UNIT-2

Process Models: Prescriptive models, Waterfall model, Incremental process models, Evolutionary process models and Unified process, Agility, Agile Process, Principles, XP, FDD.

➢ What is a software process model?

Software processes are the activities for designing, implementing, and testing a software system. The software development process is complicated and involves a lot more than technical knowledge.

A software process model is an abstraction of the software development process. The models specify the stages and order of a process. So, think of this as a representation of the **order of activities** of the process and the **sequence** in which they are performed.

A model will define the following:

- The tasks to be performed
- The input and output of each task
- The pre and post-conditions for each task
- The flow and sequence of each task

There are many kinds of process models for meeting different requirements. We refer to these as **SDLC models** (Software Development Life Cycle models). The most popular and important SDLC models are as follows:

- Waterfall model
- V model
- Incremental model
- RAD model
- Agile model
- Iterative model
- Prototype model
- Spiral model

➢ Prescriptive Process Models

The following framework activities are carried out irrespective of the process model chosen by the organization.

1. Communication
2. Planning
3. Modeling
4. Construction
5. Deployment

The name 'prescriptive' is given because the model prescribes a set of activities, actions, tasks, quality assurance and change the mechanism for every project.

There are three types of prescriptive process models. They are:

1. The Waterfall Model
2. Incremental Process model
3. RAD model

➢ <u>Waterfall Model</u>

- The waterfall model is also called as **'Linear sequential model'** or **'Classic life cycle model'.**
- In this model, each phase is fully completed before the beginning of the next phase.
- This model is used for the small projects.
- In this model, feedback is taken after each phase to ensure that the project is on the right path.
- Testing part starts only after the development is complete.

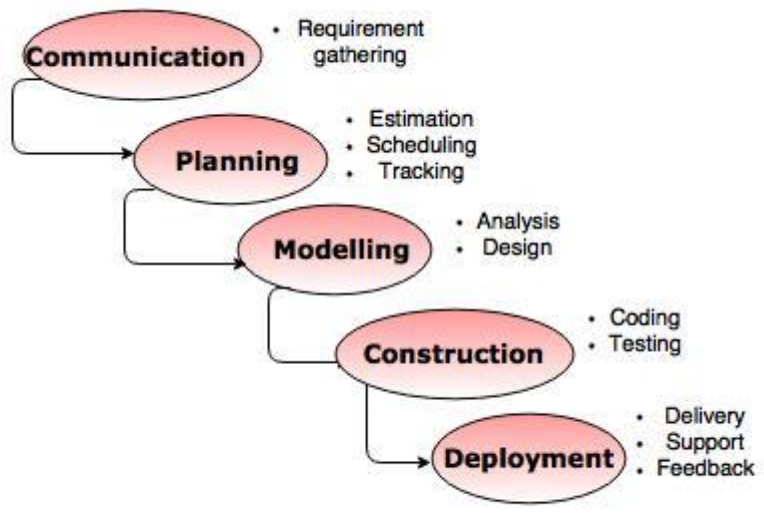


Fig. - The Waterfall model

NOTE: The description of the phases of the waterfall model is same as that of the process model.

An alternative design for 'linear sequential model' is as follows:

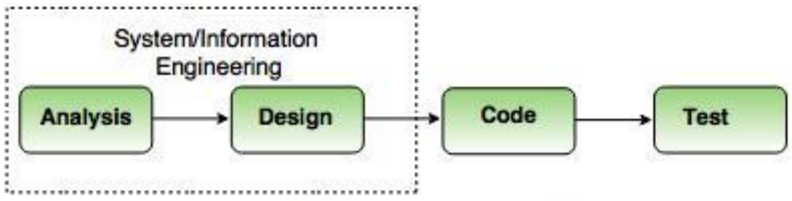


Fig. - The linear sequential model

Advantages of waterfall model

- The waterfall model is simple and easy to understand, implement, and use.
- All the requirements are known at the beginning of the project, hence it is easy to manage.
- It avoids overlapping of phases because each phase is completed at once.
- This model works for small projects because the requirements are understood very well.
- This model is preferred for those projects where the quality is more important as compared to the cost of the project.

Disadvantages of the waterfall model

- This model is not good for complex and object oriented projects.
- It is a poor model for long projects.
- The problems with this model are uncovered, until the software testing.
- The amount of risk is high.

