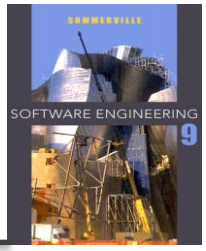
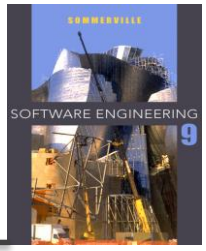


Chapter 2 – Software Processes

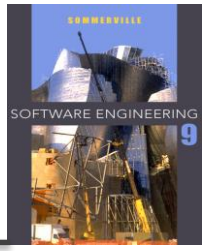
Lecture 1

Topics covered



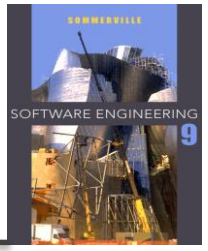
- ✧ Software process models
- ✧ Process activities
- ✧ Coping with change
- ✧ The Rational Unified Process
  - An example of a modern software process.

The software process



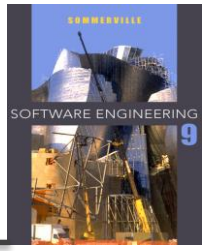
- A structured **set of activities required** to develop a software system.
- Many different software processes but **all involve**:
  - Specification – defining what the system should do;
  - Design and implementation – defining the organization of the system and implementing the system;
  - Validation – checking that it does what the customer wants;
  - Evolution – changing the system in response to changing customer needs.
- A **software process model** is an abstract representation of a process. It presents a description of a process from some particular perspective.

Software process descriptions

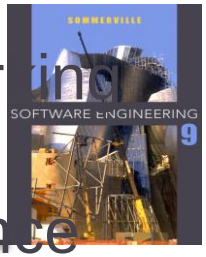


- When we describe and discuss processes, we usually talk about **the activities in these processes** such as specifying a data model, designing a user interface, etc. **and the ordering of these activities**.
- Process descriptions **may also include**:
  - Products, which are **the outcomes** of a process activity;
  - Roles, which reflect the **responsibilities of the people** involved in the process;
  - Pre- and post-conditions, which are **statements that are true before and after** a process activity has been enacted or a product produced.

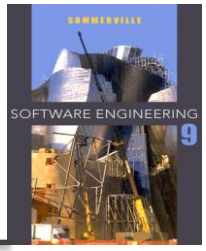
Plan-driven and agile processes



- **Plan-driven processes** are processes where all of the process activities are **planned in advance and progress is measured** against this plan.
- In agile processes, **planning is incremental** and it is **easier to change the process** to reflect changing customer requirements.
- Agile methods break tasks into **small increments** with minimal planning and **do not directly involve long-term planning**.
- Iterations are short time frames (timeboxes) that typically last from one to four weeks.

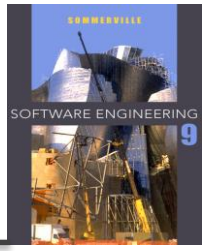


- Each iteration involves a cross functional team working in all functions: planning, requirements analysis, design, coding, unit testing, and acceptance testing.
- At the end of the iteration a working product is demonstrated to stakeholders. This minimizes overall risk and allows the project to adapt to changes quickly.
- An iteration **might not add enough functionality to warrant a market release**, but **the goal is to have an available release (with minimal bugs)** at the end of each iteration.
- **Multiple iterations might be required** to release a product or new features.

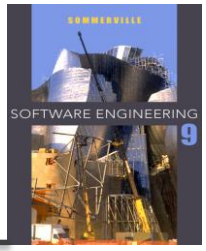


- In practice, most practical processes **include elements** of both plan-driven and agile approaches.
- There are **no right or wrong software processes**.
- Although there is **no 'ideal' software process**, there is scope for improving the software process in many organizations.
- E.g., by **standardization** where **the diversity** in software processes across an organization **is reduced**
- This leads to **improved communication and a reduction in training time, and makes automated process support more economical.**

Software process models

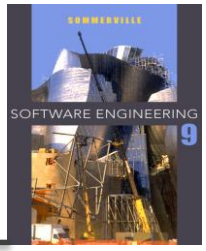


- The waterfall model
  - Plan-driven model. Separate and distinct phases of specification and development.
- Incremental development
  - Specification, development and validation are interleaved.
  - May be plan-driven or agile.
- Reuse-oriented software engineering
  - The system is assembled from existing components. May be plan-driven or agile.
- In practice, **most large systems** are developed using a process that **incorporates elements from all of these models.**



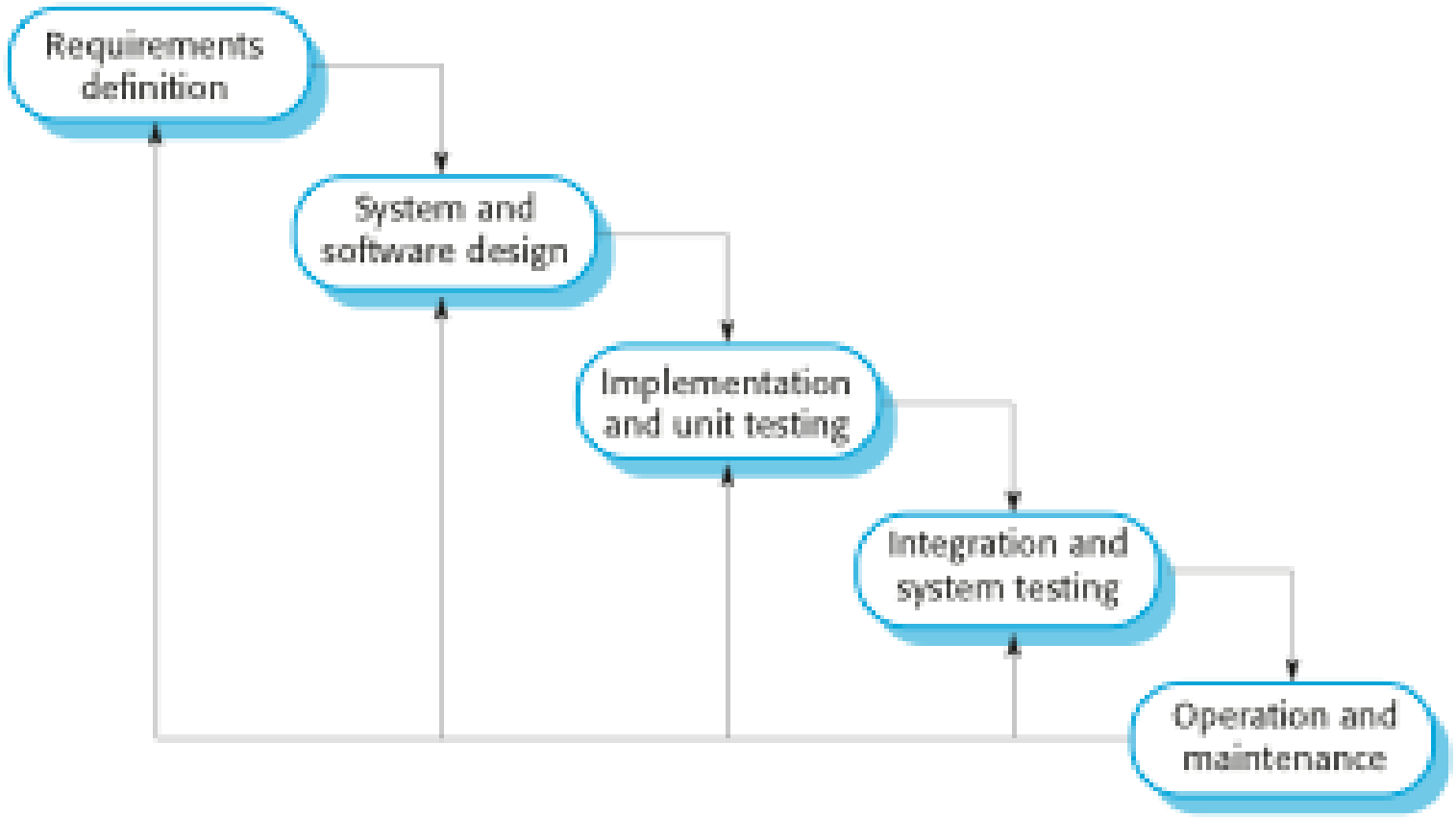
- Parts of the system that **are well understood** can be specified and developed using a **waterfall-based** process.
- Parts of the system which are **difficult to specify** in advance, such as the user interface, should always be developed using an **incremental approach**.

The waterfall model

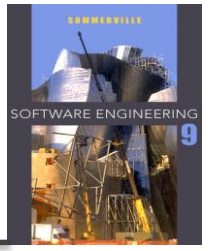


- The waterfall model is an example of **a plan-driven process**—in principle, **you must plan and schedule all of the process activities** before starting work on them.

