Software engineering

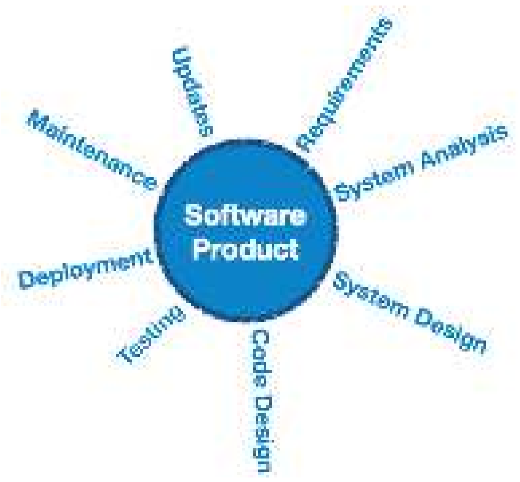
Unit 1

Software engineering is an engineering branch associated with development of software product using well-defined scientific principles, methods and procedures. The outcome of software engineering is an efficient and reliable software product.

"Software is a collection of documented program."

Software is more than just a program code. A program is an executable code, which serves some computational purpose. Software is considered to be collection of executable programming code, associated libraries and documentations. Software, when made for a specific requirement is called **software product.**

Engineering on the other hand, is all about developing products, using well-defined, scientific principles and methods.



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Characteristics of good software

A software product can be judged by what it offers and how well it can be used. This software must satisfy on the following grounds:

- Operational
- Transitional
- Maintenance

Well-engineered and crafted software is expected to have the following characteristics:

Operational

This tells us how well software works in operations. It can be measured on:

- Budget
- Usability
- Efficiency
- Correctness
- Functionality
- Dependability
- Security
- Safety

Transitional

This aspect is important when the software is moved from one platform to another:

- Portability
- Interoperability
- Reusability
- Adaptability

Maintenance

This aspect briefs about how well a software has the capabilities to maintain itself in the ever-changing environment:

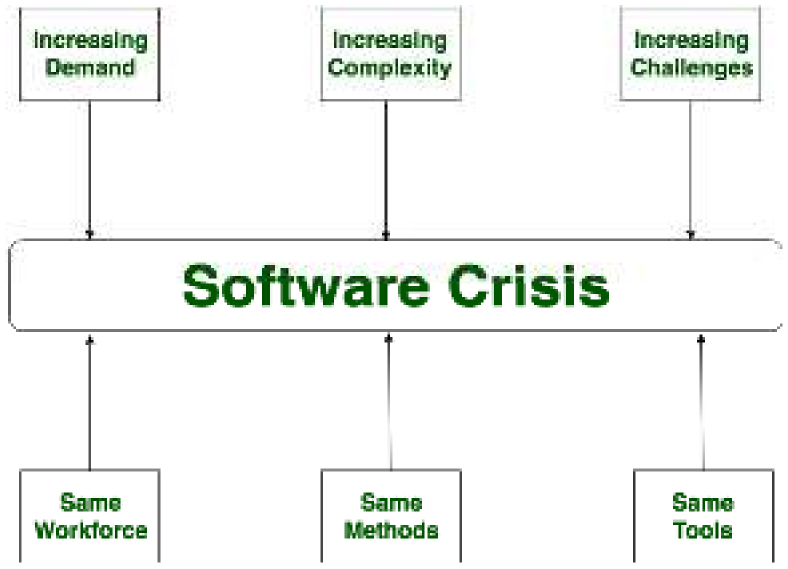
- Modularity
- Maintainability
- Flexibility
- Scalability

In short, Software engineering is a branch of computer science, which uses well-defined engineering concepts required to produce efficient, durable, scalable, in-budget and on-time software products.

Software Development Life Cycle, SDLC for short, is a well-defined, structured sequence of stages in software engineering to develop the intended software product.

Software Engineering | Software Crisis

Software Crisis is a term used in computer science for the difficulty of writing useful and efficient computer programs in the required time .software crisis was due to using same workforce, same methods, same tools even though rapidly increasing in software demand, complexity of software and software challenges. With increase in the complexity of software, many software problems arise because existing methods were insufficient.
Ff we will use same workforce, same methods and same tools after fast increasing in software demand, software complexity and software challenges, then there arose some problems like software budget problem, software efficiency problem, software quality problem, software managing and delivering problem etc. This condition is called software crisis.



10 Myths About Software Development

There are many myths and false assumptions that continue to loom around software development. Even though the first programming language, Fortran, was created in 1957 and the World Wide Web has eclipsed the quarter-century mark, software development is still viewed as some sort of dark magic, thus making people hesitant to embrace new technology. There are also lots of myths out there which prevent us from fully comprehending how business processes can be automated or improved by top quality programming which can lead to significant time and cost savings.
Let’s consider ten of these myths that need to be challenged in the name of improving business efficiency.

1. Software Development Comes with a Hefty Price Tag
Perhaps this is the most popular myth about software development. It is because of this myth companies do not harness the potential that custom software can provide which can improve their organization's efficiency. Instead, they opt for purchasing some "one size fits all" solution which, of course, doesn't fit their requirements and they have to find other means to work around it.

Also, consider the investment loss if the company outgrows the software and it just becomes unworkable. If you combine this with hidden costs such as upgrade fees, licensing and support costs, custom software doesn't seem so expensive.

2. Users Have No Idea what they Know what they Want
Even though there conversely exists a myth that customers have no idea what they want until you show them, regardless, software companies need to be both product oriented and customer oriented as long as they consider the speed of delivery to be important. Wise businesses don't simply focus on creating a top-notch, most innovative product on the market, but they also strive to deliver the best solution to the consumer, that provides market success. Doing no market research and not listening to your customers is simply not an option. Read also: How DevOps Delivers Cool Apps to Users.

3. The Waterfall Method Still Works
You would be amazed at the number of people who still believe that a system can be specified in detail, before you even build it. Not only is this almost impossible, but it is also inefficient to execute the development process in a sequence. While there also exists a myth that Agile lacks any planning whatsoever, the fact of the matter is that planning is just as necessary to the effectiveness of Agile as it is to Waterfall, but the difference is in the way the planning is done.

Waterfall promotes planning before building at the very beginning of the project that poses a lot of constraints in the flexibility and adaptation. Conversely, Agile allows for ongoing planning mechanism where changes and adjustments are made as the project goes along in an iterative manner.

4. The More, the Merrier
Unfortunately, a myth exists that adding people to a development team makes it better and speeds up delivery. However, adding more people to a project tends to prolong the project's timeframe and causes friction due to issues in training and collaboration.

