An Introduction to Software Engineering

Chapter 9

Overview

- Introduction
- Difference between hardware and software engineering
- Software development process
- Waterfall model
- Evolutionary model
- Spiral Model

Software Engineering

- The economies of ALL developed nations are dependent on software.
- More and more systems are software controlled
- Expenditure on software represents a significant fraction of GNP in all developed countries.
- Software engineering is concerned with theories, methods and tools for professional software development.

Software costs

- Software costs often dominate computer system costs. The costs of software on a PC are often greater than the hardware cost.
- Software costs more to maintain than it does to develop. For systems with a long life, maintenance costs may be several times the development costs.
- Software engineering is concerned with cost-effective software development.

FAQs about software engineering

- What is software?
- What is software engineering?
- What is the difference between software engineering and hardware engineering?
- What is the difference between software engineering and computer science?
- What is the difference between software engineering and system engineering?

FAQs about software engineering

- What are the costs of software engineering?
- What is CASE (Computer-Aided Software Engineering)
- What are the attributes of good software?
- What are the key challenges facing software engineering?
- What is a software process?
- What is a software process model?

What is software ?

- A software is a Computer programs and associated documentation such as requirements, design models and user manuals.
- Software products may be developed for a particular customer or may be developed for a general market.
- Software products may be
  - **Generic** - developed to be sold to a range of different customers e.g Excel or Word.
  - **Bespoke (custom)** - developed for a single customer according to their specification.
- New software can be created by developing new programs, configuring generic software systems or reusing existing software.

What is software engineering?

- Software engineering is an engineering discipline that is concerned with all aspects of software production.
- Software engineers should adopt a systematic and organised approach to their work and use appropriate tools and techniques depending on the problem to be solved, the development constraints and the resources available.

What is the difference between software engineering and computer science?

- Computer science is concerned with theory and fundamentals; software engineering is concerned with the practicalities of developing and delivering useful software.
- Computer science theories are still insufficient to act as a complete underpinning for software engineering (unlike e.g. physics and electrical engineering).

What is the difference between hardware and software engineering

- Both hardware and software engineering work closely with computers to design, maintain and develop operating systems and software applications for various purposes. However, **hardware engineers focus on the physical components of a computer systems while software engineers work with the virtual aspects**.

- **Software is developed or engineered but it is not manufactured in the classical sense**: Although some similarities exist between software development and hardware manufacture, the two activities are fundamentally different.