The waterfall model



The principal stages of the waterfall model



1. **Requirements analysis and definition**

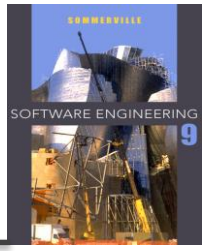
   The system's **services, constraints, and goals** are established by **consultation with system users**. They are then defined in detail and **serve as a system specification**.

2. **System and software design**

   The systems design process **allocates the requirements to either hardware or software** systems by **establishing an overall system architecture**.

3. **Implementation and unit testing**

   During this stage, the software design is **realized as a set of programs** or program units. Unit testing **involves verifying that each unit meets its specification**



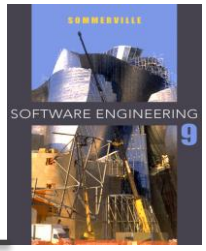
4. Integration and system testing

The individual program units or programs are integrated and tested as a complete system **to ensure that the software requirements have been met**. After testing, the software system is delivered to the customer.

5. Operation and maintenance

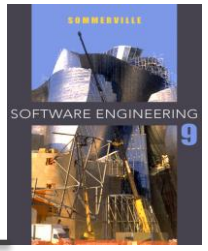
Normally (although not necessarily), this is **the longest life cycle** phase. The system is installed and put into practical use. Maintenance **involves correcting errors** which were not discovered in earlier stages of the life cycle**, improving the implementation** of system units and **enhancing the system's services as new requirements are discovered**.

the result of each phase is one or more documents



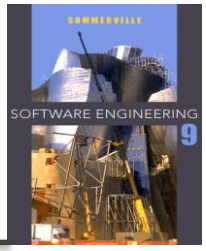
- In principle, the result of each phase is one or more documents that **are approved ('signed off').** The **following phase should not start until the previous phase has finished**.
- In practice, these stages overlap and feed information to each other.
- **During design, problems with requirements are identified.**
- **During coding, design problems are found** and so on. The software process is not a simple linear model but involves feedback from one phase to another.
- Documents produced in each phase may then **have to be modified** to reflect the changes made

Because of the costs of producing and approving documents



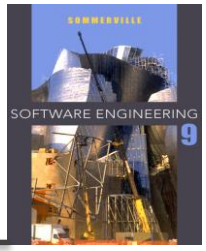
- iterations can be **costly and involve significant** rework.
- Therefore, after a small number of iterations, **it is normal to freeze parts of the development**, such as **the specification**, and to continue with the later development stages.
- **Problems are left for later resolution**, **ignored**, or **programmed around**.
- This premature freezing of requirements **may mean that the system won't do what the user wants**.
- It may also **lead to badly structured systems** as design problems are circumvented by implementation tricks.

Deliverables (Documents) in Waterfall Model



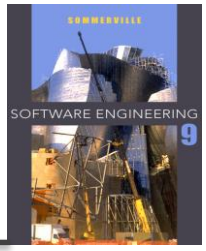
- ✧ Project plan and feasibility report
- ✧ Requirements documents (SRS: Software Requirement Specifications)
- ✧ System Design documents
- ✧ Test plans and test reports
- ✧ Source code
- ✧ Software manuals
- ✧ Each step ends with a review process and report

Advantages of producing documents



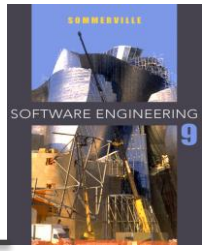
- Different teams can work on different steps of the projects
- Important for quality assurance and testing
- Important for evolution

Waterfall model drawback



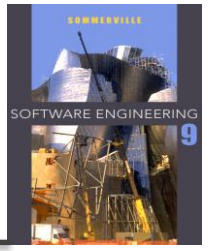
- The **main drawback** of the waterfall model is the **difficulty of accommodating change** after the process is underway.
- In principle, a **phase has to be complete** before moving onto the next phase.

Waterfall model problems



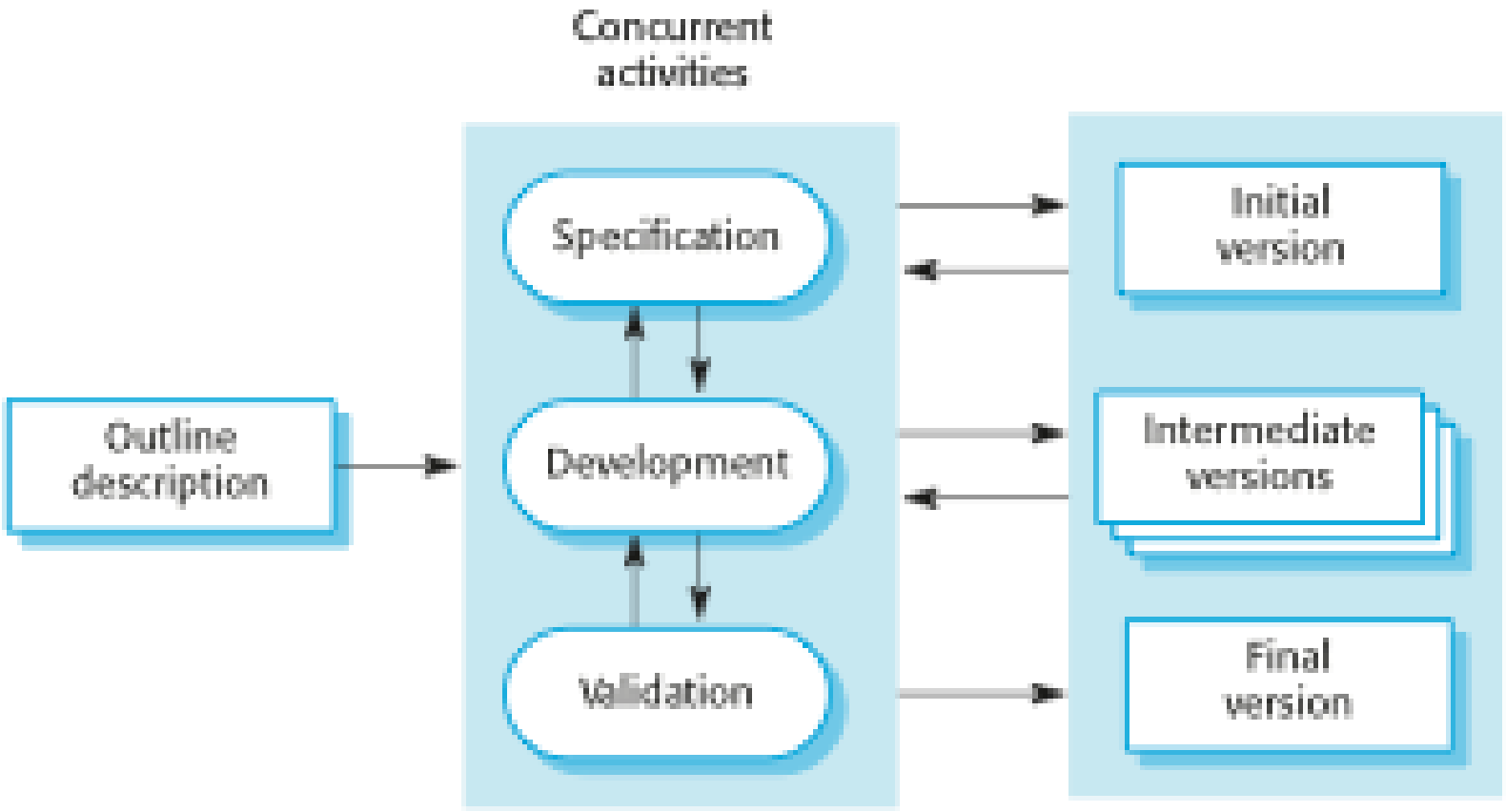
- Inflexible partitioning of the project into distinct stages makes it **difficult to respond to changing customer requirements**.
  - Therefore, this model is only **appropriate when the requirements are well-understood (e.g. there is a manual counterpart) and changes will be fairly limited** during the **design process**.
  - **Few business systems have stable requirements**.
  - **Documentation heavy**
- The waterfall model is mostly **used for large systems** engineering projects where a system is **developed at several sites.**
  - In those circumstances, the **plan-driven nature of the waterfall model helps coordinate the work.**

Incremental development

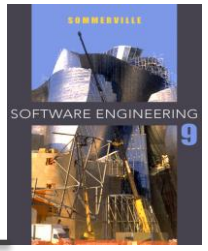


- Incremental development is based on the idea of developing **an initial implementation**, exposing this to **user comment** and **evolving it** through **several versions until** an adequate system has been developed
- Specification, development, and validation **activities are interleaved** rather than separate, **with rapid feedback across activities**.
- A **fundamental part of agile** approaches, is **better than a waterfall approach for most business**, e-commerce, and personal systems
- By developing the software incrementally, **it is cheaper and easier to make changes** in the software as it is being developed.