5. Software Development has a Fixed Cost and Strict Timeframe
Going back to the Waterfall approach, it is simply not possible to detail out the software before building it. Even though a lot of companies are lured in by the fixed price model, they must also remember that there are some hidden costs associated with it in terms of quality and additional costs incurred as the project goes beyond the projected time boundaries.

6. There's Always a "Magic Bullet"
Just like the old adage "A bad worker blames his tools", many people believe that they are missing some state-of-the-art tool which will solve all of their problems and produce magnificent

results. When building high-quality software, the utmost importance should be given to critical innovative thinking, agility and skillset. Having the best technologies is just the icing on the cake.

7. When the Software is Released, the Projects is Over
As soon as the product is released, the focus should be on receiving feedback from the users and incorporating this feedback into an iterative approach back into the product. There needs to be an ongoing process of improvement and revisions along with testing for bugs in order to provide the customer with the best quality product.

8. A Requirement of Agile is that Product Owners and Developers Work in a Single Location
Thanks to modern communication technology, distributed teams can use collaborative tools such as e-mail, shared calendars, instant messengers, screen sharing, audio and video conferencing and many others to work together and stay up to date. Nowadays companies have access to a wide array of communication tools that are widely accessible and readily available thus allowing remote developers to work seamlessly.

9. Outsourcing Solves Everything
Plain old outsourcing can create a far worse problem than you initially had. Software vendors should start thinking about establishing long-term relationships and engaging in a dedicated team model instead of fixed cost projects which lead to incomplete deliverables, frustration and high overhead costs.

10. Outsourcing Means Compromising Quality
When done properly, in a well-researched manner, outsourcing can provide you with better code and an outstanding product. When you go offshore, you gain access to a wide talent pool which has the industry expertise that you have been struggling to fill in-house. Do not hesitate to explore new strategies!

Software Process

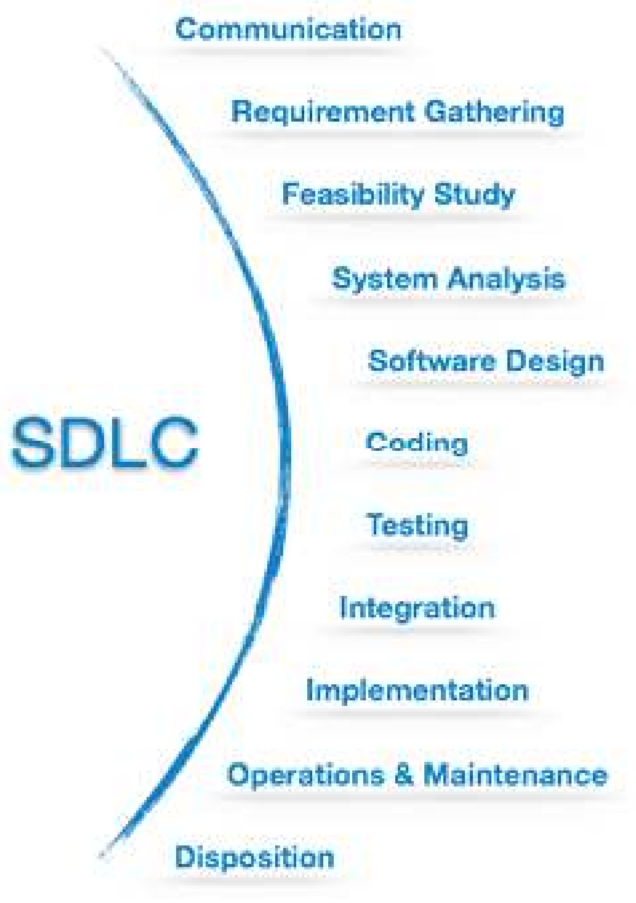
A software process (also knows as software methodology) is a set of related activities that leads to the production of the software. These activities may involve the development of the software from the scratch, or, modifying an existing system.

Any software process must include the following four activities:

1. **Software specification** (or requirements engineering): Define the main functionalities of the software and the constrain around them.
2. S**oftware design and implementation**: The software is to be designed and programmed.
3. **Software verification and validation**: The software must conforms to it's specification and meets the customer needs.
4. **Software evolution** (software maintenance): The software is being modified to meet customer and market requirements changes.

SDLC Activities

SDLC provides a series of steps to be followed to design and develop a software product efficiently. SDLC framework includes the following steps:



Communication

This is the first step where the user initiates the request for a desired software product. He contacts the service provider and tries to negotiate the terms. He submits his request to the service providing organization in writing.

Requirement Gathering

This step onwards the software development team works to carry on the project. The team holds discussions with various stakeholders from problem domain and tries to bring out as much information as possible on their requirements. The requirements are contemplated and segregated into user requirements, system requirements and functional requirements. The requirements are collected using a number of practices as given -

- studying the existing or obsolete system and software,

- conducting interviews of users and developers,
- referring to the database or
- collecting answers from the questionnaires.

Feasibility Study

After requirement gathering, the team comes up with a rough plan of software process. At this step the team analyzes if a software can be made to fulfill all requirements of the user and if there is any possibility of software being no more useful. It is found out, if the project is financially, practically and technologically feasible for the organization to take up. There are many algorithms available, which help the developers to conclude the feasibility of a software project.

System Analysis

At this step the developers decide a roadmap of their plan and try to bring up the best software model suitable for the project. System analysis includes Understanding of software product limitations, learning system related problems or changes to be done in existing systems beforehand, identifying and addressing the impact of project on organization and personnel etc. The project team analyzes the scope of the project and plans the schedule and resources accordingly.

Software Design

Next step is to bring down whole knowledge of requirements and analysis on the desk and design the software product. The inputs from users and information gathered in requirement gathering phase are the inputs of this step. The output of this step comes in the form of two designs; logical design and physical design. Engineers produce meta-data and data dictionaries, logical diagrams, data-flow diagrams and in some cases pseudo codes.

Coding

This step is also known as programming phase. The implementation of software design starts in terms of writing program code in the suitable programming language and developing error-free executable programs efficiently.

Testing

An estimate says that 50% of whole software development process should be tested. Errors may ruin the software from critical level to its own removal. Software testing is done while coding by the developers and thorough testing is conducted by testing experts at various levels of code such as module testing, program testing, product testing, in-house testing and testing the product at user's end. Early discovery of errors and their remedy is the key to reliable software.

Integration

Software may need to be integrated with the libraries, databases and other program(s). This stage of SDLC is involved in the integration of software with outer world entities.

Implementation

This means installing the software on user machines. At times, software needs post-installation configurations at user end. Software is tested for portability and adaptability and integration related issues are solved during implementation.

Operation and Maintenance

This phase confirms the software operation in terms of more efficiency and less errors. If required, the users are trained on, or aided with the documentation on how to operate the software and how to keep the software operational. The software is maintained timely by updating the code according to the changes taking place in user end environment or technology. This phase may face challenges from hidden bugs and real-world unidentified problems.