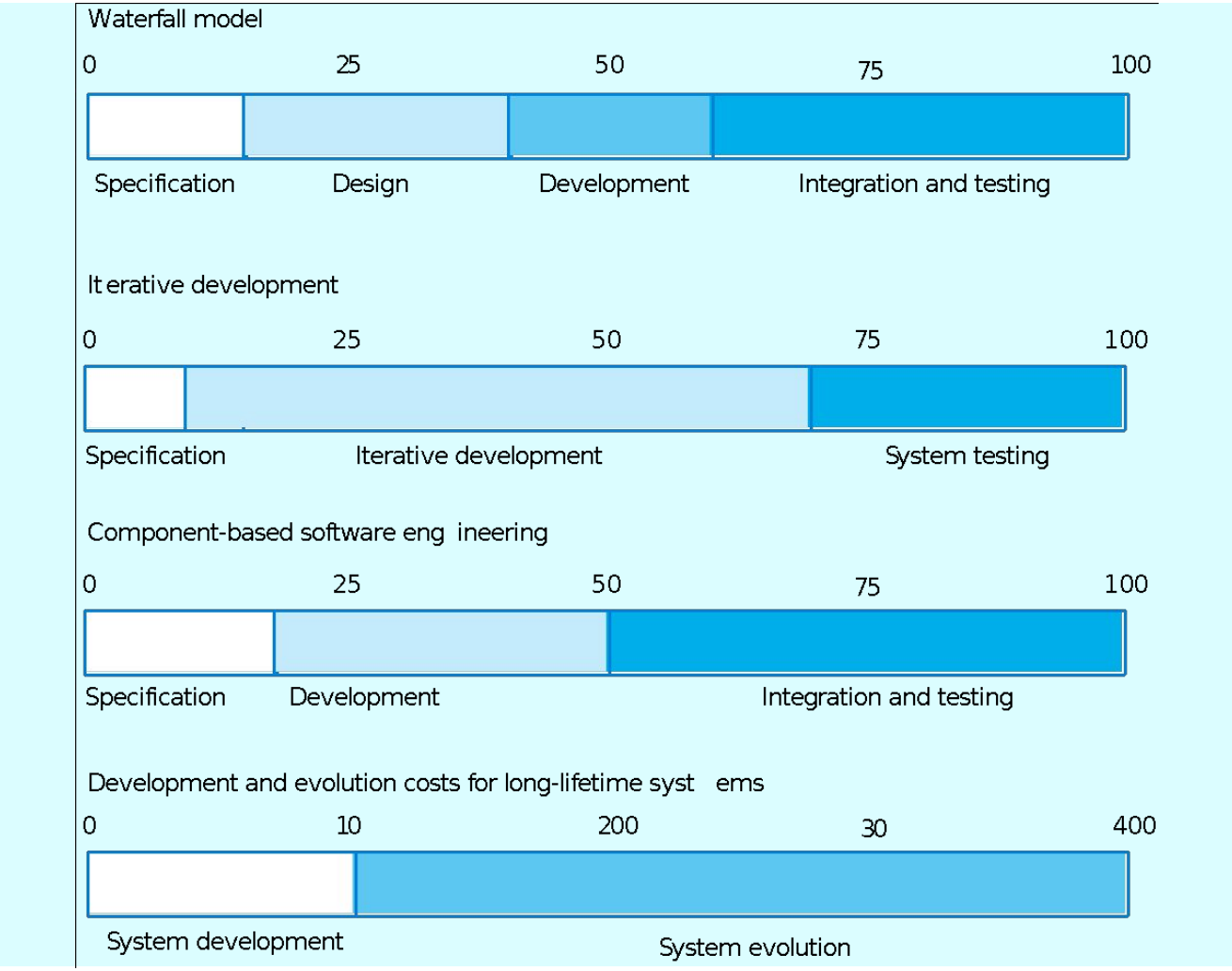
What is the difference between software engineering and system engineering?

- System engineering is concerned with all aspects of computer-based systems development including hardware, software and process engineering. Software engineering is part of this process concerned with developing the software infrastructure, control, applications and databases in the system.
- System engineers are involved in system specification, architectural design, integration and deployment.

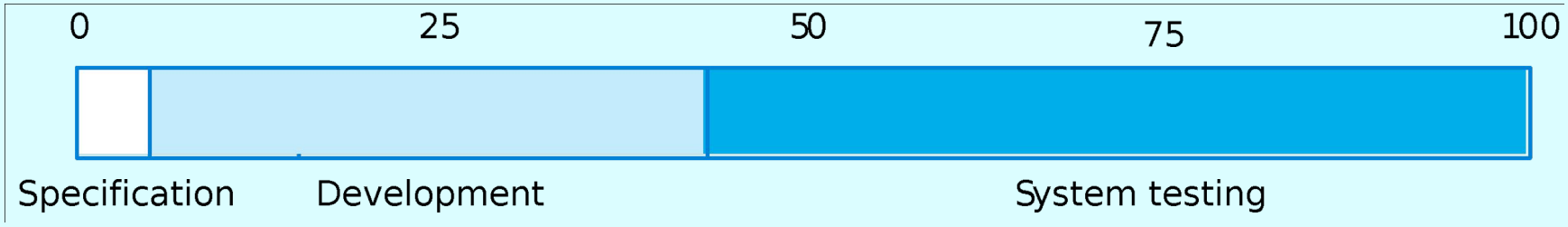
What are the costs of software engineering?

- Roughly 60% of costs are development costs, 40% are testing costs. For custom software, evolution costs often exceed development costs.
- Costs vary depending on the type of system being developed and the requirements of system attributes such as performance and system reliability.
- Distribution of costs depends on the development model that is used.

Activity cost distribution



Product development costs



What are software engineering methods?

- Structured approaches to software development which include system models, notations, rules, design advice and process guidance.
- Model descriptions
  - Descriptions of graphical models which should be produced;
- Rules
  - Constraints applied to system models;
- Recommendations
  - Advice on good design practice;
- Process guidance
  - What activities to follow.