Incremental development

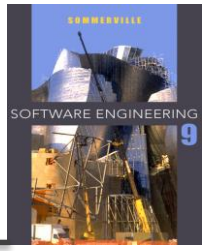


Incremental development benefits



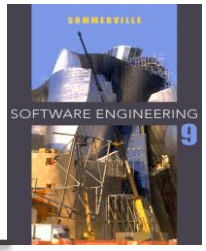
- The **cost of accommodating changing customer requirements is reduced**.
  - The **amount of analysis and documentation that has to be redone is much less** than is required with the waterfall model.
- It is **easier to get customer feedback** on the development work that has been done.
  - Customers can comment on demonstrations of the software and see how much has been implemented.
- More **rapid delivery and deployment** of useful software to the customer is possible.
  - Customers are able to use and gain value from the software earlier than is possible with a waterfall process.

Incremental development problems

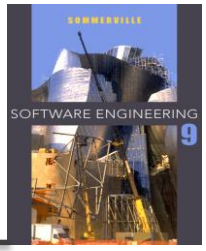


- The process is not visible.
  - Managers need regular deliverables to measure progress. If **systems are developed quickly**, it is **not cost-effective to produce documents** that reflect every version of the system.
- System **structure tends to degrade as new increments are added.**
  - **Unless time and money is spent on refactoring** to improve the software, **regular change tends to corrupt its structure**. Incorporating further software **changes becomes increasingly difficult and costly.**

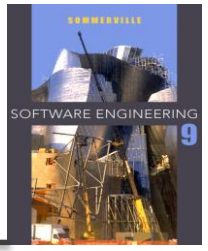
Reuse-oriented software engineering



- in the 21st century, software development processes that focus on **the reuse of existing software have become widely used**.
- Reuse-oriented approaches **rely on a large base of reusable software components** and an integrating framework for the composition of these components.
- Based on systematic reuse where systems are **integrated from existing components** or COTS **(Commercial-off-the-shelf)** systems.
- Popular in web software develeopment
- Reuse is now the **standard approach for building many types of business** system
  - Reuse covered in more depth in Chapter 16.

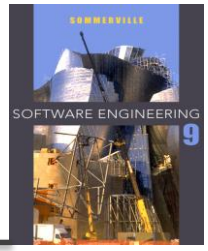


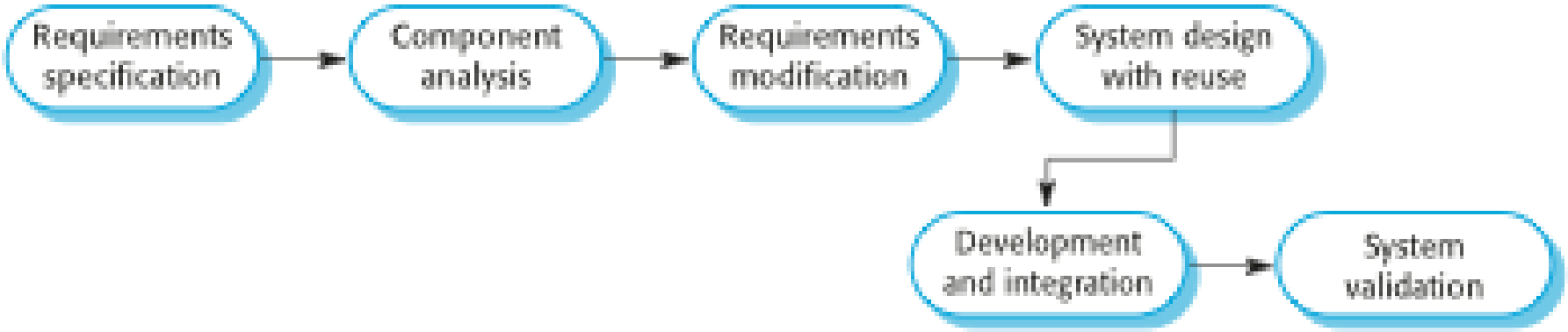
1. **Component analysis** Given the requirements specification, a search is made for components to implement that specification. Usually , **there is no exact match and the components that may be used only provide some of the functionality required**.
2. **Requirements modification** During this stage, the **requirements are analyzed** using information about the components that have been discovered. They are then **modified to reflect the available components**. **Where modifications are impossible**, the component analysis activity may be **re-entered to search for alternative solutions**.



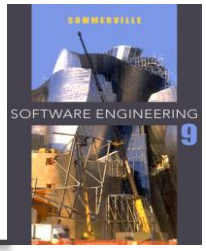
3. **System design with reuse** During this phase, the **framework of the system is designed or an existing framework is reused**. The designers take into account the components that are reused and organize the framework to cater for this. **Some new software may have to be designed if reusable** components are not available.
4. **Development and integration** Software that **cannot be externally procured is developed**, and the components and COTS systems are integrated to create the new system.

Reuse-oriented software engineering



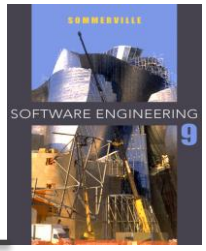


Types of software component



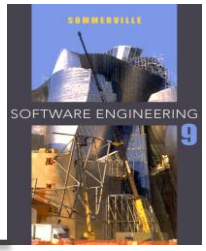
- Web services that are developed according to service standards and which are **available for remote invocation**.
- **Collections of objects** that are developed **as a package** to be integrated with a component framework such as .NET or J2EE.
- **Stand-alone software systems** (COTS) that are configured for use in a particular environment.

Advantages and Disadvantages



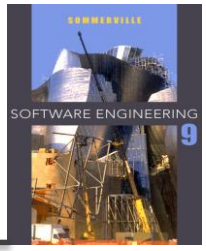
- Reuse-oriented software engineering has **the obvious advantage** of **reducing the amount of software to be developed and so reducing cost and risks**. It usually also leads to **faster delivery** of the software.
- However, **requirements compromises are inevitable** and this may **lead to a system that does not meet the real needs of users**.
- Furthermore, **some control over the system evolution is lost** as **new versions of the reusable components are not under the control of the organization** using them.

Process activities



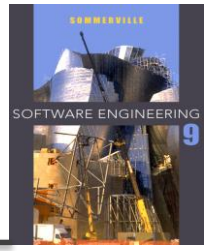
- Real software processes are inter-leaved sequences of technical, collaborative and managerial activities with the overall goal of specifying, designing, implementing and testing a software system.
- The four basic process activities of specification, development, validation and evolution are **organized differently in different development processes**. In the **waterfall** model, they are **organized in sequence**, whereas in **incremental development** they are **inter-leaved.**

