What is Software?

Software is a collection of

- **Instructions (Computer programs) that when executed provide desired function and performance.**
- **Data structure that enable the programs to adequately (effectively) manipulate information. And**
- **Documents that describe the operation and use of the programs.**
- **Software is a logical entity rather than a physical system element.**

Software Engineering

Definition of Engineering

Application of science, tools and methods to find cost effective solution to problems

Definition of SOFTWARE ENGINEERING

Software engineering is a systematic approach to the development, operation maintenance and requirements of the software.

1. **Software engineering is the application of science and mathematics by which the capabilities of computer equipment's are made useful to man via computer program, procedures and associated documents.**
2. **Software engineering is a set of 3 elements methods, tool & procedure software engineering methods provides.**

The technical – how tools for building a software it includes project planning estimation of the project system and software requirement analysis design of data structure architecture & algorithms procedures.

Software engineering tool provides automated & semi-automated support for methods. When tools are integrated so that the support can be made for software development is called CASE (Computer Aided Software Engineering). CASE combine software, hardware & software engineering database. Software engineering procedures define the sequence in which methods will be applied.

Goal of Software Engineering

Software engineering is driven by three major factors as are follows.

- **Cost**
- **Schedules**
- **Quality**

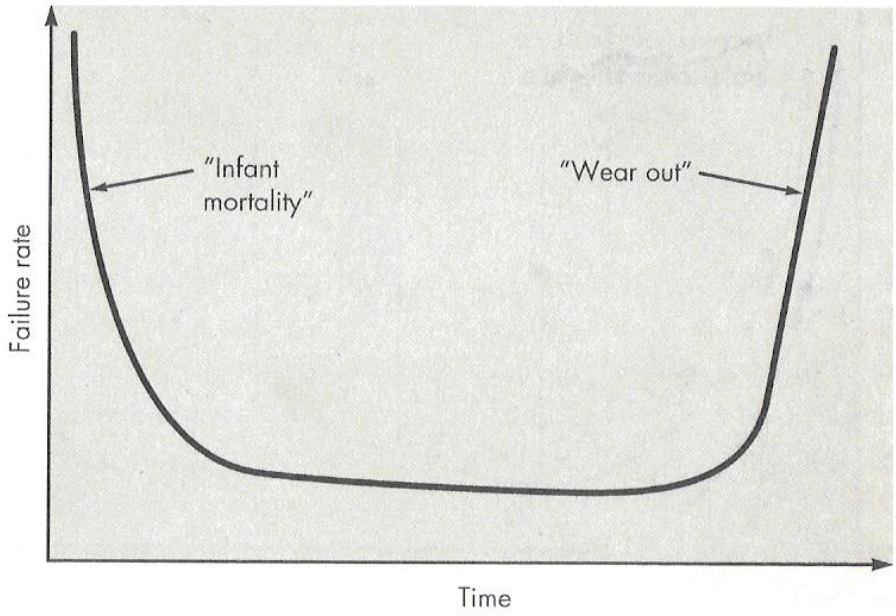
Characteristics of the Software

Software is a logical rather than a physical system element therefore software has characteristic that are different then hardware component.

1. **Software is developed or engineered it is not manufacture in the classical sense.**

In both activities software development and hardware manufacturing, high quality is achieved through good design, but the manufacturing phase for hardware can introduce quality problems that are nonexistence (or easily corrected) for software. Both activities depend on people, but the relationship between people applied and work accomplished is entirely different. Both activities require the construction of a product, but the approaches are different.

2. **Software does not wear out.**



Above figure depicts failure rate as a function of time for hardware. The relationship often called the "bathtub curve" indicates that hardware exhibits relatively high failure rate early in its life. (This failures are often attributable to design or manufacturing defects); defects are corrected and the failure rate drops to a steady state level (hopefully quite low) for some period of time. As time passes, however, the failure rate rises again as hardware components suffer from the cumulative effects of dust, vibrations, abuse, temperature extremes, etc. Stated simply, hardware begins to wear out.

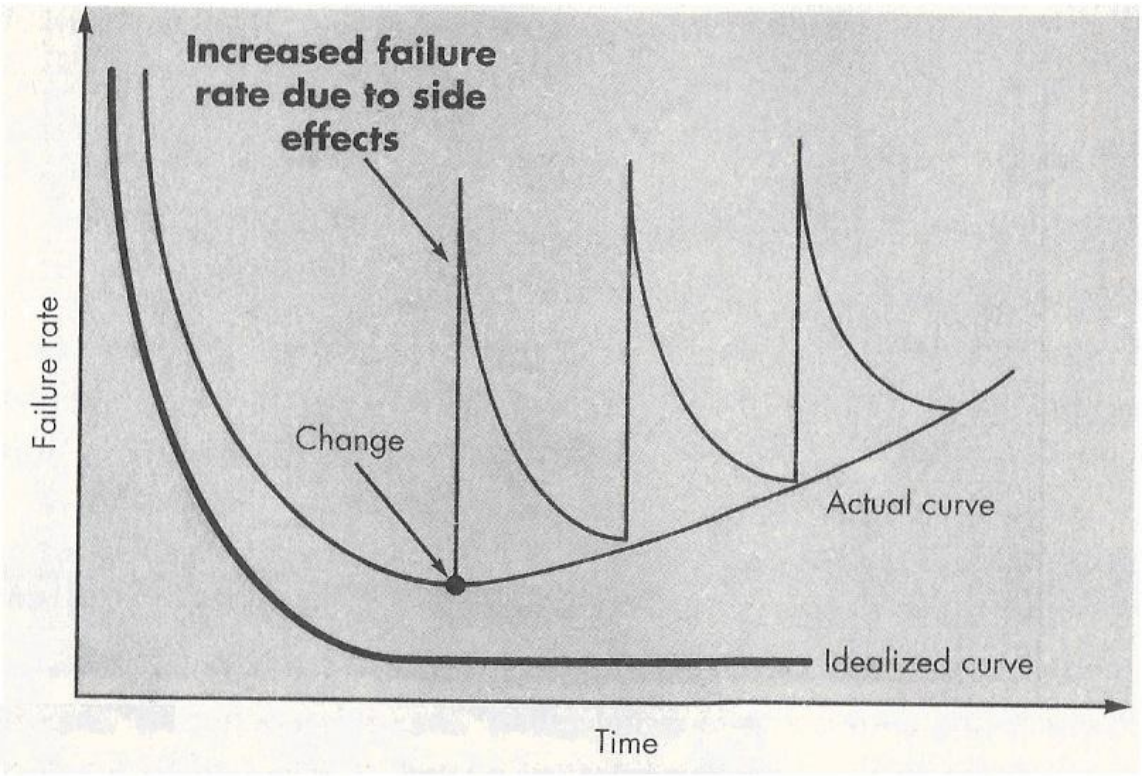


Figure B – Idealized and actual failure curves for software As shown in figure (B), the failure rate curve for software shows that, undiscovered defects will cause high failure rates early in the life of a program. These are corrected (without introducing other errors) and the curve flattens as shown in figure (B). Software doesn't wear out, but it does deteriorate. During the software life, it will undergo change (maintenance). As changes are made, it is likely that some new defects will introduced, causing the failure rate cure to spike. Before the curve can return to the original steady-state failure rate, another change is requested, causing the curve to spike again. Slowly, the minimum failure rate level begins to rise the software is deteriorating due to change. Hardware component wears out; it is replaced by a spare part. There are no software spare

parts. Every software failure indicates an error in design or in the process through which design was translated into machine executable code. Therefore, software maintenance involves considerably more complexity than hardware maintenance.

3. **Most software is custom built rather than being assembled from existing components. Re usability is an important characteristic of high quality software component. A software component should be designed and implemented so that it can be reused in many different programs. Modern reusable components encapsulate both data and the processing that is applied to the data, enabling the software engineer to create new applications from reusable parts. For e.g. today's interactive interfaces are built using reusable components that enable the creation of graphics windows, pull down menus and a wide variety of interaction mechanisms. Software components are built using a programming language that has a limited vocabulary. An explicitly defined grammar and well-formed rules of syntax and semantics. At the lowest level, the language mirrors the instruction set of the hardware. But Sometimes reusable components does not fulfill the requirement there may be some changes we want but because of its complexity of code means we have to understand the whole component for making some changes to it , which is very complex task instead of this we can create a custom component.**

Software Applications

1) System software
2) Real-Time Software
3) Business Software
4) Engineering and scientific software
5) Embedded Software
6) Personal Computer Software
7) Web-Applications
8) Artificial intelligence software

System Software

System software is a type of computer program that is designed to run a computer's hardware and application programs. If we think of the computer system as a layered model, the system software is the interface between the hardware and user applications.

The operating system (OS) is the best-known example of system software. The OS manages all the other programs in a computer.

System software is a collection of a program written to service other programs. Some system software (e.g. Compilers, editors and file management utilities) processes complex; but determinate information structures.

Other system applications (e.g. operating system components, drivers, telecommunications processors).

Real time Software

Programs that monitor/analyze/control real world events as they occur are called real time software.

Elements of real time software includes

- **Data gathering components**
- **Analysis components**
- **Control / output components**
- **Monitoring components**

A real time system must respond within strict time constraints.

Real time system differs from interactive or time sharing. The response time of an interactive system can normally be exceeded without disastrous[terrible] results.

Eg. Weather forecasting s/w

Business Software

Business information processing is the largest single software application area.

Discrete systems (e.g. Payroll, accounts receivable/payable, inventory etc.) have evolved into management information system (MIS) software that accesses one or more large databases containing business information.

Applications in this area restructure existing data in a way that facilitates business operations or management decision making.

e.g. Client/Server computing application.

Engineering and Scientific Software

Engineering and scientific software has been characterized by "number crunching" algorithms.

Application range from astronomy to volcano logy, from automotive stress analysis to space shuttle orbital dynamics and from molecular biology to automated manufacturing.

Eg. Radar s/w, military s/w

Embedded Software

Embedded software resides in RAM and is used to control products and systems for the consumer and industrial markets.

Embedded software can perform very limited and esoteric functions (e.g. key pad control for microwave oven, washing Machine, AC etc.) or provide significant function and control capability.

(e.g. Digital functions in an automobile such as fuel control, dashboard displays, braking system, etc.)

Personal Computer Software

Word processing, spreadsheets, computer graphics, multimedia, entertainment, database management, personal and business financial applications and external network or database access are some of the example of personal computer software.

Eg. Desktop Based Applications (Word, Excel , power point , Photoshop etc.)

Web-Applications

The web pages retrieved by a browser are software that incorporates executable instructions. In essence, the network becomes a massive computer providing almost unlimited software resources that can be accessed by anyone with a modem.

Eg. Websites

Artificial intelligence Software [AI s/w]

Artificial intelligence software makes used of non-numerical algorithms to solve complex problems that are not amenable to computation or straight – forward analysis.

An active Artificial Intelligence area is expert systems, also called knowledge based systems.

Other application area for AI software is pattern recognition (image and voice) theorem proving and game playing.

In recent years, new branch of AI is Artificial neural networks has evolved. A neural network simulates the structure of brain processes (the function of the biological neuron).

Eg. Decision Making s/w

Software Myths

Management Myths:

1. **We already have a book that's full of standards and procedures for building software. Won't that provide my people with everything they need to know?**

   Reality: The book of standards may very well exist, but is it used? Are software practitioners aware of its existence? Does it reflect modern software engineering practice? Is it complete? Is it streamlined to improve time to delivery while still maintaining a focus on quality? In many cases, the answer to all of these questions is "no."

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

Reality: people who were working must spend time educating the newcomers.

3. **My people have state-of-art software development tools; after all, we buy them the newest computers.**

Reality: It takes much more than the latest model mainframe, workstation, or PC to do high-quality software development. Computer-aided software engineering (CASE) tools are more important than hardware for achieving good quality and productivity, yet the majority of software developers still do not use them effectively.

4. **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 software projects internally, it will invariably struggle when it outsources software projects.

Customer Myths:

1A general statement of objective is sufficient to begin writing programs we can fill in the details later.

Reality: poor up-front definition is the major cause of failed software efforts.

2. **Project requirements continually change, but change can be easily accommodated because software is flexible.**

Reality: It is true that software requirements change, but the impact of change project schedule and planning will be disturbed.

Practitioner's Myths: [developer's myths]

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

Reality: software can be expended after it is delivered to the customer for the first time.

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

Reality: One of the most effective software quality assurance mechanisms can be applied from the inception of a project—the formal technical review. Software reviews are a "quality filter" that have been found to be more effective than testing for finding certain classes of software defects.

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

Reality: A working program is only one part of a software configuration that includes any elements. Documentation provides a foundation for successful engineering and, more important, guidance for software support.

4. **Software Engineering will make us to create voluminous and unnecessary documentation and will invariably slow us down.**

Reality: Software engineering is not about creating documents. It is about creating quality. Better quality leads to reduced rework. And reduced rework results in faster delivery times.

SOFTWARE ENGINEERING LAYERS

Software Engineering is the establishment and use of sound Engineering principles in order to obtain economical software that is reliable and works efficiently on real machines.

Software Engineering is around the three layers (elements):

- **Process**
- **Methods**
- **Tools**
- **Quality Focus**

Process:

The foundation for software engineering is a process layer. Software engineering process is the glue that holds the technology layers together and enables rational, timely development of computer software.

Process defines a framework for a set of key process areas that must be established for effective delivery of software engineering technology.

The key process area forms the basis for management control of software projects and establish the context in which technical methods are applied, work products (models, documents, data, reports, forms, etc.) are produced, milestones are established, quality is ensured, and change is properly managed.

Process is a step by step plan to complete a task.

Methods:

SE methods provide the technical "how to's" for building software. Methods encompass [include] a broad array of tasks that include requirements analysis, design, program construction, testing and maintenance.

SE methods relay on a set of basic principles that govern each area of the technology and include modeling activities and other descriptive techniques.

Tools:

SE tools provide automated or semi-automated support for the process and the methods.

When tools are integrated so that information created by one tool can be used by another, a system for the support of software development, called Computer Aided Software Engineering (CASE) is established.

CASE combines software, hardware and software engineering database (a repository containing important information about analysis, design, program construction and testing) to create a software engineering environment that is analogous to CAD/CAE (Computer Aided Design / Engineering) for hardware.

Generic-View-of-Software-Engineering

The work that is associated with software engineering can be categorized into three generic phases:

1. **Definition phase**
2. **Development phase**
3. **Maintenance phase**

Definition Phase:

Definition phase answers "what" questions that is during the definition the software developers attempts to identify.

- **What information is to be processed?**
- **What function and performance are desired?**
- **What validation conditions are required?**
- **What types of interfaces are to be established?**
- **What design constraints exists?**

All the questions can be answered through

1. **System Analysis**
2. **Software Project Planning**
3. **Requirement Analysis**

Development Phase:

Development phase answered "How" questions. In this phase developer attempts to answer

- **How data structure and software architecture are to be designed?**
- **How procedural details are to be implemented?**
- **How design will be translated into a programming language?**
- **How testing will be performed?**

All the previous questions can be answered through

1. **Software Design**
2. **Coding and**
3. **Software Testing**

Maintenance Phase:

There are four types of maintenance, namely, corrective, adaptive, perfective, and preventive. Corrective maintenance is concerned with fixing errors that are observed when the software is in use. Adaptive maintenance is concerned with the change in the software that takes place to make the software adaptable to new environment such as to run the software on a new operating system. Perfective maintenance is concerned with the change in the software that occurs while adding new functionalities in the software. Preventive maintenance involves implementing changes to prevent the occurrence of errors. The distribution of types of maintenance by type and by percentage of time consumed.

The maintenance phases focus on change that is associated with:

- **Error correction**
- **Adaptation required**
- **Enhancement**
- **Prevention**

Error Correction [corrective maintenance]

Corrective maintenance deals with the repair of faults or defects found in day-today system functions. A defect can result due to errors in software design, logic and coding. Design errors occur when changes made to the software are incorrect, incomplete, wrongly communicated, or the change request is misunderstood. Logical errors result from invalid tests and conclusions, incorrect implementation of design specifications, faulty logic flow, or incomplete test of data. All these errors, referred to as residual errors, prevent the software from conforming to its agreed specifications. Note that the need for corrective maintenance is usually initiated by bug reports drawn by the users.

It is likely that the customer will uncover defects in the software. Corrective maintenance changes the software to correct defects.

Adaptation [adaptive maintenance]

Adaptive maintenance is the implementation of changes in a part of the system, which has been affected by a change that occurred in some other part of the system. Adaptive maintenance consists of adapting software to changes in the environment such as the hardware or the operating system. The term environment in this context refers to the conditions and the influences which act (from outside) on the system. For example, business rules, work patterns, and government policies have a significant impact on the software system.

