
Software Processes

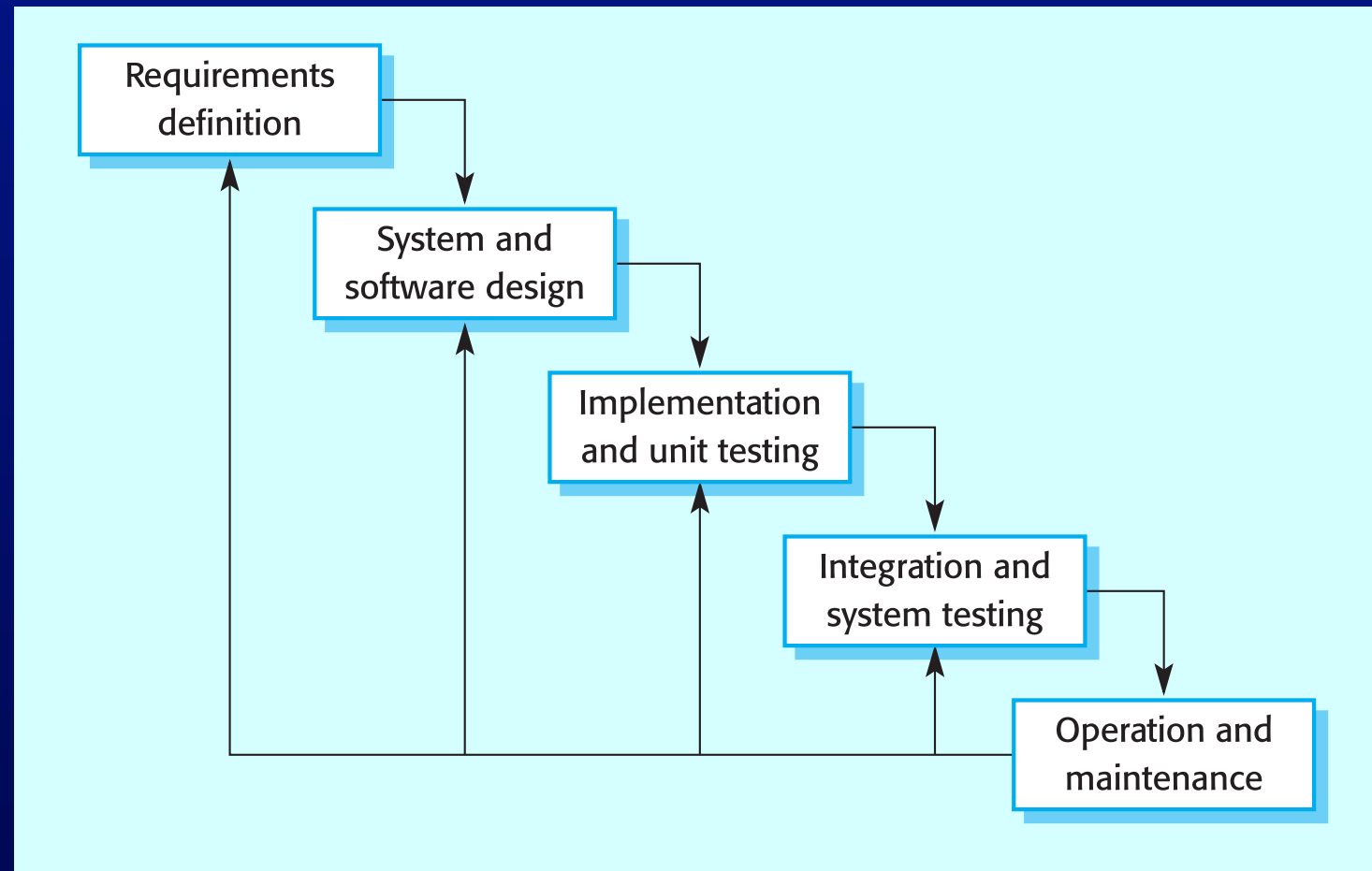
The software process

- 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.

Generic software process models

- The waterfall model
 - Separate and distinct phases of specification and development.
- Evolutionary development
 - Specification, development and validation are interleaved.
- Component-based software engineering
 - The system is assembled from existing components.
- **There are many variants of these models** e.g. formal development where a waterfall-like process is used but the specification is a formal specification that is refined through several stages to an implementable design.