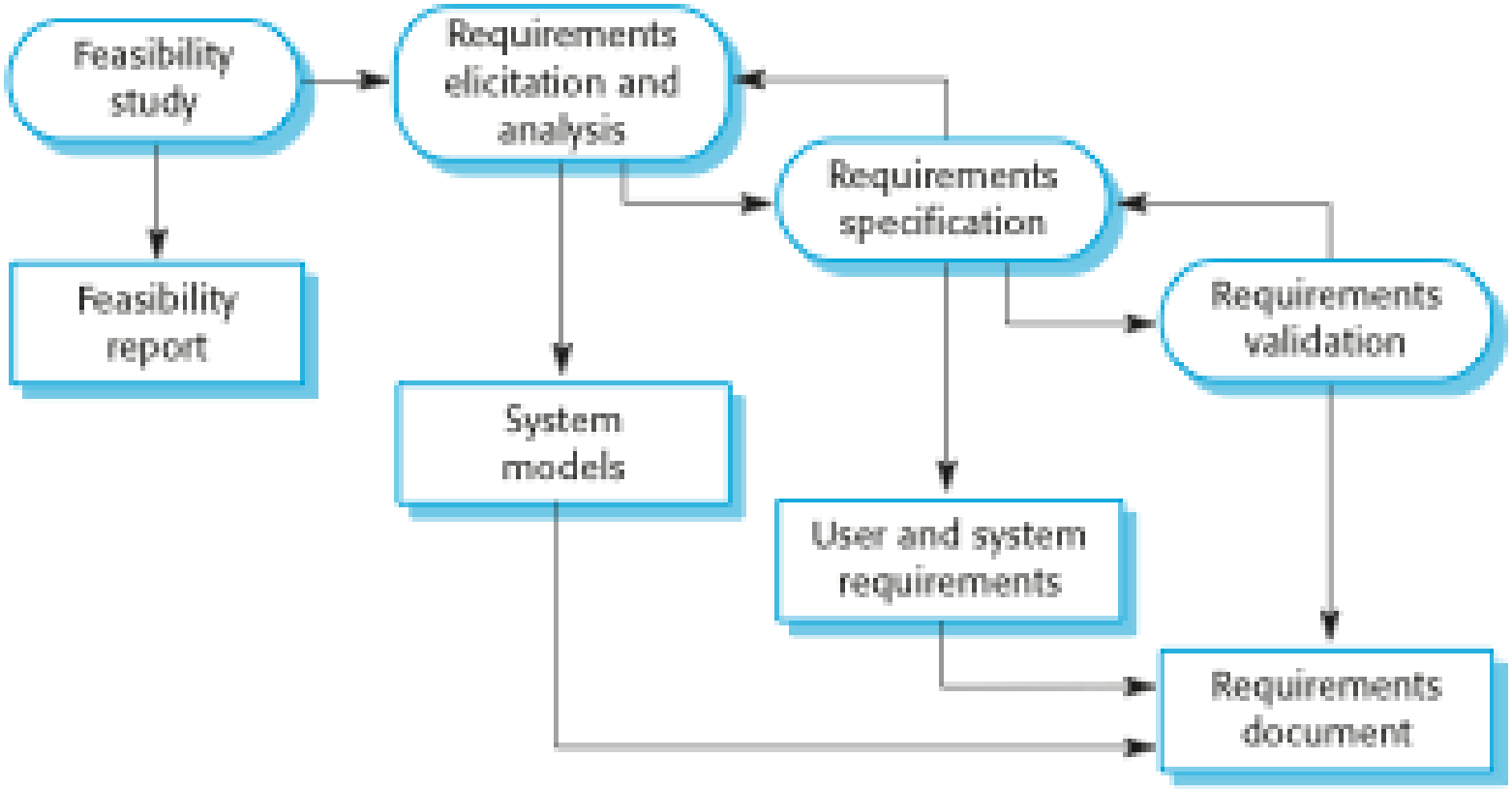
Software specification



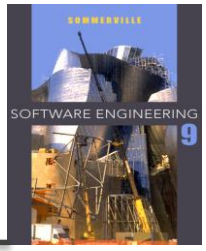
- The process of establishing **what services are required and the constraints** on the system's operation and development.
- Requirements engineering process
  - **Feasibility study**
    - Is it technically and financially feasible to build the system?
  - Requirements elicitation and analysis
    - **What do the system stakeholders require** or expect from the system?
  - Requirements specification
    - **Defining the requirements in detail**
  - Requirements validation
    - **Checking the validity of the requirements**

The requirements engineering process



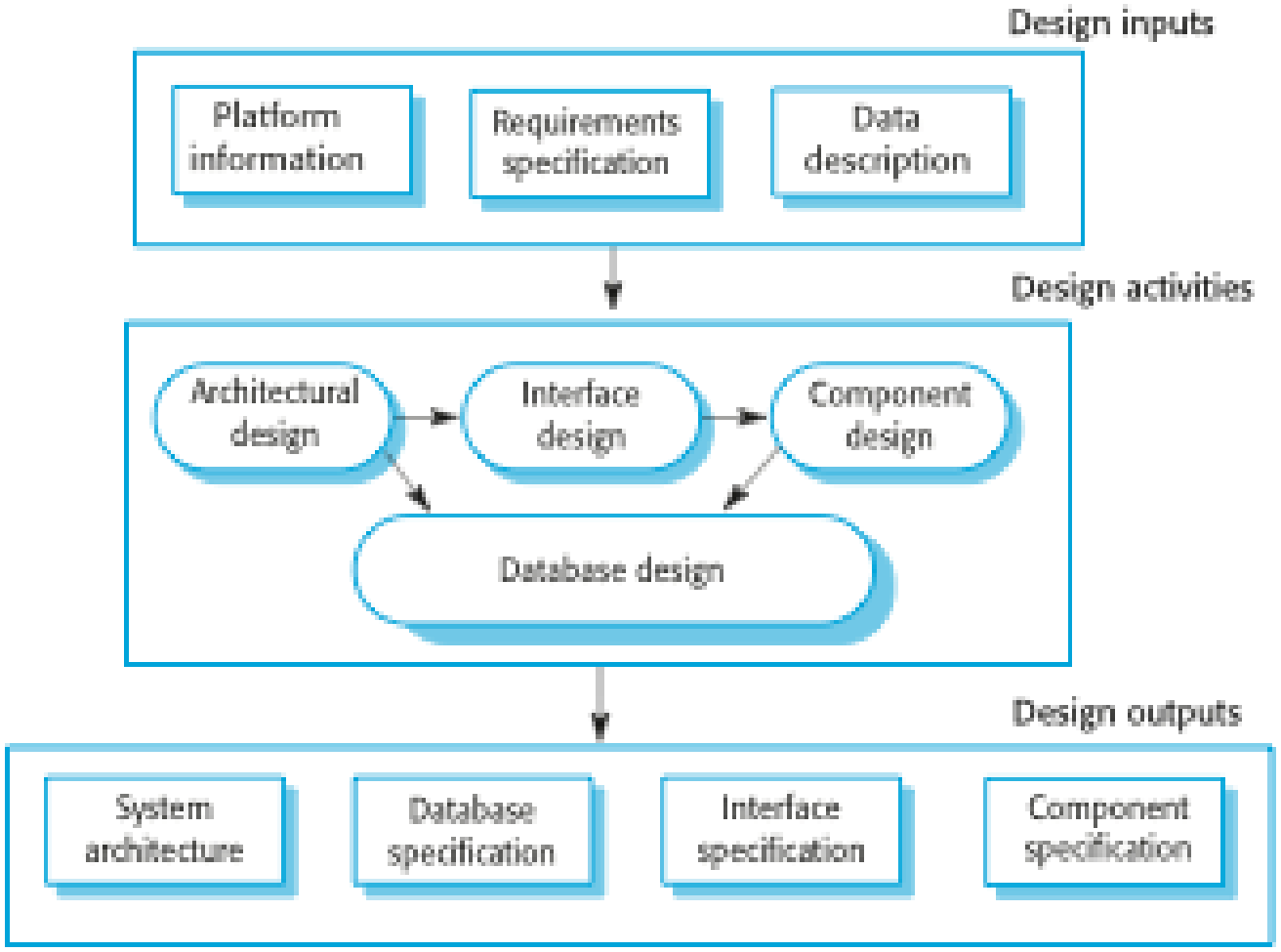


Software design and implementation

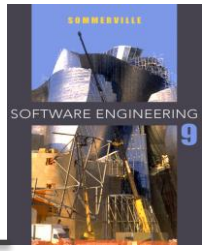


- The process of **converting the system specification into an executable system**.
- Software design
  - Design a **software structure** that realises the specification;
- Implementation
  - Translate this structure into an **executable program**;
- The activities of **design and implementation are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

A general model of the design process

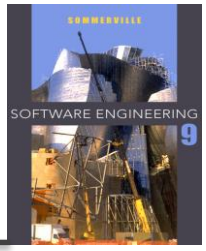


Design activities



- ***Architectural design***, where you identify the overall structure of the system, the principal components (sometimes called sub-systems or modules), their relationships and how they are distributed.
- ***Interface design***, where you define the interfaces between system components.
- ***Component design***, where you take each system component and design how it will operate.
- ***Database design***, where you design the system data structures and how these are to be represented in a database.

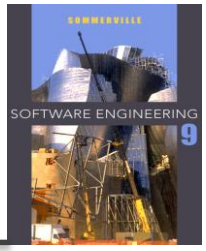
Software validation



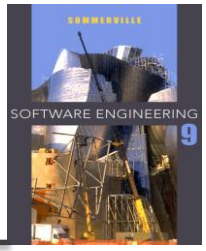
- Verification and validation (V & V) is intended to show that a system **conforms to its specification and meets the requirements of the system customer**.
- **Involves checking and review processes and system testing**.
- **System testing** involves executing the system with test cases that are **derived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

Stages of testing

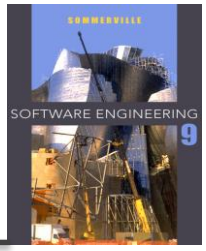
Testing stages



- Development or component testing
  - Individual components are tested **independently by the people developing the system**;
  - Components may be functions or objects or coherent groupings of these entities.
  - Test automation tools, such as JUnit (Massol and Husted, 2003), that can re-run component tests when new versions of the component are created, are commonly used