For instance, a government policy to use a single 'European currency' will have a significant effect on the software system. An acceptance of this change will require banks in various member countries to make significant changes in their software systems to accommodate this currency. Adaptive maintenance accounts for 25% of all the maintenance activities.

Over time, the original environment (e.g. CPU, OS, Business Rules etc.) for which the software was developed is likely to change. Adaptive maintenance results in modification to the software to accommodate changes to its external environment.

Perfective maintenance [Enhancement]

Perfective maintenance mainly deals with implementing new or changed user requirements. Perfective maintenance involves making functional enhancements to the system in addition to the activities to increase the system's performance even when the changes have not been suggested by faults. This includes enhancing both the function and efficiency of the code and changing the functionalities of the system as per the users' changing needs.

Examples of perfective maintenance include modifying the payroll program to incorporate a new union settlement and adding a new report in the sales analysis system. Perfective maintenance accounts for 50%, that is, the largest of all the maintenance activities.

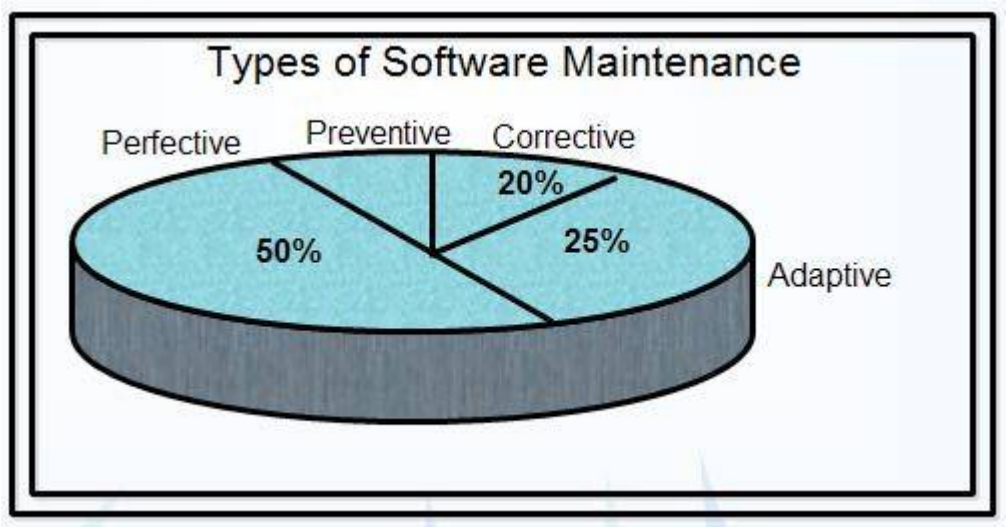
As software is used, the customer/user will recognize additional functions that will provide benefit. Perfective maintenance extends the software beyond its original functional requirements.

Prevention [Preventive maintenance]

Preventive maintenance involves performing activities to prevent the occurrence of errors. It tends to reduce the software complexity thereby improving program understandability and increasing software maintainability. It comprises documentation updating, code optimization, and code restructuring. Documentation updating involves modifying the documents affected by the changes in order to correspond to the present state of the system. Code optimization involves modifying the programs for faster execution or efficient use of storage space. Code restructuring involves transforming the program structure for reducing the complexity in source code and making it easier to understand.

Preventive maintenance is limited to the maintenance organization only and no external requests are acquired for this type of maintenance. Preventive maintenance accounts for only 5% of all the maintenance activities.

Computer software deteriorates due to change, and because of this, preventive maintenance often called software reengineering must be conducted to enable the software to serve the needs **of its end users.**



What are umbrella activities in software engineering?

The phases and related steps described in generic view of SE are complemented by a number of Umbrella Activities as under:

1. **Software project tracking and control**
- **Allows the team to assess progress against the project plan and take necessary action to maintain schedule.**
2. **Formal technical reviews**
- **Uncover and remove errors before they propagate to the next action.**
3. **Software quality assurance**
   This is very important to ensure the quality measurement of each part to ensure them.
4. **Software Configuration management**
   Software configuration management (SCM) is a set of activities designed to control change by identifying the work products that are likely to change, establishing relationships among them, defining mechanisms for managing different versions of these work products.
5. **Document preparation and production**
   All the project planning and other activities should be hardly copied and the production gets started here.
6. **Reusability management**
   This includes the backing up of each part of the software project they can be corrected or any kind of support can be given to them later to update or upgrade the software at user/time demand.
7. **Measurement**

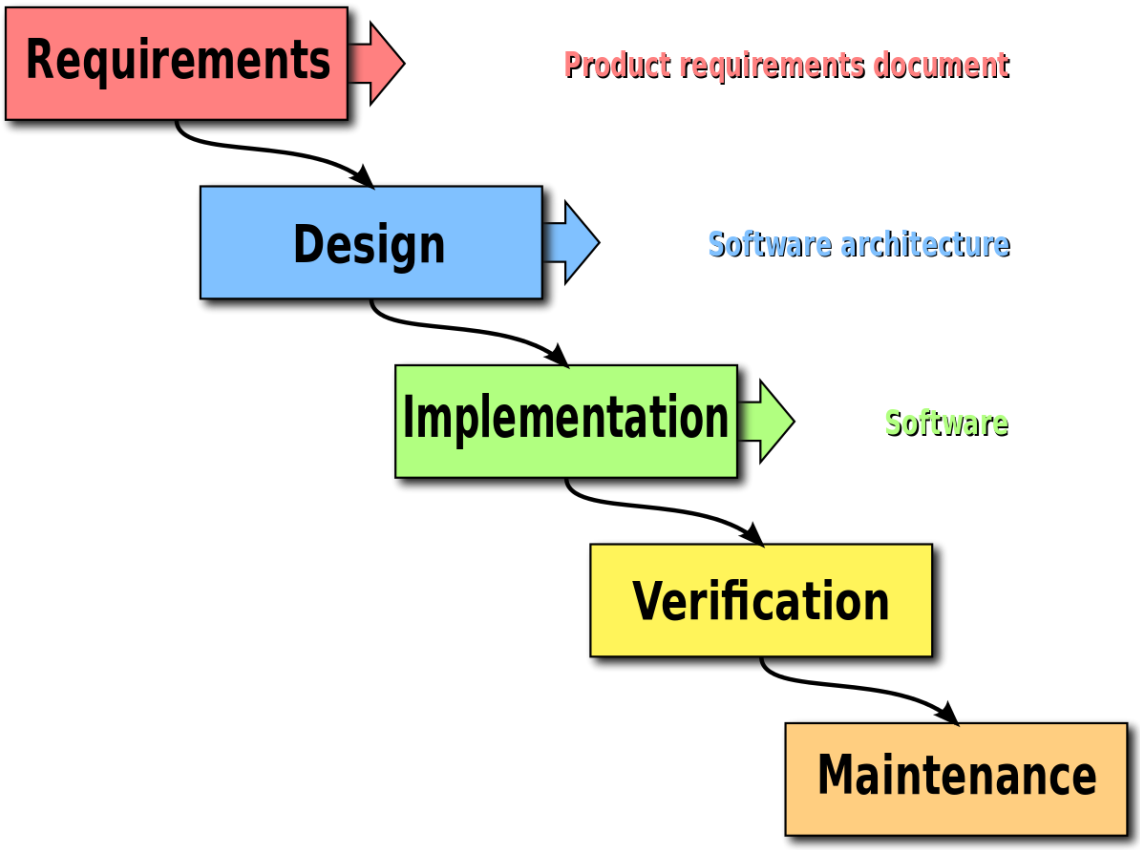
- **Defines and collects process, project, and product measures that assist the team in delivering S/W that meets customers' needs.**

8. **Risk management**

Risk management is a series of steps that help a software team to understand and manage uncertainty. It's a really good idea to identify it, assess its probability of occurrence, estimate its impact, and establish a contingency plan that— 'should the problem actually occur'.

Umbrella activities are applied throughout the software process.

Linear sequential model or Classic life cycle model or Waterfall model



The simplest process model is the water fall model which states that the force is organized in a linear order. So it is also known as the linear sequential model or classic life style model. The linear sequential model is oldest and the most widely used paradigm for software engineering. Linear sequential model suggests a systematic, sequential approach to software development that begins at the system level and progresses through analysis, design, coding, testing and maintenance.

Modeled after the conventional engineering cycle, the linear sequential model encompasses the following activities.

1. **System / Information engineering and modeling**
2. **Software requirement analysis**
3. **Design**
4. **Code generation**
5. **Testing**
6. **Maintenance**

System / Information Engineering

Because software is always part of a larger system (or business), work begins by establishing requirements for all system elements and then allocating some subset of these requirements to software.

This view is essential when software must interface with other elements such as hardware, people, and databases. This provides Top-Level design and analysis.

Software requirements analysis

The requirements gathering process is intensified and focused specifically on software.

Analysis is important for software engineer to understand the information domain for the software, required functions, behavior, performance, and interfacing.

Requirements for both the system and the software are documented and reviewed with the customer.

Design

Software design is actually a multi-step process that focuses on data structure, software architecture, procedural detail and interface characterization.

The design process translates requirements into a representation of the software that can be assessed for quality before code generation begins.

The design documents must be prepared and stored as a part of software configuration.

4. Code generation

The code generation step translates the design into a machine readable form. If design is performed in a detailed manner, code generation can be accomplished mechanistically.

5. Testing

Once code has been generated, program testing begins. The testing process focuses on the logical internals of the software, assuring that all statements have been tested, and on the functional externals – that is, conducting test to uncover errors and ensure that defined input will produce actual results that agree with required results.

6. Maintenance

Software will undergo change after it is delivered to the customer. Change will occur because, errors have been encountered or to accommodate changes in its external environment (e.g. change in device) or customer requires functional or peripheral enhancement.

Advantages:

- **Simple and systematic.**
- **Linear ordering clearly marks the end of the one phase and starting of another phase**
- **The output of particular phase will be input for next phase there for this output are normally referred as intermediate product or based line.**

Disadvantage or problems:

1) Real projects rarely follow the sequential flow that the model proposes. Changes can cause confusion as the project team proceeds.

2) It is difficult for the customer to state all requirements explicitly at the beginning of the projects.

3) The water fall model assumes that the requirement should be completely specified before the rest of the development can proceed. In some situation it might be required that first developed a part of the system completely and then later enhance a system where the client face an important role in requirement specification.

4) The customer must have patience. A working version of program(s) will not be available until late in the project time span.

5) Development is often delayed unnecessarily. The linear nature of the classic life cycle leads to "Blocking state" in which some project team members must wait for other members of the team to complete dependent tasks.

6) **The time spent waiting can exceed the time spent on productive work.**

Prototyping Model in Software Engineering

The prototyping model is applied when detailed information related to input and output requirements of the system is not available. In this model, it is assumed that all the requirements may not be known at the start of the development of the system. It is usually used when a system does not exist or in case of a large and complex system where there is no manual process to determine the requirements. This model allows the users to interact and experiment with a working model of the system known as prototype. The prototype gives the user an actual feel of the system.

At any stage, if the user is not satisfied with the prototype, it can be discarded and an entirely new system can be developed. Generally, prototype can be prepared by the approaches listed below.

• By creating main user interfaces without any substantial coding so that users can get a feel of how the actual system will appear.

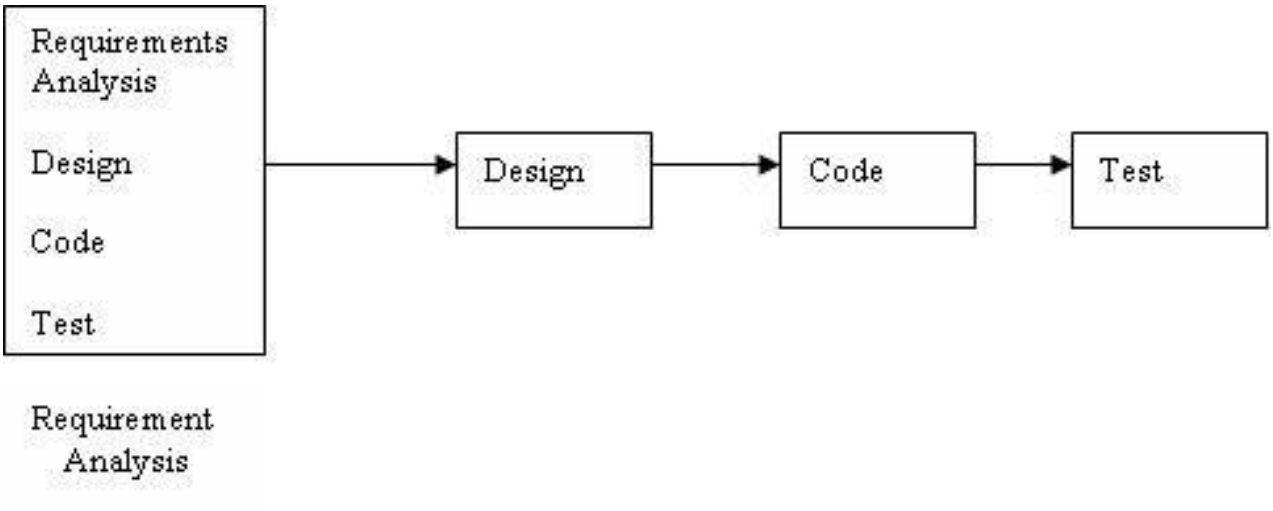
• By abbreviating a version of the system that will perform limited subsets of functions.

• By using system components to illustrate the functions that will be included in the system to be developed.

Using the prototype, the client can get an actual feel of the system. So, this case of model is beneficial in the case when requirements cannot be freezed initially.

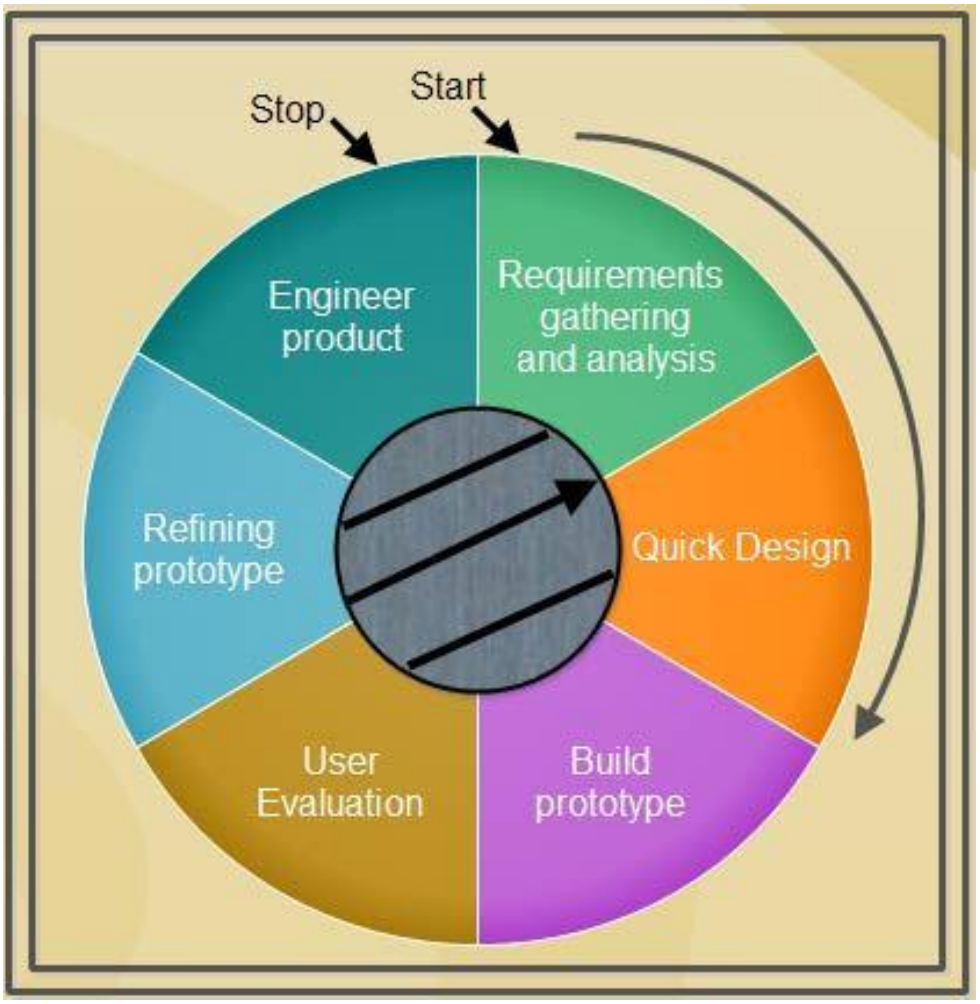
This prototype is developed based on the currently known requirements. Development of the prototype obviously undergoes design, coding, and testing, but each of these phases is not done very formally or thoroughly.