Waterfall model



Waterfall model phases

- Requirements analysis and definition
- System and software design
- Implementation and unit testing
- Integration and system testing
- Operation and maintenance
- The main drawback:
 - The difficulty of accommodating change after the process is underway.
 - One phase has to be complete before moving onto the next phase.

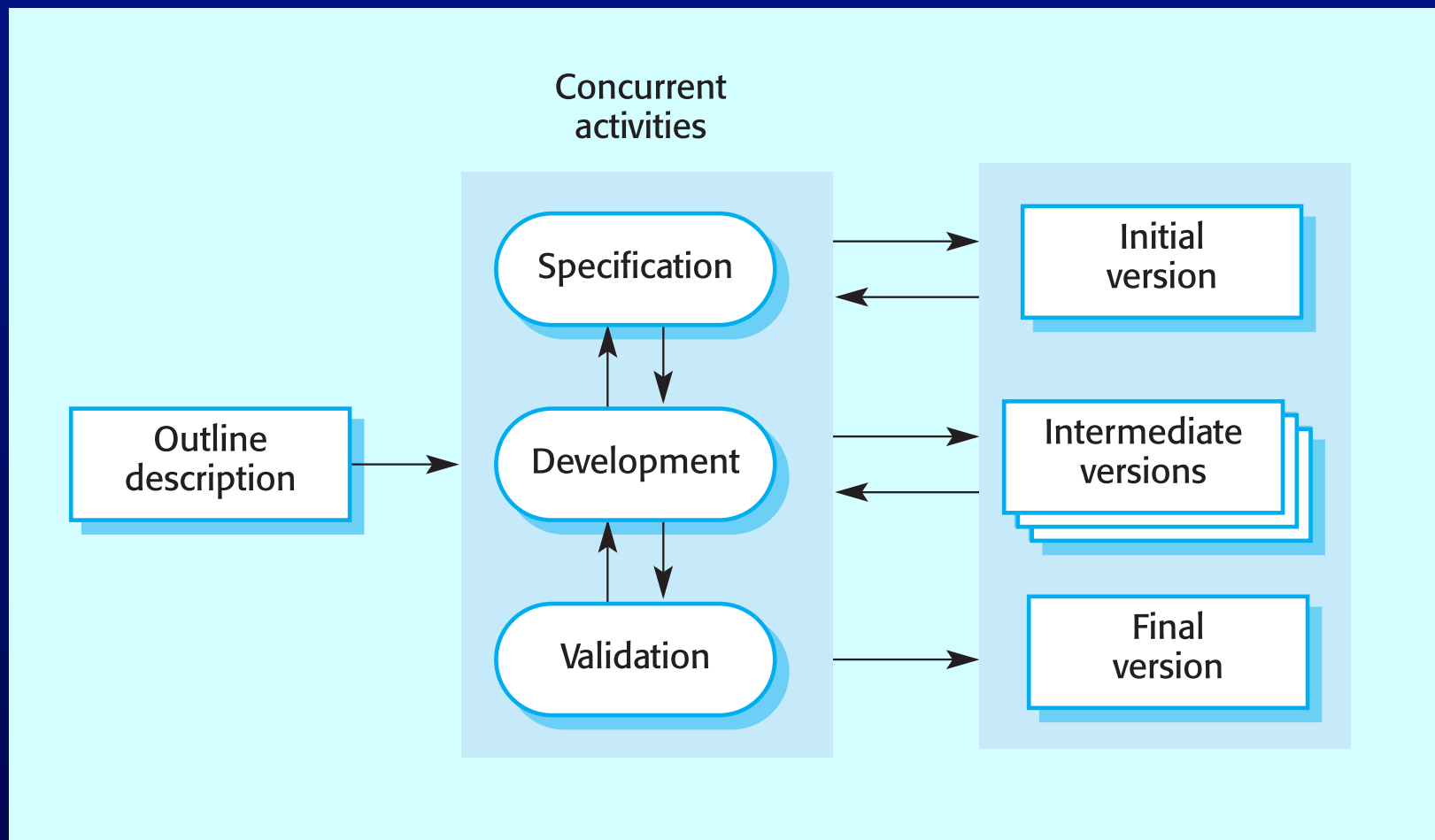
Waterfall model problems

- Inflexible partitioning of the project into distinct stages makes it difficult to respond to changing customer requirements.
- Appropriate when the requirements are well-understood and changes will be fairly limited during the design process.
- Few business systems have stable requirements.
- The waterfall model is mostly used for large systems engineering projects where a system is developed at several sites.