What is CASE (Computer-Aided Software Engineering)

- Software systems that are intended to provide automated support for software process activities.
- CASE systems are often used for method support.
- Upper-CASE
  - Tools to support the early process activities of requirements and design;
- Lower-CASE
  - Tools to support later activities such as programming, debugging and testing.

What are the attributes of good software?

- The software should deliver the required functionality and performance to the user and should be maintainable, dependable and acceptable.
- Maintainability
  - Software must evolve to meet changing needs;
- Dependability
  - Software must be trustworthy;
- Efficiency
  - Software should not make wasteful use of system resources;
- Acceptability
  - Software must accepted by the users for which it was designed. This means it must be understandable, usable and compatible with other systems.

What are the key challenges facing software engineering?

- Heterogeneity, delivery and trust.
- Heterogeneity
  - Developing techniques for building software that can cope with heterogeneous platforms and execution environments;
- Delivery
  - Developing techniques that lead to faster delivery of software;
- Trust
  - Developing techniques that demonstrate that software can be trusted by its users.

Professional and ethical responsibility

- Software engineering involves wider responsibilities than simply the application of technical skills.
- Software engineers must behave in an honest and ethically responsible way if they are to be respected as professionals.
- Ethical behaviour is more than simply upholding the law.

Issues of professional responsibility

- Confidentiality
  - Engineers should normally respect the confidentiality of their employers or clients irrespective of whether or not a formal confidentiality agreement has been signed.
- Competence
  - Engineers should not misrepresent their level of competence. They should not knowingly accept work which is outwith their competence.

Issues of professional responsibility

- Intellectual property rights
  - Engineers should be aware of local laws governing the use of intellectual property such as patents, copyright, etc. They should be careful to ensure that the intellectual property of employers and clients is protected.
- Computer misuse
  - Software engineers should not use their technical skills to misuse other people's computers. Computer misuse ranges from relatively trivial (game playing on an employer's machine, say) to extremely serious (dissemination of viruses).

What is a software process?

- A set of activities whose goal is the development or evolution of software.
- Generic activities in all software processes are:
  - Specification - what the system should do and its development constraints
  - Development - production of the software system
  - Validation - checking that the software is what the customer wants
  - Evolution - changing the software in response to changing demands.

The software process

- A structured set of activities required to develop a software system
  - Specification
  - Design
  - Validation
  - Evolution
- A software process model is an abstract representation of a process. It presents a description of a process from some particular perspective

What is a software process model?

