



# Different Types of Process Models – Software

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## Abstract

Software's move along a series of transitions involving their commencement, early development, productive operations, maintenance and repairs as well as retirement. For this, there are a multiple techniques that are applied which are known as software process models or software life cycle models. This paper represents five most widely implemented models namely Waterfall, Incremental, Spiral, V-Shaped and Agile. The main objective of this paper is to elaborate these models and also to list their advantages, disadvantages and when to use which one.

**Keywords:** *Comparative Analysis of Software Models, Software Development, Software Development Models, Software Life Cycle Models.*

## 1. Introduction

Software is engineered or developed, it is not manufactured. Unlike hardware it is logical rather than physical. A software development project is a structure imposed on the development of a software product. A software development life cycle is typically a framework that describes the activities performed at each stage of a software development project. Explicit models of software development date back to the earliest projects developing large

software systems in the 1950's. The purpose of these software development life cycle models was to provide a theoretical plan for realistically managing the development of software systems. For this, there are several models, each describing approaches to a variety of tasks or activities that take place during the process of software development. These models aim to be the standard that defines all the tasks necessary for developing and maintaining software's. The models that we will take into consideration are:-

1. Waterfall Model.
2. Incremental Model.
3. Spiral Model.
4. V-Shaped Model.
5. Agile Model.

Before analyzing these models, we will first study various activities related to software development process.

## **2. Activities of Software Development**

Software's undergo a lot of problems during their development. Problem solving in software's consist of the following activities:-

1. Understanding the problem.
2. Deciding a plan for a solution.
3. Coding the planned solution.
4. Testing the actual program.

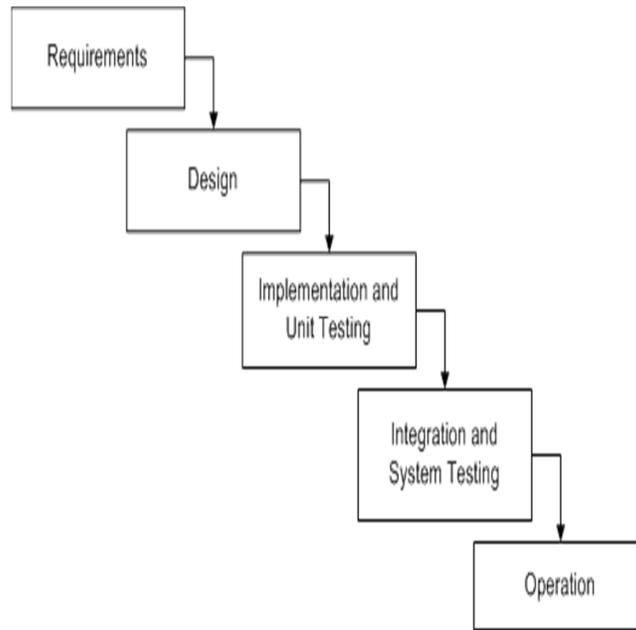
Each of these activities can be very large and handling of them is not possible in a single step. Hence, there is a need to break them into many smaller units so as to manage them efficiently. Every model gives us a unique way to perform these activities and to make software development much easier.

## **3. Software Process Models**

The various software process models are as follows:-

### **3.1 Waterfall Model**

This model is named waterfall model because its diagrammatic view displays a cascade of waterfall. It is a sequential development approach in which development is seen flowing through the phases of requirement analysis, design, implementation, testing integration and maintenance. This model is easy to understand and follows the notion of "define before design" and "design before code".



**Fig. 1 Waterfall Model**

The advantages of waterfall model are:-

- Easy to understand, easy to use.
- Provides structure to inefficient staff.
- Every stages objective is well understood.
- Sets requirement stability.
- Works well on mature products and weak teams.
- Good for management control (planning, staffing, tracking).
- Works well when quality is more important than cost or schedule.

The disadvantages of waterfall model are:-

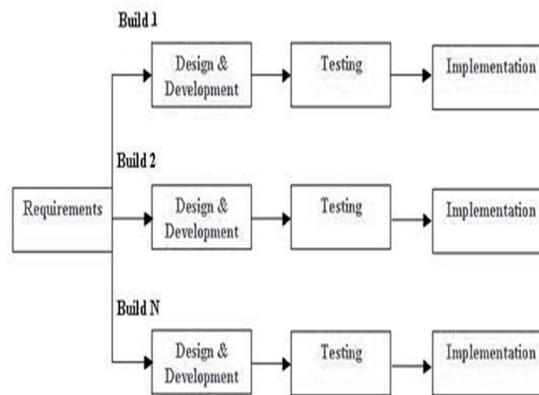
- All requirements must be known upfront.
- Milestone created for each stage is considered frozen – inhibition of flexibility.
- May give a false impression of progress.
- Does not reflect the problem solving nature of software development.
- Little opportunity for the customer to preview the system.
- Real projects rarely follow this approach.
- Costly for small teams and projects.
- Difficult to integrate it with risk management.
- Moving a step backwards is very difficult and creates a lot of problems, i.e., if something goes wrong with the design phase then there may be serious problems with the implementation phase.