Evolutionary development

- Exploratory development
 - Objective is **to work with customers** and to evolve a final system from an initial outline specification.
 - Start with well-understood requirements and
 - Add new features as proposed by the customer.
- Throw-away prototyping
 - Objective is to understand the system requirements.
 - Should start with poorly understood requirements to clarify what is really needed.

Evolutionary development



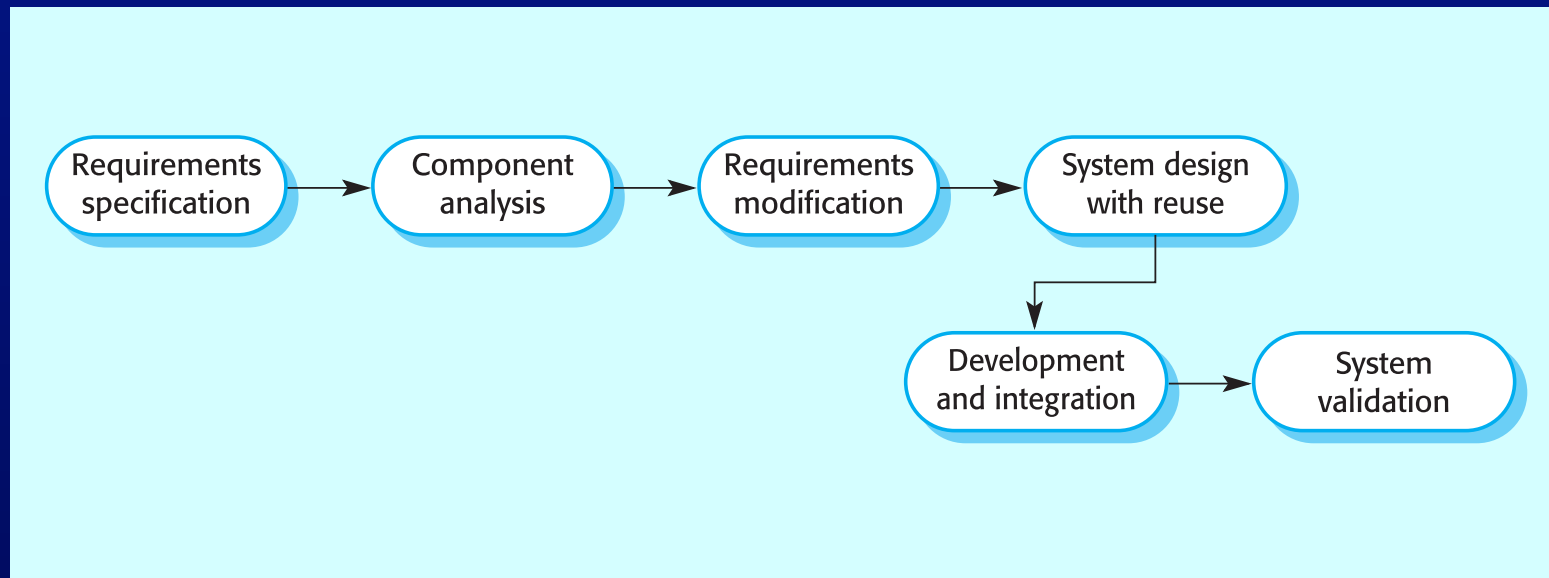
Evolutionary development

- Problems
 - Lack of process visibility;
 - Systems are often poorly structured;
 - Special skills (e.g. in languages for rapid prototyping) may be required.
- Applicability
 - For small or medium-size interactive systems;
 - For parts of large systems (e.g. the user interface);
 - For short-lifetime systems.

Component-based software engineering

- Based on systematic reuse where systems are integrated from existing components or COTS (Commercial-off-the-shelf) systems.
- Process stages
 - Component analysis;
 - Requirements modification;
 - System design with reuse;
 - Development and integration.
- This approach is becoming increasingly used as component standards have emerged.