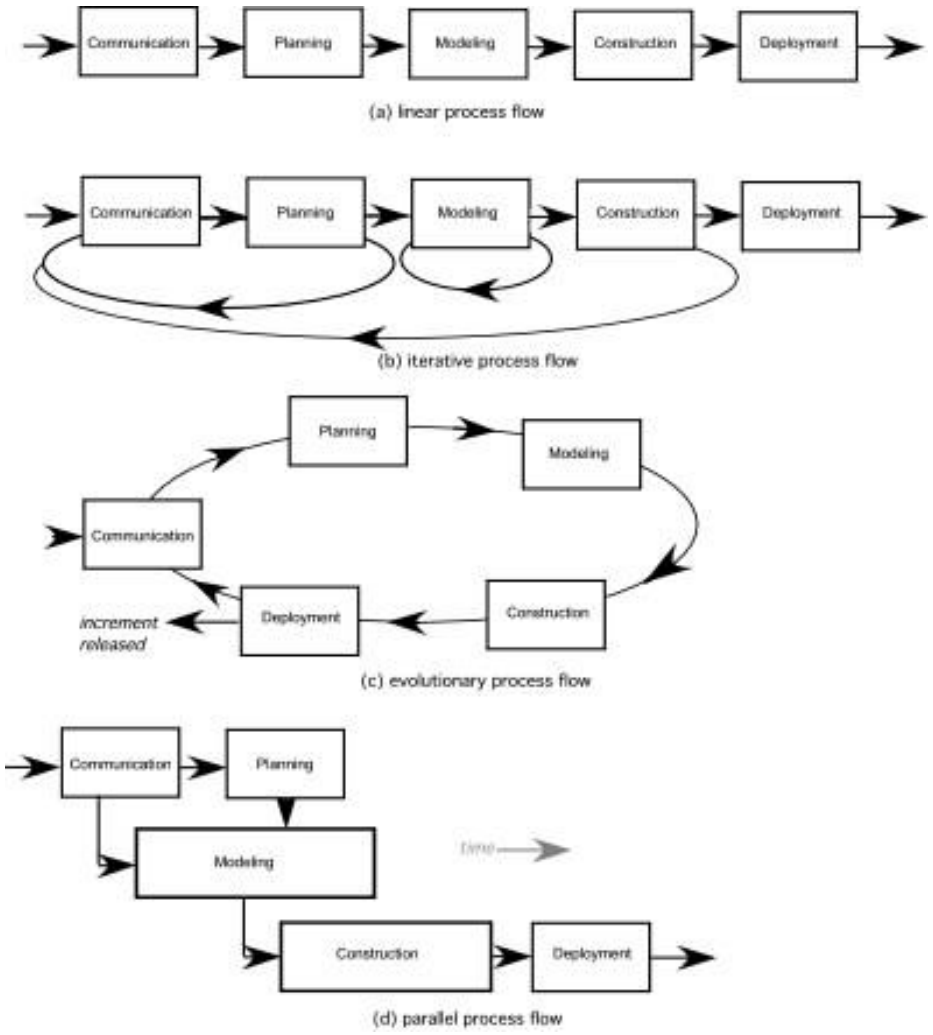
- A simplified representation of a software process, presented from a specific perspective.
- Examples of process perspectives are
  - Workflow perspective - sequence of activities;
  - Data-flow perspective - information flow;
  - Role/action perspective - who does what.
- Generic process models
  - Waterfall;
  - Iterative development;
  - Component-based software engineering.

Generic software process models

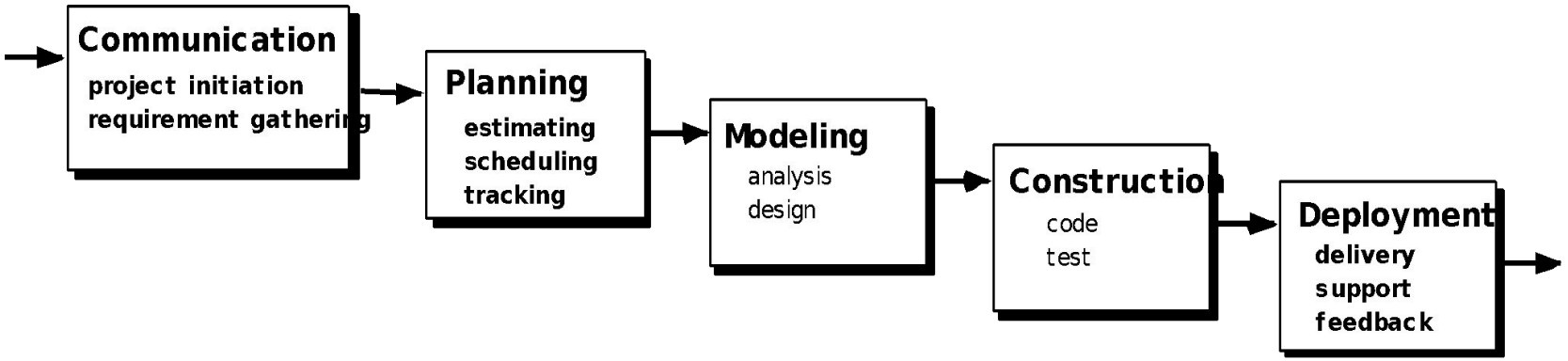
- The waterfall model
  - Separate and distinct phases of specification and development
- Evolutionary development
  - Specification and development are interleaved
- Formal systems development
  - A mathematical system model is formally transformed to an implementation
- Reuse-based development
  - The system is assembled from existing components

Process Flow

process flow :
describes how the framework activities and the actions and tasks that occur within each framework activity are organized with respect to sequence and time



The Waterfall Model



The **waterfall Model** illustrates the software development process in a linear sequential flow. This means that any phase in the development process begins only if the previous phase is complete. In this waterfall model, the phases do not overlap.