➢ <u>Incremental Process models</u>

1. Incremental Process Model
2. RAD Model

1. Incremental Process Model:

- The incremental model combines the elements of waterfall model and they are applied in an iterative fashion.
- The first increment in this model is generally a core product.
- Each increment builds the product and submits it to the customer for any suggested modifications.
- The next increment implements on the customer's suggestions and add additional requirements in the previous increment.
- This process is repeated until the product is finished.

  For example, the word-processing software is developed using the incremental model.

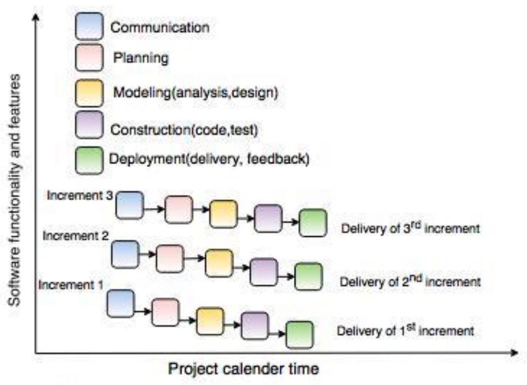

Communication
Planning
Modeling(analysis,design)
Construction(code,test)
Deployment(delivery, feedback)
Software functionality and features
Increment 3
Increment 2
Increment 1
Delivery of 3rd increment
Delivery of 2nd increment
Delivery of 1st increment
Project calender time

Fig. - Incremental Process Model

Characteristics of an Incremental module includes

- System development is broken down into many mini development projects
- Partial systems are successively built to produce a final total system
- Highest priority requirement is tackled first
- Once the requirement is developed, requirement for that increment are frozen

Advantages of incremental model

- This model is flexible because the cost of development is low and initial product delivery is faster.
- It is easier to test and debug during the smaller iteration.
- The working software generates quickly and early during the software life cycle.
- The customers can respond to its functionalities after every increment.

Disadvantages of the incremental model

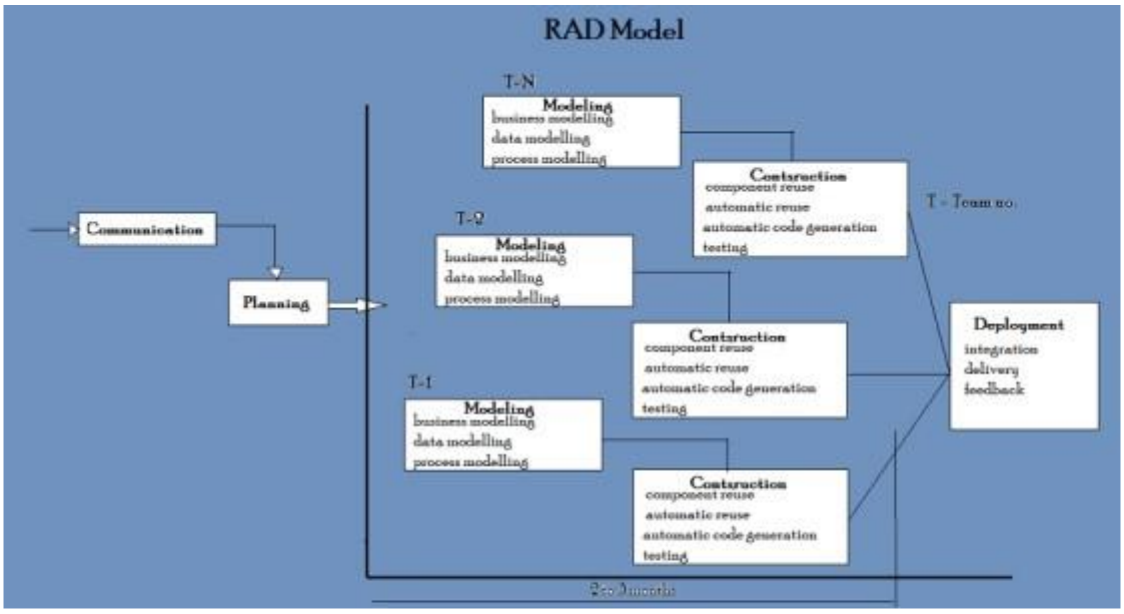
- The cost of the final product may cross the cost estimated initially.
- This model requires a very clear and complete planning.
- The planning of design is required before the whole system is broken into small increments.
- The demands of customer for the additional functionalities after every increment causes problem during the system architecture.
- Planning is more important to work together on different modules.