Reuse-oriented development



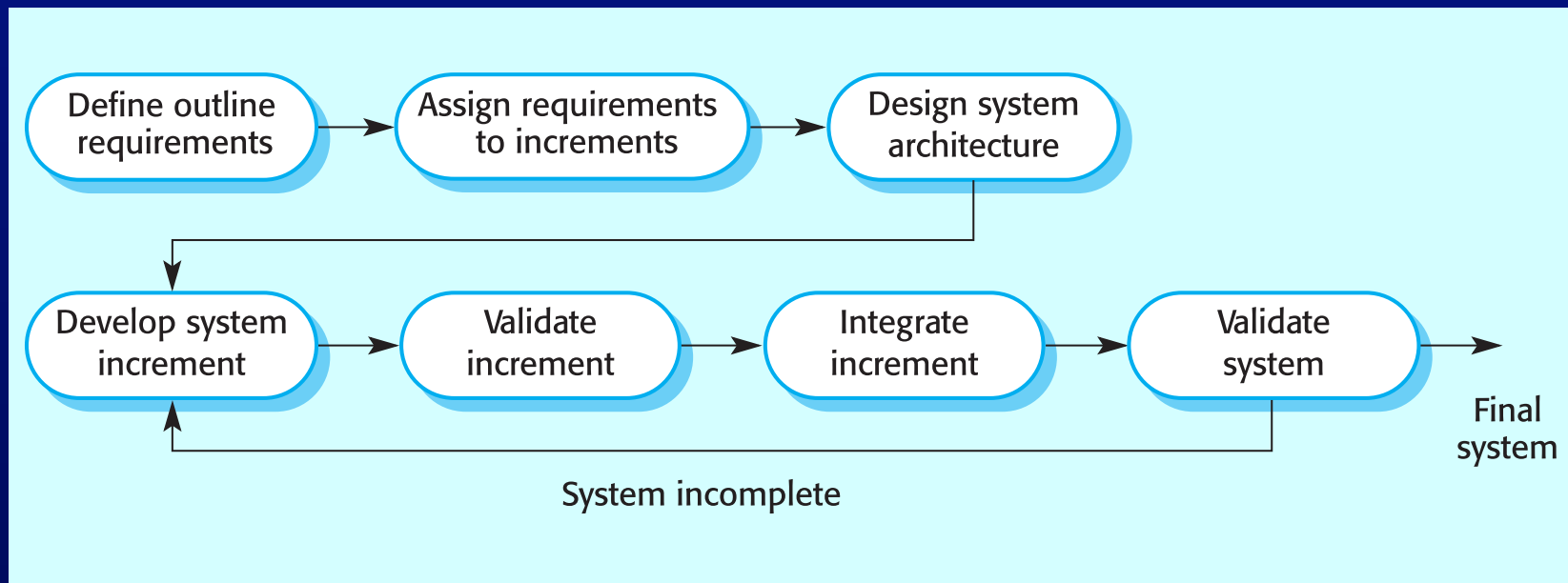
Process iteration

- System requirements **ALWAYS** evolve in the course of a project
- Iteration can be applied to any of the generic process models.
- Two (related) approaches
 - Incremental delivery;
 - Spiral development.

Incremental delivery

- The development and delivery is broken down into increments
 - each increment delivering part of the required functionality.
- User requirements are prioritised and the highest priority requirements are included in early increments.
- Once the development of an increment is started, the requirements are frozen though requirements for later increments can continue to evolve.

Incremental development



Incremental development advantages

- Customer value can be delivered with each increment so system functionality is available earlier.
- Early increments act as a prototype to help elicit requirements for later increments.
- Lower risk of overall project failure.
- The highest priority system services tend to receive the most testing.

Spiral development

- Process is represented as a spiral rather than as a sequence of activities with backtracking.
- Each loop in the spiral represents a phase in the process.
- No fixed phases such as specification or design - loops in the spiral are chosen depending on what is required.
- Risks are explicitly assessed and resolved throughout the process.

Spiral model sectors

- Objective setting
 - Specific objectives for the phase are identified.
- Risk assessment and reduction
 - Risks are assessed and activities put in place to reduce the key risks.
- Development and validation
 - A development model for the system is chosen which can be any of the generic models.
- Planning
 - The project is reviewed and the next phase of the spiral is planned.