The Waterfall Model was the oldest/first Process Model to be introduced. It is also referred to as a **linear-sequential life cycle model**.

Waterfall Model

- There are times when the requirements for a problem are well understood—when work flows from communication through deployment in a reasonably linear fashion.
- This situation is sometimes encountered when well-defined adaptations or enhancements to an existing system must be made (e.g., an adaptation to accounting software that has been mandated because of changes to government regulations).
- It may also occur in a limited number of new development efforts, but only when requirements are well defined and reasonably stable.

Waterfall Model

- The waterfall model, sometimes called the classic life cycle, suggests a systematic sequential approach to software development that begins with customer specification of requirements and progresses through planning, modeling, construction, and deployment, culminating in ongoing support of the completed software

Waterfall Model

Key Advantages:

-The system requirements are identified long before programming begins.

-Changes to the requirements are minimized as the project proceeds

Key Disadvantages:

-The design must be completely specified before programming begins.

-A long time elapses between the completion of the system proposal in the analysis phase and the delivery of the system.

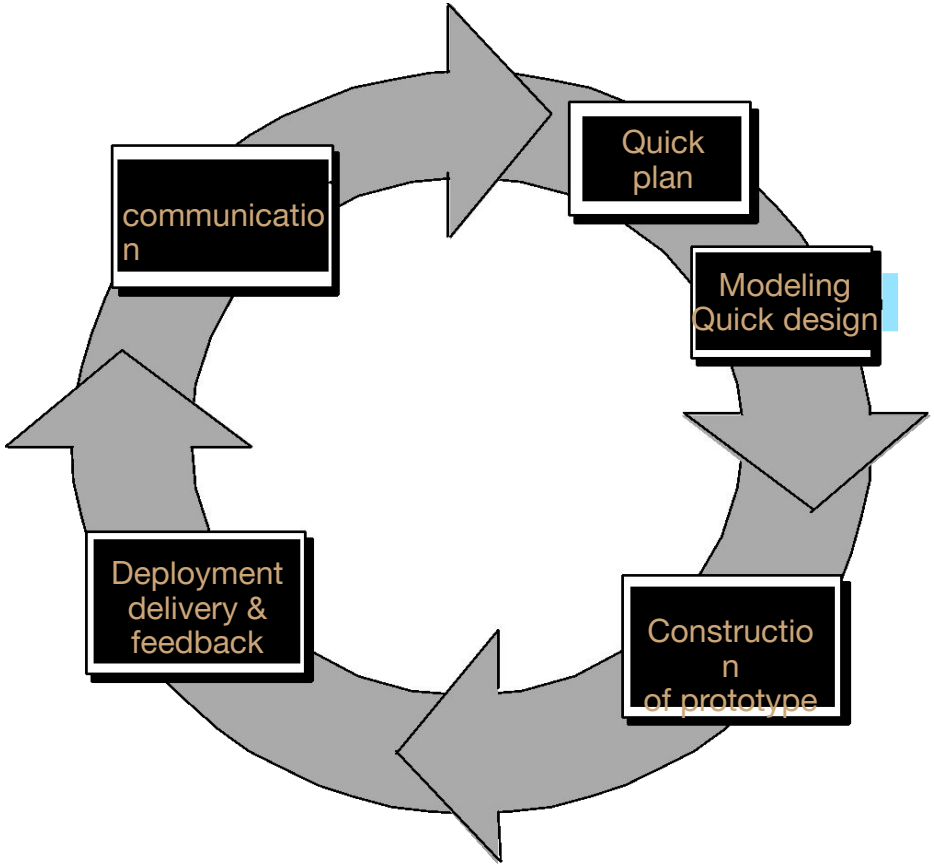
Criticism of waterfall Model

1. Real projects rarely follow the sequential flow that the model proposes. Although the linear model can accommodate iteration, it does so indirectly. As a result, changes can cause confusion as the project team proceeds.

1. It is often difficult for the customer to state all requirements explicitly. The waterfall model requires this and has difficulty accommodating the natural uncertainty that exists at the beginning of many projects.

1. The customer must have patience. A working version of the program(s) will not be available until late in the project time span. A major blunder, if undetected until the working program is reviewed, can be disastrous.
2. the linear nature of the classic life cycle leads to “blocking states” in which some project team members must wait for other members of the team to complete dependent tasks.