When to use waterfall model:-

- Requirements are very well known.
- Technology is understood.
- Product definition is stable.
- New version of an existing product is to be created.
- Porting an existing product on a new platform.

### 3.2 Incremental Model

In incremental model the whole requirement is divided into various constructs. Multiple development cycles take place, making the incremental life cycle a “multi – waterfall” cycle. Developing systems through incremental releases requires the provision of essential operating functions, then providing system users with improved and more skilled versions of a system at regular intervals. Every cycle is divided into smaller, more easily manageable module. Each module passes through the requirements, design, implementation and testing phases. A working version of software is produced at the end of the first module, so the consumer has working software in the beginning of the development process. Each subsequent release of the module adds function to the previous release. The process continues till the complete system is achieved.



**Fig. 2 Incremental Model**

The advantages of incremental model are:-

- Generates working software quickly.
- More flexible.
- Easier to test and debug.
- Customer can respond to each built.
- Lowers initial delivery cost.
- Easier to manage risk because risky pieces are identified and handled during  $i^{\text{th}}$  iteration.

The disadvantages of incremental model are:-

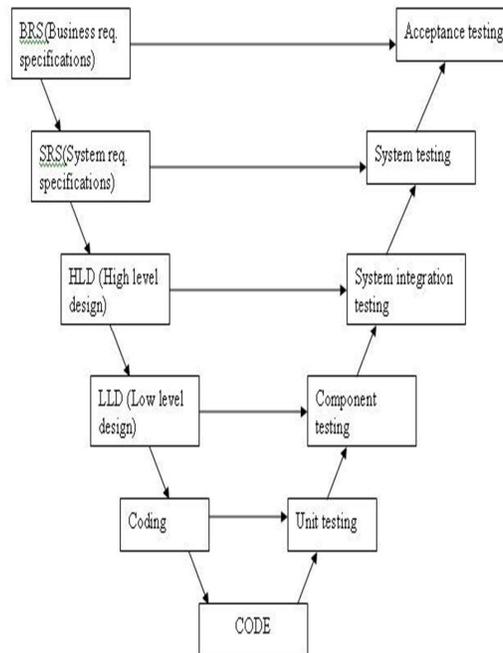
- Needs good planning and design.
- Needs a clear and complete definition of the whole system before it can be broken down and built incrementally.
- Total cost is higher than waterfall model.

When to use incremental model:-

- Requirements of the complete system are clearly defined and understood.
- Major requirements must be defined; however, some details can evolve with time.
- There is a need to build the product quickly.
- A new technology is being implemented.
- Resources with needed skill set are not available.

### 3.3 V-Shaped Model

The V – Shaped model is a sequential path of execution of processes. It is a variant of waterfall model that emphasizes on verification and validation of the product. Each phase must be completed before the next phase begins. Testing of the product is planned in parallel with the corresponding phase of development. Requirements are the beginning of the life cycle model just like the waterfall model. The high-level design phase focuses on system architecture for which an integration test plan is created in order to test the pieces of the software systems ability to work together. However, the low-level design phase lies where the actual software components are designed, and the unit tests are carried out in this phase as well.



**Fig. 2 V - Shaped Model**

The advantages of v - shaped model are:-

- Emphasize planning for verification and validation of the product in early stages of product development.
- Each deliverable must be testable.
- Project management can track progress by milestones.
- Easy to use and implement.
- Higher chance of success over the waterfall model due to the early development of test plans during the life cycle.

The disadvantages of v - shaped model are:-

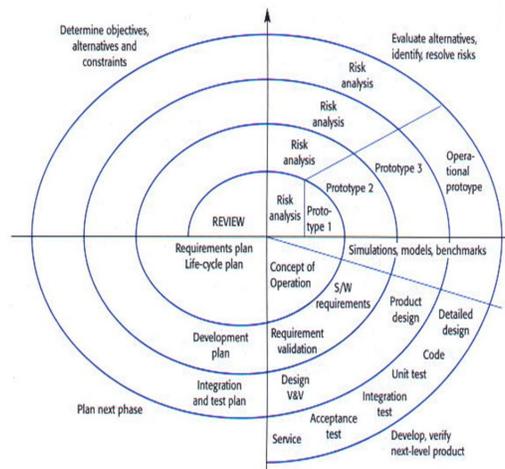
- Does not easily handle concurrent events.
- Does not handle iterations or phases.
- Does not easily handle dynamic changes in requirements.
- Does not contain risk analysis activities.
- Little flexibility.