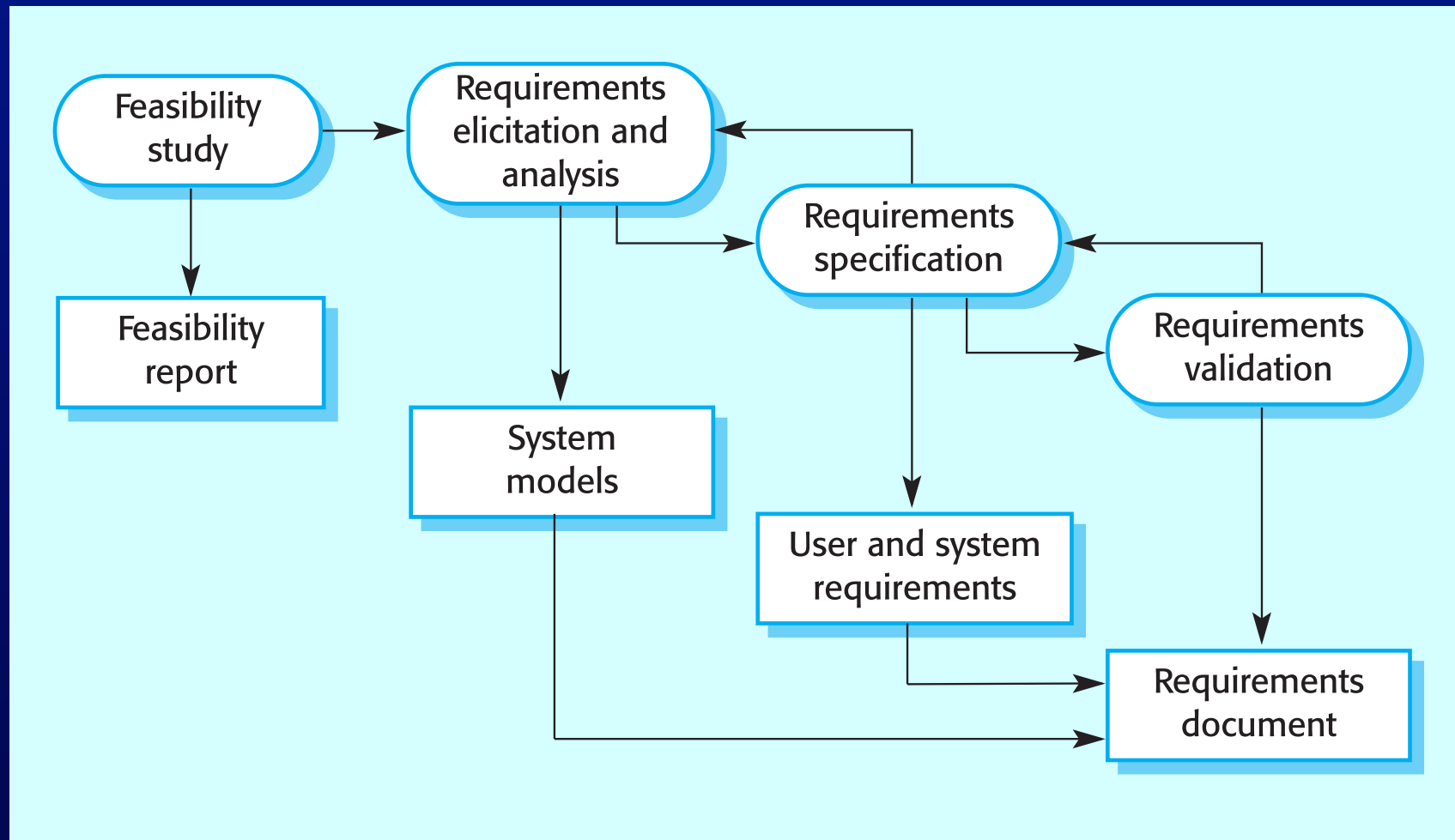
Process activities

- Software specification
- Software design and implementation
- Software validation
- Software evolution

Software specification

- The process of establishing what services are required and the constraints on the system's operation and development.
- Requirements engineering process
 - Feasibility study;
 - Requirements elicitation and analysis;
 - Requirements specification;
 - Requirements validation.