Disposition

As time elapses, the software may decline on the performance front. It may go completely obsolete or may need intense upgradation. Hence a pressing need to eliminate a major portion of the system arises. This phase includes archiving data and required software components, closing down the system, planning disposition activity and terminating system at appropriate end-of-system time.

Software Development Paradigm

The software development paradigm helps developer to select a strategy to develop the software. A software development paradigm has its own set of tools, methods and procedures, which are expressed clearly and defines software development life cycle. A few of software development paradigms or process models are defined as follows:

Typical characteristics of a product and project

Product	**Project**
Permanent (until decommissioned)	Beginning and end date
Long-lived feature team	Short-term project team
Adaptive planning (iterative)	Predictive planning (up-front)
Continual improvements	One-off delivery
Evolving customer needs	Project requirements
Investment delivers benefits / KPIs	Investment delivers scope

Emergence of Software Engineering

Early Computer Programming

As we know that in the early 1950s, computers were slow and expensive. Though the programs at that time were very small in size, these computers took considerable time to process them. They relied on assembly language which was specific to computer architecture. Thus, developing a program required lot of effort. Every programmer used his own style to develop the programs.

High Level Language Programming

With the introduction of semiconductor technology, the computers became smaller, faster, cheaper, and reliable than their predecessors. One of the major developments includes the progress from assembly language to high-level languages. Early high level programming languages such as COBOL and FORTRAN came into existence. As a result, the programming became easier and thus, increased the productivity of the programmers. However, still the programs were limited in size and the programmers developed programs using their own style and experience.

Control Flow Based Design

With the advent of powerful machines and high level languages, the usage of computers grew rapidly: In addition, the nature of programs also changed from simple to complex. The increased size and the complexity could not be managed by individual style. It was analyzed that clarity of control flow (the sequence in which the program's instructions are executed) is of great importance. To help the programmer to design programs having good control flow structure, **flowcharting technique** was developed. In flowcharting technique, the algorithm is represented using flowcharts. A **flowchart** is a graphical representation that depicts the sequence of operations to be carried out to solve a given problem.

Note that having more GOTO constructs in the flowchart makes the control flow messy, which makes it difficult to understand and debug. In order to provide clarity of control flow, the use of GOTO constructs in flowcharts should be avoided and **structured constructs-decision,** sequence, and loop-should be used to develop **structured flowcharts.** The decision structures are used for conditional execution of statements (for example, if statement). The sequence structures are used for the sequentially executed statements. The loop structures are used for performing some repetitive tasks in the program. The use of structured constructs formed the basis of the **structured programming** methodology.

Structured programming became a powerful tool that allowed programmers to write moderately complex programs easily. It forces a logical structure in the program to be written in an efficient and understandable manner. The purpose of structured programming is to make the software code easy to modify when required. Some languages such as Ada, Pascal, and dBase are designed with features that implement the logical program structure in the software code.

Data-Flow Oriented Design

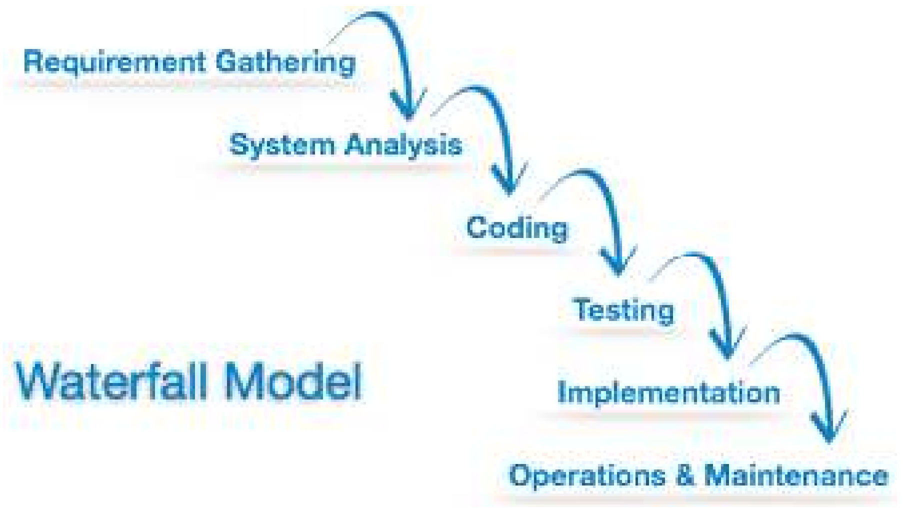
With the introduction of very Large Scale Integrated circuits (VLSI), the computers became more powerful and faster. As a result, various significant developments like networking and GUIs came into being. Clearly, the complexity of software could not be dealt using control flow based design. Thus, a new technique, namely, **data-flow-oriented** technique came into existence. In this technique, the flow of data through business functions or processes is represented using **Data-flow Diagram (DFD). IEEE** defines a data-flow diagram (also known as **bubble chart** and **work-flow diagram)** as 'a diagram that depicts data sources, data sinks, data storage, and processes performed on data as nodes, and logical flow of data as links between the nodes.'

Object Oriented Design

Object-oriented design technique has revolutionized the process of software development. It not only includes the best features of structured programming but also some new and powerful features such as encapsulation, abstraction, inheritance, and polymorphism. These new features have tremendously helped in the development of well-designed and high-quality software. Object-oriented techniques are widely used these days as they allow reusability of the code. They lead to faster software development and high-quality programs. Moreover, they are easier to adapt and scale, that is, large systems can be created by assembling reusable subsystems.

Waterfall Model

Waterfall model is the simplest model of software development paradigm. It says the all the phases of SDLC will function one after another in linear manner. That is, when the first phase is finished then only the second phase will start and so on.