When to use v - shaped model:-

- For systems requiring high reliability – hospital patient control applications.
- All requirements are known up-front.
- When it can be modified to handle changing requirements beyond analysis phase.
- Solutions and technology are well known and understood.

### 3.4 Spiral Model

The spiral model of software development represents a risk driven approach to software process analysis. This approach incorporates the elements of specification-driven, prototype-driven process methods, together with the classic software life cycle. It has two main distinctive features. First is its cyclic approach for incrementally growing a system's degree of definition and the second one is the implementation while decreasing the degree of risk. The requirements are gathered during the planning phase. In the risk analysis phase, a process is undertaken to identify risk and alternate solutions. A prototype is produced at the end of the risk analysis phase. Software is produced in the engineering phase, along with testing at the end of the phase. The evaluation phase allows the customer to evaluate the output of the project before the project continues to the next spiral.



**Fig. 4 Spiral Model**

The advantages of spiral model are:-

- Provides early indication of insurmountable risks without much cost.
- Users see the system early because of rapid prototyping tools.
- Critical high-risk functions are developed first.
- The design does not have to be perfect.
- Users can be closely tied to all lifecycle steps.
- Early and frequent feedback from users.
- Cumulative costs assessed frequently.
- Good for large and mission critical projects.

The disadvantages of spiral model are:-

- Time spent for evaluating risks too large for small or low-risk projects.

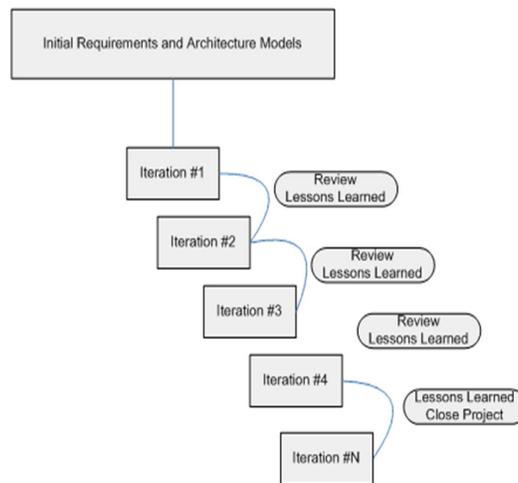
- Time spent planning, resetting objectives, doing risk analysis and prototyping may be excessive.
- The model is complex.
- Risk assessment expertise is required.
- Spiral may continue indefinitely.
- Developers must be reassigned during non-development phase activities.
- May be hard to define objective, verifiable milestones that indicate readiness to advance to the next iteration.

When to use spiral model:-

- When creation of a prototype is appropriate.
- When costs and risk evaluation is important.
- For medium to high-risk projects.
- Long-term project commitment unwise because of potential changes to economic priorities.
- Users are unsure of their needs.
- Requirements are complex.
- New product line.
- Significant changes are expected.

### 3.5 Agile Model

Agile development model is also a type of incremental model. Software is developed in rapid cycles known as increments. This results in small incremental releases with each release building on previous ones functionality. The application is typically delivered in incremental fashion. The agile development approaches are typically concerned with maintaining user involvement through the application of design teams and special workshops. The delivered increments tend to be small and limited to short delivery periods to ensure rapid completion. Extreme Programming (XP) is currently one of the most well known agile models.



**Fig. 5 Agile Model**

The advantages of agile model are:-

- Customer satisfaction.
- People and interactions specified rather than tools.
- Face-to-Face communications.

- Daily cooperation among consumer and developer.
- Working software delivered frequently.
- Regular adaption to change.
- Even late changes are not much problem.

The disadvantages of agile model are:-

- In case of some software deliverables, especially the large ones, it is difficult to assess the effort required at the beginning of the development process.
- Lack of emphasis on necessary designing.
- The project can easily go off track if customer is not clear with the final outcome that they desire.
- Only senior programmers are capable of taking the kind of decisions required during the development process.

When to use agile model:-

- When new changes are to be implemented.
- To implement a new feature the developers lose the work of only a short duration of time.
- Very limited planning required.
- Both system developers and stakeholders get more freedom of time and options if the software was developed in a more sequential way.

## 4. Conclusions

After conducting the analysis of the various process models that are being implemented for more than 4 decades, one can conclude that each and every model has its advantages and disadvantages and are used according to the situation. The best part about these models is that one may use them the way the development team wants. One can create new process models as per its requirement. The waterfall and spiral models are still the most commonly used models. But with increased urgency among customers, the agile model is also being used a lot. Hence, it can be said that all the models are effective enough to be implemented as per the requirement. It depends on the developer which one to use.

## 5. Acknowledgments

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