The requirements engineering process



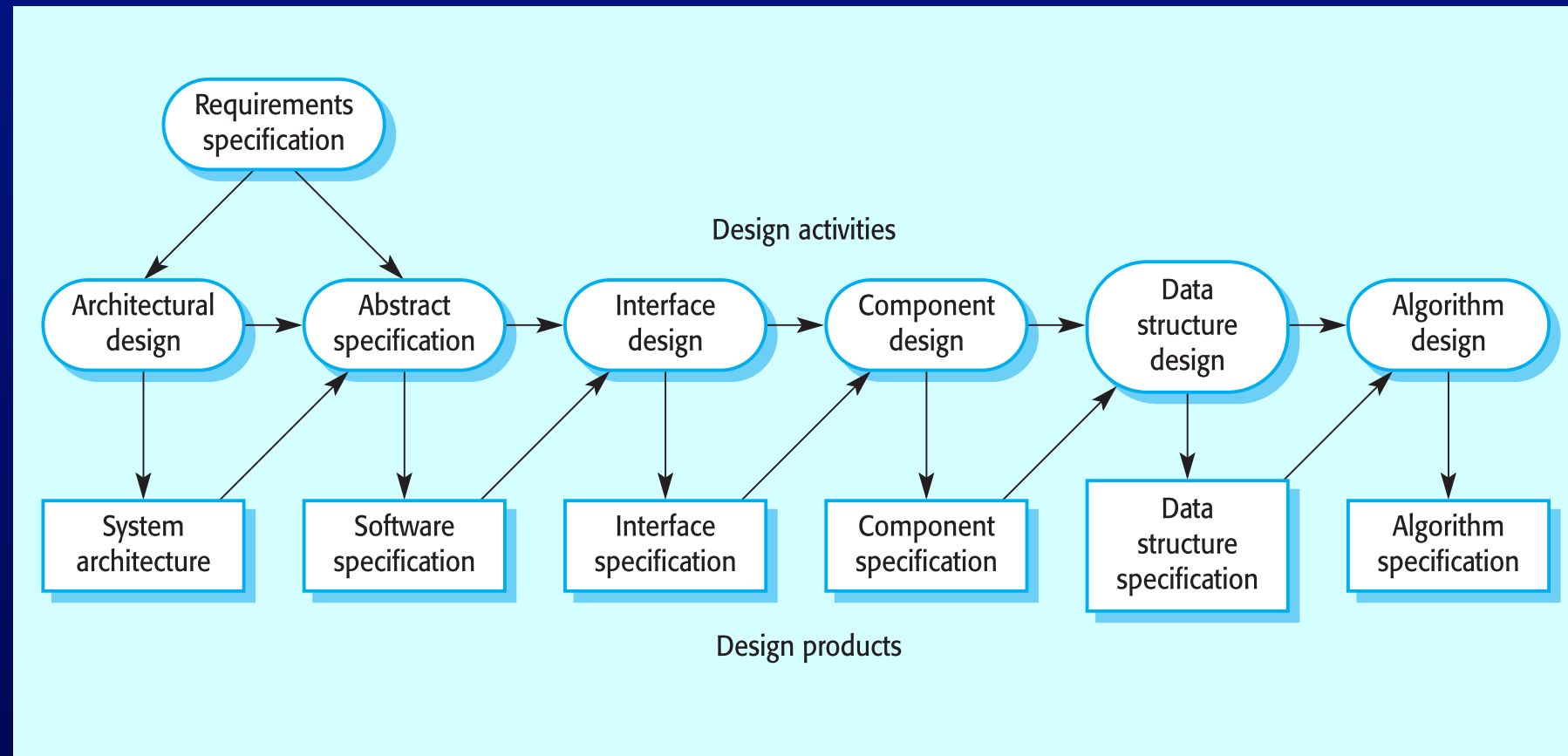
Software design and implementation

- The process of converting the system specification into an executable system.
- Software design
 - Design a software structure that realises the specification;
- Implementation
 - Translate this structure into an executable program;
- The activities of design and implementation are closely related and may be inter-leaved.

Design process activities

- Architectural design
- Abstract specification
- Interface design
- Component design
- Data structure design
- Algorithm design

The software design process



Structured methods

- Systematic approaches to developing a software design.
- The design is usually documented as a set of graphical models.
- Possible models
 - Object model;
 - Sequence model;
 - State transition model;
 - Structural model;
 - Data-flow model.

Programming and debugging

- Translating a design into a program and removing errors from that program.
- Programming is a personal activity - there is no generic programming process.
- Programmers carry out some program testing to discover faults in the program and remove these faults in the debugging process.