2. RAD (Rapid Application Development) Model

RAD is a linear sequential software development process model that emphasizes a concise development cycle using an element based construction approach. If the requirements are

well understood and described, and the project scope is a constraint, the RAD process enables
a development team to create a fully functional system within a concise time period.
RAD (Rapid Application Development) is a concept that products can be developed faster and of higher quality through:

- Gathering requirements using workshops or focus groups
- Prototyping and early, reiterative user testing of designs
- The re-use of software components
- A rigidly paced schedule that refers design improvements to the next product version
- Less formality in reviews and other team communication.



The various phases of RAD are as follows:

1. Business Modelling: The information flow among business functions is defined by answering questions like what data drives the business process, what data is generated, who generates it, where does the information go, who process it and so on.

2. Data Modelling: The data collected from business modeling is refined into a set of data objects (entities) that are needed to support the business. The attributes (character of each entity) are identified, and the relation between these data objects (entities) is defined.

Process Modelling: The information object defined in the data modeling phase are transformed to achieve the data flow necessary to implement a business function. Processing descriptions are created for adding, modifying, deleting, or retrieving a data object.

4. Application Generation: Automated tools are used to facilitate construction of the software; even they use the 4th GL techniques.

5. Testing &amp; Turnover: Many of the programming components have already been tested since RAD emphasis reuse. This reduces the overall testing time. But the new part must be tested, and all interfaces must be fully exercised.

When to use RAD Model?

- When the system should need to create the project that modularizes in a short span time (2-3 months).
- When the requirements are well-known.
- When the technical risk is limited.
- When there&#39;s a necessity to make a system, which modularized in 2-3 months of period.
- It should be used only if the budget allows the use of automatic code generating tools.

Advantage of RAD Model

- This model is flexible for change.
- In this model, changes are adoptable.
- Each phase in RAD brings highest priority functionality to the customer.
- It reduced development time.
- It increases the reusability of features.

Disadvantage of RAD Model

- It required highly skilled designers.
- All application is not compatible with RAD.
- For smaller projects, we cannot use the RAD model.
- On the high technical risk, it&#39;s not suitable.
- Required user involvement.

➢ <u>Evolutionary Process Models</u>

- Evolutionary models are iterative type models.
- They allow to develop more complete versions of the software.

Following are the evolutionary process models.
1. The prototyping model
2. The spiral model
3. Concurrent development model

1. The Prototyping model

- Prototype is defined as first or preliminary form using which other forms are copied or derived.
- Prototype model is a set of general objectives for software.
- It does not identify the requirements like detailed input, output.
- It is software working model of limited functionality.
- In this model, working programs are quickly produced.

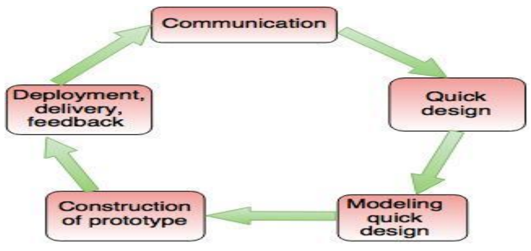


Fig. - The Prototyping Model

The different phases of Prototyping model are:

1. Communication
In this phase, developer and customer meet and discuss the overall objectives of the software.

2. Quick design

- Quick design is implemented when requirements are known.
- It includes only the important aspects like input and output format of the software.
- It focuses on those aspects which are visible to the user rather than the detailed plan.
- It helps to construct a prototype.

3. Modeling quick design

- This phase gives the clear idea about the development of software because the software is now built.
- It allows the developer to better understand the exact requirements.

4. Construction of prototype
The prototype is evaluated by the customer itself.

5. Deployment, delivery, feedback

- If the user is not satisfied with current prototype then it refines according to the requirements of the user.
- The process of refining the prototype is repeated until all the requirements of users are met.
- When the users are satisfied with the developed prototype then the system is developed based on final prototype.