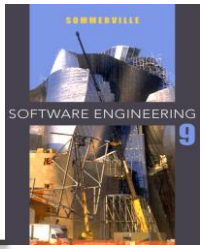


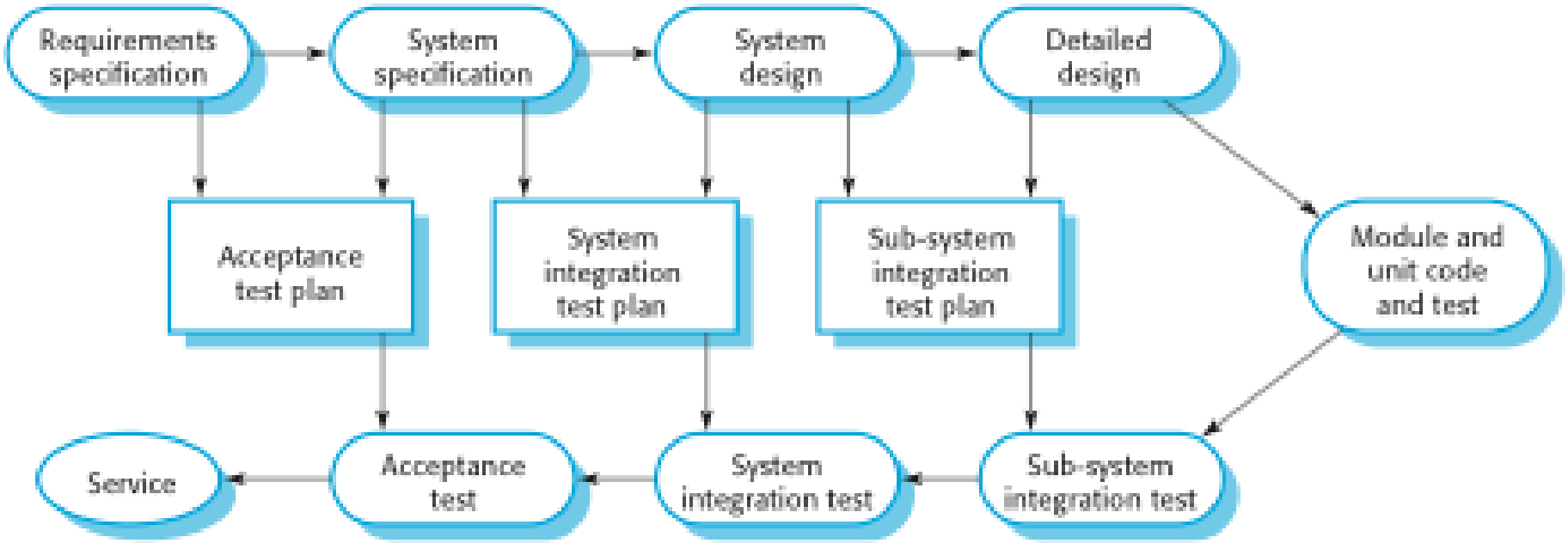
- System testing (Testing of the system as a whole)
  - concerned with finding errors that result from unanticipated interactions between components and component interface problems
  - Testing the functional as well as non-functional requirements.
  - **Testing of emergent properties (e.g. Reliability, Security, Repair ability)** is particularly important.



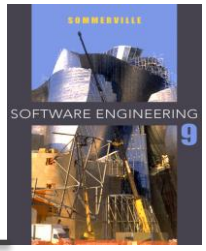
- Acceptance testing (sometimes called **'alpha testing'**.)
  - Testing with **customer data** to check that the system meets the customer's needs.
  - May reveal errors and **omissions in the system requirements** definition
  - may also reveal requirements problems where **the system's facilities do not really meet the user's needs** or the system performance is unacceptable.

Testing phases in a plan-driven software process (the V-model of development)



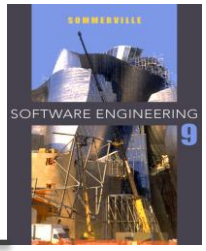


Beta Testing



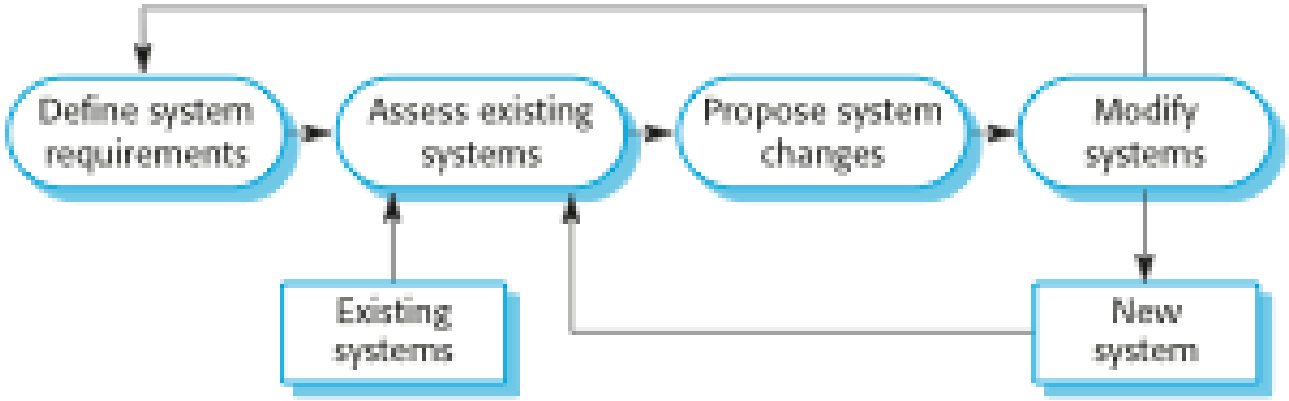
- When a system is to be marketed as a software product, a testing process called ‘beta testing’ is often used.
- Beta testing involves **delivering a system to a number of potential customers who agree to use that system**.
- **They report problems** to the system developers.
- This **exposes the product to real use** and detects errors that may not have been anticipated by the system builders.
- After this feedback, **the system is modified and released** either for further beta testing or for general sale.

Software evolution

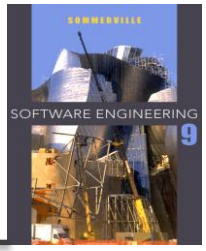


- Software is **inherently flexible and can change**.
- As requirements change through changing business circumstances, **the software that supports the business must also evolve and change**.
- Although there has been a **demarcation** between development and evolution (maintenance) this is increasingly irrelevant as **fewer and fewer systems are completely new.**
- the **costs of maintenance** are often several times the initial development costs,

System evolution

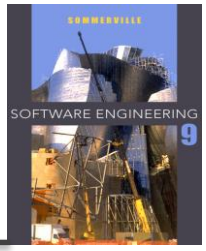


Key points

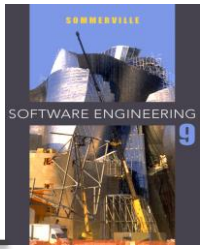


- **Software processes** are the **activities involved** in producing a software system. Software process models are abstract representations of these processes.
- General **process models describe the organization of software processes**.
- **Examples** of these general models include the '**waterfall' model**, **incremental development**, and **reuse-oriented development**.

Key points



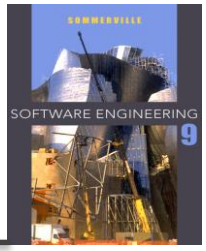
- **Requirements engineering** is the process of developing a software specification.
- **Design and implementation** processes are concerned with **transforming a requirements specification into an executable software system**.
- **Software validation** is the process of checking that the system conforms to its specification and that it meets the real needs of the users of the system.
- **Software evolution** takes place when you change existing software systems to meet new requirements. **The software must evolve to remain useful.**



Chapter 2 – Software Processes

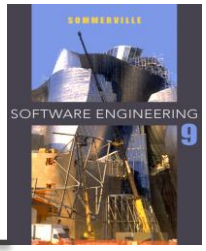
Lecture 2

Coping with change



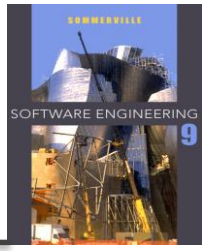
- **Change is inevitable** in all large software projects.
  - **Business changes** lead to new and changed system requirements
  - **New technologies** open up new possibilities for improving implementations
  - **Changing platforms** require application changes
- Change leads to rework so the **costs of change include both rework (e.g. re-analysing requirements) as well as the costs of implementing new functionality**

Reducing the costs of rework



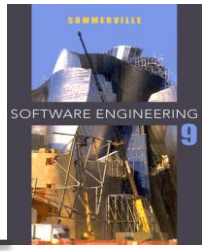
1. **Change avoidance**, where the software process includes activities that can **anticipate possible changes** before significant rework is required.
   - For example, **a prototype system** may be developed to show some key features of the system to customers.
   - They can experiment with the prototype and refine their requirements before committing to high software production costs.
2. Change Tolerance

Reducing the costs of rework



- **Change tolerance**, where the process is designed so that **changes can be accommodated** at relatively low cost.
  - This normally **involves some form of incremental development**.
  - **Proposed changes may be implemented in increments that have not yet been developed**.
  - **If this is impossible, then only a single increment** (a small part of the system) may have be altered to incorporate the change.
- The notion of **refactoring**, namely improving the structure and organization of a program, is also an important mechanism that **supports change tolerance** (**see chap3 on Agile development**)

Two ways of coping with change and changing system requirements



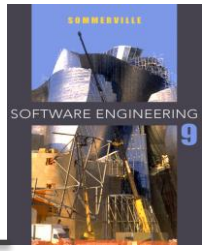
✧ System prototyping

- **supports change avoidance** as it allows users to experiment with the system before delivery and so refine their requirements.
- The number of requirements change proposals made after delivery is therefore likely to be reduced.