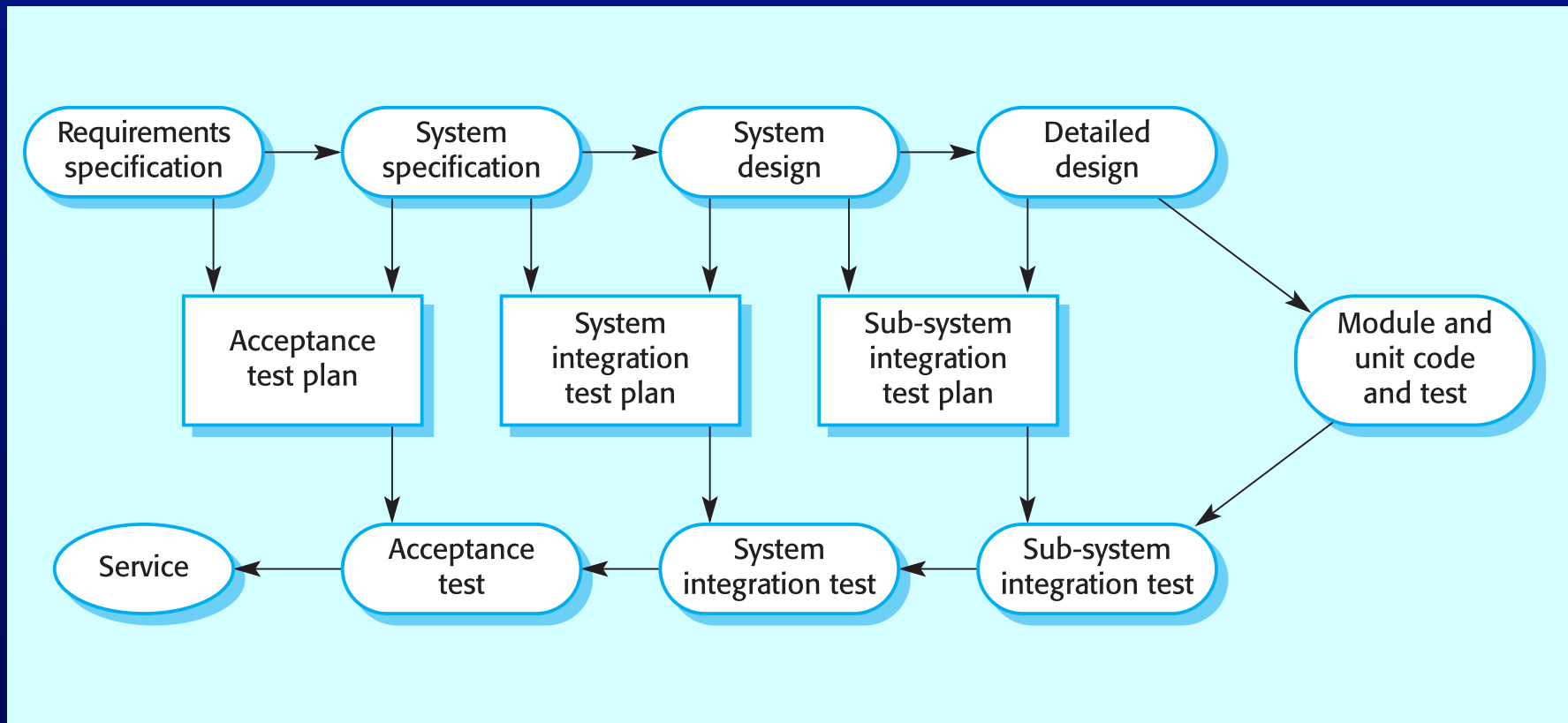
Software validation

- Verification and validation (V & V) is intended to show that a system conforms to its specification and meets the requirements of the system customer.
- Involves checking and review processes and system testing.
- System testing involves executing the system with test cases that are derived from the specification of the real data to be processed by the system.

Testing stages

- Component or unit testing
 - Individual components are tested independently;
 - Components may be functions or objects or coherent groupings of these entities.
- System testing
 - Testing of the system as a whole. Testing of emergent properties is particularly important.
- Acceptance testing
 - Testing with customer data to check that the system meets the customer's needs.