By using this prototype, the client can get an actual feel of the system, because the interactions with the prototype can enable the client to better understand the requirements of the desired system.



Requirement Analysis

Prototyping is an attractive idea for complicated and large systems for which there is no manual process or existing system to help determine the requirements. Risks associated with the projects are being reduced through the use of prototyping. The development of the prototype typically starts when the preliminary version of the requirements specification document has been developed.



1. Requirements gathering and analysis: A prototyping model begins with requirements analysis and the requirements of the system are defined in detail. The user is interviewed in order to know the requirements of the system.

2. Quick design: When requirements are known, a preliminary design or quick design for the system is created. It is not a detailed design and includes only the important aspects of the system, which gives an idea of the system to the user. A quick design helps in developing the prototype.

3. Build prototype: Information gathered from quick design is modified to form the first prototype, which represents the working model of the required system.

4. User evaluation: Next, the proposed system is presented to the user for thorough evaluation of the prototype to recognize its strengths and weaknesses such as what is to be added or removed. Comments and suggestions are collected from the users and provided to the developer.

5. Refining prototype: Once the user evaluates the prototype and if he is not satisfied, the current prototype is refined according to the requirements. That is, a new prototype is developed with the additional information provided by the user. The new prototype is evaluated just like the previous prototype. This process continues until all the requirements specified by the user are met. Once the user is satisfied with the developed prototype, a final system is developed on the basis of the final prototype.

6. Engineer product: Once the requirements are completely met, the user accepts the final prototype. The final system is evaluated thoroughly followed by the routine maintenance on regular basis for preventing large-scale failures and minimizing downtime.

Various advantages and disadvantages associated with the prototyping model are listed in Table.

Table Advantages and Disadvantages of Prototyping Model

Advantages	Disadvantages
1. Provides a working model to the user early in the process, enabling early assessment and increasing user's confidence. **2. The developer gains experience and insight by developing a prototype there by resulting in better implementation of requirements.** **3. The prototyping model serves to clarify requirements, which are not clear, hence reducing ambiguity and improving communication between the developers and users.** **4. There is a great involvement of users in software development. Hence, the requirements of the users are met to the greatest extent.** **5. Helps in reducing risks associated with the software.**	**1. If the user is not satisfied by the developed prototype, then a new prototype is developed. This process goes on until a perfect prototype is developed. Thus, this model is time consuming and expensive.** **2. The developer loses focus of the real purpose of prototype and hence, may compromise with the quality of the software. For example, developers may use some inefficient algorithms or inappropriate programming languages while developing the prototype.** **3. Prototyping can lead to false expectations. For example, a situation may be created where the user believes that the development of the system is finished when it is not.** **4. The primary goal of prototyping is speedy development, thus, the system design can suffer as it is developed in series without considering integration of all other components.**

Fourth Generation Techniques (4GT)

"Fourth generation techniques are the package of software tools that enable a software Engineer to specify the characteristics at a high level and then a source code is automatically generated based on these specifications"

In 4GT, we can specify the user requirements in graphic notation or small abbreviated Language form.

The 4GT includes following tools:

- **Data definition**
- **Data manipulation**
- **Non procedural language for query**
- **Report generation**
- **Code generation**
- **Spreadsheet capability**

Four steps for making a software product using 4GT:

- **Requirement gathering**
- **Design strategy**
- **Implementation**
- **Transformation into product**

Advantages of 4GT:

- **Reduction in software development time.**
- **Improved productivity of software engineers.**
- **4GT helped by CASE, tools and code generators that offer solution to many problems.**

Disadvantages:

- **Some 4GT are not at all easier than programming languages.**
- **Generated source code are sometimes inefficient´**
- **Time is reduced for only small and medium projects.**
- **Large software developed by 4GT is not maintainable or difficult to maintain.**

Effort Distribution

Each of the software project estimation techniques required to complete software development.

A recommended distribution of effort across the definition and development phases is often referred to as the 40–20–40 rule. Forty percent of all effort is allocated to front-end analysis and design. A similar percentage is applied to back-end testing. You can correctly infer that coding (20 percent of effort) is de-emphasized.

40% - analysis and design

20% - Coding

40% - Testing

Requirement Analysis and Testing is the main Part of Software development.

Coding is not most expensive

In-general Ration

10-25 % - Requirement Analysis

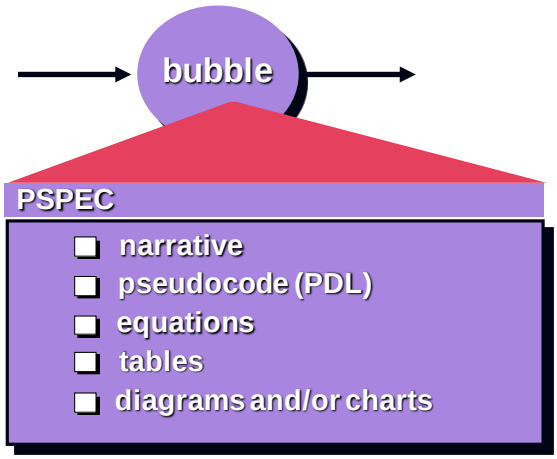
20-25 % -Design

15-20% -Coding

30-40% -Testing

The Process Specification

The *Process Specification* (PSPEC) is used to describe all flow model processes that appear at the final level of refinement. It is a "mini" specification for each transform at the lowest refined of a DFD.



Analysis Model in Software Engineering

- Analysis model operates as a link between the 'system description' and the 'design model'.
- In the analysis model, information, functions and the behavior of the system is defined and these are translated into the architecture, interface and component level design in the 'design modeling'.

Elements of the analysis model

1. Scenario based element

- This type of element represents the system user point of view.
- Scenario based elements are use case diagram, user stories.

2. Class based elements

- The object of this type of element manipulated by the system.
- It defines the object, attributes and relationship.
- The collaboration is occurring between the classes.
- Class based elements are the class diagram, collaboration diagram.

3. Behavioral elements

- Behavioral elements represent state of the system and how it is changed by the external events.
- The behavioral elements are sequenced diagram, state diagram.

4. Flow oriented elements

- An information flows through a computer-based system it gets transformed.
- It shows how the data objects are transformed while they flow between the various system functions.
- The flow elements are data flow diagram, control flow diagram.

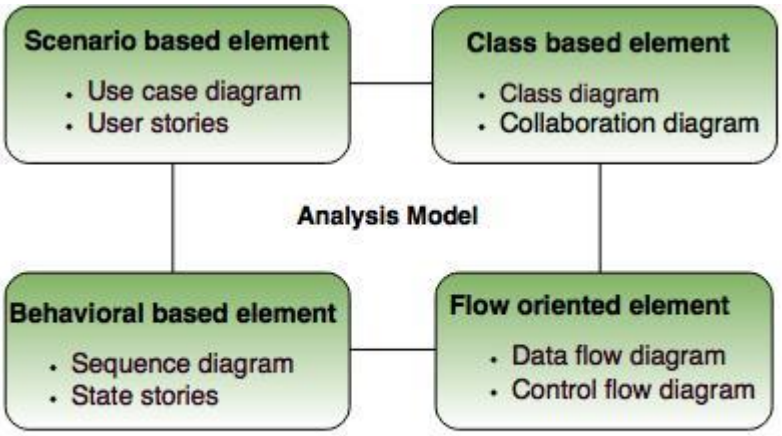


Fig. - Elements of analysis model

Analysis Rules of Thumb

The rules of thumb that must be followed while creating the analysis model.

The rules are as follows:

- The model focuses on the requirements in the business domain. The level of abstraction must be high i.e there is no need to give details.
- Every element in the model helps in understanding the software requirement and focus on the information, function and behavior of the system.

- The consideration of infrastructure and nonfunctional model delayed in the design.

  For example, the database is required for a system, but the classes, functions and behavior of the database are not initially required. If these are initially considered then there is a delay in the designing.
- Throughout the system minimum coupling is required. The interconnections between the modules is known as 'coupling'.
- The analysis model gives value to all the people related to model.
- The model should be simple as possible. Because simple model always helps in easy understanding of the requirement.

Data Modeling Concepts

1. Data Objects

A *data object* is a representation of almost any composite information that must be processed by software. By composite, we mean something that has a number of different properties and attributes.

- "Width" (a single value) would not be a valid data object, but **dimensions** (incorporating height, width and depth) could be defined as object.

A data object encapsulates data only – there is no reference within a data object to operations that act on the data. Therefore, the data can be represented as a table below.

object: automobile
attributes:
- **make**
- **model**
- **body type**
- **price**
- **options code**

2. Data Attributes

Data attributes define the properties of a data object and take one of three different characteristics. They can be used to:

1. Name an instance of the data object.
2. Describe the instance, or
3. Make reference to another instance in another table.

In addition, one or more of the attributes, must be defined as an identifier, i.e., the identifier attribute becomes a "key" when we want to find an instance of the data object. Values for the identifier(s) are unique, although this is not a requirement.

Referring to the data object **car**, a reasonable identifier might be the ID number.

3. Relationships

Indicates "connectedness"; a "fact" that must be "remembered" by the system and cannot or is not computed or derived mechanically

- several instances of a relationship can exist
- objects can be related in many different ways

We can define a set of object/relationship pairs that define the relevant relationships. For example:

- A person *owns* a car.
- A person is *insured to drive* a car.

The relationship *owns* and *insured to drive* define the relevant connections between **person** and **car**.

Object-Oriented Analysis

The intent of Object Oriented Analysis (OOA) is to define all classes (and the relationships and behavior associated with them that are relevant to the problem to be solved.

To accomplish this, a number of tasks must occur:

1. Basic user requirements must be communicated between the customer and the software engineer.
2. Classes must be defined.
3. A class hierarchy is defined
4. Object-to-object relationships should be represented.
5. Object behavior must be modeled.
6. 1 – 5 are repeated iteratively until the model is complete.

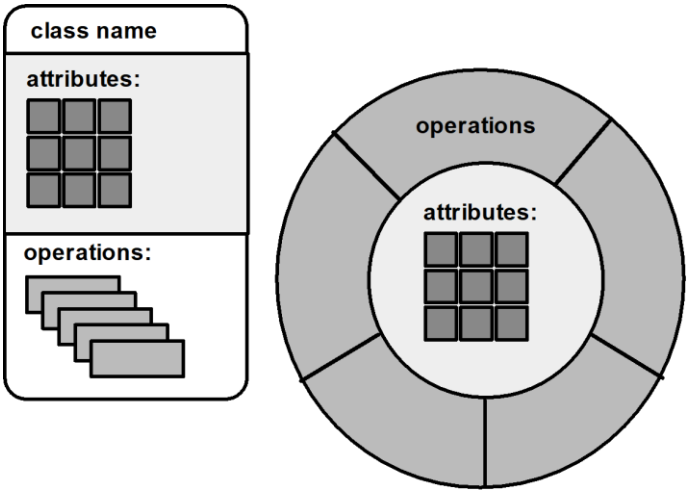
OOA builds a class-oriented model that relies on an understanding of OO concepts.

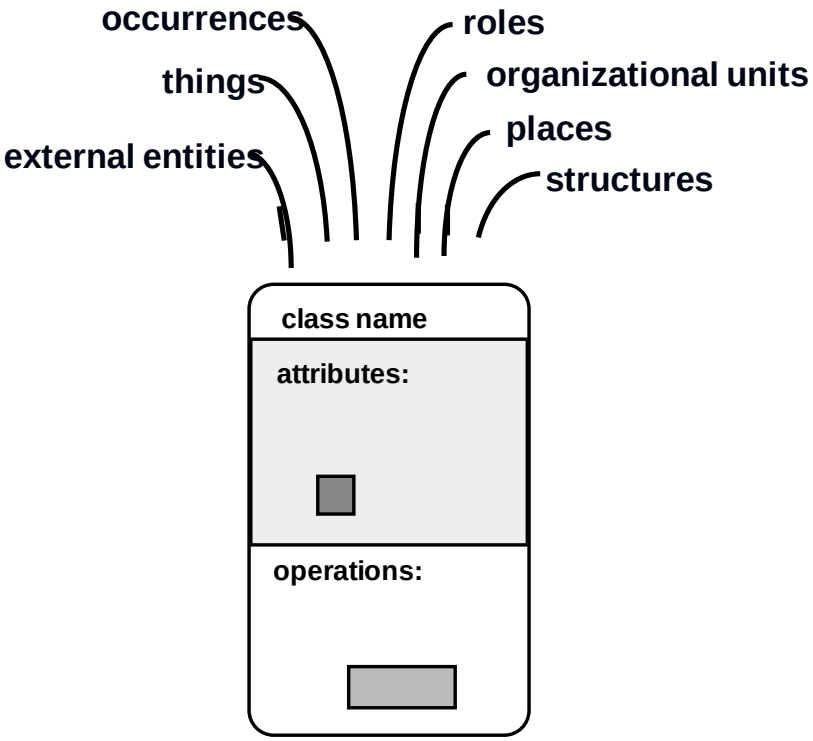
- Classes and objects
- Attributes and operations
- Encapsulation and instantiation
- Inheritance

Object-Oriented thinking begins with the definition of a class, often defined as:

- template
- generalized description
- “blueprint” ... describing a collection of similar items
- a metaclass (also called a superclass) establishes a hierarchy of classes once a class of items is defined, a specific instance of the class can be identified.

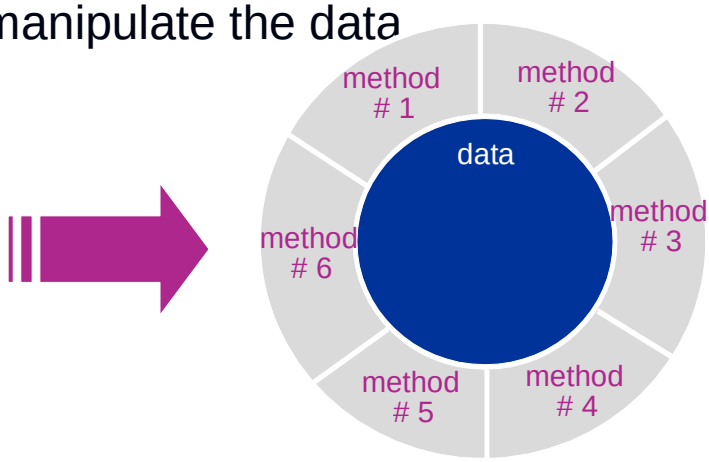
Building a class



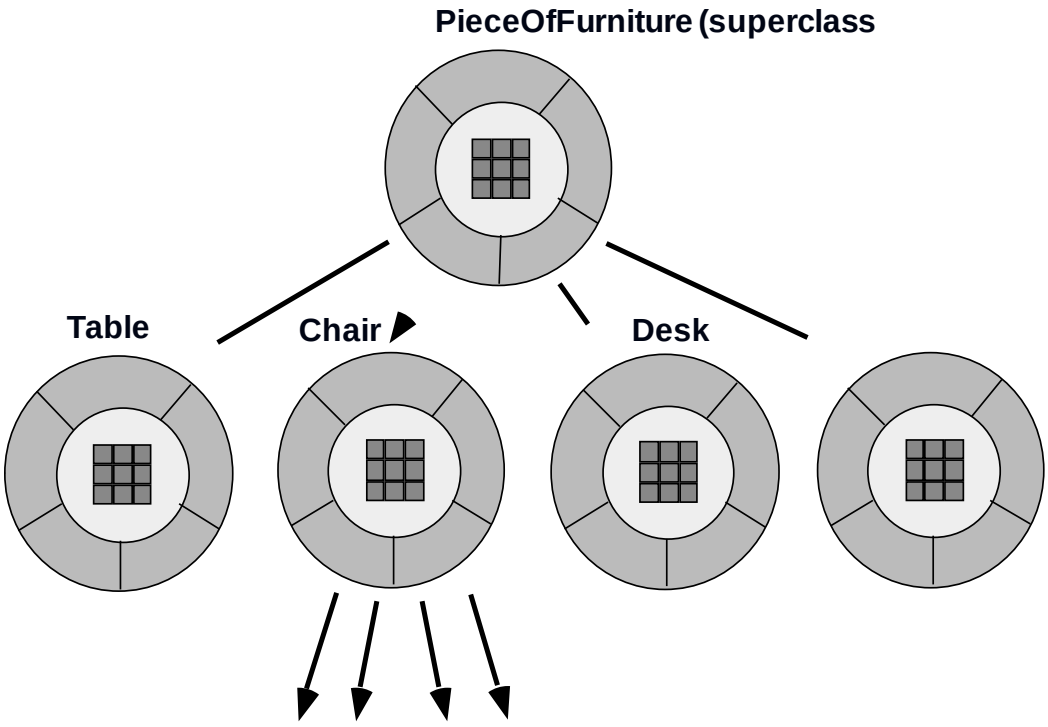


Encapsulating and Hiding:

The object encapsulates both data and the logical procedures required To manipulate the data



Class Hierarchy:



Methods (Operations, Services)

An executable procedure that is encapsulated in a class and is designed to operate on one or more data attributes that are defined as part of the class.

