Software Life Cycle Models

Software Life Cycle Models

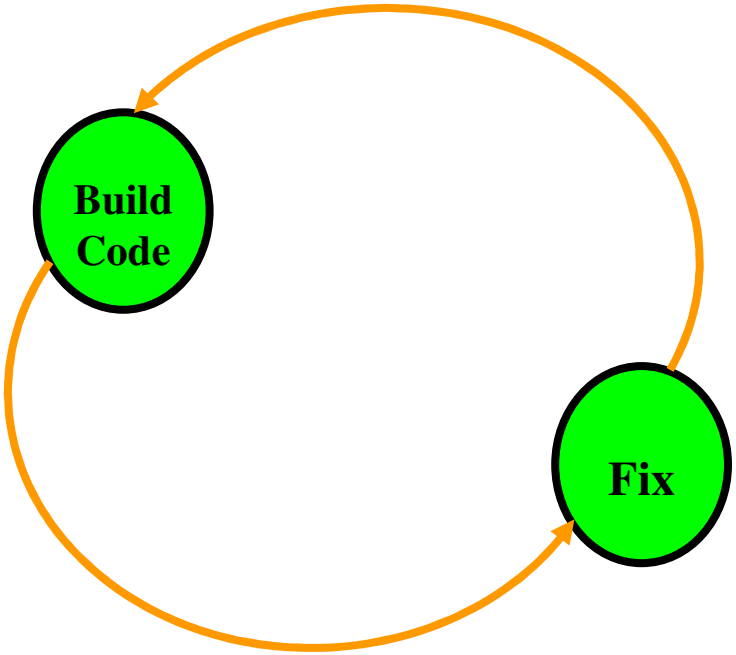
The goal of Software Engineering is to provide models and processes that lead to the production of well-documented maintainable software in a manner that is predictable.

Software Life Cycle Models

"The period of time that starts when a software product is conceived and ends when the product is no longer available for use. The software life cycle typically includes a requirement phase, design phase, implementation phase, test phase, installation and check out phase, operation and maintenance phase, and sometimes retirement phase".

Build & Fix Model

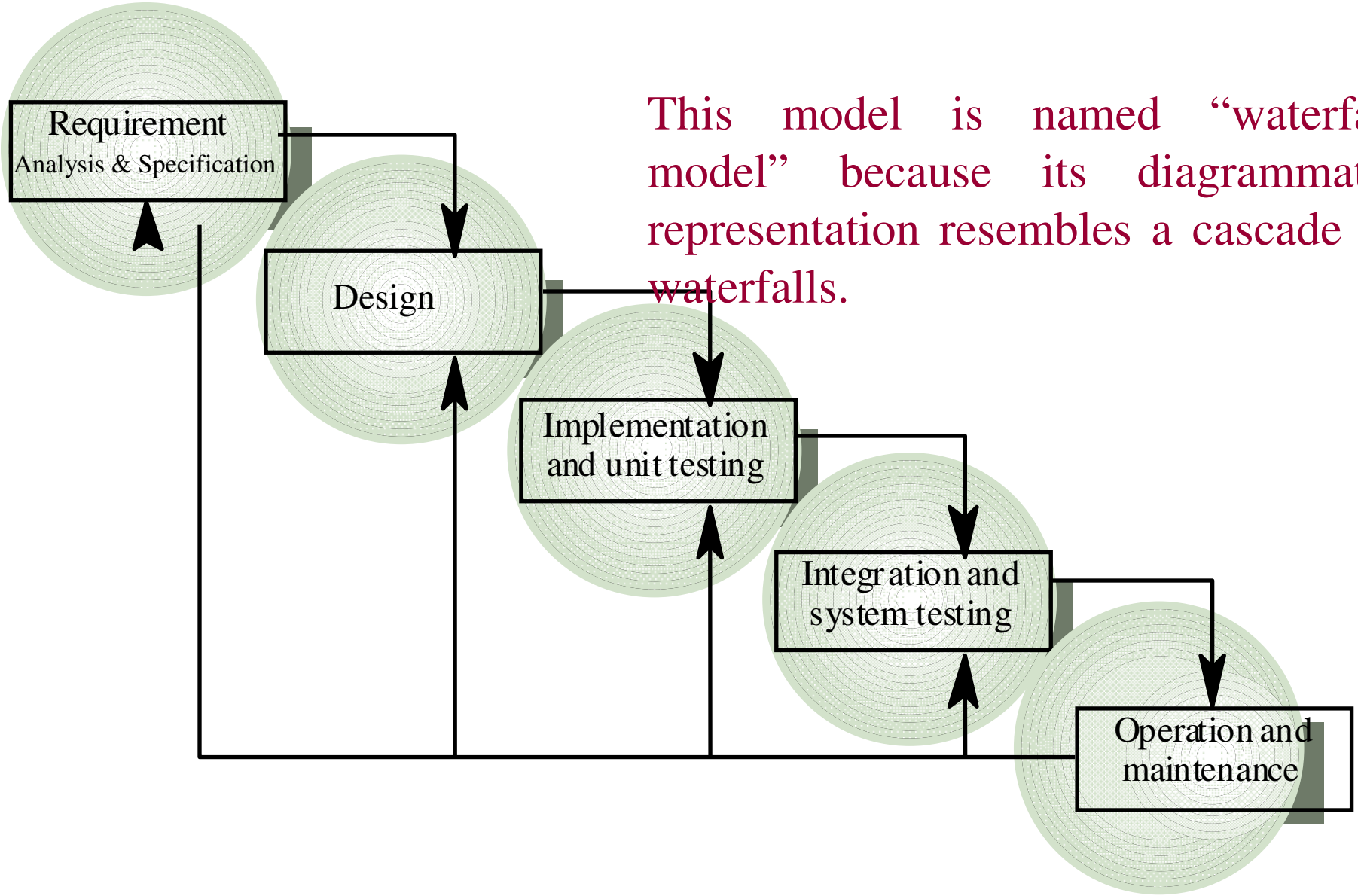
- Product is constructed without specifications or any attempt at design
- Adhoc approach and not well defined
- Simple two phase model



Build & Fix Model

- Suitable for small programming exercises of 100 or 200 lines
- Unsatisfactory for software for any reasonable size
- Code soon becomes unfixable & unenhanceable
- No room for structured design
- Maintenance is practically not possible

Waterfall Model



This model is named "waterfall model" because its diagrammatic representation resembles a cascade of waterfalls.

Waterfall Model

This model is easy to understand and reinforces the notion of "define before design" and "design before code".

The model expects complete & accurate requirements early in the process, which is unrealistic

Waterfall Model

Problems of waterfall model

i. It is difficult to define all requirements at the beginning of a project

ii. This model is not suitable for accommodating any change

iii. A working version of the system is not seen until late in the project's life

iv. It does not scale up well to large projects.

v. Real projects are rarely sequential.

Incremental Process Models

They are effective in the situations where requirements are defined precisely and there is no confusion about the functionality of the final product.

After every cycle a useable product is given to the customer.