Advantages of Prototyping Model

- Prototype model need not know the detailed input, output, processes, adaptability of operating system and full machine interaction.
- In the development process of this model users are actively involved.
- The development process is the best platform to understand the system by the user.
- Errors are detected much earlier.
- Gives quick user feedback for better solutions.
- It identifies the missing functionality easily. It also identifies the confusing or difficult functions.

Disadvantages of Prototyping Model:

- The client involvement is more and it is not always considered by the developer.
- It is a slow process because it takes more time for development.
- Many changes can disturb the rhythm of the development team.
- It is a thrown away prototype when the users are confused with it.

2. The Spiral model

- Spiral model is a risk driven process model.
- It is used for generating the software projects.
- In spiral model, an alternate solution is provided if the risk is found in the risk analysis, then alternate solutions are suggested and implemented.
- It is a combination of prototype and sequential model or waterfall model.
- In one iteration all activities are done, for large project's the output is small.

The framework activities of the spiral model are as shown in the following figure.

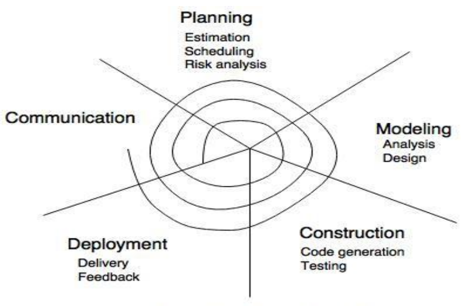


Fig. - The Spiral Model

NOTE: The description of the phases of the spiral model is same as that of the process model.

Advantages of Spiral Model

- It reduces high amount of risk.
- It is good for large and critical projects.
- It gives strong approval and documentation control.
- In spiral model, the software is produced early in the life cycle process.

Disadvantages of Spiral Model

- It can be costly to develop a software model.
- It is not used for small projects.

3. The concurrent development model

- The concurrent development model is called as concurrent model.
- The communication activity has completed in the first iteration and exits in the awaiting changes state.
- The modeling activity completed its initial communication and then go to the underdevelopment state.
- If the customer specifies the change in the requirement, then the modeling activity moves from the under development state into the awaiting change state.
- The concurrent process model activities moving from one state to another state.

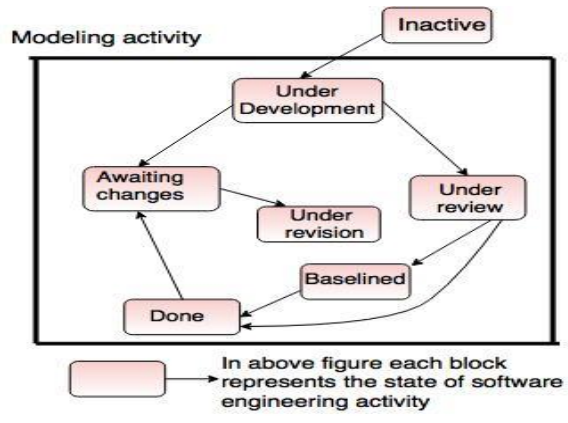


Fig. - One element of the concurrent process model

Advantages of the concurrent development model

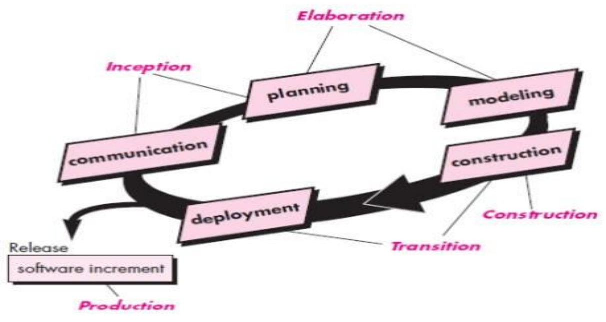
- This model is applicable to all types of software development processes.
- It is easy for understanding and use.
- It gives immediate feedback from testing.
- It provides an accurate picture of the current state of a project.

Disadvantages of the concurrent development model

- It needs better communication between the team members. This may not be achieved all the time.
- It requires to remember the status of the different activities.

➢ Unified Process model

Unified process (UP) is an architecture centric, use case driven, iterative and incremental development process. UP is also referred to as the unified software development process.