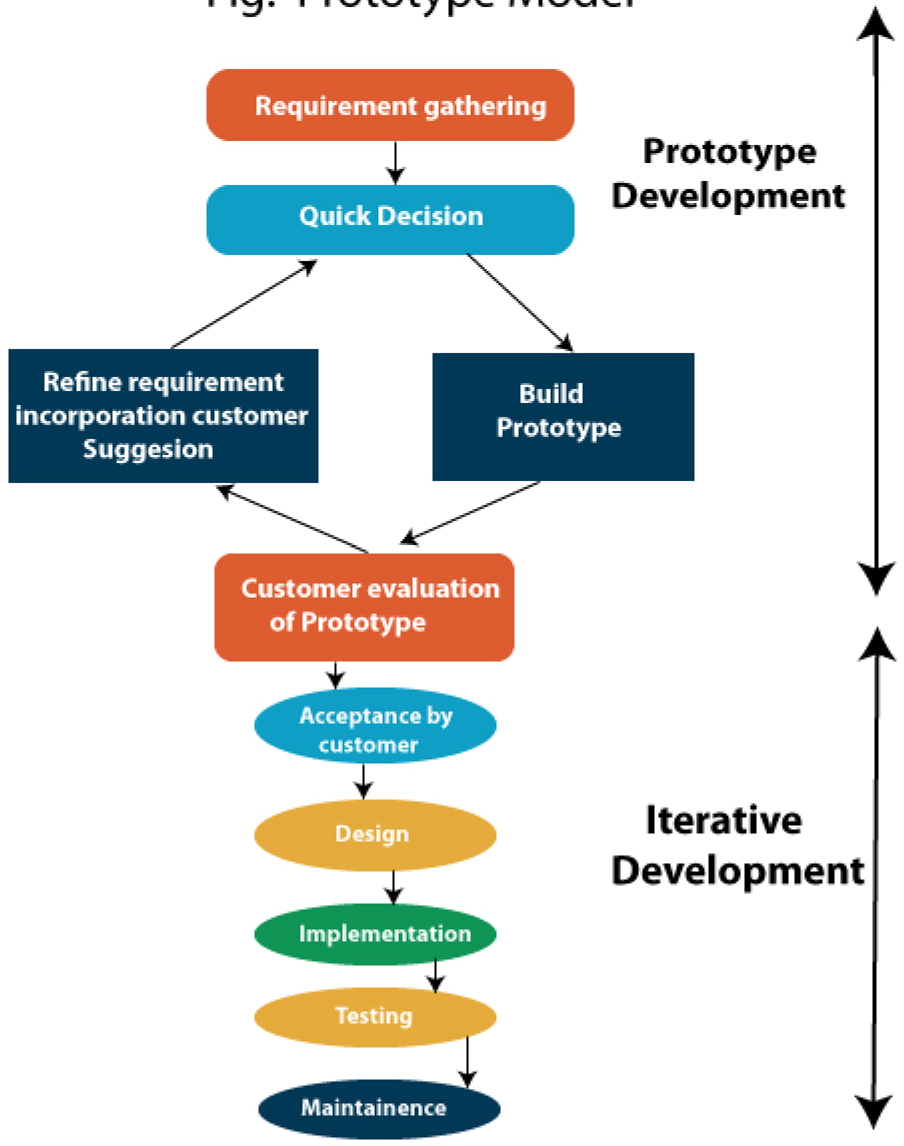
This model assumes that everything is carried out and taken place perfectly as planned in the previous stage and there is no need to think about the past issues that may arise in the next phase. This model does not work smoothly if there are some issues left at the previous step. The sequential nature of model does not allow us go back and undo or redo our actions.

This model is best suited when developers already have designed and developed similar software in the past and are aware of all its domains.

Prototype Model

The prototype model requires that before carrying out the development of actual software, a working prototype of the system should be built. A prototype is a toy implementation of the system. A prototype usually turns out to be a very crude version of the actual system, possible exhibiting limited functional capabilities, low reliability, and inefficient performance as compared to actual software. In many instances, the client only has a general view of what is expected from the software product. In such a scenario where there is an absence of detailed information regarding the input to the system, the processing needs, and the output requirement, the prototyping model may be employed.

Fig: Prototype Model



Steps of Prototype Model

1. Requirement Gathering and Analyst
2. Quick Decision
3. Build a Prototype
4. Assessment or User Evaluation
5. Prototype Refinement
6. Engineer Product

Advantage of Prototype Model

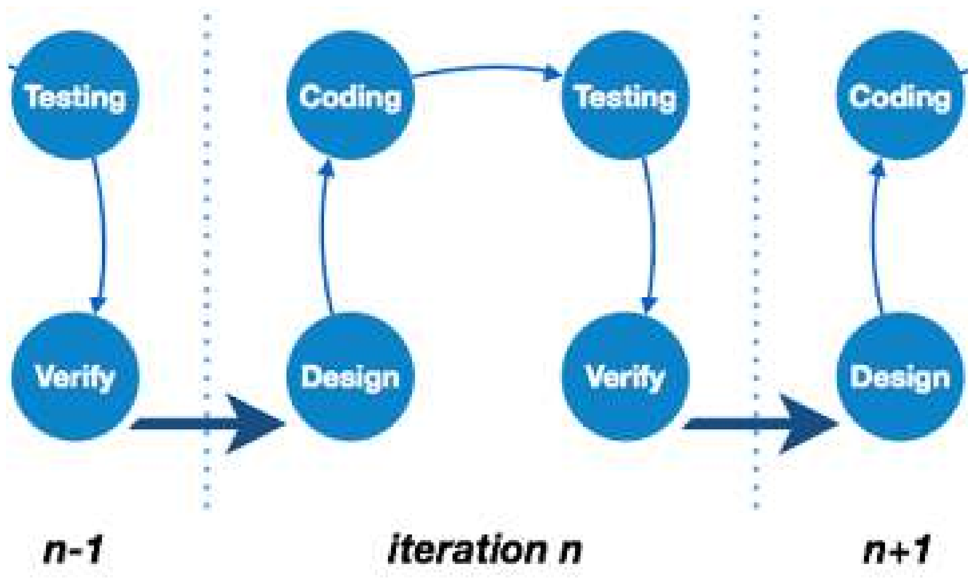
1. Reduce the risk of incorrect user requirement
2. Good where requirement are changing/uncommitted
3. Regular visible process aids management
4. Support early product marketing
5. Reduce Maintenance cost.
6. Errors can be detected much earlier as the system is made side by side.

Disadvantage of Prototype Model

1. An unstable/badly implemented prototype often becomes the final product.
2. Require extensive customer collaboration
   - Costs customer money
   - Needs committed customer
   - Difficult to finish if customer withdraw
   - May be too customer specific, no broad market
3. Difficult to know how long the project will last.
4. Easy to fall back into the code and fix without proper requirement analysis, design, customer evaluation, and feedback.
5. Prototyping tools are expensive.
6. Special tools & techniques are required to build a prototype.
7. It is a time-consuming process.

Iterative Model

This model leads the software development process in iterations. It projects the process of development in cyclic manner repeating every step after every cycle of SDLC process.