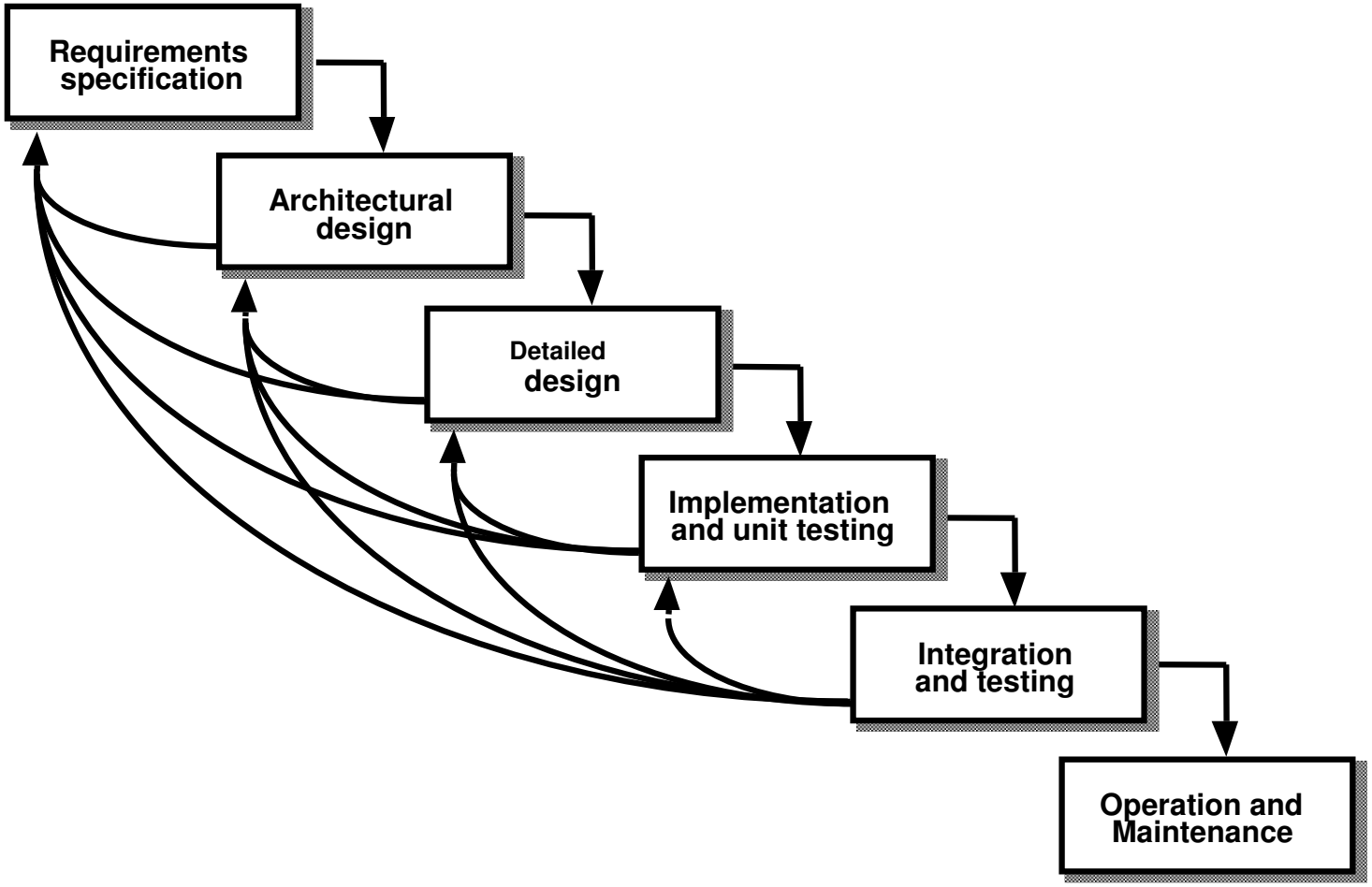
Popular particularly when we have to quickly deliver a limited functionality system.

Iterative Enhancement Model

This model has the same phases as the waterfall model, but with fewer restrictions. Generally the phases occur in the same order as in the waterfall model, but they may be conducted in several cycles. Useable product is released at the end of the each cycle, with each release providing additional functionality.

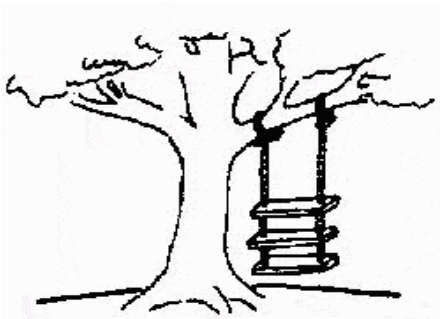
- ✓ Customers and developers specify as many requirements as possible and prepare a SRS document.
- ✓ Developers and customers then prioritize these requirements
- ✓ Developers implement the specified requirements in one or more cycles of design, implementation and test based on the defined priorities.

Iterative Enhancement Model

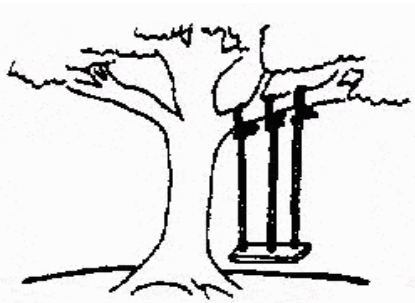


The Rapid Application Development (RAD) Model

- Developed by IBM in 1980
- User participation is essential

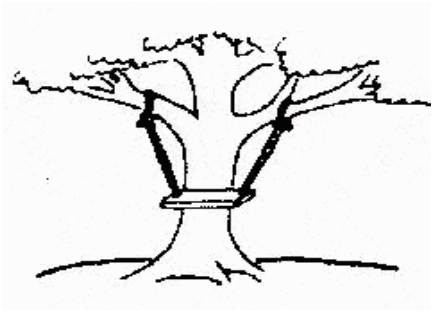


The requirements specification was defined like this



The developers understood it in that way

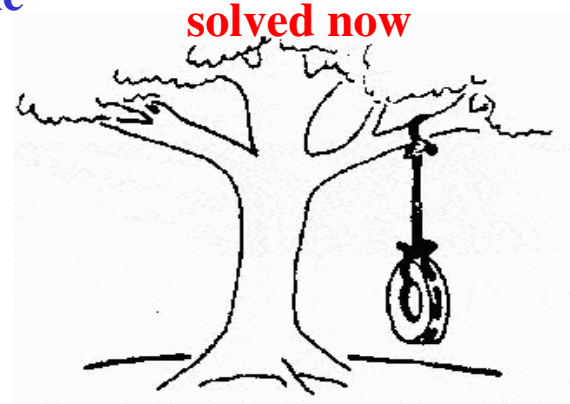
This is how the problem was solved before.



This is how the problem is solved now

That is the program after debugging

This is how the program is described by marketing department

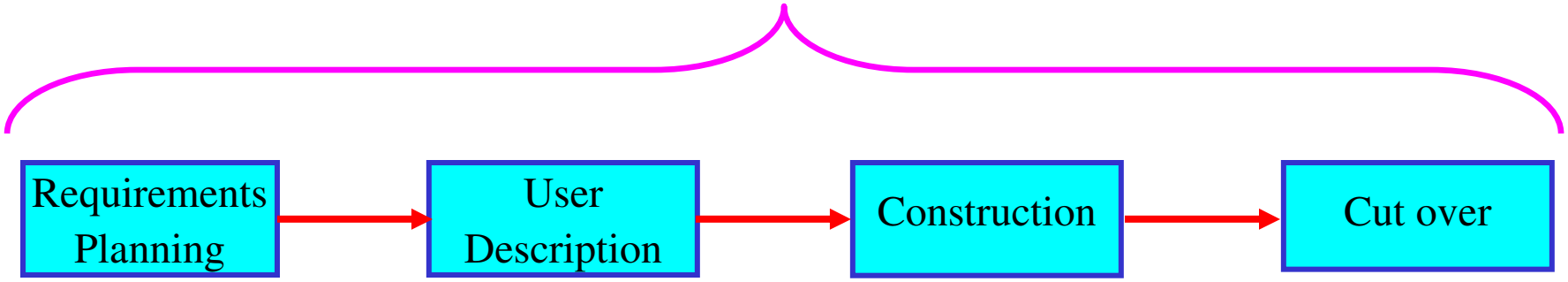


This, in fact, is what the customer wanted …

The Rapid Application Development (RAD) Model

- Build a rapid prototype
- Give it to user for evaluation & obtain feedback
- Prototype is refined

With active participation of users



The Rapid Application Development (RAD) Model

Not an appropriate model in the absence of user participation.