The Unified Process is an attempt to draw on the best features and characteristics of traditional software process models, but characterize them in a way that implements many of the best principles of agile software development.

The Unified Process recognizes the importance of customer communication and streamlined methods for describing the customer's view of a system. It emphasizes the important role of software architecture and "helps the architect focus on the right goals, such as understandability, reliance to future changes, and reuse".

It suggests a process flow that is iterative and incremental, providing the evolutionary feel that is essential in modern software development.

Phases of the Unified Process

This process divides the development process into five phases:

- Inception
- Elaboration
- Conception
- Transition
- Production

1. **Inception –**
   - Communication and planning are the main ones.
   - Identifies the scope of the project using a use-case model allowing managers to estimate costs and time required.
   - Customers' requirements are identified and then it becomes easy to make a plan for the project.
   - The project plan, Project goal, risks, use-case model, and Project description, are made.
   - The project is checked against the milestone criteria and if it couldn't pass these criteria then the project can be either cancelled or redesigned.
2. **Elaboration –**
   - Planning and modeling are the main ones.
   - A detailed evaluation and development plan is carried out and diminishes the risks.
   - Revise or redefine the use-case model (approx. 80%), business case, and risks.
   - Again, checked against milestone criteria and if it couldn't pass these criteria then again project can be cancelled or redesigned.
   - Executable architecture baseline.
3. **Construction –**
   - The project is developed and completed.
   - System or source code is created and then testing is done.
   - Coding takes place.
4. **Transition –**
   - The final project is released to the public.

- Transit the project from development into production.
- Update project documentation.
- Beta testing is conducted.
- Defects are removed from the project based on feedback from the public.

5. **Production –**
    - The final phase of the model.
    - The project is maintained and updated accordingly.

Advantages:

1. It provides good documentation, it completes the process in itself.
2. It provides risk-management support.
3. It reuses the components, and hence total time duration is less.
4. Good online support is available in the form of tutorials and training.

Disadvantages:

1. Team of expert professional is required, as the process is complex.
2. Complex and not properly organized process.
3. More dependency on risk management.
4. Hard to integrate again and again.

➢ Agility

Agility has become today's buzzword when describing a contemporary software method. Everyone is agile. An associate agile team could be a nimble team able to befittingly reply to changes. modification is what software development is extremely abundant.

- Changes within the software being engineered,
- Changes to the team members,
- Changes attributable to new technology,
- Changes of all types that will have an effect on the merchandise they build or the project that makes the merchandise.

➢ Agile Process:

Agile process model" refers to a software development approach based on iterative development. Agile methods break tasks into smaller iterations, or parts do not directly involve long term planning.

The project scope and requirements are laid down at the beginning of the development process. Plans regarding the number of iterations, the duration and the scope of each iteration are clearly defined in advance.

Each iteration is considered as a short time "frame" in the Agile process model, which typically lasts from one to four weeks. The division of the entire project into smaller parts helps to minimize the project risk and to reduce the overall project delivery time requirements. Each iteration involves a team working through a full software development life cycle including planning, requirements analysis, design, coding, and testing before a working product is demonstrated to the client.

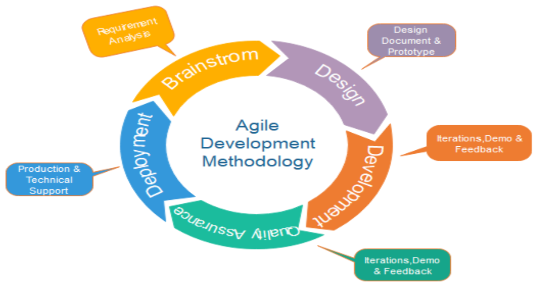

Requirement Analysis
Brainstrom
Design
Design Document & Prototype
Agile Development Methodology
Development
Iterations,Demo & Feedback
Quality Assurance
Iterations,Demo & Feedback
Deployment
Production & Technical Support

Fig. Agile Model

Phases of Agile Model:

Following are the phases in the Agile model are as follows:

1. Requirements gathering
2. Design the requirements
3. Construction/ iteration
4. Testing/ Quality assurance
5. Deployment
6. Feedback

1. Requirements gathering: In this phase, you must define the requirements. You should explain business opportunities and plan the time and effort needed to build the project. Based on this information, you can evaluate technical and economic feasibility.