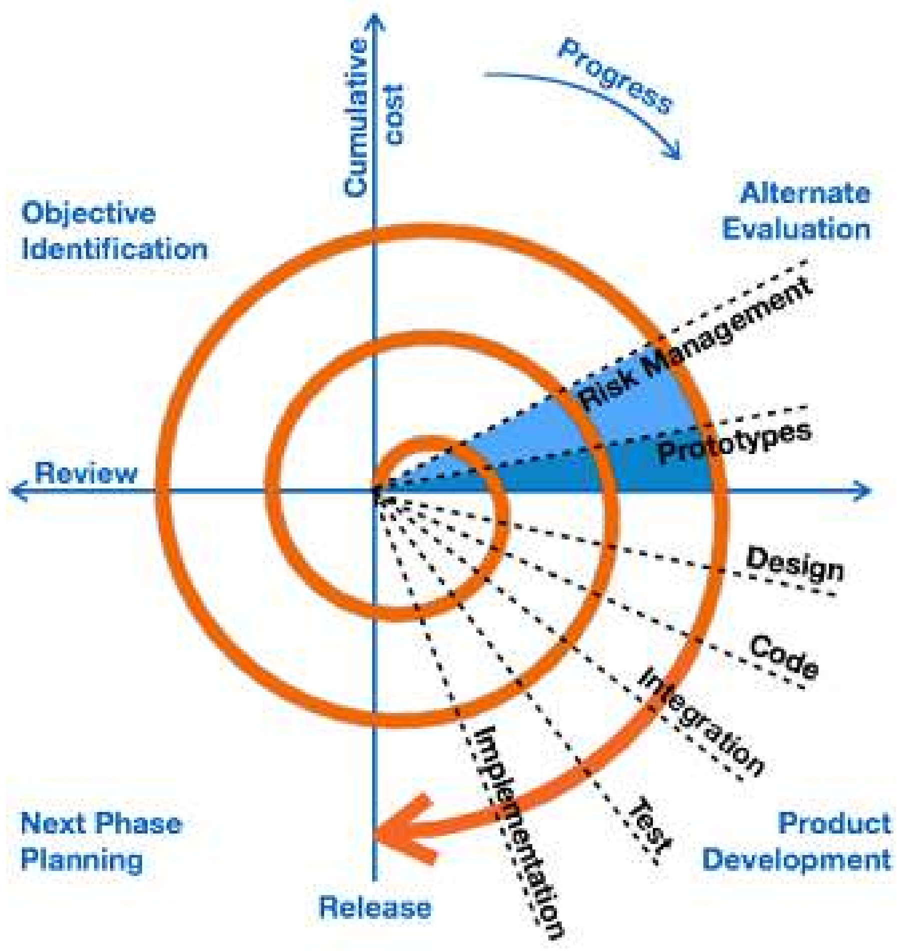


The software is first developed on very small scale and all the steps are followed which are taken into consideration. Then, on every next iteration, more features and modules are designed, coded, tested and added to the software. Every cycle produces a software, which is complete in itself and has more features and capabilities than that of the previous one.

After each iteration, the management team can do work on risk management and prepare for the next iteration. Because a cycle includes small portion of whole software process, it is easier to manage the development process but it consumes more resources.

Spiral Model

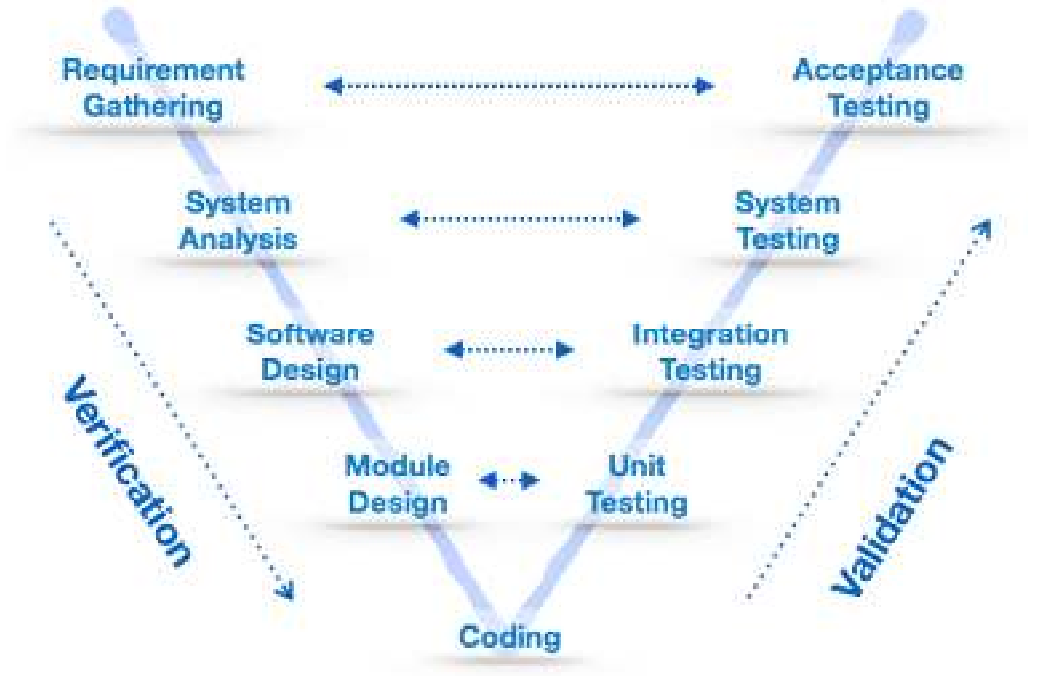
Spiral model is a combination of both, iterative model and one of the SDLC model. It can be seen as if you choose one SDLC model and combine it with cyclic process (iterative model).



This model considers risk, which often goes un-noticed by most other models. The model starts with determining objectives and constraints of the software at the start of one iteration. Next phase is of prototyping the software. This includes risk analysis. Then one standard SDLC model is used to build the software. In the fourth phase of the plan of next iteration is prepared.

V – model

The major drawback of waterfall model is we move to the next stage only when the previous one is finished and there was no chance to go back if something is found wrong in later stages. V-Model provides means of testing of software at each stage in reverse manner.

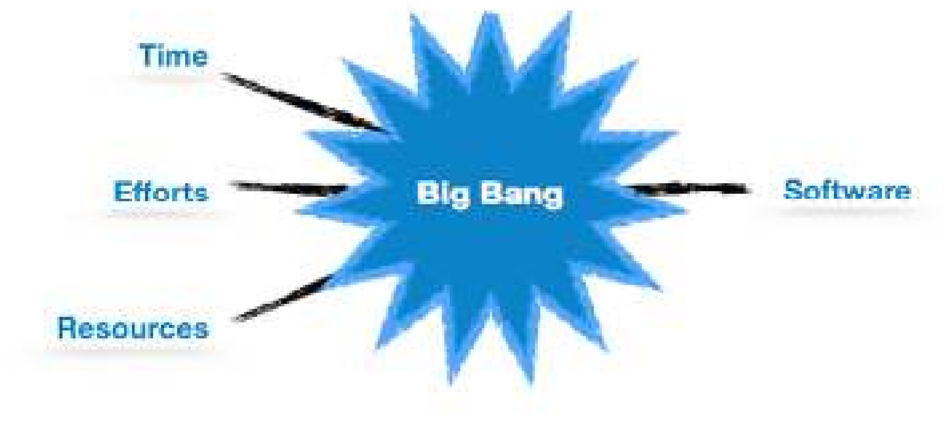


At every stage, test plans and test cases are created to verify and validate the product according to the requirement of that stage. For example, in requirement gathering stage the test team prepares all the test cases in correspondence to the requirements. Later, when the product is developed and is ready for testing, test cases of this stage verify the software against its validity towards requirements at this stage.