Reusable components are required to reduce development time.

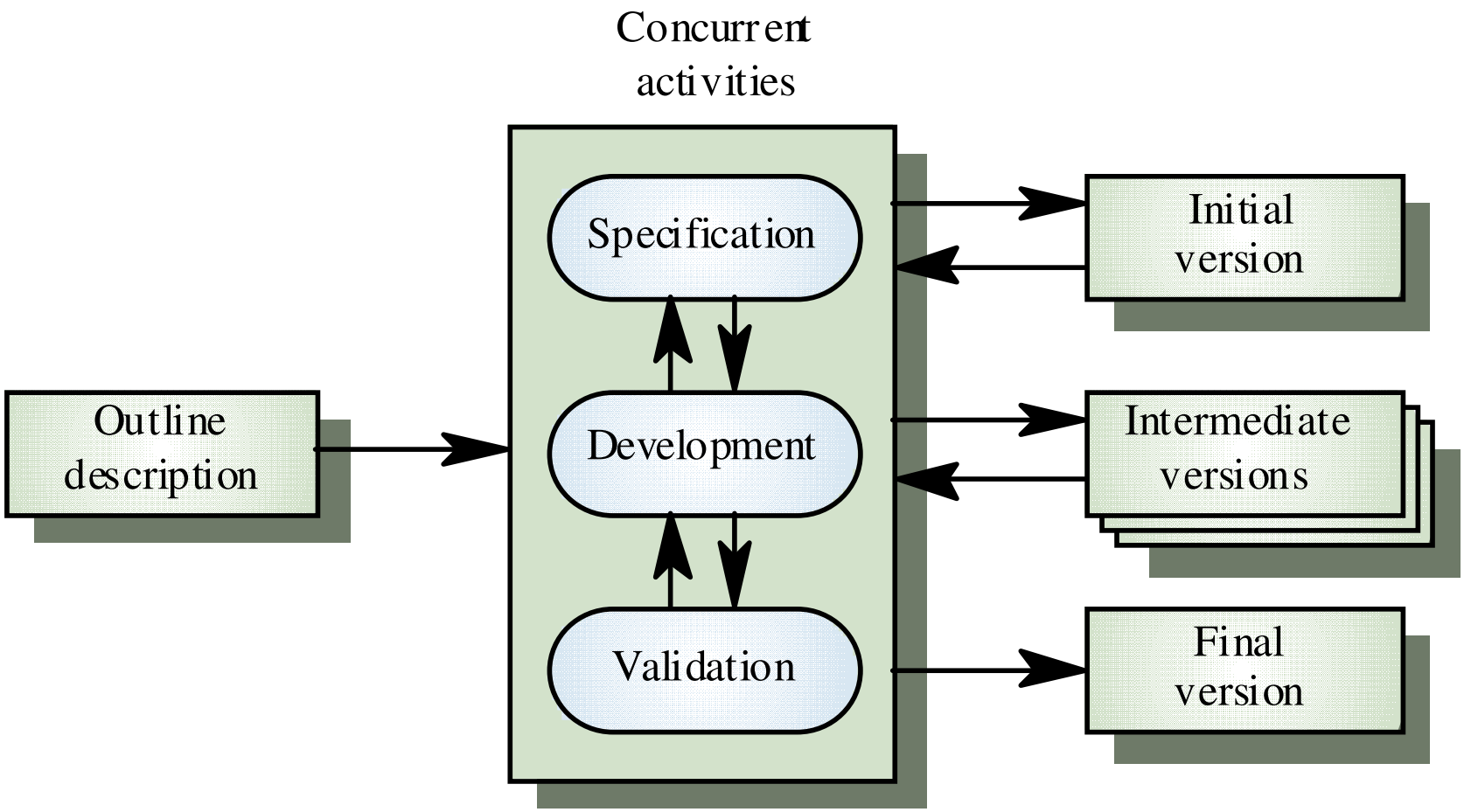
Highly specialized & skilled developers are required and such developers are not easily available.

Evolutionary Process Models

Evolutionary process model resembles iterative enhancement model. The same phases as defined for the waterfall model occur here in a cyclical fashion. This model differs from iterative enhancement model in the sense that this does not require a useable product at the end of each cycle. In evolutionary development, requirements are implemented by category rather than by priority.

This model is useful for projects using new technology that is not well understood. This is also used for complex projects where all functionality must be delivered at one time, but the requirements are unstable or not well understood at the beginning.