2. Design the requirements: When you have identified the project, work with stakeholders to define requirements. You can use the user flow diagram or the high-level UML diagram to show the work of new features and show how it will apply to your existing system.

3. Construction/ iteration: When the team defines the requirements, the work begins. Designers and developers start working on their project, which aims to deploy a working product. The product will undergo various stages of improvement, so it includes simple, minimal functionality.

4. Testing: In this phase, the Quality Assurance team examines the product's performance and looks for the bug.

5. Deployment: In this phase, the team issues a product for the user's work environment.

6. Feedback: After releasing the product, the last step is feedback. In this, the team receives feedback about the product and works through the feedback.

When to use the Agile Model?

- When frequent changes are required.
- When a highly qualified and experienced team is available.

- When a customer is ready to have a meeting with a software team all the time.
- When project size is small.

Advantage(Pros) of Agile Method:

1. Frequent Delivery
2. Face-to-Face Communication with clients.
3. Efficient design and fulfils the business requirement.
4. Anytime changes are acceptable.
5. It reduces total development time.

Disadvantages(Cons) of Agile Model:

1. Due to the shortage of formal documents, it creates confusion and crucial decisions taken throughout various phases can be misinterpreted at any time by different team members.
2. Due to the lack of proper documentation, once the project completes and the developers allotted to another project, maintenance of the finished project can become a difficulty.

➢ Agility Principles:

The Agile Alliance defines twelve lightness principles for those that need to attain agility:

1. Our highest priority is to satisfy the client through early and continuous delivery of valuable computer software.
2. Welcome dynamical necessities, even late in development. Agile processes harness modification for the customer's competitive advantage.
3. Deliver operating computer software often, from a pair of weeks to a couple of months, with a preference to the shorter timescale.
4. Business individuals and developers should work along daily throughout the project.
5. The build comes around actuated people. Offer them the setting and support they have, and trust them to urge the task done.
6. The foremost economical and effective methodology of convincing info to and among a development team is face-to-face speech.
7. Working computer software is the primary live of progress.
8. Agile processes promote property development. The sponsors, developers, and users got to be able to maintain a relentless pace indefinitely.
9. Continuous attention to technical excellence and smart style enhances nimbleness.
10. Simplicity—the art of maximizing the number of work not done—is essential.

11. the most effective architectures, necessities, and styles emerge from self–organizing groups.
12. At regular intervals, the team reflects on a way to become simpler, then tunes and adjusts its behaviour consequently.

➢ Extreme Programming

Extreme programming (XP) is one of the most important software development frameworks of Agile models. It is used to improve software quality and responsiveness to customer requirements. The extreme programming model recommends taking the best practices that have worked well in the past in program development projects to extreme levels. **Good practices need to be practiced in extreme programming:** Some of the good practices that have been recognized in the extreme programming model and suggested to maximize their use are given below:

- **Code Review:** Code review detects and corrects errors efficiently. It suggests pair programming as coding and reviewing of written code carried out by a pair of programmers who switch their works between them every hour.
- **Testing:** Testing code helps to remove errors and improves its reliability. XP suggests test-driven development (TDD) to continually write and execute test cases. In the TDD approach test cases are written even before any code is written.
- **Incremental development:** Incremental development is very good because customer feedback is gained and based on this development team comes up with new increments every few days after each iteration.
- **Simplicity:** Simplicity makes it easier to develop good quality code as well as to test and debug it.
- **Design:** Good quality design is important to develop good quality software. So, everybody should design daily.
- **Integration testing:** It helps to identify bugs at the interfaces of different functionalities. Extreme programming suggests that the developers should achieve continuous integration by building and performing integration testing several times a day.

