THE WATERFALL MODEL

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The four software engineering activities:

- Specification
- Development
- Validation
- Evolution

are carried out as separate *phases* of the development *eg:*

- *Requirements specification phase*
- *Software design phase*
- *Implementation phase*
- *Testing phase,…etc.*

- The Waterfall Model was the first published model of a software development process
- This model evolved from general system engineering processes
- This process *cascades* from one phase to the next
- Hence the name *waterfall* model or *system life cycle (SDLC)*
- Process phases map onto development activities

The software development life cycle
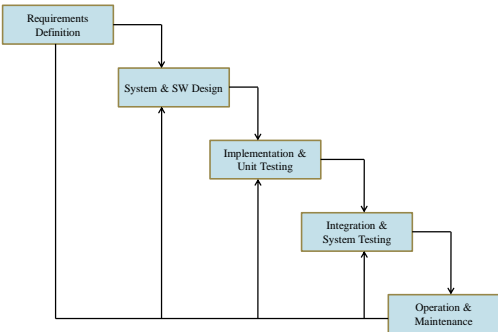
Organisations may use more phases..

Requirements Engineering: RE06   The Waterfall Process Model   7
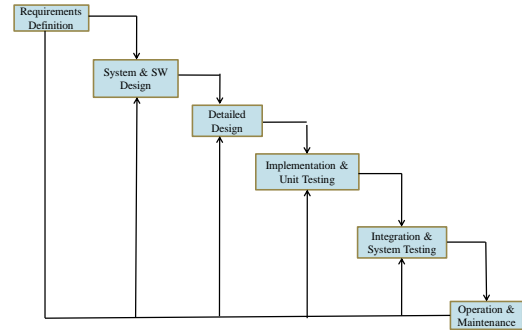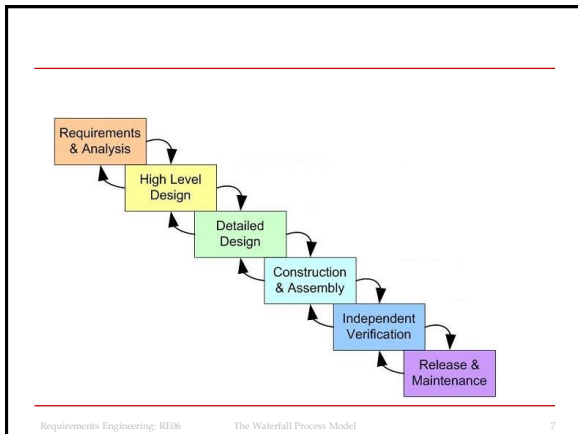
Requirements Analysis & Definition

- This phase establishes the system's services, constraints and goals

- Consultation with the system users/stakeholders

- When **all** information is gathered, it is defined in detail

- The *Requirements Specification Document* serves as a system specification

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System and Software Design

- Partitions the requirements into hardware or software requirements
- Establishes overall system architecture
- Identifies and describes the basic system abstractions and their relationships
- May produce alternative designs(high, medium, Low cost options)
- Phase may be split into System Design and Detailed Design

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Implementation and Unit Testing

- Software design is transformed into a set of programs or program units (code)

- **Unit test** verifies that the unit (program) meets its specification
- A unit might be:
  - A class
  - A method

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Integration and System testing

- Individual programs (units) are integrated

- System as a whole is tested to ensure requirements (functional, non-functional & domain) are met (Validation/Verification)

- On successful completion of testing, the system is deployed (delivered) to the client

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Operation and Maintenance (Evolution)

- Normally the longest life cycle phase
- The system is installed and put into operation ('goes live')
- Correction of errors undetected in earlier phases
- Improving implementation of system units
- Enhance system functionality as new requirements are discovered

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In theory, each phase produces one or more documents that must be approved ('signed off') before the next phase can commence.

These documents are often referred to as '**Exit Criteria**'

See the handout for more detail.

In practice, the phases may overlap.
- Problems with requirements may be identified during design…
- Design problems may be identified during coding…

This process may therefore include iterations of the development activities.

There are problems with the waterfall model:
- Producing and approving documents is costly
- Iterations involve significant re-work and therefore cost
- After a small number of iterations, tend to freeze part of the development (eg. Specification) and continue with later development stages
- Problems are then often 'left' for later consideration, ignored or programmed around

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Freezing the requirements specification can result in a system that does not provide the required functionality.

Some functions/services may be overlooked.

May also result in a badly structured system – design problems tend to be resolved by implementation tricks

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During the final phase (operation and maintenance):
- The system 'goes live'.
- Errors and omissions in requirements are discovered
- Program and design errors emerge
- New functional requirements are identified
- System must evolve to remain useful
- May require previous process stages to be repeated

Advantages of Waterfall Model

- Documentation produced at each phase
- Serves as a communication tool between team members
- Fits with other software engineering processes

Disadvantages of Waterfall Model

- Inflexible partitioning of project into distinct phases

- Requires commitment (funding) at an early stage of the process

- Does not easily facilitate changing customer requirements

When to use the Waterfall Model?

- When there is well understood user requirements
- Requirements are unlikely to change radically during system development
- Critical system development

This model is still widely used for software development

Particularly when developing part of a larger systems engineering project