Evolutionary Process Model

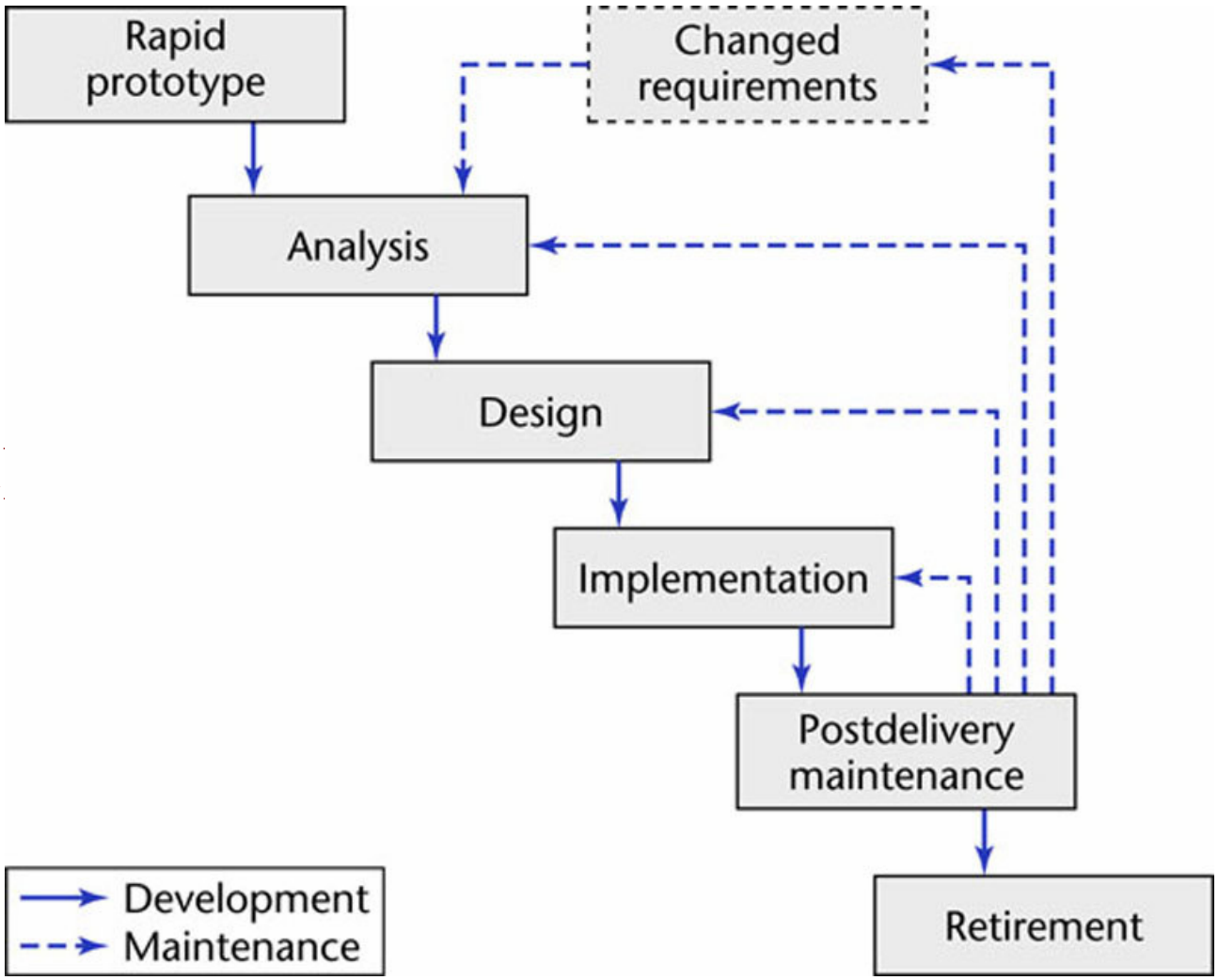


Prototyping Model

- The prototype may be a usable program but is not suitable as the final software product.
- The code for the prototype is thrown away. However experience gathered helps in developing the actual system.
- The development of a prototype might involve extra cost, but overall cost might turnout to be lower than that of an equivalent system developed using the waterfall model.

Prototyping Model

- Linear mode
- "Rapid"



Spiral Model

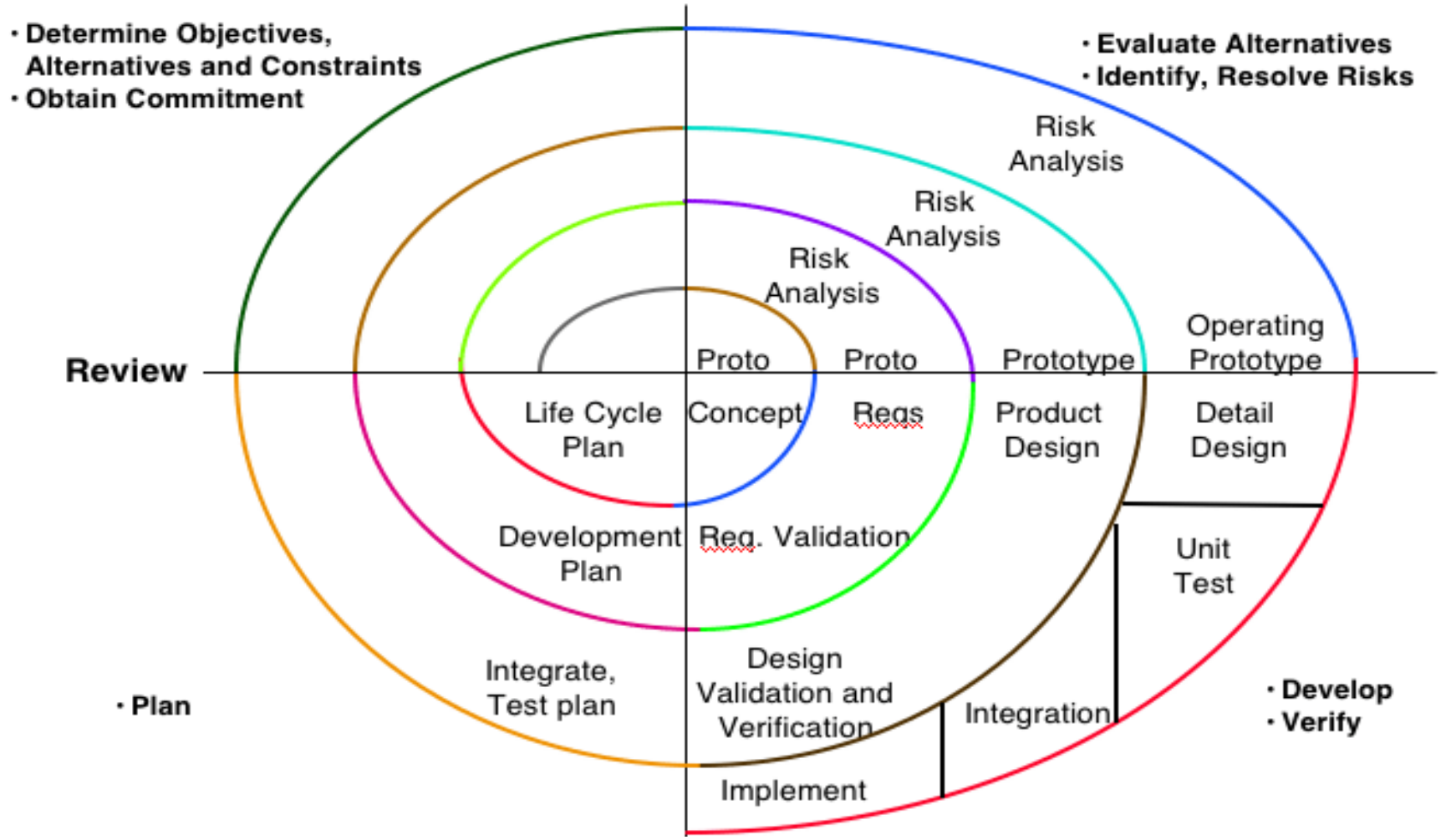
Models do not deal with uncertainly which is inherent to software projects.

Important software projects have failed because project risks were neglected & nobody was prepared when something unforeseen happened.

Barry Boehm recognized this and tired to incorporate the "project risk" factor into a life cycle model.

The result is the spiral model, which was presented in 1986.

Spiral Model



Spiral Model

The radial dimension of the model represents the cumulative costs. Each path around the spiral is indicative of increased costs. The angular dimension represents the progress made in completing each cycle. Each loop of the spiral from X-axis clockwise through 360^{o} represents one phase. One phase is split roughly into four sectors of major activities.

- **Planning:** Determination of objectives, alternatives & constraints.
- **Risk Analysis:** Analyze alternatives and attempts to identify and resolve the risks involved.
- **Development:** Product development and testing product.
- **Assessment:** Customer evaluation