✧ Incremental delivery

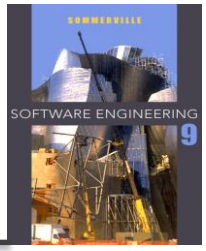
- system increments are delivered to the customer for comment and experimentation
- supports both **change avoidance and change tolerance**
- It **avoids the premature commitment to requirements** for the whole system and **allows changes to be incorporated into later increments at relatively low cost**.

Software prototyping



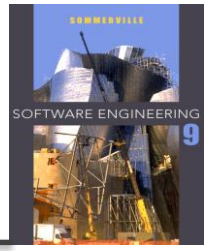
- A prototype is an initial version of a system **used to demonstrate concepts and try out design options**, and **find out more about the problem** and its possible solutions.
- A prototype can be **used in:**
  - The **requirements engineering** process to help with requirements elicitation and validation of system requirements;
  - In **design processes** to **explore options** and **develop a UI** design (to **check the feasibility** of a proposed design or to check that it **supports efficient data access**);
  - In the **testing process** to run back-to-back tests.

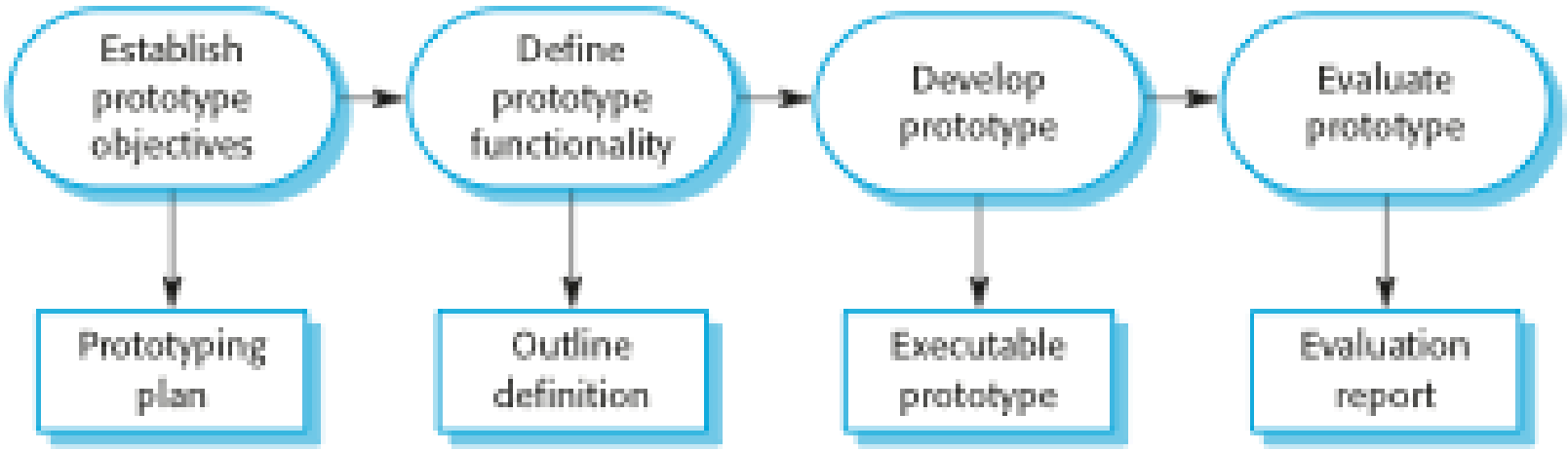
Benefits of prototyping



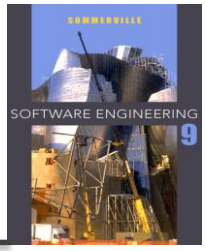
- ✧ Improved system usability.
  - Prototyping is also an essential part of the **user interface** design process.
- ✧ A closer match to users' real needs.
  - A prototype may **reveal errors and omissions** in the requirements that have been proposed.
- ✧ Improved design quality.
  - For example, **a database design** may be prototyped and tested to check that it supports efficient data access for the most common user queries.
- ✧ Improved maintainability.
- ✧ Reduced development effort.

The process of prototype development



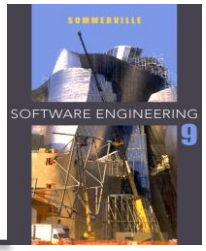


Prototype development



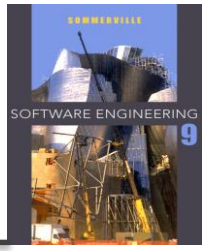
- ✧ May be based on rapid prototyping languages or tools
- ✧ May involve leaving out functionality
  - Prototype should **focus on areas of the product that are not well-understood;**
  - **Error checking and recovery may not be included in the prototype**;
  - **Focus on functional rather than non-functional requirements** such as reliability and security

Throw-away prototypes



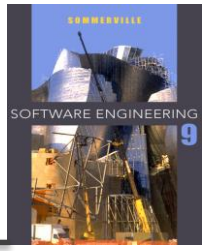
- Prototypes **should be discarded** after development as they are not a good basis for a production system:
- Developers are sometimes **pressured by managers to deliver throwaway prototypes**, particularly when there are delays in delivering the final version of the soft-ware.
- However, **this is usually unwise**:
  - It may be **impossible to tune** the system **to meet non-functional requirements;**
  - Prototypes are **normally undocumented**;
  - The prototype **structure is usually degraded** through rapid change;
  - The prototype probably will **not meet normal organizational quality standards.**

Paper-based mock-ups Prototypes



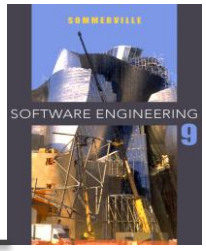
- Prototypes **do not have to be executable** to be useful. **Paper-based mock-ups of the system user interface** (Rettig, 1994) can be effective in helping users refine an interface design and work through usage scenarios.
- These are **very cheap to develop** and can be constructed **in a few days**.
- An extension of this technique is **a Wizard of Oz prototype** where only the user interface is developed.
- Users interact with this interface but **their requests are passed to a person** who interprets them and outputs the appropriate response.

Incremental delivery



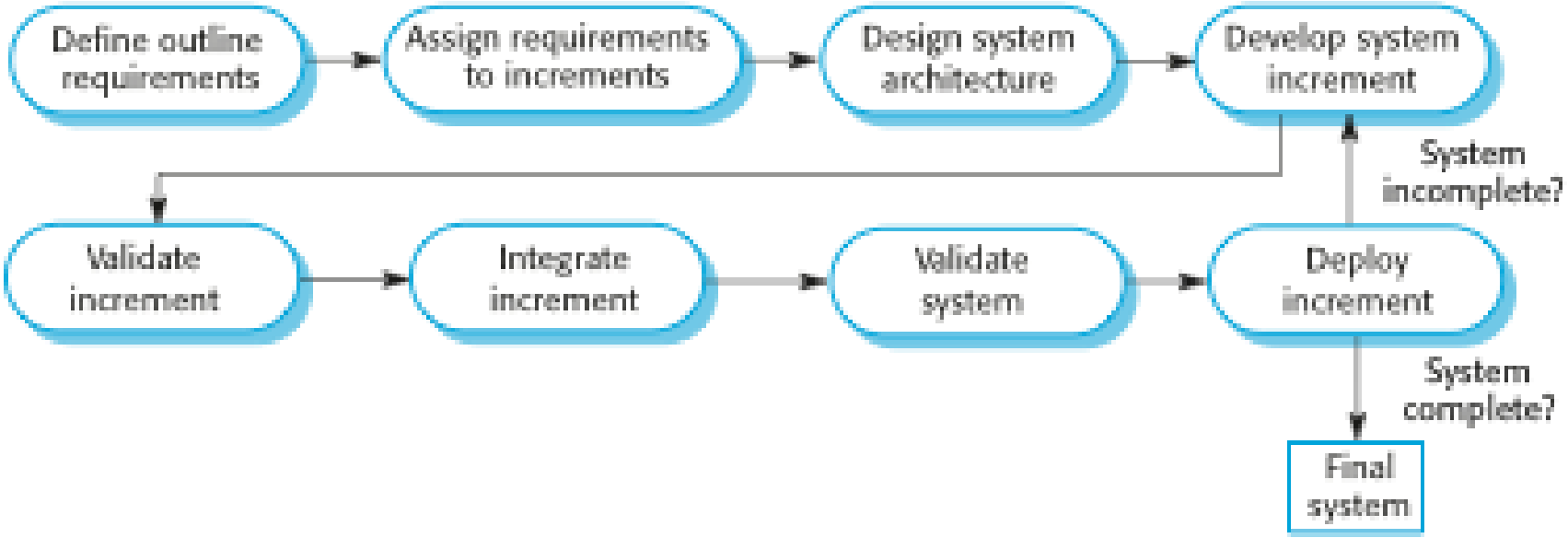
- Rather than deliver the system as a single delivery, the development and delivery is **broken down** into increments with **each increment delivering part of the required functionality**.
- **User requirements are prioritised** and the highest priority requirements are included in early increments.
- Once the development of an increment is started**, the requirements are frozen** though **requirements for later increments can continue to evolve**.
- Once an increment is completed and delivered, **customers can put it into service**
- **Unlike prototypes, increments are part of the real system**