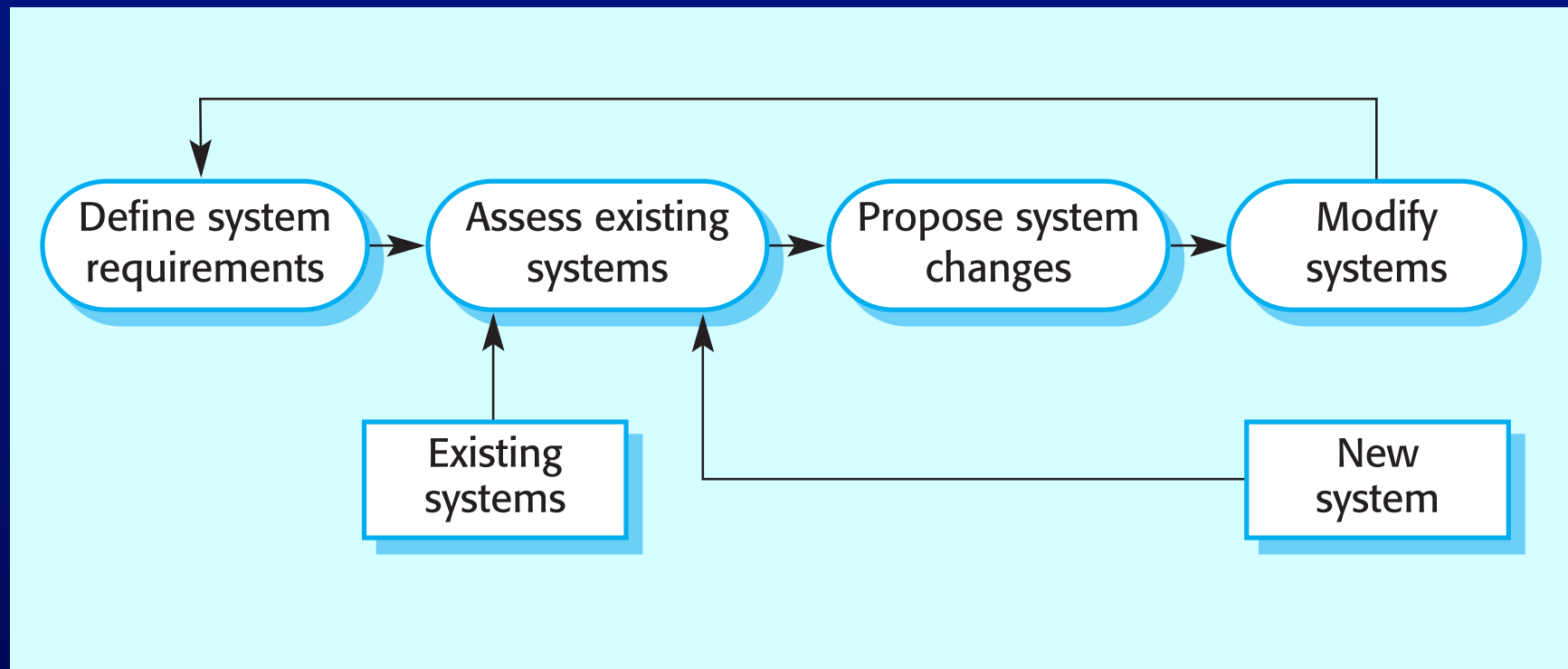
Testing phases



Software evolution

- Software is inherently flexible and can change.
- Requirements change => the software must evolve and change.
- Although there has been a demarcation between development and evolution (maintenance) this is increasingly irrelevant as fewer and fewer systems are completely new.

System evolution



Computer-aided software engineering

- Computer-aided software engineering (CASE) is software to support software development and evolution processes.
- Activity automation
 - Graphical editors for system model development;
 - Data dictionary to manage design entities;
 - Graphical UI builder for user interface construction;
 - Debuggers to support program fault finding;
 - Automated translators to generate new versions of a program.

Case technology

- Case technology has led to significant improvements in the software process. However, these are not the order of magnitude improvements that were once predicted
 - Software engineering requires creative thought - this is not readily automated;
 - Software engineering is a team activity and, for large projects, much time is spent in team interactions. CASE technology does not really support these.

CASE integration

- Tools
 - Support individual process tasks such as design consistency checking, text editing, etc.
- Workbenches
 - Support a process phase such as specification or design, Normally include a number of integrated tools.
- Environments
 - Support all or a substantial part of an entire software process. Normally include several integrated workbenches.

Tools, workbenches, environments