A method is invoked via message passing.

Software quality guidelines:

- A design is generated using the recognizable architectural styles and compose a good design characteristic of components and it is implemented in evolutionary manner for testing.
- A design of the software must be modular i.e the software must be logically partitioned into elements.
- In design, the representation of data , architecture, interface and components should be distinct.
- A design must carry appropriate data structure and recognizable data patterns.
- Design components must show the independent functional characteristic.
- A design creates an interface that reduce the complexity of connections between the components.
- A design must be derived using the repeatable method.
- The notations should be use in design which can effectively communicates its meaning.

Quality attributes

The attributes of design name as 'FURPS' are as follows:

Functionality:
It evaluates the feature set and capabilities of the program.

Usability:
It is accessed by considering the factors such as human factor, overall aesthetics, consistency and documentation.

Reliability:
It is evaluated by measuring parameters like frequency and security of failure, output result accuracy, the mean-time-to-failure(MTTF), recovery from failure and the program predictability.

Performance:
It is measured by considering processing speed, response time, resource

consumption, throughput and efficiency.

Supportability:

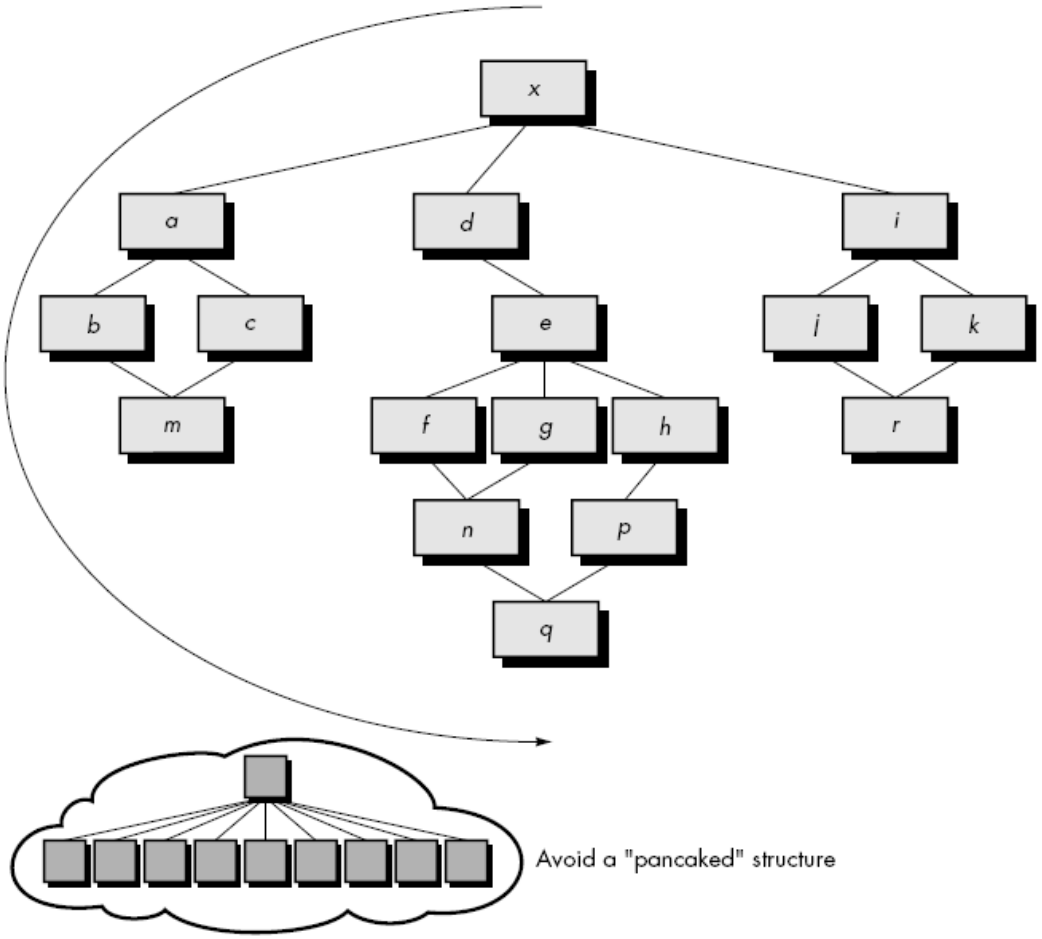
- It combines the ability to extend the program, adaptability, serviceability. These three term defines the maintainability.
- Testability, compatibility and configurability are the terms using which a system can be easily installed and found the problem easily.
- Supportability also consists of more attributes such as compatibility, extensibility, fault tolerance, modularity, reusability, robustness, security, portability, scalability.

Design Heuristics:

[1] Evaluate the "First Interaction" of the program structure to reduce coupling and improve cohesion

- Modules may be explored or implied for making module independent.
- An explored module becomes two or more modules in final program structure
- An implied module is the result of combining the processing implied by two or more modules.

[2] Attempt to minimize structure with high fan-out; strive for fan-in as depth increases.



[3] Keep the scope of effect of a module within the scope control of that module.

[4] Evaluate module interfaces to reduce complexity and redundancy and improve consistency.

[5] Define Modules where function is pre-detectable but avoid modules that are overly [excessively] relative.

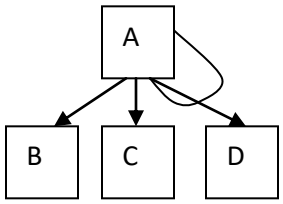
Design Documentation

- The design Specification addresses different aspects of design models.
- The data design is specifies Data structure , any external File Structure, internal Data Structure and a Cross Reference that connects data object to specific files are all defined.
- The architectural design indicates how the program architecture has been derived from the analysis model.
- Structural Charts are use to represent the module hierarchy.
- Components – separately addressable elements of s/w such as subroutines, functions or procedures are initially describe with an English Language.
- Procedural Design is use to translate the Narratives into a structural description.
- The design Specification contains a requirements cross reference. The propose of this cross reference is
  (1) To establish that all requirements are satisfied by s/w design.
  (2) To indicate which components are created to implements specific requirements?
- We can develop guidelines for testing of individual modules and integration of the entire package.
- Design Constraints such as Physical Memory limitations are the necessity for a specific external interface may dictate special requirements for assembling of package of s/w

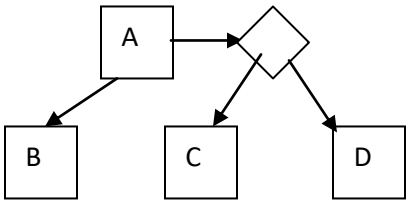
- The Final section of the Design specification contains supplementary data, Algorithmic Description, native procedures, tabular Data, imports from external Documents, and other relative information.
- It is also advisable to develop a Preliminary Operational installation manual. It includes as an appendix to the design documents.

Structural Charts

- It is graphical Representation of the structure of the program.
- A module is representing by a box with module name and an arrow that means invocation between two modules that called Subordinate and Super ordinate.
- The arrow is labeled by parameter received with input and output as a parameters.
- The direction of input and output is represented as (→)
- If module A repeatedly call module C and D the it can be re presented as



- The decision can be represented as small diamond box.



- Modules can be categorized into five forms
    1) Input Modules
       It obtains the information from its subordinate and pass it to subordinate.

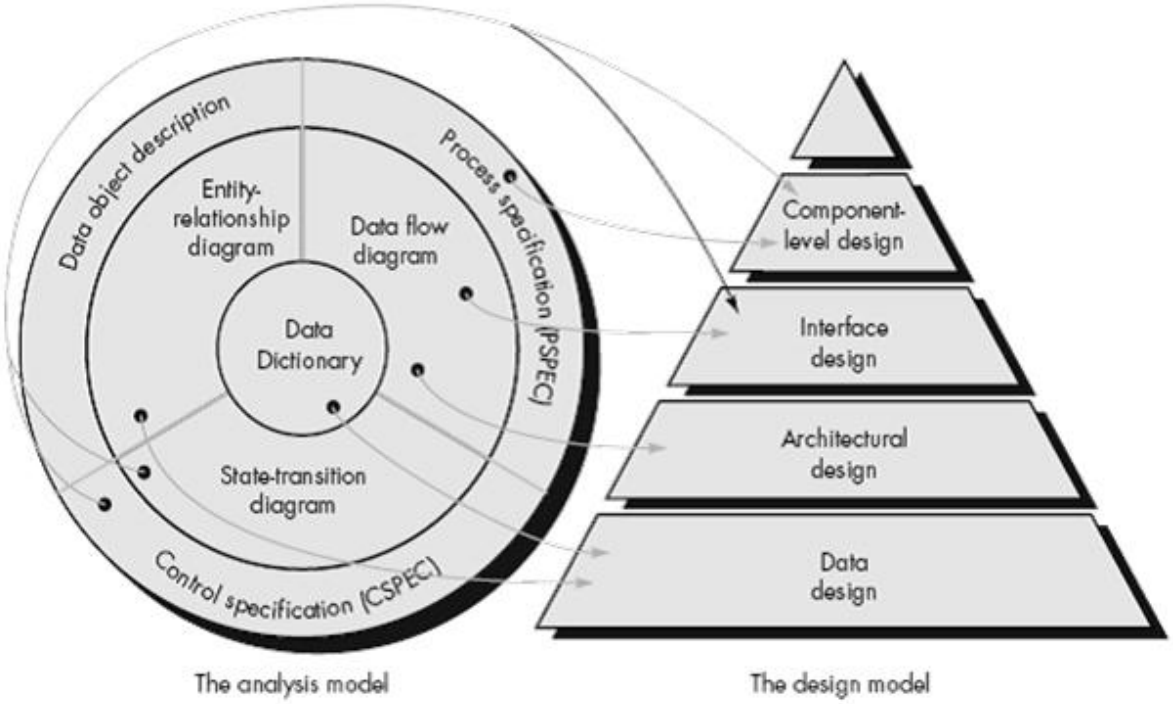
    2) Output Modules
       It Takes the information from its super ordinates and pass it to its sub ordinate.

    3) Transform Module
       This module exists only for the sake of transforming the data into some other from.

    4) Coordinate Module
       It manages the Flow of data to and from different Subordinates.

5) Composite Module
It performs the function of more than one type of module.

Explain transformation from analysis model to design model.



1. **Data Design: -**
   The data design transforms the information domain model which is created during analysis into the data structure that will be required to implement the software. The data objects and relationships defined in the entity relationship diagram and the detail data content which is shown in the data dictionary proving the bases for the data design activity.

2. **Architecture Design: -**
   The architectural design defined the relationship between major structural elements of the software, the design patterns that can be used to achieve the requirement that have been defined for the system and the constraints that affect the way in which architectural design patterns can be applied. This design represents the frame work of a computer based system can be derived from the system specification.

3. **Interface Design: -**

The interface design describes how the software communicates within itself with systems that interoperate with it and with people who use it. An interface implies a flow of information. E.g. data or control and a specification type of behavior therefore data and control flow diagram provides much of the information required for interface design.

4. Components Design: -

The component level design transforms structural elements of the software architectural into a procedural description of software component. Information obtains from the process specification and control specifications serve as the basis for component design.

Software Development Life Cycle

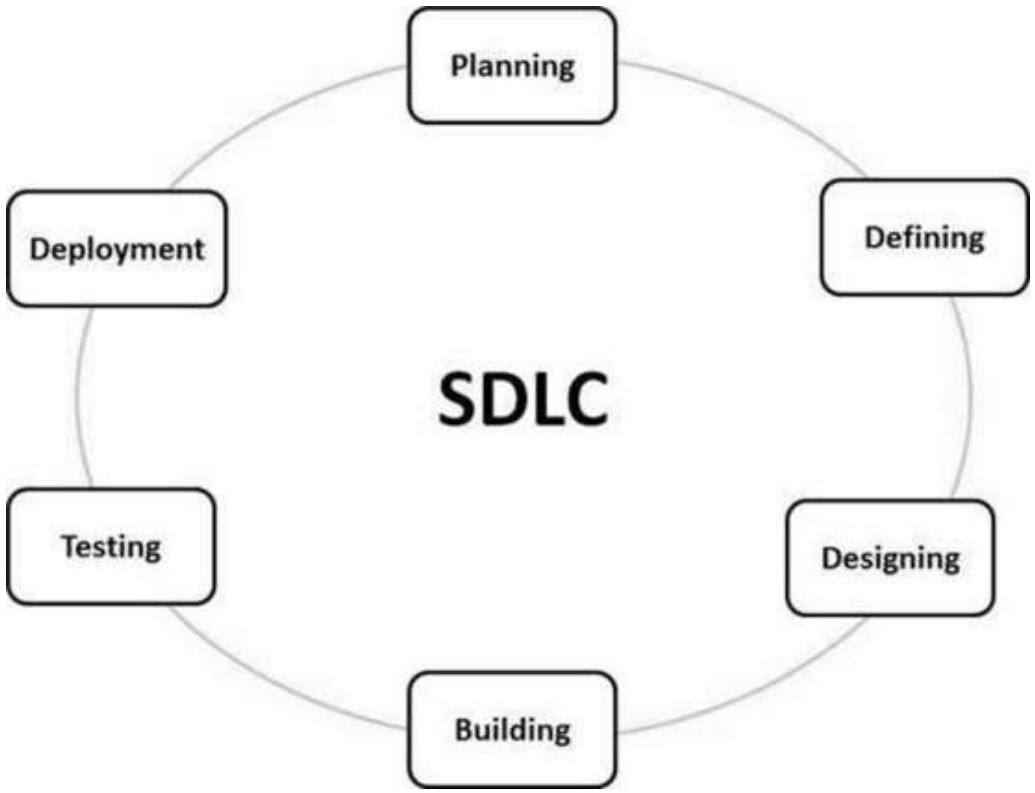
Software Development Life Cycle (SDLC) is a process used by the software industry to design, develop and test high quality software. The SDLC aims to produce high-quality software that meets or exceeds customer expectations, reaches completion within times and cost estimates.

- **SDLC is the acronym of Software Development Life Cycle.**
- **It is also called as Software Development Process.**
- **SDLC is a framework defining tasks performed at each step in the software development process.**
- **ISO/IEC 12207 is an international standard for software life-cycle processes. It aims to be the standard that defines all the tasks required for developing and maintaining software.**

What is SDLC?

SDLC is a process followed for a software project, within a software organization. It consists of a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle defines a methodology for improving the quality of software and the overall development process.

The following figure is a graphical representation of the various stages of a typical SDLC.



A typical Software Development Life Cycle consists of the following stages –

Stage 1: Planning and Requirement Analysis

Requirement analysis is the most important and fundamental stage in SDLC. It is performed by the senior members of the team with inputs from the customer, the sales department, market surveys and domain experts in the industry. This information is then used to plan the basic project approach and to conduct product feasibility study in the economical, operational and technical areas.

Planning for the quality assurance requirements and identification of the risks associated with the project is also done in the planning stage. The outcome of the technical feasibility study is to define the various technical approaches that can be followed to implement the project successfully with minimum risks.

Stage 2: Defining Requirements

Once the requirement analysis is done the next step is to clearly define and document the product requirements and get them approved from the customer or the market analysts. This is done through an SRS (Software Requirement Specification) document which consists of all the product requirements to be designed and developed during the project life cycle.

Stage 3: Designing the Product Architecture

SRS is the reference for product architects to come out with the best architecture for the product to be developed. Based on the requirements specified in SRS, usually more than one design approach for the product architecture is proposed and documented in a DDS - Design Document Specification.

This DDS is reviewed by all the important stakeholders and based on various parameters as risk assessment, product robustness, design modularity, budget and time constraints, the best design approach is selected for the product.

A design approach clearly defines all the architectural modules of the product along with its communication and data flow representation with the external and third party modules (if any). The internal design of all the modules of the proposed architecture should be clearly defined with the minutest of the details in DDS.

Stage 4: Building or Developing the Product

In this stage of SDLC the actual development starts and the product is built. The programming code is generated as per DDS during this stage. If the design is performed in a detailed and organized manner, code generation can be accomplished without much hassle.

Developers must follow the coding guidelines defined by their organization and programming tools like compilers, interpreters, debuggers, etc. are used to generate the code. Different high level programming languages such as C, C++, Pascal, Java and PHP are used for coding. The programming language is chosen with respect to the type of software being developed.