Basic principles of Extreme programming: XP is based on the frequent iteration through which the developers implement User Stories. User stories are simple and informal statements of the customer about the functionalities needed. A User Story is a conventional description by the user of a feature of the required system. It does not mention finer details such as the different scenarios that can occur. Based on User stories, the project team proposes Metaphors. Metaphors are a common vision of how the system would work. The development team may decide to build a Spike for some features. A Spike is a very simple program that is constructed to explore the suitability of a solution being proposed. It can be considered similar to a prototype. Some of the basic activities that are followed during software development by using the XP model are given below:

- **Coding:** The concept of coding which is used in the XP model is slightly different from traditional coding. Here, the coding activity includes drawing diagrams (modeling) that will be transformed into code, scripting a web-based system, and choosing among several alternative solutions.
- **Testing:** XP model gives high importance to testing and considers it to be the primary factor to develop fault-free software.
- **Listening:** The developers need to carefully listen to the customers if they have to develop good quality software. Sometimes programmers may not have the depth knowledge of the system to be developed. So, the programmers should

understand properly the functionality of the system and they have to listen to the customers.

- **Designing:** Without a proper design, a system implementation becomes too complex and very difficult to understand the solution, thus making maintenance expensive. A good design results elimination of complex dependencies within a system. So, effective use of suitable design is emphasized.
- **Feedback:** One of the most important aspects of the XP model is to gain feedback to understand the exact customer needs. Frequent contact with the customer makes the development effective.
- **Simplicity:** The main principle of the XP model is to develop a simple system that will work efficiently in the present time, rather than trying to build something that would take time and may never be used. It focuses on some specific features that are immediately needed, rather than engaging time and effort on speculations of future requirements.

Applications of Extreme Programming (XP): Some of the projects that are suitable to develop using the XP model are given below:

- **Small projects:** XP model is very useful in small projects consisting of small teams as face-to-face meeting is easier to achieve.
- **Projects involving new technology or Research projects:** This type of project face changing requirements rapidly and technical problems. So XP model is used to complete this type of project.

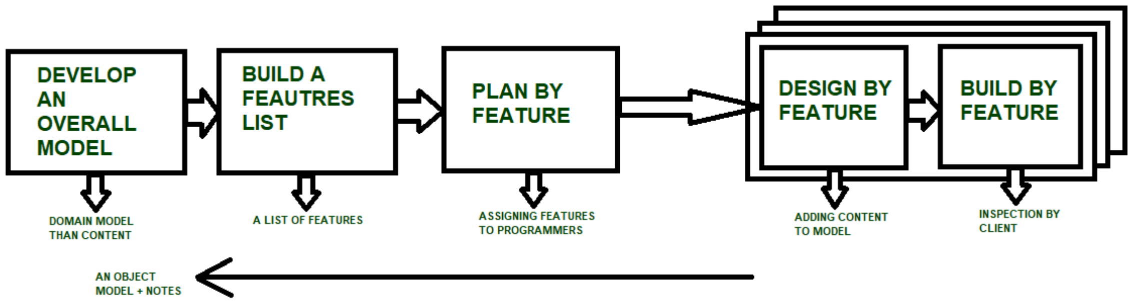
Extreme Programming (XP) is an Agile software development methodology that focuses on delivering high-quality software through frequent and continuous feedback, collaboration, and adaptation. XP emphasizes a close working relationship between the development team, the customer, and stakeholders, with an emphasis on rapid, iterative development and deployment.

➢ FDD :

FDD stands for **Feature-Driven Development**. It is an agile iterative and incremental model that focuses on progressing the features of the developing software. The main motive of feature-driven development is to provide timely updated and working software to the client. In FDD, reporting and progress tracking is necessary at all levels.

FDD Lifecycle

- Build overall model
- Build feature list
- Plan by feature
- Design by feature
- Build by feature



Characteristics of FDD

- **Short iterative:** FDD lifecycle works in simple and short iterations to efficiently finish the work on time and gives good pace for large projects.
- **Customer focused:** This agile practice is totally based on inspection of each feature by client and then pushed to main build code.
- **Structured and feature focused:** Initial activities in lifecycle builds the domain model and features list in the beginning of timeline and more than 70% of efforts are given to last 2 activities.
- **Frequent releases:** Feature-driven development provides continuous releases of features in the software and retaining continuous success of the project.

Advantages of FDD

- Reporting at all levels leads to easier progress tracking.
- FDD provides continuous success for larger size of teams and projects.
- Reduction in risks is observed as whole model and design is built in smaller segments.
- FDD provides greater accuracy in cost estimation of the project due to feature segmentation.

Disadvantages of FDD

- This agile practice is not good for smaller projects.
- There is high dependency on lead programmers, designers and mentors.
- There is lack of documentation which can create an issue afterwards.