This makes both verification and validation go in parallel. This model is also known as verification and validation model.

Big Bang Model

This model is the simplest model in its form. It requires little planning, lots of programming and lots of funds. This model is conceptualized around the big bang of universe. As scientists say that after big bang lots of galaxies, planets and stars evolved just as an event. Likewise, if we put together lots of programming and funds, you may achieve the best software product.



For this model, very small amount of planning is required. It does not follow any process, or at times the customer is not sure about the requirements and future needs. So the input requirements are arbitrary.

This model is not suitable for large software projects but good one for learning and experimenting.

The **RAD (Rapid Application Development)** model is based on prototyping and iterative development with no specific planning involved. The process of writing the software itself involves the planning required for developing the product.

Rapid Application Development focuses on gathering customer requirements through workshops or focus groups, early testing of the prototypes by the customer using iterative concept, reuse of the existing prototypes (components), continuous integration and rapid delivery.

What is RAD?

Rapid application development is a software development methodology that uses minimal planning in favor of rapid prototyping. A prototype is a working model that is functionally equivalent to a component of the product.

In the RAD model, the functional modules are developed in parallel as prototypes and are integrated to make the complete product for faster product delivery. Since there is no detailed preplanning, it makes it easier to incorporate the changes within the development process.

RAD projects follow iterative and incremental model and have small teams comprising of developers, domain experts, customer representatives and other IT resources working progressively on their component or prototype.

The most important aspect for this model to be successful is to make sure that the prototypes developed are reusable.

RAD Model Design

RAD model distributes the analysis, design, build and test phases into a series of short, iterative development cycles.

Following are the various phases of the RAD Model −

Business Modeling

The business model for the product under development is designed in terms of flow of information and the distribution of information between various business channels. A complete business analysis is performed to find the vital information for business, how it can be obtained, how and when is the information processed and what are the factors driving successful flow of information.

Data Modeling

The information gathered in the Business Modeling phase is reviewed and analyzed to form sets of data objects vital for the business. The attributes of all data sets is identified and defined. The relation between these data objects are established and defined in detail in relevance to the business model.

Process Modeling

The data object sets defined in the Data Modeling phase are converted to establish the business information flow needed to achieve specific business objectives as per the business model. The process model for any changes or enhancements to the data object sets is defined in this phase. Process descriptions for adding, deleting, retrieving or modifying a data object are given.

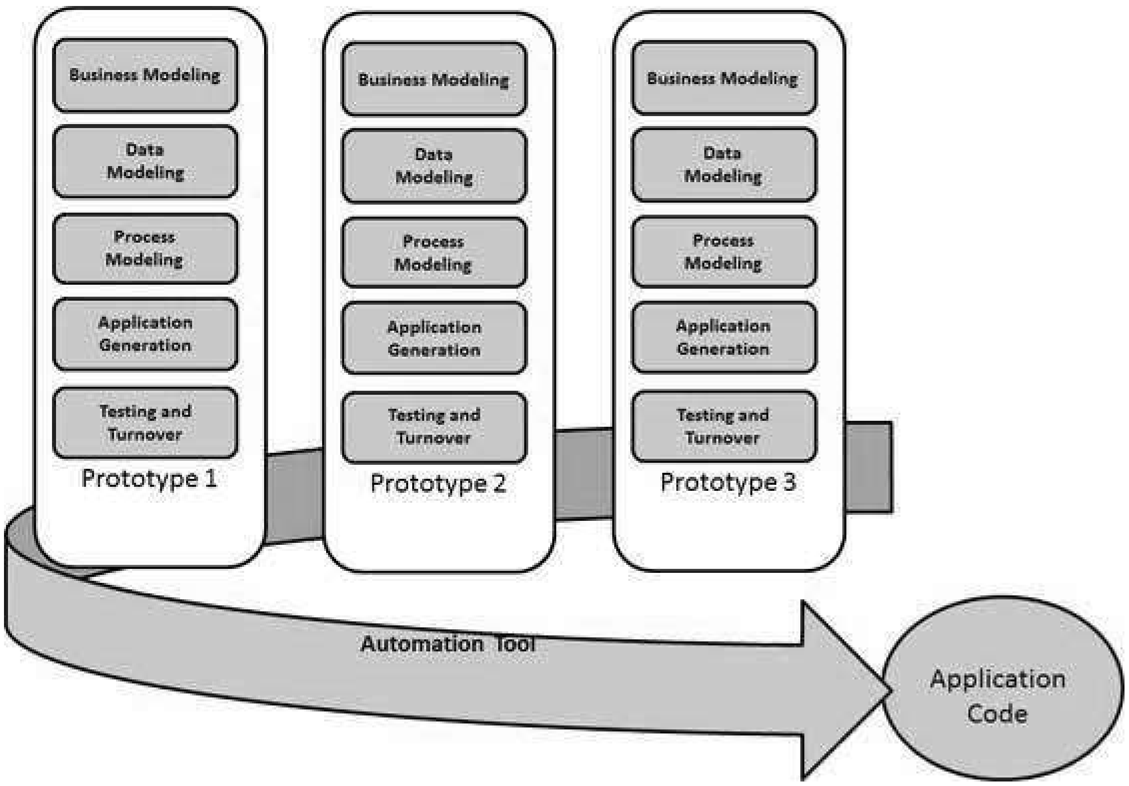
Application Generation

The actual system is built and coding is done by using automation tools to convert process and data models into actual prototypes.

Testing and Turnover

The overall testing time is reduced in the RAD model as the prototypes are independently tested during every iteration. However, the data flow and the interfaces between all the components need to be thoroughly tested with complete test coverage. Since most of the programming components have already been tested, it reduces the risk of any major issues.

The following illustration describes the RAD Model in detail.



RAD Model Vs Traditional SDLC

The traditional SDLC follows a rigid process models with high emphasis on requirement analysis and gathering before the coding starts. It puts pressure on the customer to sign off the requirements before the project starts and the customer doesn’t get the feel of the product as there is no working build available for a long time.

The customer may need some changes after he gets to see the software. However, the change process is quite rigid and it may not be feasible to incorporate major changes in the product in the traditional SDLC.