Spiral Model

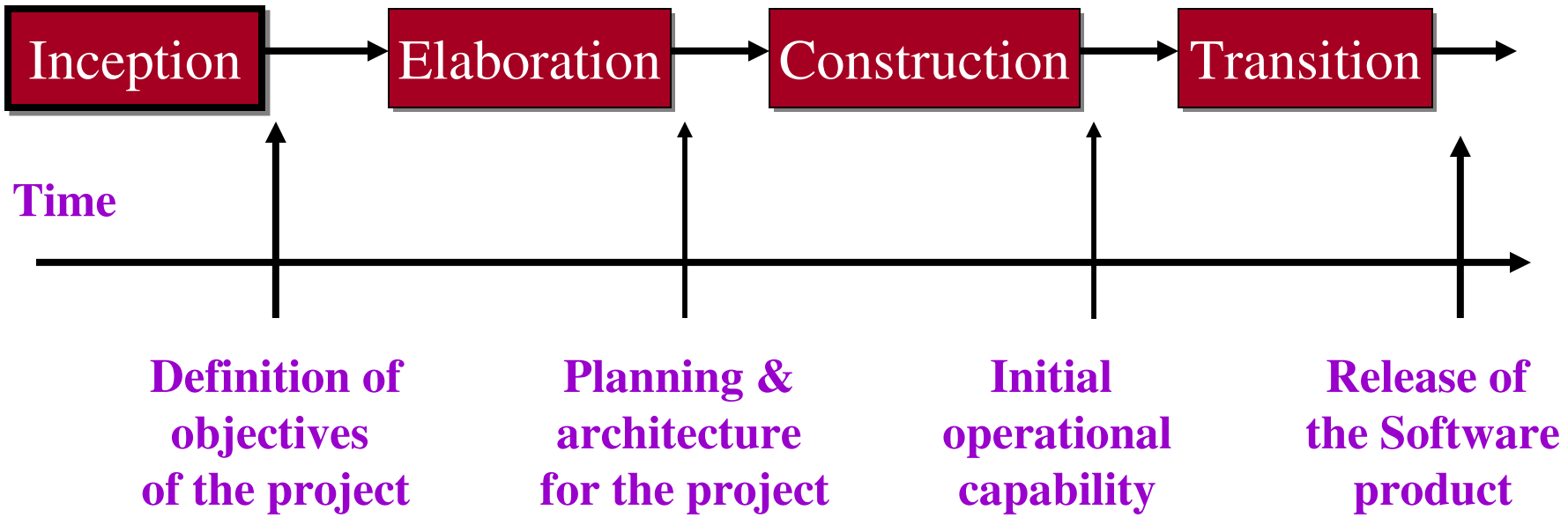
- An important feature of the spiral model is that each phase is completed with a review by the people concerned with the project (designers and programmers)
- The advantage of this model is the wide range of options to accommodate the good features of other life cycle models.
- It becomes equivalent to another life cycle model in appropriate situations.

The spiral model has some difficulties that need to be resolved before it can be a universally applied life cycle model. These difficulties include lack of explicit process guidance in determining objectives, constraints, alternatives; relying on risk assessment expertise; and provides more flexibility than required for many applications.

The Unified Process

- Developed by I.Jacobson, G.Booch and J.Rumbaugh.
- Software engineering process with the goal of producing good quality maintainable software within specified time and budget.
- Developed through a series of fixed length mini projects called iterations.
- Maintained and enhanced by Rational Software Corporation and thus referred to as Rational Unified Process (RUP).

Phases of the Unified Process



Phases of the Unified Process

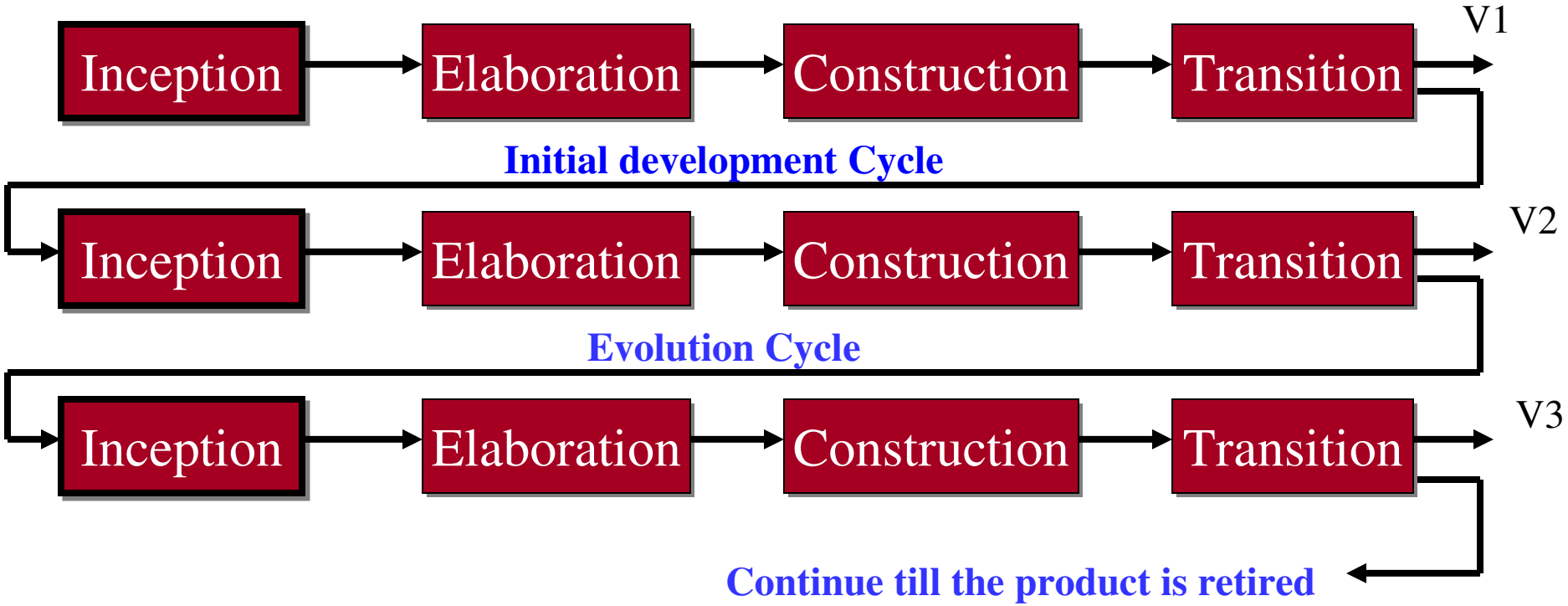
- Inception: defines scope of the project.
- Elaboration

  - How do we plan & design the project?

  - What resources are required?