Evolutionary Models: Prototyping



Evolutionary Model

- Software, like all complex systems, evolves over a period of time. Business and product requirements often change as development proceeds, making a straight line path to an end product unrealistic; tight market deadlines make completion of a comprehensive software product impossible, but a limited version must be introduced to meet competitive or business pressure; a set of core product or system requirements is well understood, but the details of product or system extensions have yet to be defined.
- Evolutionary model is a combination of Iterative and Incremental model of software development life cycle. They are characterized in a manner that enables you to develop increasingly more complete versions of the software.

Prototyping

- Often, a customer defines a set of general objectives for software, but does not identify detailed requirements for functions and features. In other cases, the developer may be unsure of the efficiency of an algorithm, the adaptability of an operating system, or the form that human-machine interaction should take. In these, and many other situations, a prototyping paradigm may offer the best approach.

Prototyping

- The prototyping paradigm begins with communication. You meet with other stakeholders to define the overall objectives for the software, identify whatever requirements are known, and outline areas where further definition is mandatory.
- A prototyping iteration is planned quickly, and modeling (in the form of a “quick design”) occurs. A quick design focuses on a representation of those aspects of the software that will be visible to end users (e.g., human interface layout or output display formats).
- The quick design leads to the construction of a prototype. The prototype is deployed and evaluated by stakeholders, who provide feedback that is used to further refine requirements.
- Iteration occurs as the prototype is tuned to satisfy the needs of various stakeholders, while at the same time enabling you to better understand what needs to be done

Advantages and Disadvantages of Prototyping

Advantage:

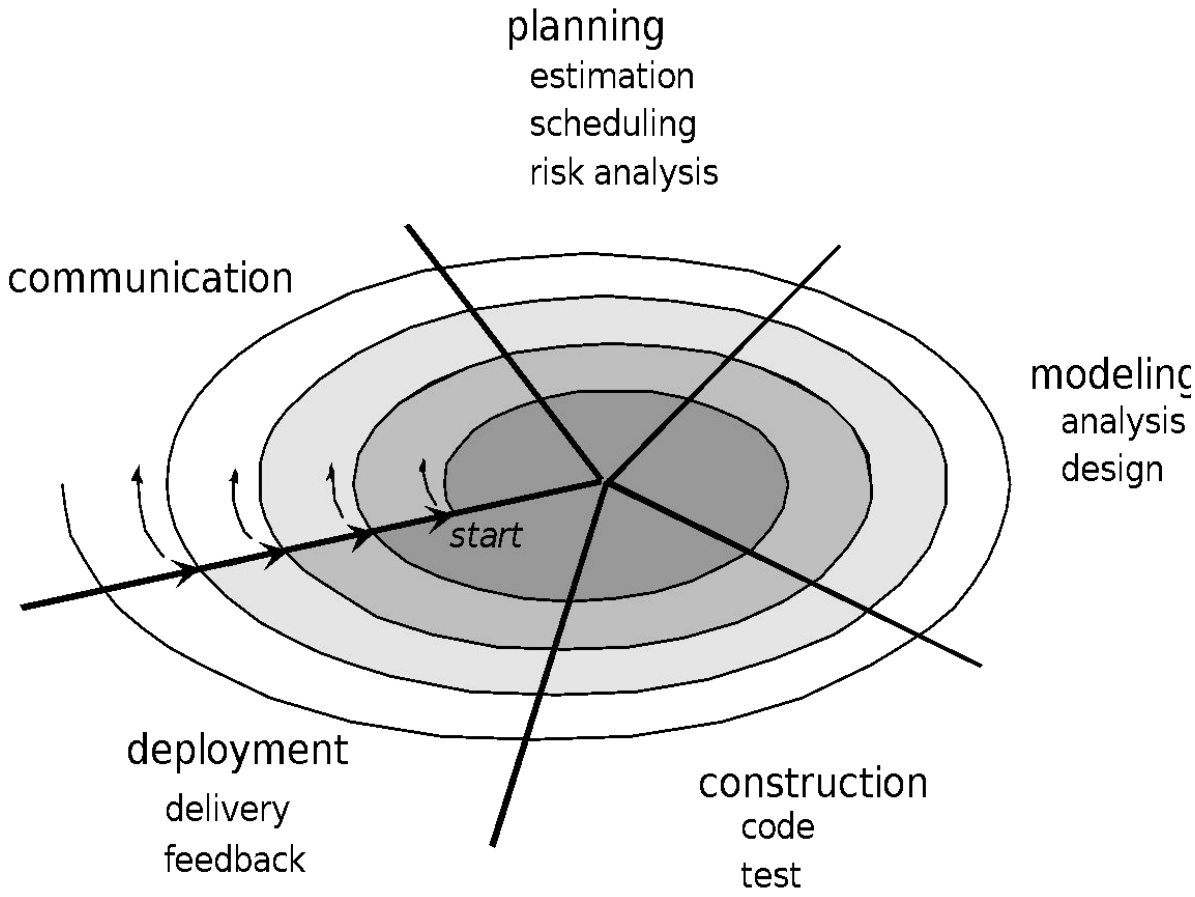
Provides a system for the users to interact with, even if it is not initially ready for use. The user can give feedback.