Incremental development and delivery

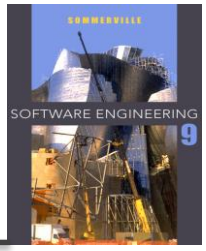


- Incremental development
  - Develop the system in increments and **evaluate each increment before proceeding** to the development of the next increment;
  - Normal approach **used in agile methods**;
  - **Evaluation done by user/customer** proxy.
- Incremental delivery
  - Deploy an increment for use by end-users;
  - **More realistic evaluation** about practical use of software;
  - **Difficult to implement for replacement systems (i.e. to replace an existing system)** as increments have less functionality than the system being replaced.

Incremental delivery

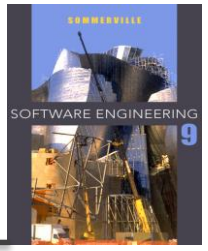


Incremental delivery advantages



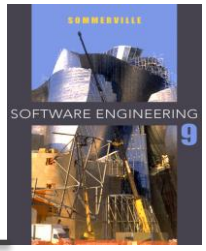
- Customer value can be delivered with each increment so **system functionality is available earlier**.
- **Early increments act as a prototype** to help elicit requirements for later increments but unlike prototypes, these are part of the real system.
- **Lower risk** of overall project failure.
- **The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

Incremental delivery problems



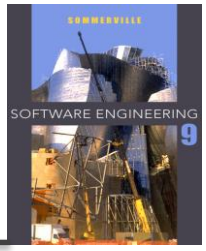
- Most systems require a **set of basic facilities** that are used by different parts of the system.
  - As requirements are not defined in detail until an increment is to be implemented, **it can be hard to identify common facilities that are needed by all increments**.
- Users want all of the functionality of **the old system** and are often **unwilling to experiment with an incomplete new system**. Therefore, **getting useful customer feedback is difficult**.
- The essence of iterative processes is that the **specification is developed in conjunction with the software**.
  - However**, this conflicts with the procurement model of many organizations**, where the **complete system specification is part of the system development contract.** In the incremental approach, there is **no complete system specification until the final increment is specified**.

The spiral model



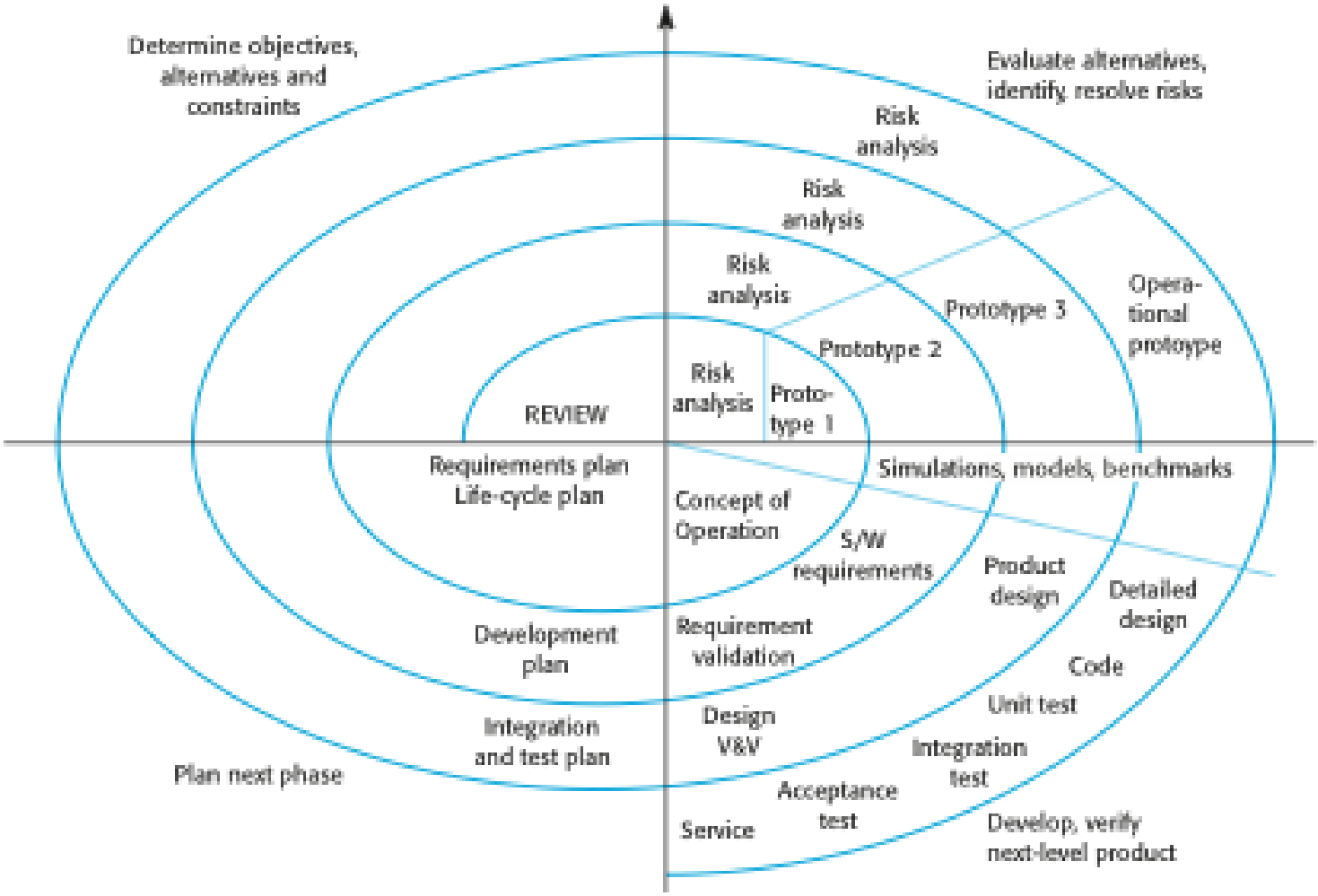
- Here, the software **process is represented as a spiral**, rather than a sequence of activities with some **backtracking** from one activity to another.
- Each loop in the spiral **represents a phase of the software process.**
- Thus, **the innermost loop** might be **concerned with system feasibility**, the **next loop with requirements definition**, the **next loop with system design**, and so on.
- **No fixed phases such as specification or design** - loops in the spiral are chosen **depending on what is required.**

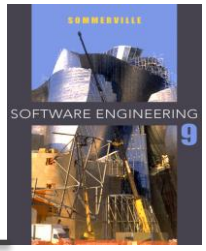
The spiral model



- The spiral model **combines change avoidance with change tolerance**.
- The main difference between the spiral model and other software process models is its **explicit recognition of risk**.
- This model of development **combines the features of the prototyping and the waterfall model**.
- The spiral model is **intended for large, expensive and complicated projects.**
- It allows for **incremental releases** of the product, or incremental refinement through each time around the spiral.
- The spiral model also explicitly includes **risk**

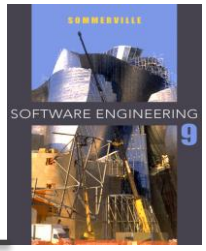
Boehm's spiral model of the software process





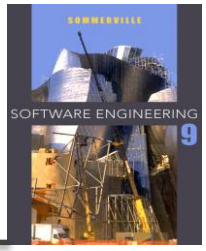
- Starting at the center, each turn around the spiral goes through several task regions :
  - **Determine the objectives**, alternatives, and constraints on the new iteration.
  - **Evaluate alternatives** and identify and **resolve risk issues**.
  - **Develop and verify** the product for this iteration.
  - **Plan the next iteration**.