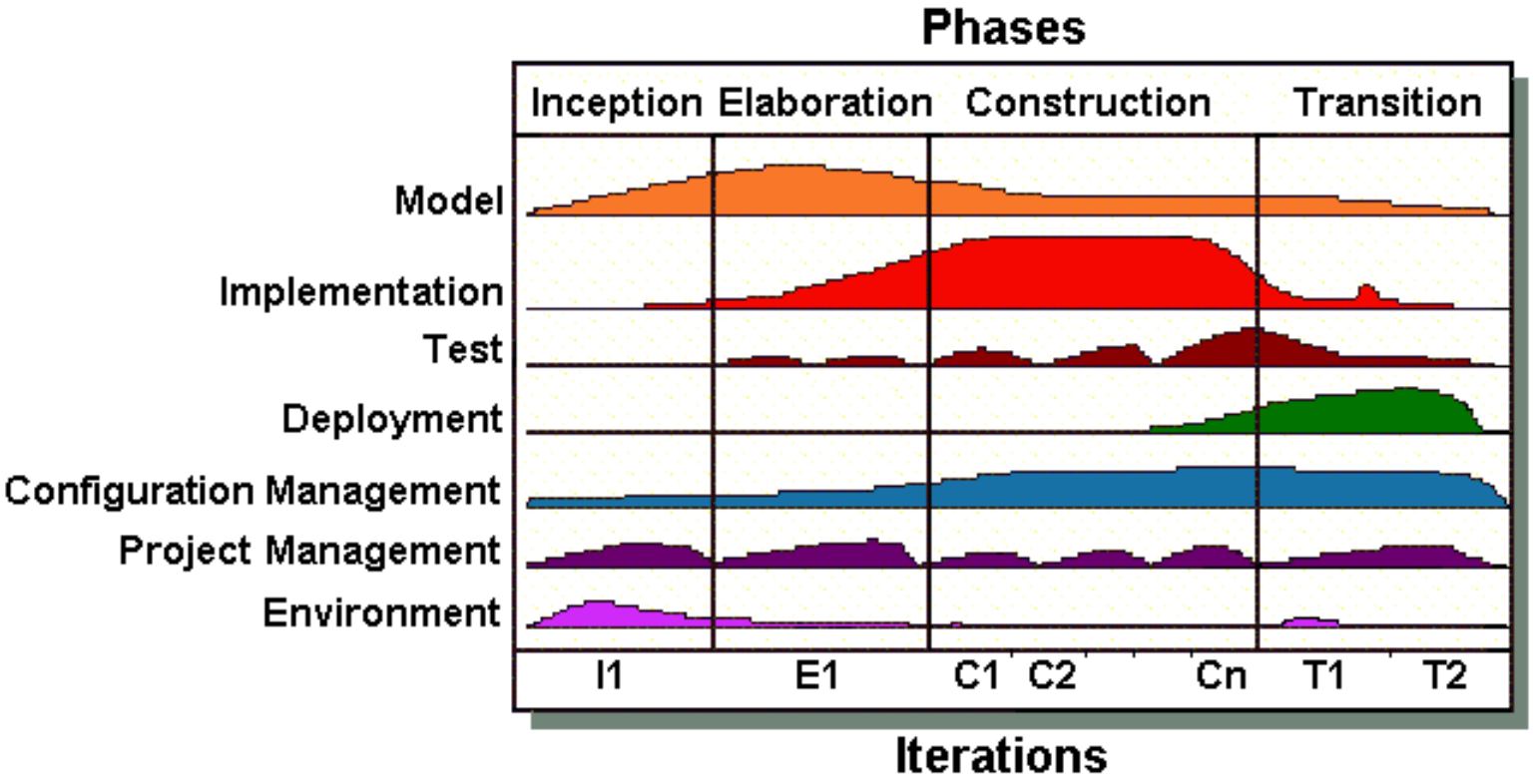
  - What type of architecture may be suitable?
- Construction: the objectives are translated in design & architecture documents.
- Transition : involves many activities like delivering, training, supporting, and maintaining the product.

Initial development & Evolution Cycles



V1=version1, V2 =version2, V3=version3

Iterations & Workflow of Unified Process

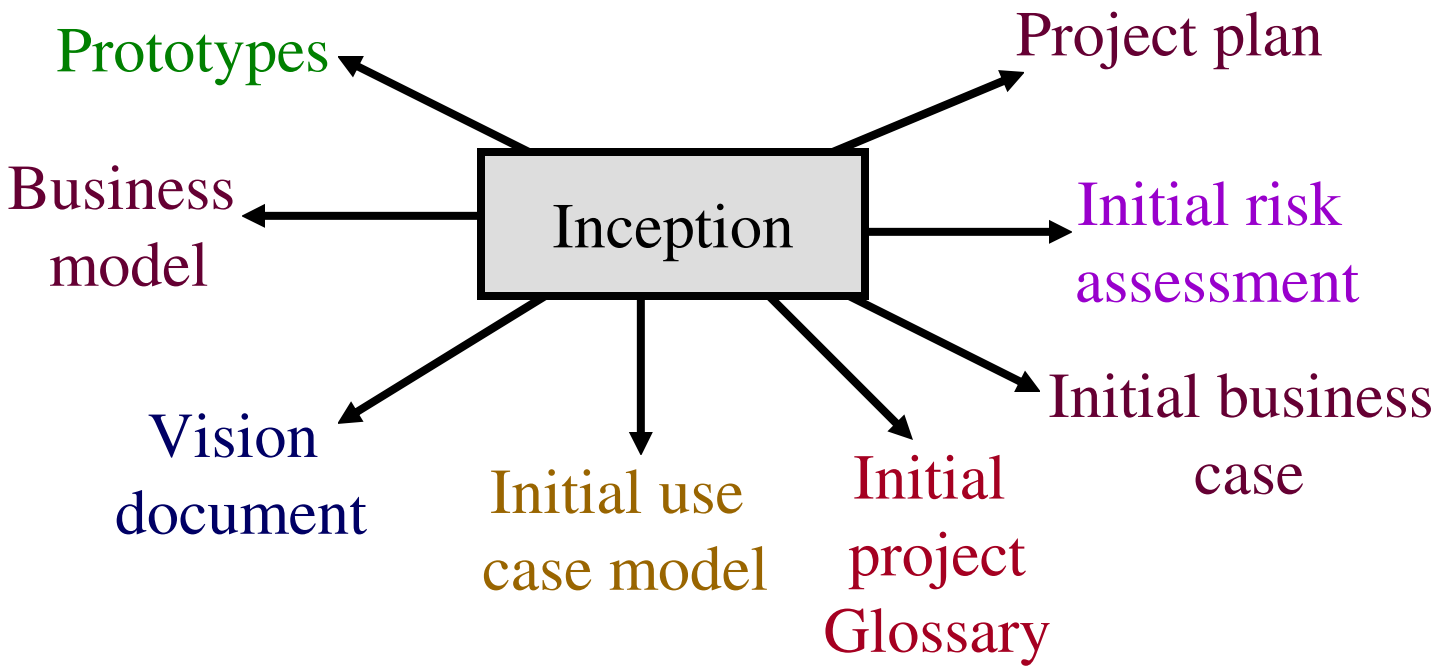


Inception Phase

The inception phase has the following objectives:

- Gathering and analyzing the requirements.
- Planning and preparing a business case and evaluating alternatives for risk management, scheduling resources etc.
- Estimating the overall cost and schedule for the project.
- Studying the feasibility and calculating profitability of the project.