Stage 5: Testing the Product

This stage is usually a subset of all the stages as in the modern SDLC models, the testing activities are mostly involved in all the stages of SDLC. However, this stage refers to the testing only stage of the product where product defects are reported, tracked, fixed and retested, until the product reaches the quality standards defined in the SRS.

Stage 6: Deployment in the Market and Maintenance

Once the product is tested and ready to be deployed it is released formally in the appropriate market. Sometimes product deployment happens in stages as per the business strategy of that organization. The product may first be released in a limited segment and tested in the real business environment (UAT- User acceptance testing).

Then based on the feedback, the product may be released as it is or with suggested enhancements in the targeting market segment. After the product is released in the market, its maintenance is done for the existing customer base.

Data Flow Diagram [DFD]

Data flow diagram is graphical representation of flow of data in an information system. It is capable of depicting incoming data flow, outgoing data flow and stored data. The DFD does not mention anything about how data flows through the system.

There is a prominent difference between DFD and Flowchart. The flowchart depicts flow of control in program modules. DFDs depict flow of data in the system at various levels. DFD does not contain any control or branch elements.

Types of DFD

Data Flow Diagrams are either Logical or Physical.

- **Logical DFD - This type of DFD concentrates on the system process and flow of data in the system. For example in a Banking software system, how data is moved between different entities.**
- **Physical DFD - This type of DFD shows how the data flow is actually implemented in the system. It is more specific and close to the implementation.**

DFD Components

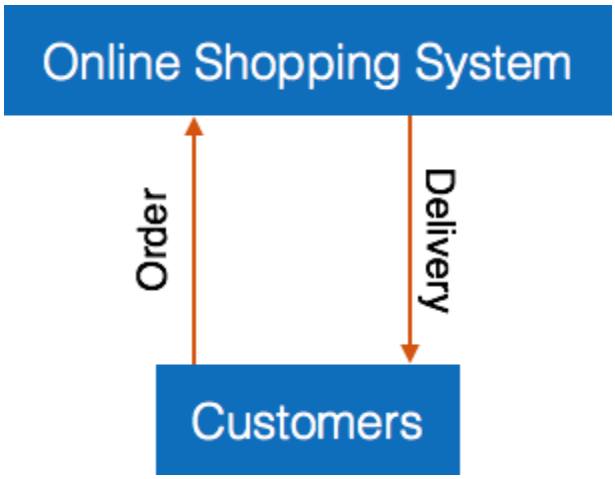
DFD can represent Source, destination, storage and flow of data using the following set of components -

- **Entities - Entities are source and destination of information data. Entities are represented by a rectangles with their respective names.**
- **Process - Activities and action taken on the data are represented by Circle or Round-edged rectangles.**
- **Data Storage - There are two variants of data storage - it can either be represented as a rectangle with absence of both smaller sides or as an open-sided rectangle with only one side missing.**

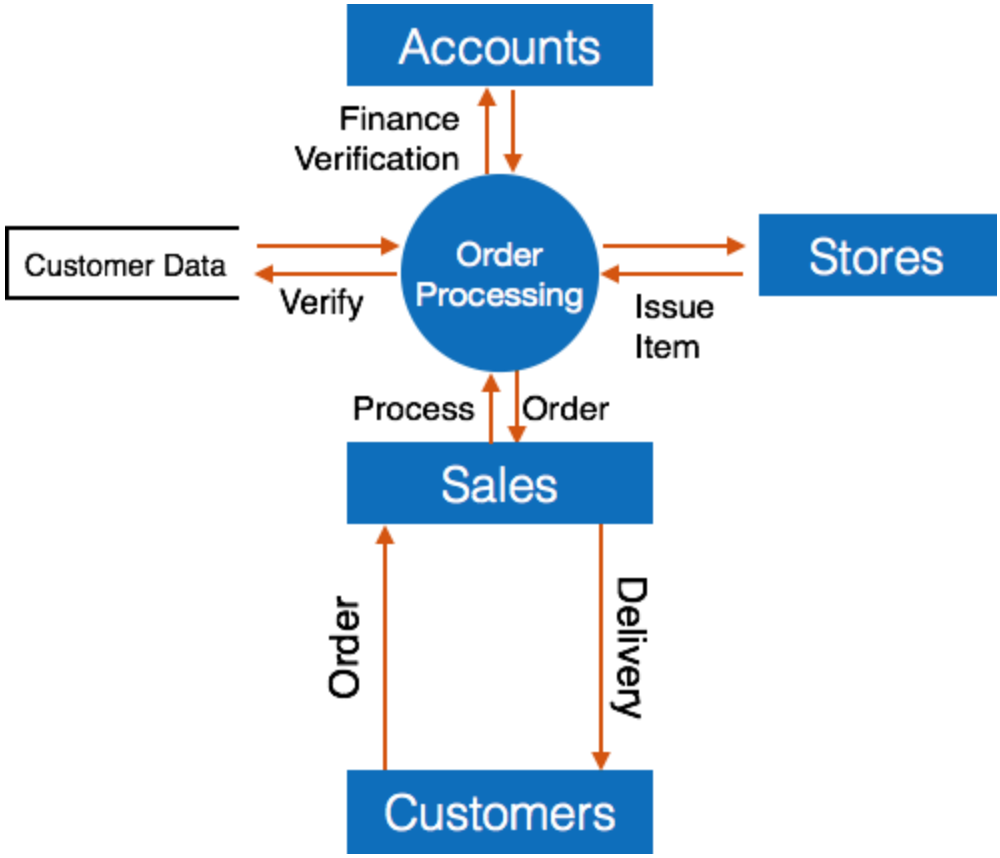
- **Data Flow - Movement of data is shown by pointed arrows. Data movement is shown from the base of arrow as its source towards head of the arrow as destination.**

Levels of DFD

- **Level 0 - Highest abstraction level DFD is known as Level 0 DFD, which depicts the entire information system as one diagram concealing all the underlying details. Level 0 DFDs are also known as context level DFDs.**



- **Level 1 - The Level 0 DFD is broken down into more specific, Level 1 DFD. Level 1 DFD depicts basic modules in the system and flow of data among various modules. Level 1 DFD also mentions basic processes and sources of information.**



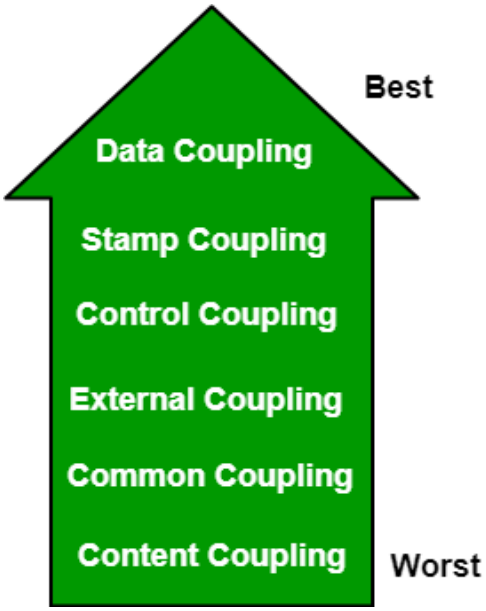
- **Level 2 - At this level, DFD shows how data flows inside the modules mentioned in Level 1.**

  Higher level DFDs can be transformed into more specific lower level DFDs with deeper level of understanding unless the desired level of specification is achieved.

Modularization: Modularization is the process of dividing a software system into multiple independent modules where each module works independently. There are many advantages of Modularization in software engineering. Some of these are given below:

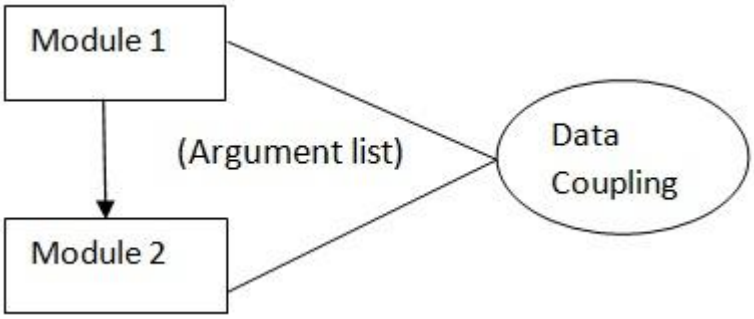
- **Easy to understand the system.**
- **System maintenance is easy.**
- **A module can be used many times as their requirements. No need to write it again and again.**

Coupling: Coupling is the measure of the degree of interdependence between the modules. Good software will have low coupling.

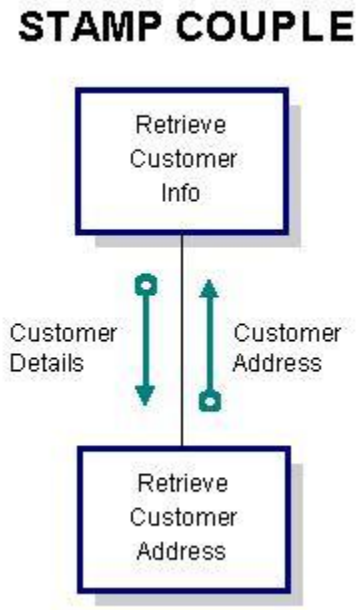


Types of Coupling:

- **Data Coupling: If the dependency between the modules is based on the fact that they communicate by passing only data, then the modules are said to be data coupled. In data coupling, the components are independent to each other and communicating through data. Module communications don't contain tramp [without declaration] data. Example-customer billing system.**

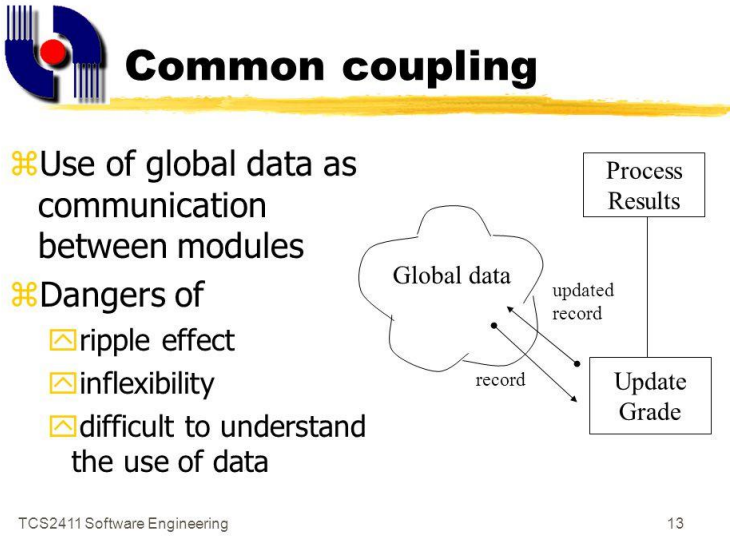


- **Stamp Coupling In stamp coupling, the complete data structure is passed from one module to another module. Therefore, it involves tramp data. It may be necessary due to efficiency factors- this choice made by the insightful designer, not a lazy programmer.**



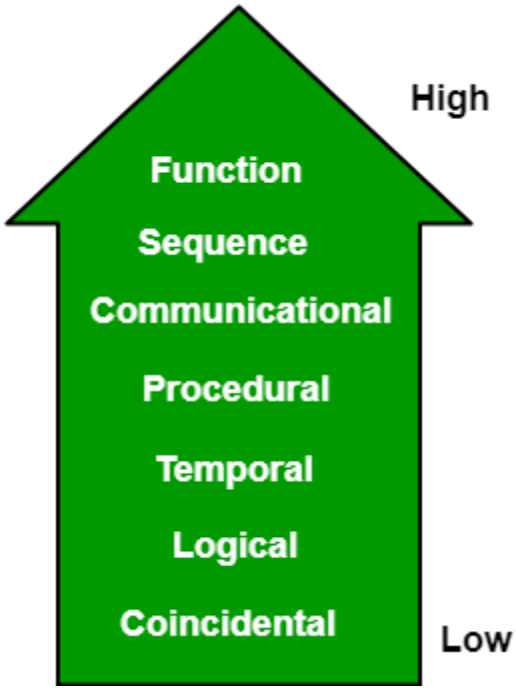
- **Control Coupling: If the modules communicate by passing control information, then they are said to be control coupled. It can be bad if parameters indicate completely different behavior and good if parameters allow factoring and reuse of functionality. Example- sort function that takes comparison function as an argument.**

- **External Coupling: In external coupling, the modules depend on other modules, external to the software being developed or to a particular type of hardware. Ex- protocol, external file, device format, etc.**
- **Common Coupling: The modules have shared data such as global data structures. The changes in global data mean tracing back to all modules which access that data to evaluate the effect of the change. So it has got disadvantages like difficulty in reusing modules, reduced ability to control data accesses and reduced maintainability.**



- **Content Coupling: In a content coupling, one module can modify the data of another module or control flow is passed from one module to the other module. This is the worst form of coupling and should be avoided.**

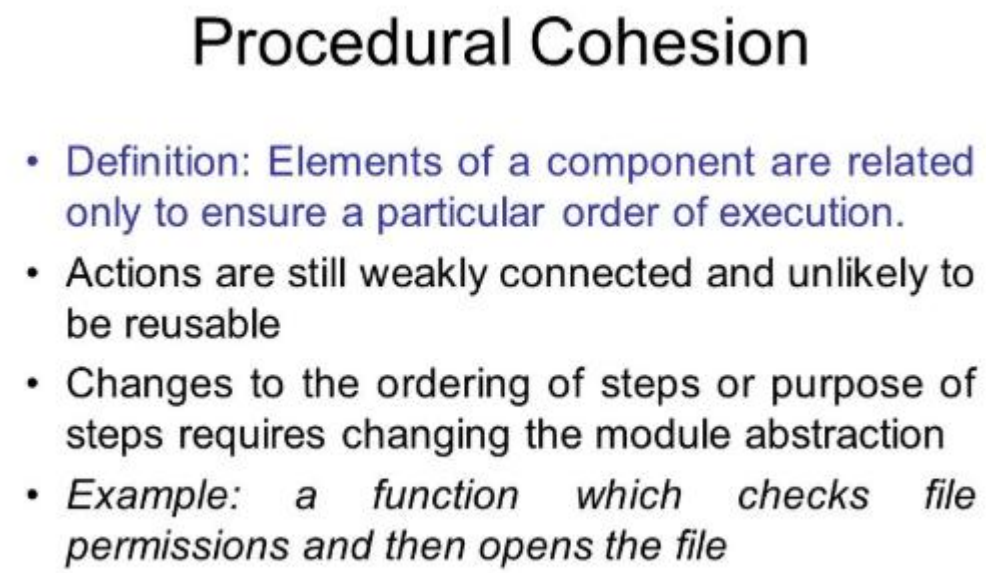
Cohesion: Cohesion is a measure of the degree to which the elements of the module are functionally related. It is the degree to which all elements directed towards performing a single task are contained in the component. Basically, cohesion is the internal glue that keeps the module together. A good software design will have high cohesion.



Types of Cohesion:

- **Functional Cohesion: Every essential element for a single computation is contained in the component. A functional cohesion performs the task and functions. It is an ideal situation.**
- **Sequential Cohesion: An element outputs some data that becomes the input for other element, i.e., data flow between the parts. It occurs naturally in functional programming languages.**
- **Communicational Cohesion: Two elements operate on the same input data or contribute towards the same output data. Example- update record into the database and send it to the printer.**
- **Procedural Cohesion: Elements of procedural cohesion ensure the order of execution. Actions are still weakly connected and unlikely to be**

reusable. Ex- calculate student GPA, print student record, calculate cumulative GPA, and print cumulative GPA.