The RAD model focuses on iterative and incremental delivery of working models to the customer. This results in rapid delivery to the customer and customer involvement during the complete development cycle of product reducing the risk of non-conformance with the actual user requirements.

RAD Model - Application

RAD model can be applied successfully to the projects in which clear modularization is possible. If the project cannot be broken into modules, RAD may fail.

The following pointers describe the typical scenarios where RAD can be used −

- RAD should be used only when a system can be modularized to be delivered in an incremental manner.

- It should be used if there is a high availability of designers for modeling.
- It should be used only if the budget permits use of automated code generating tools.
- RAD SDLC model should be chosen only if domain experts are available with relevant business knowledge.
- Should be used where the requirements change during the project and working prototypes are to be presented to customer in small iterations of 2-3 months.

RAD Model - Pros and Cons

RAD model enables rapid delivery as it reduces the overall development time due to the reusability of the components and parallel development. RAD works well only if high skilled engineers are available and the customer is also committed to achieve the targeted prototype in the given time frame. If there is commitment lacking on either side the model may fail.

The advantages of the RAD Model are as follows −

- Changing requirements can be accommodated.
- Progress can be measured.
- Iteration time can be short with use of powerful RAD tools.
- Productivity with fewer people in a short time.
- Reduced development time.
- Increases reusability of components.
- Quick initial reviews occur.
- Encourages customer feedback.
- Integration from very beginning solves a lot of integration issues.

The disadvantages of the RAD Model are as follows −

- Dependency on technically strong team members for identifying business requirements.
- Only system that can be modularized can be built using RAD.
- Requires highly skilled developers/designers.
- High dependency on modeling skills.
- Inapplicable to cheaper projects as cost of modeling and automated code generation is very high.
- Management complexity is more.
- Suitable for systems that are component based and scalable.
- Requires user involvement throughout the life cycle.
- Suitable for project requiring shorter development times.

Agile SDLC model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product. Agile Methods break the product into small incremental builds. These builds are provided in iterations. Each iteration typically lasts from about one to three weeks. Every iteration involves cross functional teams working simultaneously on various areas like −

- Planning
- Requirements Analysis
- Design
- Coding
- Unit Testing and
- Acceptance Testing.

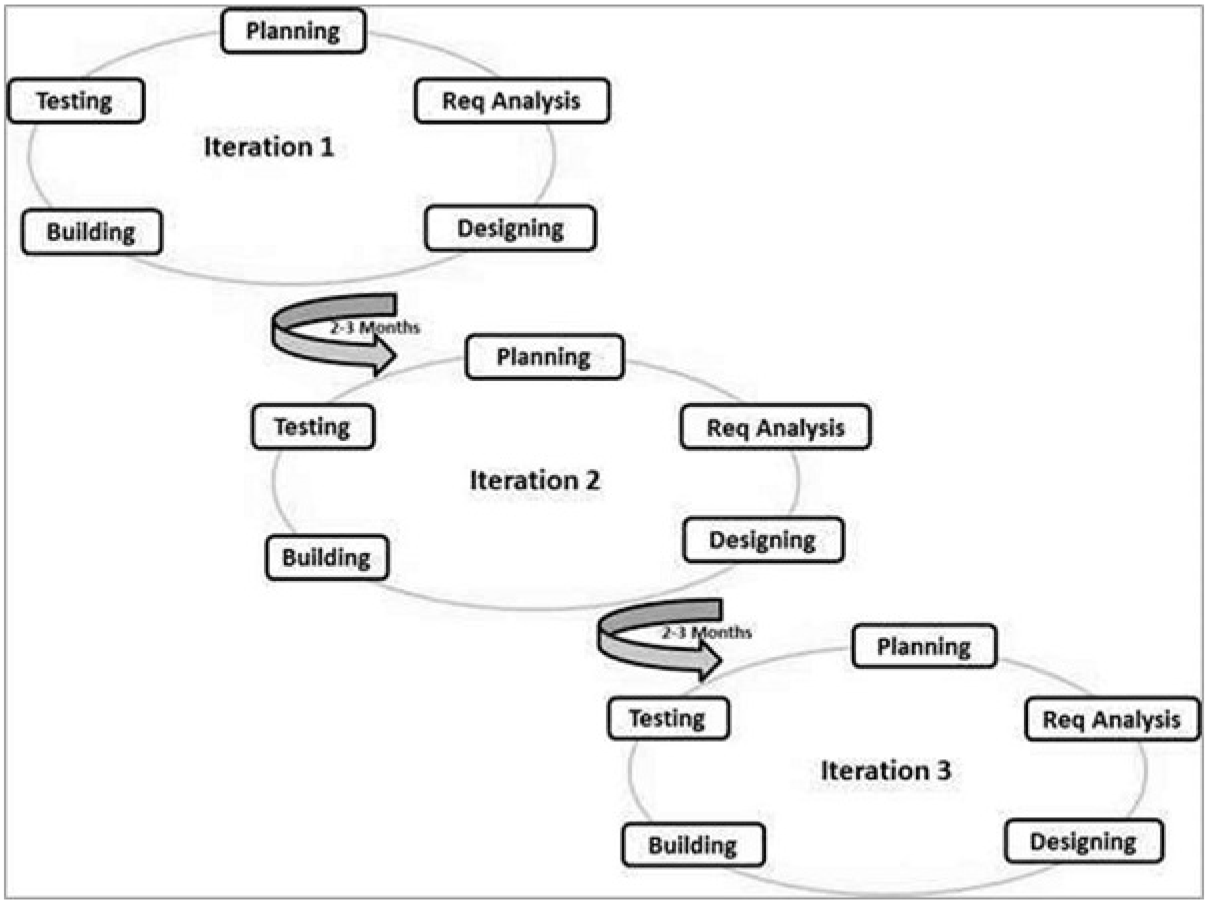
At the end of the iteration, a working product is displayed to the customer and important stakeholders.

What is Agile?

Agile model believes that every project needs to be handled differently and the existing methods need to be tailored to best suit the project requirements. In Agile, the tasks are divided to time boxes (small time frames) to deliver specific features for a release.

Iterative approach is taken and working software build is delivered after each iteration. Each build is incremental in terms of features; the final build holds all the features required by the customer.

Here is a graphical illustration of the Agile Model −



The Agile thought process had started early in the software development and started becoming popular with time due to its flexibility and adaptability.

The most popular Agile methods include Rational Unified Process (1994), Scrum (1995), Crystal Clear, Extreme Programming (1996), Adaptive Software Development, Feature Driven Development, and Dynamic Systems Development Method (DSDM) (1995). These are now collectively referred to as **Agile Methodologies**, after the Agile Manifesto was published in 2001.