Outcomes of Inception Phase

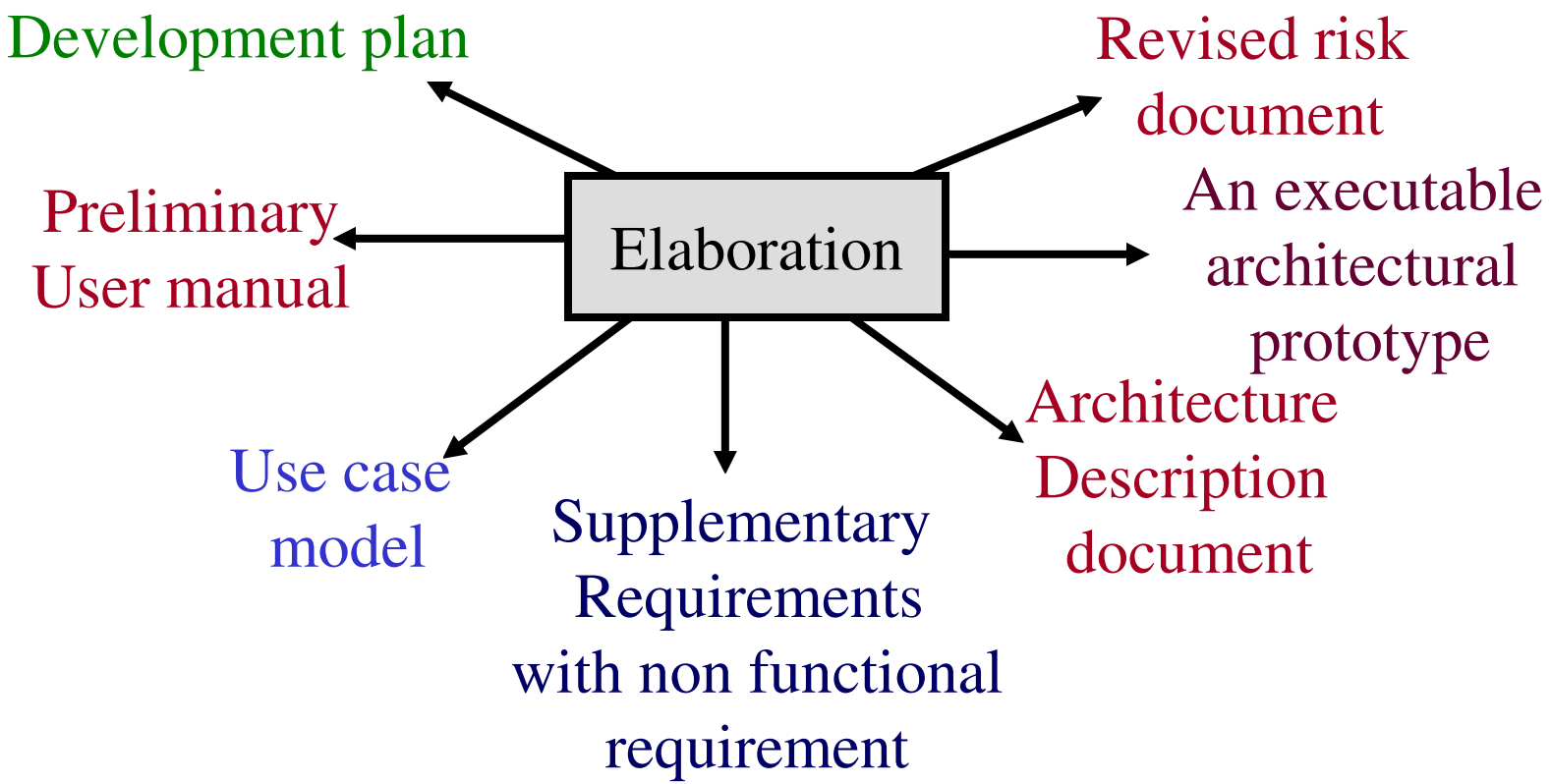


Elaboration Phase

The elaboration phase has the following objectives:

- Establishing architectural foundations.
- Design of use case model.
- Elaborating the process, infrastructure & development environment.
- Selecting component.
- Demonstrating that architecture support the vision at reasonable cost & within specified time.

Outcomes of Elaboration Phase

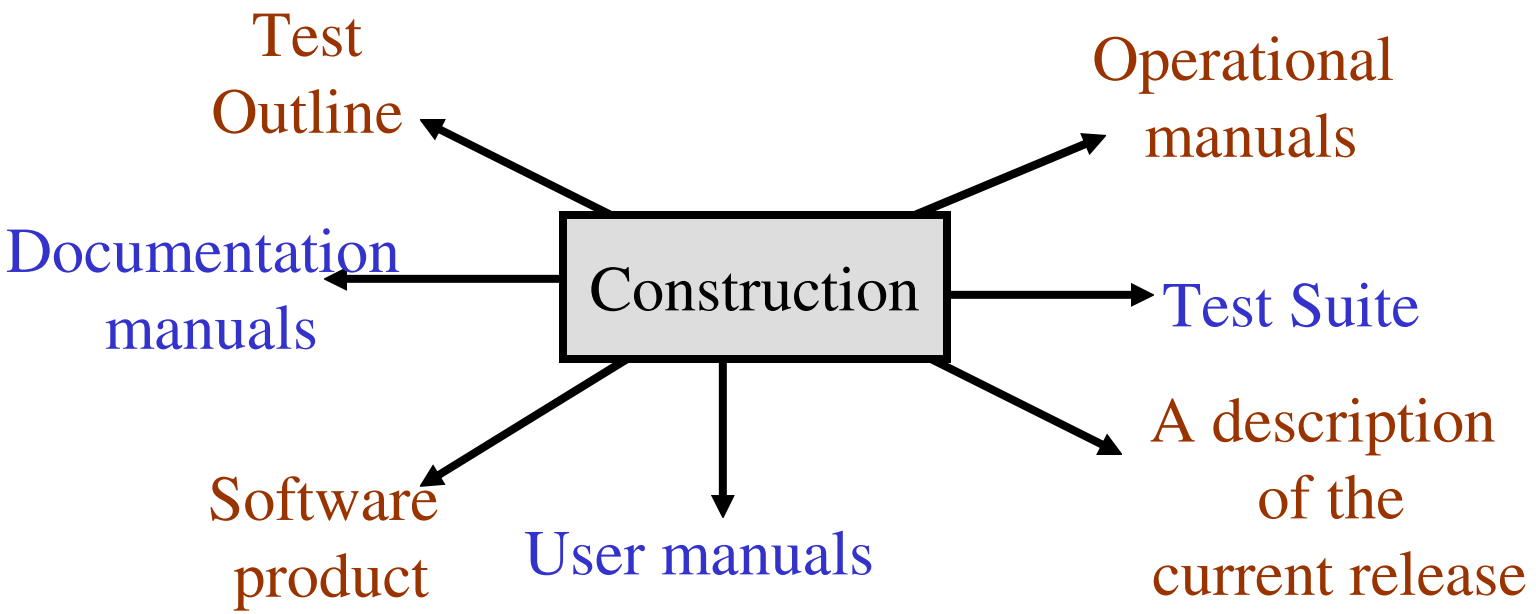


Construction Phase

The construction phase has the following objectives:

- Implementing the project.
- Minimizing development cost.
- Management and optimizing resources.
- Testing the product
- Assessing the product releases against acceptance criteria

Outcomes of Construction Phase

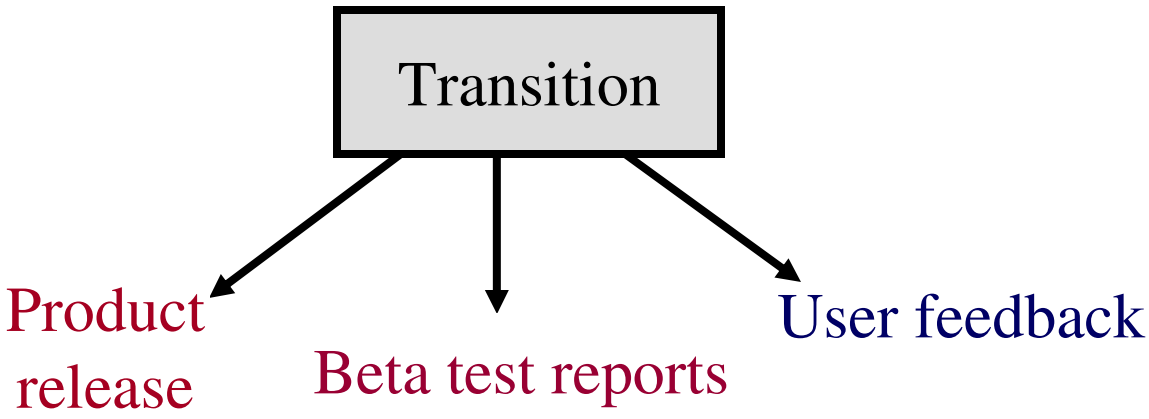


Transition Phase

The transition phase has the following objectives:

- Starting of beta testing
- Analysis of user's views.
- Training of users.
- Tuning activities including bug fixing and enhancements for performance & usability
- Assessing the customer satisfaction.