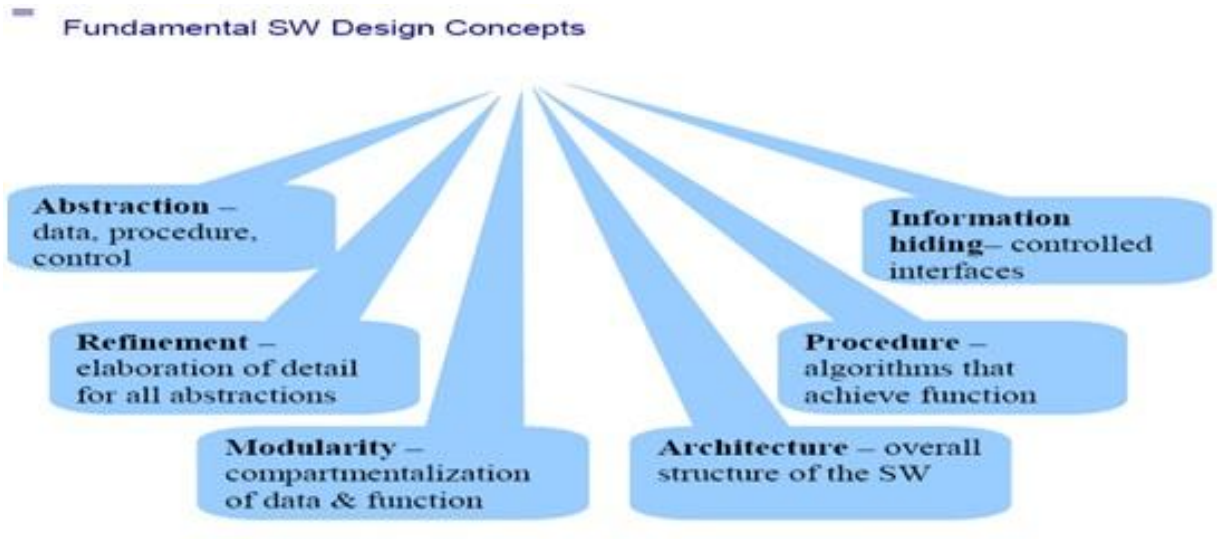
- **Temporal Cohesion: The elements are related by their timing involved. A module connected with temporal cohesion all the tasks must be executed in the same time-span. This cohesion contains the code for initializing all the parts of the system. Lots of different activities occur, all at init time.**

- **Logical Cohesion: The elements are logically related and not functionally. Ex- A component reads inputs from tape, disk, and network. All the code for these functions is in the same component. Operations are related, but the functions are significantly different.**

- **Coincidental Cohesion: The elements are not related (unrelated). The elements have no conceptual relationship other than location in source code. It is accidental and the worst form of cohesion. Ex- prints next line and reverse the characters of a string in a single component.**

Design Concepts:

Following are some design concepts which designer should keep in mind while preparing a design for the software.



1. **<u>Abstraction:</u>-**

Concentrate on the essential features and ignore details that are not relevant Means hiding the complexity.

1) Procedural Abstraction: -

It is name sequence of instructions that has a specific and limited function. E.g. procedural abstraction would be the word open for a door for open implies a long sequence of procedural steps like walk to the door, reached out and knocked and pull door and step away from moving door etc.

Means in-sort hiding the Procedure details here hiding the procedure of how to open door.

2) Data Abstraction: -

Data abstraction is a name collection of data that describes a data object in the context of the procedural abstraction open we can define a data abstraction called door like any data object. The data abstraction for door would be a set of attributes that describe the door. E.g. Door type, swing direction, opening mechanism, weight dimension etc. it follows that the procedural abstraction

would make use of information contain in the attributes of the data abstraction door.

Means in-sort hiding the data details here hide the door details.

3) Control abstraction:

Implies a program control mechanisms without specify internal details.

Means in-short hiding the Control Details.

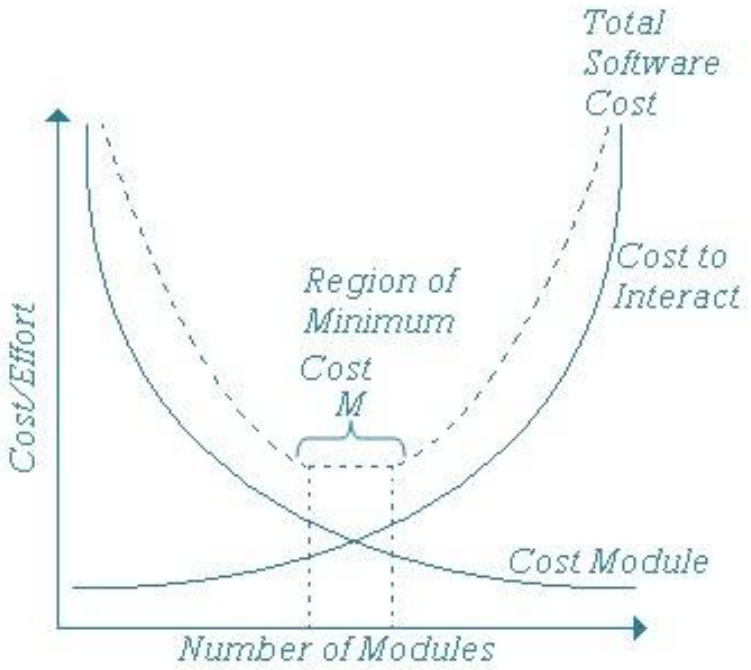
2. **Refinements: -**

The process of program refinement (modification or enhancement) is a partitioning process i.e. used during requirement analysis. Refinement is actually a process of elaboration (expansion). We begin with a statement of function or description of information i.e. defines a high level of abstraction. The statement describes function or information conceptually but provides no information about the internal working of the functions or the internal structure of the information. Refinement causes the system designer to elaborate on the original statement providing more and more detail as each successive refinement occurs.

Abstraction and refinement are complimentary concepts. Abstractions enable a designer to specify procedure and data refinement helps the designer a detail at a low level.

3. **Modularity: -**

Software is divided into separately named and addressable components which are called modules. Those are integrated to satisfy problem requirements. Modularity is a single attribute of software that allows a program to be intellectually manageable. Monolithic software i.e. a large program composed of a single module cannot be easily readable the number of control paths, spend of referential number of variables and overall complexity would make understanding close of impossible.



It is easier to solve a complex problem when you break it into manageable pieces (Modules). When we divide software in to modules then development effort also decreased. From above graph we can show that as the number of modules grows the effort or cost associated with integrating the module also grows. These characteristics leads to a total cost or effort which shown in above figure. This is a M of modules that would result in minimum development cost and here another important question arises when modularity is consider how do we define an appropriate module of a given size? The answer lies in the method use to define modules within a system. These are arteries define that enable us to evaluate a design method with respect to define an effective module system.

1) Modular Decomposability: -

Provide a systematic approach for decomposing the problem into sub-problems. If a design method provides a systematic mechanism for decomposable problem into the sub problem then we can reduce the complexity of overall problem by achieving effective modularity software.

2) Modular Composability: -

Modular Composability means if a design method enable existing or reusable design components to be assembled into a new system then the modular solution does not reinventing wheel.

3) Modular Understandability: -

If a module can be understood as a standalone unit without reference to other module then it will be easier to build and easier to change.

4) Modular Continuity: -

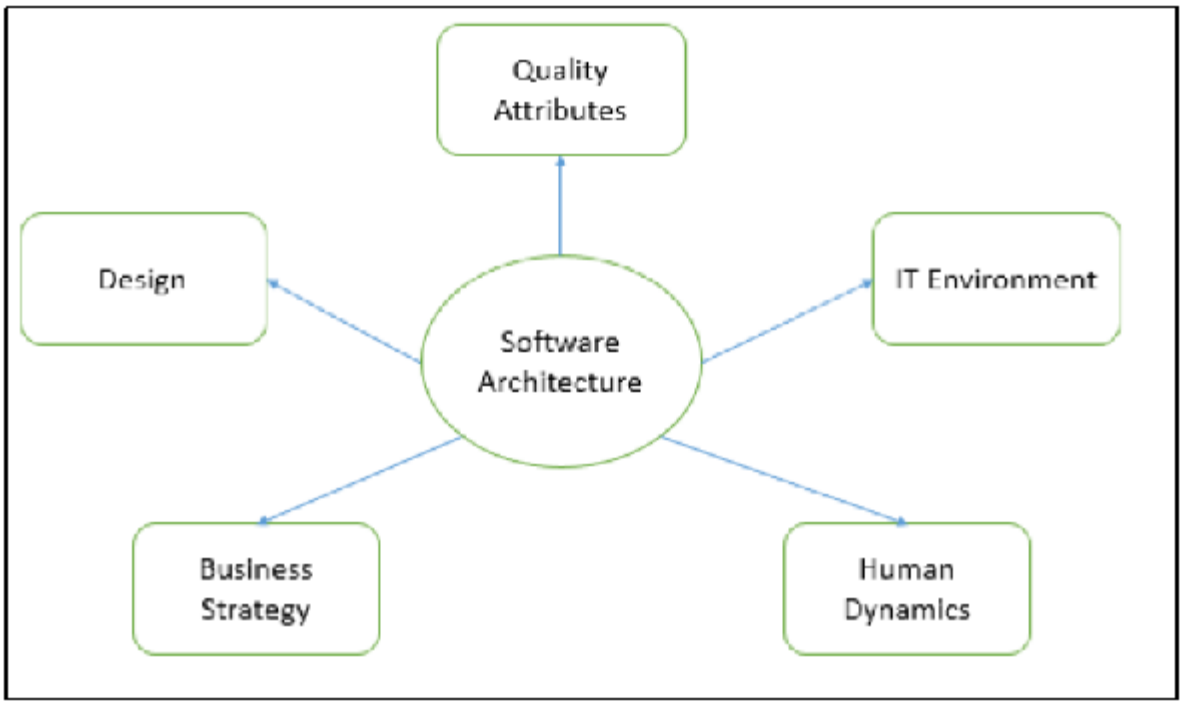
If small changes to the system requirements results in changes to individual modules rather-then system wise changes the impact of change all other side effects should be minimized.

5) Modular Protection: -

If any unexpected condition occurs within a module and its effects are contain within that module only, the impact of other side effects should be minimized.

4. Software Architecture: -

The architecture of a system describes its major components, their relationships (structures), and how they interact with each other. Software architecture and design includes several contributory factors such as Business strategy, quality attributes, human dynamics, design, and IT environment.



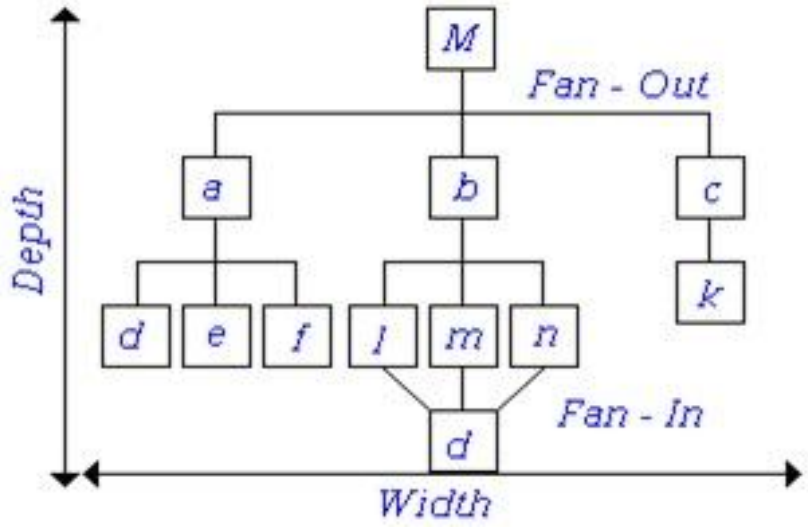
Architecture serves as a blueprint for a system. It provides an abstraction to manage the system complexity and establish a communication and coordination mechanism among components. It defines a structured

solution to meet all the technical and operational requirements, while optimizing the common quality attributes like performance and security.

Further, it involves a set of significant decisions about the organization related to software development and each of these decisions can have a considerable impact on quality, maintainability, performance, and the overall success of the final product. These decisions comprise of –

- **Selection of structural elements and their interfaces by which the system is composed.**
- **Behavior as specified in collaborations among those elements.**
- **Composition of these structural and behavioral elements into large subsystem.**
- **Architectural decisions align with business objectives.**
- **Architectural styles guide the organization.**

Control Hierarchy: -

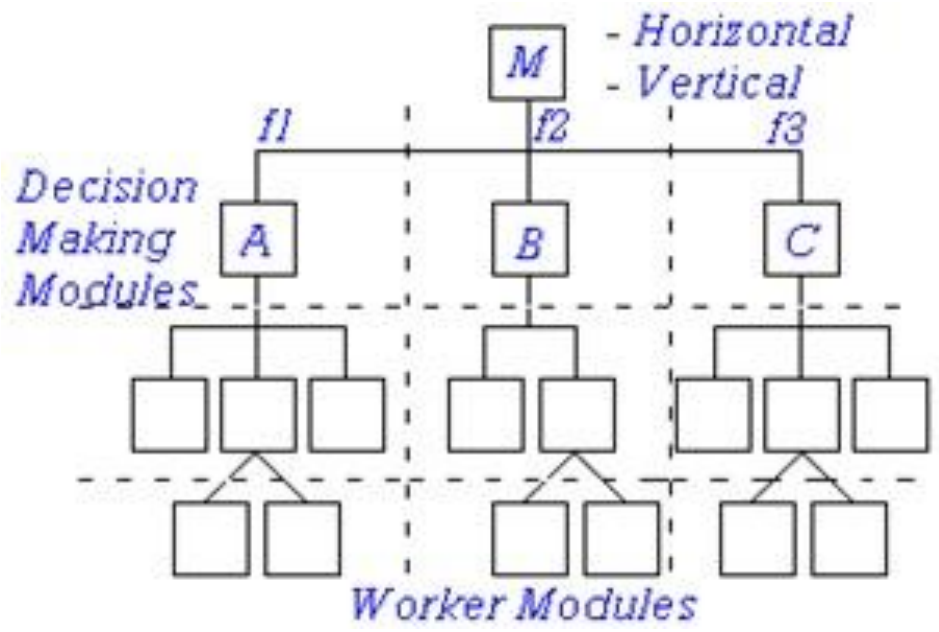


The control hierarchy also called program structure represents the organization of program components and implies a hierarchy of control. It does not represent procedural aspects of software such as sequence of software, occurrence, and order of decision or representation of operations.

In above figure depth and width provide an indication of the number of levels of control and overall span of control. Fan – out is a measure of the number of modules that are directly controlled by another module. Fan – in indicate how

many modules directly control a given module? The control relationship among modules is expressed in the following way. A module that controls another module is said to be super ordinate to it and a module controlled by another is said to subordinate to the controller. In above figure module M is super-ordinate to modules a, b and c and module k is subordinate to module c.

Structural Partitioning: -



Program structure can be partitioned both horizontally and vertically.

Horizontal partitioning: defines separate principles branches of modular hierarchy for each major program function. Control modules represents each coordination between remaining modules and execution of the function, partitioning horizontally provides following benefits.

1) **Software i.e. easier to test.**
2) **Software i.e. easier to maintain.**
3) **Software i.e. easier to extend.**
4) **Propagation of fewer side effects or less side effects.**

Vertical partitioning: is also called factoring we suggest that control and work should be distinguished top down in program structure. Top level modules should perform control functional does less actual processing work, modules that reside low in structure are called the worker modules performing all input computation and output task.

Data Structure: -

Data structure is a representation of logical relationship among individual elements of data. Data structure is an important program structure to the representation of software architecture.

Data structure shows the organization of methods to access a scalar item is the simplest form of all data structure. A scalar item represents a single element of information which is addressed by an identifier and i.e. accessed by specific a single address in memory. When scalar items are organized as a list of continuous group then a sequential vector is formed, when the sequential vector is extended into two or three or an arbitrary number of dimension then a n dimension space is created and the most common n dimension space is two dimensional matrix and n dimension space is also called an array and a link list is a data structure that organized the memory elements into a noncontiguous scalar item or vector.

5. **Software Procedure: -**

Focus on the processing details of each module. Procedure must provide exact specification of processing, including sequence of events, exact decision points, repetitive operation and even data organization and structure, there is relationship between structure and procedure.

6. **Information Hiding: -**

The principle of information hiding suggest that modules should be specify and design so that procedure and data contain within a module is in accessible to other modules that have no need for such information hiding implies that effective modularity can be achieved by a set of independent module.

- **They pass only that much information to each other, which is required to accomplish the software functions.**
- **The way of hiding unnecessary details is referred to as information hiding.**
- **Information hiding is of immense use when modifications are required during the testing and maintenance phase.**

- **Hiding Defines and enforces access constraints to both procedural detail within a module and any local data structure used by the module.**
- **Hiding implies that effective modularity can be achieved by defining a set of independent modules that communicate with one another only that information necessary to achieve software function.**

Advantages:

- **Leads to low coupling**
- **Emphasizes communication through controlled interfaces.**
- **Decreases the probability of adverse effects.**
- **Restricts the effects of changes in one component on others.**
- **Results in higher quality software.**

QFD (quality Function Deployment): -

QFD is a quality management technique that translates the need of the customer into technical requirement for software. QFD defines requirement in a way that maximizes the customer specification. QFD constraint on maximizing customer satisfaction from the software engineering process. QFD identifies three types of requirements. (1) Normal Requirements, (2) Expected Requirements and (3) Exciting Requirements.

