is marked as 100%.

⇒ Status Reporting:

The weekly status report is made in order to note what tasks are accomplished and what is to be done.

Status reports typically contain a summary of the activities successfully completed since the last status report.

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⇒ Milestone analysis:

During the development of project certain milestones are set

In this milestone the actual & Planned schedule are compared. If there is a significant deviation then it indicates that Project may be in danger & some corrective actions need to be taken

Imp Detailed Scheduling:-

The overall schedule is broken into a detailed schedule of tasks/activities to be done so as to meet the goals and constraints.

These tasks are assigned to specific team members, with identified start & end dates. The detailed Project schedule is never static, because of change request from the customers, corrective actions have to be taken, additional resources are to be added, etc.

The detailed design schedule Plan should be consistent with overall Effort & schedule estimate of the Planned Project for execution.