Disadvantages:

- Manage user expectations.

- Forget some important points since we are prototyping (opposite of careful design)

Evolutionary Models: The Spiral



Spiral Model

- The spiral development model is a risk-driven process model generator that is used to guide multi-stakeholder concurrent engineering of software intensive systems. It has two main distinguishing features. One is a cyclic approach for incrementally growing a system’s degree of definition and implementation while decreasing its degree of risk. The other is a set of anchor point milestones for ensuring stakeholder commitment to feasible and mutually satisfactory system solutions.

Spiral Model

- the spiral model is an evolutionary software process model that couples the iterative nature of prototyping with the controlled and systematic aspects of the waterfall model.
- It provides the potential for rapid development of increasingly more complete versions of the software.
- Using the spiral model, software is developed in a series of evolutionary releases. During early iterations, the release might be a model or prototype. During later iterations, increasingly more complete versions of the engineered system are produced.

Spiral Model

- A spiral model is divided into a set of framework activities defined by the software engineering team. Each of the framework activities represent one segment of the spiral path illustrated in Figure. As this evolutionary process begins, the software team performs activities that are implied by a circuit around the spiral in a clockwise direction, beginning at the center. Risk is considered as each revolution is made.
- Anchor point milestones—a combination of work products and conditions that are attained along the path of the spiral—are noted for each evolutionary pass.

Spiral Model

- The first circuit around the spiral might result in the development of a product specification; subsequent passes around the spiral might be used to develop a prototype and then progressively more sophisticated versions of the software. Each pass through the planning region results in adjustments to the project plan. Cost and schedule are adjusted based on feedback derived from the customer after delivery.
- In addition, the project manager adjusts the planned number of iterations required to complete the software.

Spiral Model

- The spiral model is a realistic approach to the development of large-scale systems and software. Because software evolves as the process progresses, the developer and customer better understand and react to risks at each evolutionary level.
- The spiral model uses prototyping as a risk reduction mechanism but, more important, enables you to apply the prototyping approach at any stage in the evolution of the product.
- It maintains the systematic stepwise approach suggested by the classic life cycle but incorporates it into an iterative framework that more realistically reflects the real world. The spiral model demands a direct consideration of technical risks at all stages of the project and, if properly applied, should reduce risks before they become problematic.

Key points

- Software engineering is an engineering discipline that is concerned with all aspects of software production.
- Software products consist of developed programs and associated documentation. Essential product attributes are maintainability, dependability, efficiency and usability.
- The software process consists of activities that are involved in developing software products. Basic activities are software specification, development, validation and evolution.
- Methods are organised ways of producing software. They include suggestions for the process to be followed, the notations to be used, rules governing the system descriptions which are produced and design guidelines.

Key points

- CASE tools are software systems which are designed to support routine activities in the software process such as editing design diagrams, checking diagram consistency and keeping track of program tests which have been run.
- Software engineers have responsibilities to the engineering profession and society. They should not simply be concerned with technical issues.
- Professional societies publish codes of conduct which set out the standards of behaviour expected of their members.

References

- Thank you !!!