1. **Normal Requirements:-**

The objectives and goals that are defined a product or system during meetings with the customer if these requirements are presents then the customer is satisfied. Examples of normal requirements might be requested types of graphical display, specific system functions and define level of performance.

2. **Expected Requirements:-**

These requirements are implicit to the product or system and may be so fundamental that the customer does not explicit state them their absence then it is a cause of significant dissatisfaction examples of expected requirements are base of human machine interaction, overall operational correctness and reliability and software installation.

3. **Exciting Requirements:-**

These features go beyond the customers expectation proves to be very satisfying when present. E.g. word processing software is requested with standard function, the delivered product contains a number of page layout capabilities.

In meeting with the customer function deployment is used to determine the value of each function i.e. required for the system information deployment identities both the data objects & events that the system must consume and produced. Task deployment examines the behavior of the system or product within the given environment.

QFD uses customer interviews and observation surveys and examination of historical data as row data for the requirement gathering activity. Those data are then translated into a table of requirement and this table is called customer voice table.

Analysis Principles:

1. **The information domain of a problem must be represented and understood.**
2. **The functions that the software is to perform must be defined.**
3. **The behavior of the software (as a consequence of external events) must be represented.**
4. **The models that depict information function and behavior must be partitioned in a manner and uncovers details in a layered (or hierarchical) fashion.**
5. **The analysis should move from essential information toward implementation detail.**

The information domain is examined so that function may be understood completely.

The models are used so that the characteristic of function and behavior can be communicated in a compact fashion. Partitioning is applied to reduce complexity.

1. **Understand the problem before you begin to create the analysis model.**
2. **Develop prototypes that enable a user to understand how human/machine interaction will occur.**
3. **Record the origin of and reason for every requirement.**
4. **Use multiple views of requirements**
5. **Rank requirements**
6. **Work to eliminate ambiguity**

A software engineer who takes these principles to heart is more likely to develop a software specification that will provide an excellent foundation for design.

The Information Domain:

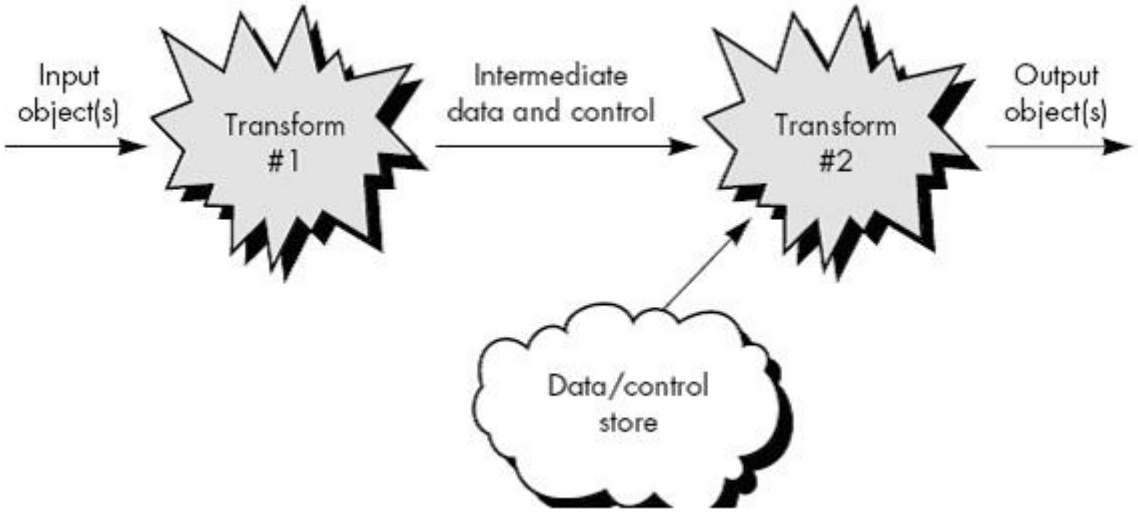
All software applications can be collectively called data processing. Software is built to process data also processes the events. An event represents some aspect of system control and is really nothing more than Boolean data.

e.g. software controlled automobile engine.

(i.e. to control flow of fuel)

The information domain contains three views of the data and control as each is processed by a computer program. The views are as:

1. **Information Flow**
2. **Information content and relationship**
3. **Information structure**



The information flow represents the manner in which data and control change as each moves through a system.

The information applied to the data are function or sub-functions that a program must perform.

Data and control that move between two transformations (functions) define the interface for each function.

2) Information Content and Relationship

Information content represents the individual data and control objects that comprise some larger collection of information that is transformed by the software.

e.g. The data object paycheque is a composite of a number of important pieces of data.

The content of paycheque is defined by the attributes that are needed to create it. Similarly, the content of a control object called system status, might be defined by a string of bits. Each bit represents a separate item of information that indicates whether or not a particular device is on or off-line.

Data and control objects can be related to other data and control objects.

e.g. The data object paycheck has one or more relationship with the objects timecard, employee, bank and others. During the analysis of the information domain, these relationships should be defined.

3) Information Structure

Information on structure represents the internal organization of various data and control items.

A concept of data structure refers to the design and implementation of information structure.

Questions like,

- **Are data and control items to be organized as an n-dimensional tables OR Hierarchical tree structure?**
- **Within the context of the structure, what information is related to other information?**
- **Is all information contained within a single structure or are distinct structures to be used?**
- **How does information structure relate to information in another structure?**

Are answered by an assessment of information structure.

Specification:

The specification is directly associated with the quality of software. If the specification is incomplete its results into frustration and confusion among the software engineer and ultimately it affects the quality, completeness, timeliness of the software.

The software specification can be viewed as representation of the requirements which tends us to successful software implementation.

Specification is a description of what is desired rather than how it is to be obtained.

Specification Principles

A number of specification principles adapted from the work of Balzer and Goldman [BAL86]:

1) Separate functionality from implementation

2) Develop a model of the desired behavior of a system that encompasses data and the functional responses of a system to various stimuli from the environment.

3) Establish the contact in which software operates by specifying the manner in which other system components interact with software.

4) A specification must encompass the environment in which the system operates.

5) A system specification must be a cognitive model

6) A specification must be operational

7) A specification must be tolerant of incompleteness and augmentable.

8) A specification must be localized and loosely coupled.

The list of basic specification principles noted above provides a basis for representing software requirements.

Representation of Specification

A set of guidelines for represents the specification is as under.

1) Representation format and content should be relevant to the problem.

i.e. a specification of a manufacturing automation system would use different symbology, diagrams and language than the specification for a programming language compiler.

2) Information contained within the specification should be nested.

Representation should reveal layers of information so that a reader can move to the level of detail that is required. Paragraph and diagram numbering schemes should indicate the level of detail that is being presented.

3) Diagrams and other notational forms should be restricted in number and consistent in use.

Confusing notation or inconsistent notation (graphical or symbolic) degrades understanding and tends towards errors.

4) Representation should be revisable.

FAST (Facilitated Application Specification Technique): -

- **In this technique or approach joint team of customers & developers who work together to identify the problem, purpose and elements of the solution.**
- **In that team one expert from each field included like Analyst side(one expert from developers side , one from tester side , one from designer side etc.) same way the experts from the customer side from each department are included in the meeting.**
- **Each experts note down some points in meting based on points they prepares one report and finally reports are submitted to leader of the team.**

- **After collecting the all the reports from the experts analyst or (team leader) will prepares an agenda for software development means make schedule.**
- **FAST has been used predominantly by the information system but the technique affects quotient [amount of / share] for improved communication in applications of all kinds. The basic guidelines for FAST approach are,**

1) Meeting is conducted and attempted by both software engineers and customers.

2) Rules for preparation and participation are established.

3) An agenda is suggested that is formal enough to cover all important points.

4) Facilitator controls the meeting.

5) Definition mechanism is used when it can be a worksheet or an electronic bulletin board.

6) The goal is to identify the problem, proposed elements of the solution, negotiate different approaches and specify a preliminary set of solution requirements.

♣ Initial meetings between the developer and customer occur and basic questions and answers help to establish the scope of the problem and the overall perception of the solution

♣ Out of these initial meetings the developer and customer write one or two page product request. Meeting place, time and date for FAST are selected and a facilitator is chosen.

♣ Attendees from both the development and customer organization are invited to attempt. The product request is distributed to all attendees before the meeting date while reviewing the request in the days before the meeting each FAST attendees is use to make the list of objects that are part of the environment surrounds the system, other objects that are to be produced by the systems and objects that are used by the system. To perform its function list of constraints i.e. cost size and sometimes business rule of policy, performance criteria are also developed.

♣ Each person on the FAST team develop the list which is describe about objects describes for e.g. safe home system might include smoke detectors, window & doors sensor, motion detector and alarm, an event from which a sensor has been activated, a control panel and so on.

♣ Services can be setting the alarm, monitoring the sensor dialing the phone, reading display.

♣ In a similar fashion each FAST develop list of constraints as a FAST meeting being the first topic of discussion is the need and justification for the new product at the FAST.

♣ After the mini specifications are computed each FAST attendees makes a list of validation criteria for the product or system.

♣ Finally one or more participants is assigned the task of writing the complete specification using all inputs from the FAST meeting and later on all requirement point of view from all members and refinement is prepared for development of a design.

Characteristics of SRS:

(System Requirement Specification Document)

The final output of the requirement analysis phase is the software requirements specification document it is also known as SRS document. To properly satisfy the basic goals and SRS should contain different types of the requirements following are some of the desirable characteristics of SRS.

1). Correct

An SRS is correct if every requirement included in the SRS represents something required in the final system.

2). Complete

An SRS is complete if every this software is supposed to do the responses of the software to all classes of input data are specified data into SRS. Correctness ensure that what is specified is done correctly, completeness ensures that everything is indeed specified.

3). Unambiguous (unmistakable/clear cut)

An SRS is unambiguous if and only is every requirements stated or written has one and only one interpretation.

4). Verifiable

Verification of requirements is done through reviews. It also implies that an SRS is understandable at least by the developer, by client and by the user.

5). Consistent

An SRS is consistent if there is no requirement that conflict with another terminology can cause inconsistency. Ex Different requirements may use different terms to refer to the same object. There may be logical conflict may be requirement causing inconsistency. Ex A requirements states that an event E should occur before F but than other set of requirement stays that and event F should occur before event E. Inconsistency in SRS can be a reflection of major problem.

6). Ranked of importance / Stability

An SRS is ranked for an importance if for each requirement the importance and stability of a requirement reflect a term of expected change stability of a requirement reflects in futures. Writing and SRS is an interactive process, when the requirement systems are specified.

7). Modifiable

They are later modified as the needs of the clients change. SRS should be easy to modify. SRS is modifiable if its structures and style are such that any necessary change can be made easily while continuing completeness and consistency.

8). Traceable

An SRS is traceable if the origin of each of its requirement is clear and if it fulfill the reference in of each requirement in future development should be traceable to some design and code element and backward traceability requirement. If be possible to trace design and code element to the requirement. They support traceability aids verification and validation from all this characteristics completeness is the most important requirement. One of the most common problems in requirement specification is when some of the requirement of the client is to specify.

Techniques for Requirements Gathering

In the business environment, it is required to have an effective way of market research to understand what a customer wants and how to be successful over competitors. We need to focus on how to make the users to achieve their goals. The Requirements gathering process will help in understanding the needs of a customer, especially in the IT industry.

There are several different requirement gathering techniques that can be used. Several tools and techniques are used by the stakeholders and business analyst to facilitate this process and capture the exact and detailed requirements. The Requirements gathering techniques should help in breaking down Requirements and Gathering into digestible steps thereby providing instructions to complete each step.

Following are some of the requirements gathering techniques.

- **Interviews**
- **Questionnaires**
- **Observations**
- **Facilitated Workshops**
- **Focus groups**
- **JAD**
- **Brainstorming**
- **Prototyping**
- **Documentation analysis**

Interviews

Interviews are of primary ways for information gathering where the system analyst will have face-to-face interaction with relevant stakeholders or subject matter experts. The business analyst will spend most of the time to interview system users and system owner during the early stages of project life cycle.

It is important to be very clearly articulate of the objectives of interviews and the questions could be prepared ahead of time or asked spontaneously and the responses should be recorded. Interviews could also be done with multiple interviewers and / or multiple interviewers. Interviews could be either one on one or group interviews.

Types of Interviews

There are two types of interviews namely unstructured interviews and structured interviews.

UNSTRUCTURED INTERVIEWS

These involve a conversation by the interviewee asking general questions. It is usually inefficient technique as it has a tendency to go off track from the main goal and the analyst will have to redirect the interview in the right path.

STRUCTURED INTERVIEWS

The interviewer will be the one making specific questions in order to obtain the required information from the interviewee. This type of interview is considered to be efficient.

SEMI-STRUCTURED INTERVIEWS

It begins with focused questions and moves to open-ended discussion. The data of interest will have to be predetermined. Some of the questions that need to be asked are mentioned below.

- **How should a task be performed?**
- **Why is this task being performed?**
- **Under what conditions, this task should be performed?**
- **What information do you need to complete the task**
- **Whom should the communication be sent to?**

Components of SRS:

Some of the system properties that an SRS should specified and the basic an SRS must address are as follows.

1. **Functionality**
2. **Performance**
3. **Design Constrains imposed on an implementation**
4. **External Interfaces**

1). Functionality

Specified which output should be produce from the given input. They describe the relationship into the input or output of the system for each functional requirement for detail description is all the data input and their source the unit of measure and the range of valid output must be

Specified all the option to be performed on the input data to obtain the output should be specified. This include specified the validity checks on the input or output data parameters effected by the option and equations or other logical there must be used to transform, the input or the corresponding output. Ex. if there is a formula keep must be specified in SRS. An important part of the specification is the system behavior in abnormal situation like invalid input or error during computation. The function requirement must clearly state that what the system should the who keep such situation occurs specified the behavior of the system for invalid input invalid output. Ex. of the situation is an airline reservation system where a reservation cannot be made even for valid passenger if the airline is fully full in sort the system behavior for input or all possible stacks should be specified.

2). Performance Requirement

This part of an SRS specifies the performance constraints on the software system. The entire requirement relating to the performance characteristics of the system must be clearly specified there are two types of performance requirements.

1. **Static**
2. **Dynamic**

1). Static Requirement

Static requirement are those that do not imposed constraints on the execution characteristics of the system. This includes requirement like the number of terminal to be supported the number of simultaneous users to be supported and the number of files that the system has to process and their sizes. These are also called capacity requirement of the system.

2). Dynamic Requirement

Dynamic requirement specification constraints on the execution behavior of the system this includes response and through put constraints on the system. Response time is expected time for the compilation on an option and through put is an expected time for the compilation on an option and through put is an expected number of options that can be perform in a unit time. The SRS may specify. The number of transaction must be process for time. What the response time for a particular command should be requirement such as response time should be good or the system must be able to process all the transaction quickly are not describe because they are depended on machine can verified according to the machine.

3). Design constraints:

There are number of factors in client environment that may restrict that choice of a designer such factors is:

1. **Resource limits**
2. **Operating Environment**
3. **Reliability & Fault tolerance**
4. **Security environment and Policies of organization**

1). Resource Limits

Standard Compliance

This specifies the requirements for the standard that the system must follow the standard may include the report format and accounting procedure.

2). Operating Environment

Hardware Limitations

The software may have to operate on some existing or predetermine hardware. Hardware limitations can include the types of machines; operating system available on the system languages supported a limit on primary and secondary storage.

3). Reliability and fault tolerance

Fault tolerance requirement can place a major constraints on how the system is to be design fault tolerance requirement often make the system more complex and expensive requirement it recovery require are integral part of the system. Detailing what the system should do if some failure occurs to ensure certain properties reliability is very important for critical applications.

4). Security

Security requirements are particularly significant in defense system and many database system security requirements place restrictions on the use of certain commands, control access to data, provide different kinds of access requirement for different people, require the use of passwords and cryptography techniques and maintain a log of activities in the system.

4). External Interface Requirements

All the possible interaction of the software with people, hardware and other software should be clearly specify for the user interface the characteristics each user interface of the software product should be specify user interface is become an important and must be given proper attention a preliminary user manual should be created with all user commands, screen formats, an

explanation of how the system will appear to the user and feedback and error messages for hardware interface requirement the SRS should specified the logical characteristics of each interface between the software product and hardware components if the software is to execute on existing hardware or on predetermine hardware all the characteristics of the hardware including memory restriction should be specified. The interface requirement should specify the interface with other software the system will use or that will use the system. These include the interface with the operating system and other applications.