Outcomes of Transition Phase



Selection of a Life Cycle Model

Selection of a model is based on:

a) Requirements

b) Development team

c) Users

d) Project type and associated risk

Based On Characteristics Of Requirements

Requirements	Waterfall	Prototype	Iterative enhancement	Evolutionary development	Spiral	RAD
Are requirements easily understandable and defined?	Yes	No	No	No	No	Yes
Do we change requirements quite often?	No	Yes	No	No	Yes	No
Can we define requirements early in the cycle?	Yes	No	Yes	Yes	No	Yes
Requirements are indicating a complex system to be built	No	Yes	Yes	Yes	Yes	No

Based On Status Of Development Team

Development team	Waterfall	Prototype	Iterative enhancement	Evolutionary development	Spiral	RAD
Less experience on similar projects?	No	Yes	No	No	Yes	No
Less domain knowledge (new to the technology)	Yes	No	Yes	Yes	Yes	No
Less experience on tools to be used	Yes	No	No	No	Yes	No
Availability of training if required	No	No	Yes	Yes	No	Yes

Based On User's Participation

Involvement of Users	Waterfall	Prototype	Iterative enhancement	Evolutionary development	Spiral	RAD
User involvement in all phases	No	Yes	No	No	No	Yes
Limited user participation	Yes	No	Yes	Yes	Yes	No
User have no previous experience of participation in similar projects	No	Yes	Yes	Yes	Yes	No
Users are experts of problem domain	No	Yes	Yes	Yes	No	Yes

Based On Type Of Project With Associated Risk

Project type and risk	Waterfall	Prototype	Iterative enhancement	Evolutionary development	Spiral	RAD
Project is the enhancement of the existing system	No	No	Yes	Yes	No	Yes
Funding is stable for the project	Yes	Yes	No	No	No	Yes
High reliability requirements	No	No	Yes	Yes	Yes	No
Tight project schedule	No	Yes	Yes	Yes	Yes	Yes
Use of reusable components	No	Yes	No	No	Yes	Yes
Are resources (time, money, people etc.) scare?	No	Yes	No	No	Yes	No

Multiple Choice Questions

Note: Select most appropriate answer of the following questions:

2.1 Spiral Model was developed by

(a) Bev Littlewood (b) Berry Boehm

(c) Roger Pressman (d) Victor Basili

2.2 Which model is most popular for student's small projects?

(a) Waterfall model (b) Spiral model

(c) Quick and fix model (d) Prototyping model

2.3 Which is not a software life cycle model?

(a) Waterfall model (b) Spiral model

(c) Prototyping model (d) Capability maturity model

2.4 Project risk factor is considered in

(a) Waterfall model (b) Prototyping model

(c) Spiral model (d) Iterative enhancement model

2.5 SDLC stands for

(a) Software design life cycle (b) Software development life cycle

(c) System development life cycle (d) System design life cycle

Multiple Choice Questions

Note: Select most appropriate answer of the following questions:

2.6 Build and fix model has

(a) 3 phases (b) 1 phase

(c) 2 phases (d) 4 phases

2.7 SRS stands for

(a) Software requirements specification (b) Software requirements solution

(c) System requirements specification (d) none of the above

2.8 Waterfall model is not suitable for

(a) small projects (b) accommodating change

(c) complex projects (d) none of the above

2.9 RAD stands for

(a) Rapid application development (b) Relative application development

(c) Ready application development (d) Repeated application development

2.10 RAD model was proposed by

(a) Lucent Technologies (b) Motorola

(c) IBM (d) Microsoft

Multiple Choice Questions

Note: Select most appropriate answer of the following questions:

2.11 If requirements are easily understandable and defined,which model is best suited?

(a) Waterfall model (b) Prototyping model

(c) Spiral model (d) None of the above

2.12 If requirements are frequently changing, which model is to be selected?

(a) Waterfall model (b) Prototyping model

(c) RAD model (d) Iterative enhancement model

2.13 If user participation is available, which model is to be chosen?

(a) Waterfall model (b) Iterative enhancement model

(c) Spiral model (d) RAD model

2.14 If limited user participation is available, which model is to be selected?

(a) Waterfall model (b) Spiral model

(c) Iterative enhancement model (d) any of the above

2.15 If project is the enhancement of existing system, which model is best suited?

(a) Waterfall model (b) Prototyping model

(c) Iterative enhancement model (d) Spiral model

Multiple Choice Questions

Note: Select most appropriate answer of the following questions:

2.16 Which one is the most important feature of spiral model?

(a) Quality management (b) Risk management

(c) Performance management (d) Efficiency management

2.17 Most suitable model for new technology that is not well understood is:

(a) Waterfall model (b) RAD model

(c) Iterative enhancement model (d) Evolutionary development model

2.18 Statistically, the maximum percentage of errors belong to the following phase of SDLC

(a) Coding (b) Design

(c) Specifications (d) Installation and maintenance

2.19 Which phase is not available in software life cycle?

(a) Coding (b) Testing

(c) Maintenance (d) Abstraction

2.20 The development is supposed to proceed linearly through the phase in

(a) Spiral model (b) Waterfall model

(c) Prototyping model (d) None of the above

Multiple Choice Questions

Note: Select most appropriate answer of the following questions:

2.21 Unified process is maintained by

(a) Infosys
(b) Rational software corporation
(c) SUN Microsystems
(d) None of the above

2.22 Unified process is

(a) Iterative
(b) Incremental
(c) Evolutionary
(d) All of the above

2.23 Who is not in the team of Unified process development?

(a) I.Jacobson
(b) G.Booch
(c) B.Boehm
(d) J.Rumbaugh

2.24 How many phases are in the unified process?

(a) 4
(b) 5
(c) 2
(d) None of the above

2.25 The outcome of construction phased can be treated as:

(a) Product release
(b) Beta release
(c) Alpha release
(d) All of the above

Exercises

2.1 What do you understand by the term Software Development Life Cycle (SDLC)? Why is it important to adhere to a life cycle model while developing a large software product?

2.2 What is software life cycle? Discuss the generic waterfall model.

2.3 List the advantages of using waterfall model instead of adhoc build and fix model.

2.4 Discuss the prototyping model. What is the effect of designing a prototype on the overall cost of the project?

2.5 What are the advantages of developing the prototype of a system?

2.6 Describe the type of situations where iterative enhancement model might lead to difficulties.

2.7 Compare iterative enhancement model and evolutionary process model.

Exercises

2.8 Sketch a neat diagram of spiral model of software life cycle.

2.9 Compare the waterfall model and the spiral model of software development.

2.10 As we move outward along with process flow path of the spiral model, what can we say about software that is being developed or maintained.

2.11 How does "project risk" factor effect the spiral model of software development.

2.12 List the advantages and disadvantages of involving a software engineer throughout the software development planning process.

2.13 Explain the spiral model of software development. What are the limitations of such a model?

2.14 Describe the rapid application development (RAD) model.Discuss each phase in detail.

2.15 What are the characteristics to be considered for the selection of the life cycle model?

Exercises

2.16 What is the role of user participation in the selection of a life cycle model?.
2.17 Why do we feel that characteristics of requirements play a very significant role in the selection of a life cycle model?

2.18 Write short note on "status of development team" for the selection of a life cycle model?.

2.19 Discuss the selection process parameters for a life cycle model.

2.20 What is unified process? Explain various phases along with the outcome of each phase.

2.21 Describe the unified process work products after each phase of unified process.

2.22 What are the advantages of iterative approach over sequential approach? Why is unified process called as iterative or incremental?