Following are the Agile Manifesto principles −

- **Individuals and interactions** − In Agile development, self-organization and motivation are important, as are interactions like co-location and pair programming.
- **Working software** − Demo working software is considered the best means of communication with the customers to understand their requirements, instead of just depending on documentation.
- **Customer collaboration** − As the requirements cannot be gathered completely in the beginning of the project due to various factors, continuous customer interaction is very important to get proper product requirements.
- **Responding to change** − Agile Development is focused on quick responses to change and continuous development.

Agile Vs Traditional SDLC Models

Agile is based on the **adaptive software development methods**, whereas the traditional SDLC models like the waterfall model is based on a predictive approach. Predictive teams in the traditional SDLC models usually work with detailed planning and have a complete forecast of the exact tasks and features to be delivered in the next few months or during the product life cycle.

Predictive methods entirely depend on the **requirement analysis and planning** done in the beginning of cycle. Any changes to be incorporated go through a strict change control management and prioritization.

Agile uses an **adaptive approach** where there is no detailed planning and there is clarity on future tasks only in respect of what features need to be developed. There is feature driven development and the team adapts to the changing product requirements dynamically. The product is tested very frequently, through the release iterations, minimizing the risk of any major failures in future.

Customer Interaction is the backbone of this Agile methodology, and open communication with minimum documentation are the typical features of Agile development environment. The agile teams work in close collaboration with each other and are most often located in the same geographical location.

Agile Model - Pros and Cons

Agile methods are being widely accepted in the software world recently. However, this method may not always be suitable for all products. Here are some pros and cons of the Agile model.

The advantages of the Agile Model are as follows −

- Is a very realistic approach to software development.
- Promotes teamwork and cross training.
- Functionality can be developed rapidly and demonstrated.
- Resource requirements are minimum.
- Suitable for fixed or changing requirements
- Delivers early partial working solutions.
- Good model for environments that change steadily.
- Minimal rules, documentation easily employed.
- Enables concurrent development and delivery within an overall planned context.
- Little or no planning required.
- Easy to manage.
- Gives flexibility to developers.

The disadvantages of the Agile Model are as follows −

- Not suitable for handling complex dependencies.
- More risk of sustainability, maintainability and extensibility.
- An overall plan, an agile leader and agile PM practice is a must without which it will not work.
- Strict delivery management dictates the scope, functionality to be delivered, and adjustments to meet the deadlines.
- Depends heavily on customer interaction, so if customer is not clear, team can be driven in the wrong direction.
- There is a very high individual dependency, since there is minimum documentation generated.
- Transfer of technology to new team members may be quite challenging due to lack of documentation.

The Big Bang model is an SDLC model where we do not follow any specific process. The development just starts with the required money and efforts as the input, and the output is the software developed which may or may not be as per customer requirement. This Big Bang Model does not follow a process/procedure and there is a very little planning required. Even the customer is not sure about what exactly he wants and the requirements are implemented on the fly without much analysis.

Usually this model is followed for small projects where the development teams are very small.

Big Bang Model ─ Design and Application

The Big Bang Model comprises of focusing all the possible resources in the software development and coding, with very little or no planning. The requirements are understood and implemented as they come. Any changes required may or may not need to revamp the complete software.

This model is ideal for small projects with one or two developers working together and is also useful for academic or practice projects. It is an ideal model for the product where requirements are not well understood and the final release date is not given.

Big Bang Model - Pros and Cons

The advantage of this Big Bang Model is that it is very simple and requires very little or no planning. Easy to manage and no formal procedure are required.

However, the Big Bang Model is a very high risk model and changes in the requirements or misunderstood requirements may even lead to complete reversal or scraping of the project. It is ideal for repetitive or small projects with minimum risks.

The advantages of the Big Bang Model are as follows −

- This is a very simple model
- Little or no planning required
- Easy to manage
- Very few resources required
- Gives flexibility to developers
- It is a good learning aid for new comers or students.

The disadvantages of the Big Bang Model are as follows −

- Very High risk and uncertainty.
- Not a good model for complex and object-oriented projects.
- Poor model for long and ongoing projects.
- Can turn out to be very expensive if requirements are misunderstood.

One of the key components of Spring Framework is the **Aspect oriented programming (AOP)** framework. Aspect-Oriented Programming entails breaking down program logic into distinct parts called so-called concerns. The functions that span multiple points of an application are called **cross-cutting concerns** and these cross-cutting concerns are conceptually separate from the application's business logic. There are various common good examples of aspects like logging, auditing, declarative transactions, security, caching, etc.

The key unit of modularity in OOP is the class, whereas in AOP the unit of modularity is the aspect. Dependency Injection helps you decouple your application objects from each other and AOP helps you decouple cross-cutting concerns from the objects that they affect. AOP is like triggers in programming languages such as Perl, .NET, Java, and others.

Spring AOP module provides interceptors to intercept an application. For example, when a method is executed, you can add extra functionality before or after the method execution.

AOP Terminologies

Before we start working with AOP, let us become familiar with the AOP concepts and terminology. These terms are not specific to Spring, rather they are related to AOP.

Sr.No	Terms & Description
1	**Aspect** This is a module which has a set of APIs providing cross-cutting requirements. For example, a logging module would be called AOP aspect for logging. An application can have any number of aspects depending on the requirement.
2	**Join point** This represents a point in your application where you can plug-in the AOP aspect. You can also say, it is the actual place in the application where an action will be taken using Spring AOP framework.
3	**Advice** This is the actual action to be taken either before or after the method execution. This is an actual piece of code that is invoked during the program execution by Spring AOP framework.
4	**Pointcut** This is a set of one or more join points where an advice should be executed. You can specify pointcuts using expressions or patterns as we will see in our AOP examples.
5	**Introduction** An introduction allows you to add new methods or attributes to the existing classes.
6	**Target object** The object being advised by one or more aspects. This object will always be a proxied object, also referred to as the advised object.
7	**Weaving** Weaving is the process of linking aspects with other application types or objects to create an advised object. This can be done at compile time, load time, or at runtime.

Types of Advice

Spring aspects can work with five kinds of advice mentioned as follows −

Sr.No	Advice & Description

1	**before** Run advice before the a method execution.
2	**after** Run advice after the method execution, regardless of its outcome.
3	**after-returning** Run advice after the a method execution only if method completes successfully.
4	**after-throwing** Run advice after the a method execution only if method exits by throwing an exception.
5	**around** Run advice before and after the advised method is invoked.

Custom Aspects Implementation

Spring supports the **@AspectJ annotation style** approach and the **schema-based** approach to implement custom aspects. These two approaches have been explained in detail in the following sections.

Sr.No	Approach & Description
1	XML Schema based Aspects are implemented using the regular classes along with XML based configuration.
2	@AspectJ based @AspectJ refers to a style of declaring aspects as regular Java classes annotated with Java 5 annotations.