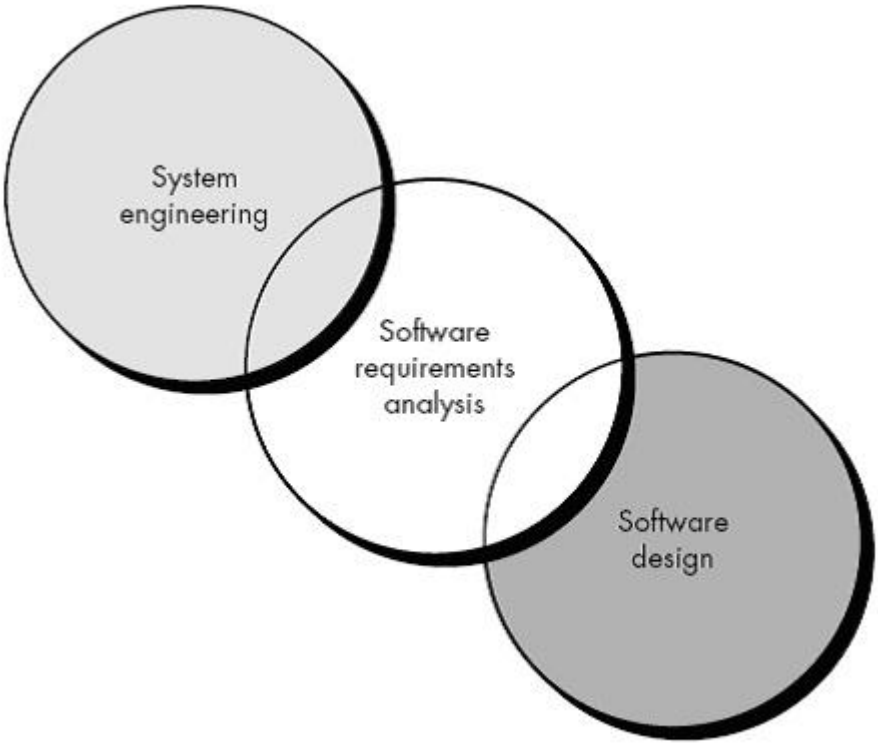
Systems analyst

A systems analyst is a person who uses analysis and design techniques to solve business problems using information technology. Systems analysts may serve as change agents who identify the organizational improvements needed, design systems to implement those changes, and train and motivate others to use the systems.

A systems analyst may:

- **Identify, understand and plan for organizational and human impacts of planned systems, and ensure that new technical requirements are properly integrated with existing processes and skill sets.**
- **Plan a system flow from the ground up.**
- **Interact with internal users and customers to learn and document requirements that are then used to produce business requirements documents.**
- **Write technical requirements from a critical phase.**
- **Interact with designers to understand software limitations.**
- **Help programmers during system development, e.g. provide use cases, flowcharts or even database design.**
- **Perform system testing.**
- **Deploy the completed system.**
- **Document requirements or contribute to user manuals.**
- **Whenever a development process is conducted, the system analyst is responsible for designing components and providing that information to the developer.**

Requirement Analysis



Requirements analysis is a software engineering task that bridges the gap between system level software allocation and software design.

It enables the system engineer to specify software function and performance indicate software's interface with other system elements and establish constraints that software must meet.

Requirement analysis allows the software engineer (i.e. analyst) to refine the software allocation and build models of the data, functional and behavior domains that will be treated by software.

Finally, the requirement specification provides the developer and the customer with the means to assess quality once software is built.

Requirement analysis divided into five areas:

1) **Problem recognition**

2) **Evaluation and synthesis**

3) **Modeling**

4) Specification

5) Review

Requirement analysis Task

1). Problem Recognition

Initialize the system analyst studies the system specification of the software and project plan and the analyst must establish contact with management and technical staff of the user or customer organization and software development organization. The project manager can serve as a coordinator for establishment of communications paths. The goal of the analysis is to reorganize the basic problem element which is perceived by the user or customer.

2). Synthesis and evaluation

Problem evaluation and solution synthesis is the next major area of effort for analysis. The analyst must evaluate the flow and content of information, define and expand all software function, understand software behavior in the context of event of the effect system, establish system interface characteristics and on cover design constrains. Each of these tasks serves to describe the problem so that and overall approach or solution may be synthesis. Evaluating current problems and desired information and input and the output the analyst begins to synthesis one or more solution.

Throughout evaluation and solution synthesis the analyst's primary focus is on "What" or "How" what data does the system produce and consume what functions must the system perform what interfaces are define and what constrains applied?

3). Modeling

During the evaluation and solution synthesis activities the analyst creates models of the system in an effort to better understand data and control flow, functions processing and behavior operation. The model serves the foundation for software design and the basic for the creation of a specification for the software.

4). Requirement Specification & Review:

After making the model analyst makes a plan and schedule for development. The information gathered during the system study was analyzed to determine the requirement specifications. Based on the issues governing the system, requirements in non-technical terms formulated.

1. **We need to develop rough prototype to check the basic functionality of the software.**
2. **If the major modules are not working properly then the software might not satisfy the user.**
3. **Interaction between the operator and system analyst must be fast and reliable.**

Requirement Gathering Techniques (Elicitation): -

1. **<u>Initiating a Process of Requirement Gathering: -</u>**
2. **The most commonly used requirement gathering technique is to conduct a meeting or interview.**
3. **We can say to get the requirements of our customer communication must be initiated.**
4. **The analyst start by asking context free questions i.e. a set of questions that will lead to a basic understanding of the problem.**
5. **Analyst and customer arrange one meeting, in that meeting customer gives the software requirement, based on that requirement analyst asks some question to customer for better understanding the requirement and overall goals and the benefits e.g. the analyst can ask following questions.**

- **Who is behind the request for this system?**
- **Who will use the solution?**
- **What will be the economic benefit of a successful solution?**
- **Is there another source for the solution that customer require?**

The next set of questions enables the analyst to gain better understanding of the problem and the customer to voice about the solution. The second set of questions can be how can you characterize good output that would be generated by a successful solution of software.

- **What problems will this solution address?**
- **Can you describe the environment in which the solution will be used?**
- **Will special performance issues or constraints affect to way the solution approach?**
- **The final set of questions focuses on the effectiveness of the meeting, it is called Meta**
- **Can anyone else provide additional information?**
- **Should I ask anything else about the problem?**
- **Are my questions relevant to the problem that customer have?**
- **Am I asking too many questions?**

Software/System Requirement Specification

Software requirement specification (SRS) is produced at the end of analysis task. The following is the general outlines for SRS, which is suggested by National Bureau of Standards and U.S. Departments of defense.

1. **Introduction**
2. **System reference**
3. **Overall description**
4. **Software project constraints**
5. **Information Description**
6. **Information content representation**
7. **Information flow representation**
8. **Data flow**
9. **Control flow**

III. Functional Description

1. **Functional partitioning**
2. **Functional Description**
3. **Processing narrative**
4. **Restrictions / Limitations**
5. **Performance requirements**
6. **Design constraints**
7. **Supporting diagrams**
8. **Behavioral Description**
9. **System states**
10. **Events and actions**
11. **Validation criteria**
12. **Performance bounds**
13. **Classes of tests**
14. **Expected software response**
15. **Special considerations**
16. **Bibliography**

VII. Appendix

The Introduction states the goals and objectives of the software, describing it in the context of the computer based system.

The Information Description provides a detailed description of the problem that software must solve.

A description of each function required to solve the problem is presented in the Functional Description. A processing narrative is provided for each function; design constraints are stated and justified; performance characteristics are stated.

The Behavioral Description section examines the operation of the software as a consequence of external events and internally generated control characteristics.

The most important section of SRS is Validation Criteria.

The Bibliography contains references to all documents that relate to the software. These include other software engineering documentation, technical references, vendor literature, and standards.

The Appendix contains information that supplements the specification. Tabular data, detailed description of algorithms, charts, graphs, and other material are presented as appendixes.

In many cases SRS may be accompanied by an executable prototype, paper prototype, or preliminary user's manual.

The preliminary user's manual presents the software as a black box. That is, heavy emphasis is placed on user input and resultant output. The manual can serve as a valuable tool for uncovering problems at the human-machine interface.

Specification Review:

Review of SRS is conducted by both software developer and customer.

The review is first conducted at a macroscopic level. At this level, reviewers attempt to ensure that the specification is complete, consistent, and accurate.

The following questions are addressed:

1) Do stated goals and objectives for software remain consistent with system goals and objectives?

2) Have important interfaces to all system elements been described?

3) Is information flow and structure adequately defined for the problem domain?

4) Are diagrams clear? Can each stand-alone without supplementary text?

5) Do major functions remain within scope, and has each been adequately described?

6) Is the behavior of the software consistent with the information it must process and the function it must perform?

7) Are design constraints realistic?

8) Have the technological risks of development been considered?

9) Have alternative software requirements been considered

10) Have validation criteria been stated in detail? Are they adequate to describe a successful system?

11) Do inconsistencies, omissions, or redundancy exits

12) Is the customer contact complete?

13) Has the user reviewed the preliminary user's manual or prototype?

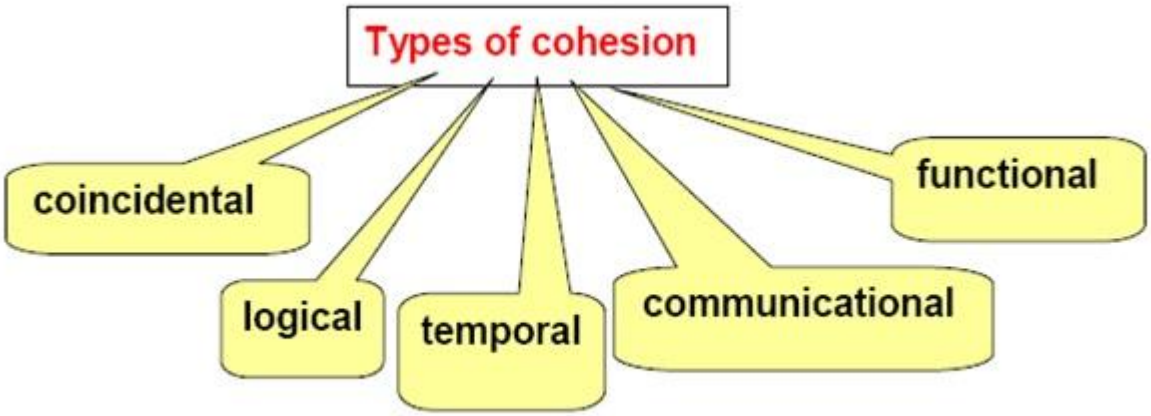
14) How are planning estimates affected?

Coupling and Cohesion

When a software program is modularised, its tasks are divided into several modules based on some characteristics. As we know, modules are set of instructions put together in order to achieve some tasks. They are though, considered as single entity but may refer to each other to work together. There are measures by which the quality of a design of modules and their interaction among them can be measured. These measures are called coupling and cohesion.

- **Cohesion**

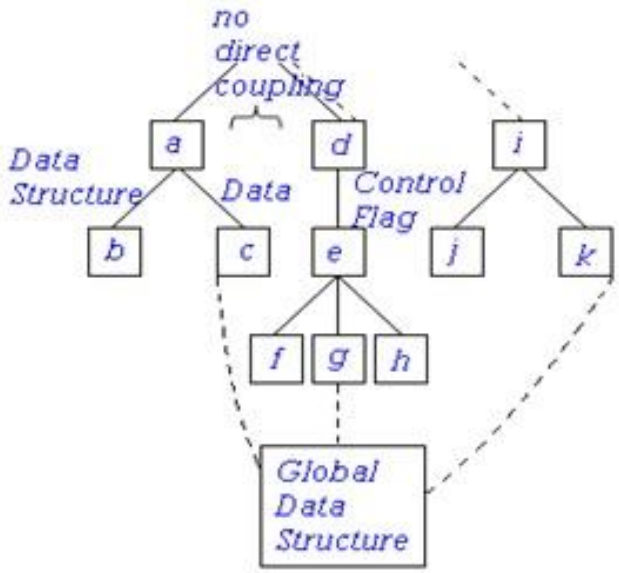
Cohesion is a measure that defines the degree of intra-dependability within elements of a module. The greater the cohesion, the better is the program design.



There are seven types of cohesion, namely –

- **Co-incidental cohesion - It is unplanned and random cohesion, which might be the result of breaking the program into smaller modules for the sake of modularization. Because it is unplanned, it may serve confusion to the programmers and is generally not-accepted.**
- **Logical cohesion - When logically categorized elements are put together into a module, it is called logical cohesion.**
- **Temporal Cohesion - When elements of module are organized such that they are processed at a similar point in time, it is called temporal cohesion.**
- **Procedural cohesion - When elements of module are grouped together, which are executed sequentially in order to perform a task, it is called procedural cohesion.**
- **Communicational cohesion - When elements of module are grouped together, which are executed sequentially and work on same data (information), it is called communicational cohesion.**
- **Sequential cohesion - When elements of module are grouped because the output of one element serves as input to another and so on, it is called sequential cohesion.**
- **Functional cohesion - It is considered to be the highest degree of cohesion, and it is highly expected. Elements of module in functional cohesion are grouped because they all contribute to a single well-defined function. It can also be reused.**
-
- **Coupling**

Coupling is a measure that defines the level of inter-dependability among modules of a program. It tells at what level the modules interfere and interact with each other. The lower the coupling, the better the program.



High coupling makes modifying parts of the system difficult, e.g., modifying a component affects all the components to which the component is connected.

Coupling is a measure of interconnection among modules in a software structure. Coupling depends on the interface complexity between modules. The point at which entry or references made to a module and what data passes across the interface. In software design we should try for lowest possible coupling.

- **If modules share common data, it should be minimized**
- **Few parameters should be passed between modules in procedure calls [recommended 2 – 4 parameters]**

Types of coupling, from strongly coupled (least desirable)

Weakly coupled (most desirable):

1) **Content coupling**

2) **Common coupling**

3) **External coupling**

4) **Control coupling**

5) Stamp coupling

6) Data coupling

There are five levels of coupling, namely -

- **Content coupling - When a module can directly access or modify or refer to the content of another module, it is called content level coupling.**
  - **module directly affects the working of another module**
  - **occurs when a module changes another module's data or when control is passed from 1 module to the middle of another (as in a jump)**
- **Common coupling- When multiple modules have read and write access to some global data, it is called common or global coupling.**
  - **2 modules have shared data**
  - **occurs when a number of modules reference a global data area**
  - **Eg. In our Example Module c,g,k.**
- **Control coupling- Two modules are called control-coupled if one of them decides the function of the other module or changes its flow of execution.**
- **Stamp coupling- When multiple modules share common data structure and work on different part of it, it is called stamp coupling.**
  - **Occurs when complete data structures are passed from 1 module to another**
  - **The precise format of the data structures is a common property of those modulesEg. In our Example between Module a and b.**
- **Data coupling- Data coupling is when two modules interact with each other by means of passing data (as parameter). If a module passes data structure as parameter, then the receiving module should use all its components.**
  - **Only simple data is passed between modules**
  - **1 to 1 correspondence of items exists**
  - **Eg. In our Example between Module a and c.**

Design Principles:

Software design is both a process and a model. The design process is sequence of steps that enable the designer to describe all aspects of the software to be built. It is important that the design process is not simply sequential process but it is a sense of what makes quality software. The design model is the equivalent of an architectural plan for a house. It begins by representing the total things to be built. Davis has suggested following principles for software.

1. **The design process should not suffer from "tunnel vision"means a good designer should consider alternative approaches, judging each based on the problem, the resources available to do the job and should consider all design concepts.**
2. **The design should be traceable to the analysis model means a single element of the design model often traces to multiple requirements so it is necessary to have a means for tracking how requirements have been satisfied by the design model.**
3. **The design should not reinvent the wheel means systems are constructed using a set of design patterns. These patterns should always been chosen as an alternative to reinvention because time is short and resources are limited so design time should be invested in representing truly new ideas and integrating those patterns that already exists.**
4. **The design should minimize the intellectual distance between the software and the problem as it exists in the real word.**
5. **The design should exhibit uniformly and integration.Design is uniform means it appears that one person develop the entire thing. Rules of style and formats should be defined for a design till before design work begins. Design is integrated if care is taken in defining interface between design components.**
6. **The design should be structured to accommodate change means if we are using prototyping according to above concept.**
7. **The design is not a coding and coding is not a design means even when detail procedural design are created for program components the level of abstraction of the design model is higher than source code.**
8. **The design should be received and assess for quality as it is being created. A variety of design concepts and design measures are available to access the designer is assessing quality.**

When these design principles are properly applied the software engineer creates a design that exhibit both external and internal quality factors. External quality factors are those properties of the software that can be

observed by users. E.g. speed, reliability, concentrate etc. an inter quality factors are of important to software engineer they lead to a high quality design from the technical point of view to achieve internal quality factors. The designer must understand basic design concepts.