Spiral model sectors



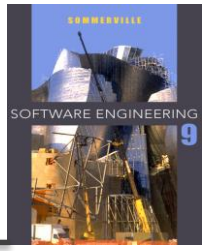
- ✧ Objective setting
  - Specific objectives for the phase are identified.
- ✧ Risk assessment and reduction
  - Risks are assessed and activities put in place to reduce the key risks.
- ✧ Development and validation
  - A development model for the system is chosen which can be any of the generic models.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

Spiral model usage

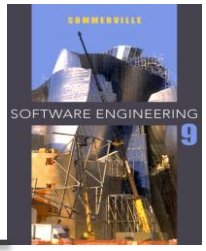


- Spiral model has been very influential in helping people think about **iteration in software** processes and **introducing the risk-driven approach** to development.
- In practice, however, the model is **rarely used as published** for practical software development.

The Rational Unified Process

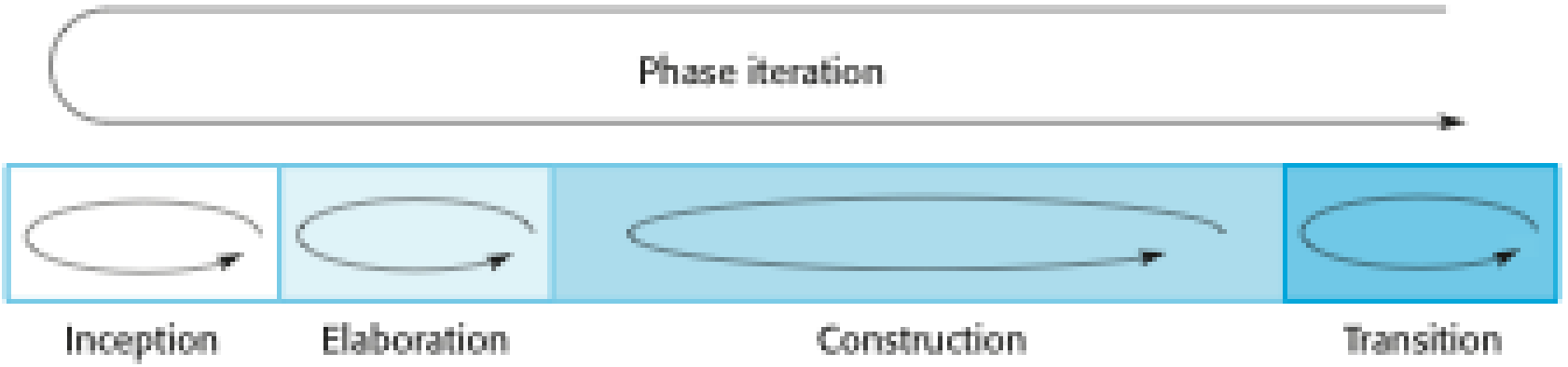


- A modern generic process **derived from the work on the UML and associated process**.
- A good example of **a hybrid process model**.
- It brings together **elements from all of the generic process models**, illustrates **good practice in specification and design** and **supports prototyping** and **incremental delivery**.
- Normally described from **3 perspectives**
  - A **dynamic perspective** that shows phases over time;
  - A **static perspective** that shows process activities;
  - A **practice perspective** that suggests good practice

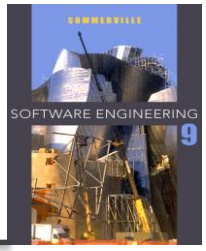


- the RUP is a **phased model** that identifies four discrete phases in the software process.
- However, **unlike the waterfall** model where phases are equated with process activities, the phases in **the RUP are more closely related to business rather than technical concerns.**

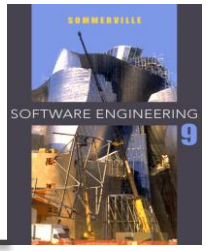
Phases in the Rational Unified Process (Dynamic Perspective)



RUP phases

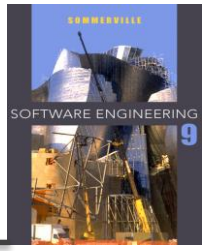


- Inception
  - **Establish the business case for the system**.
  - You should **identify all external entities** (people and systems) that will interact with the system and define these interactions.
  - You then use this information **to assess the contribution** that the system makes to the business.
  - **If this contribution is minor**, then **the project may be cancelled** after this phase.



✧ Elaboration

- Develop an **understanding of the problem** domain and the **system architecture**.
- develop **the project plan**,
- and identify **key project risks.**
- On completion of this phase you should have
  - a **requirements model** for the system, which may be a set of **UML use-cases**,
  - **an architectural description**,
  - And a **development plan for the software.**



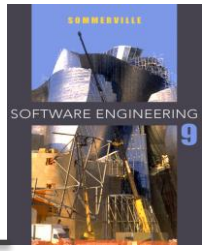
✧ Construction

- System design, programming and testing.
- **On completion of this phase**, you should have **a working software system and associated documentation** that is ready for delivery to users.

✧ Transition

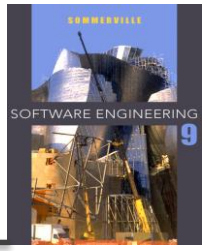
- Deploy the system (move it to the user community)
- This is something that is **ignored in most software process models** but is, in fact, an **expensive and sometimes problematic activity.**
- **On completion** of this phase, you should have **a documented software system that is working correctly in its operational environment.**

Inception



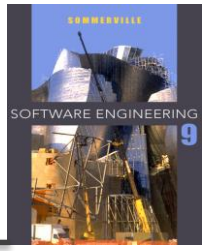
- In this phase the business case which includes business context, success factors (expected revenue, market recognition, etc.), and financial forecast is established.
- To complement the business case, a basic use case model, project plan, initial risk assessment and project description (the core project requirements, constraints and key features) are generated.

Elaboration Phase



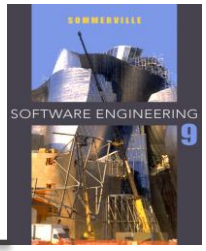
- The elaboration phase is where the project starts to take shape.
- In this phase the problem domain analysis is made and the architecture of the project gets its basic form.
- Outcomes
  - **A use-case model** in which the use-cases and the actors have been identified and most of the use-case descriptions are developed. The use-case model should be 80% complete.
  - A description of the software architecture in a software system development process.
  - Business case and risk list which are revised.
  - A **development plan** for the overall project.
  - **Prototypes** that demonstrably mitigate each identified technical risk.
  - A preliminary user manual (optional)

Construction Phase



- In this phase, the main focus is on the **development of components** and other features of the system.
- This is the phase when the **bulk of the coding** takes place.
- In larger projects, **several construction iterations** may be developed in an effort to divide the use cases into manageable segments that produce demonstrable prototypes.
- This phase produces the **first external release** of the software.

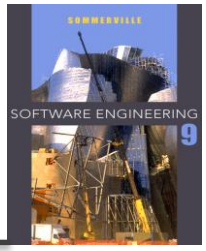
Transition Phase



- The primary objective is to **'transit' the system** from development into production, **making it available to and understood by the end user**

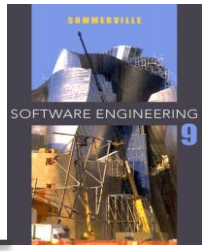
- The activities of this phase include **training the end users** and **maintainers and beta testing** the system to validate it against the end users' expectations.
- The product is also **checked against the quality level set in the Inception phase.**

RUP iteration



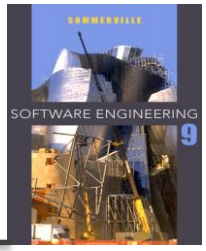
- Iteration within the RUP is supported in two ways.
  - In-phase iteration
    - Each phase **is iterat**ive with results developed incrementally.
  - Cross-phase iteration
    - As shown by the loop in the RUP model, the whole set of phases may be enacted **incrementally**.

The static view of the RUP



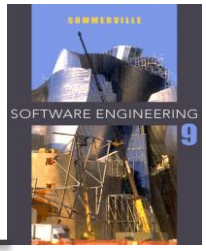
- **focuses on the activities that take place during the development process**.
- These are **called workflows** in the RUP description.
- There are **six core process** workflows identified in the process and **three core supporting work-flows**.
- The RUP has **been designed in conjunction with the UML**, so the workflow description is **oriented around associated UML models** such as **sequence models, object models**

Static workflows in the Rational Unified Process



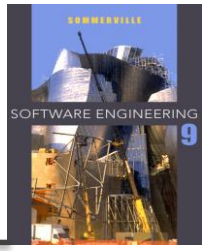
Workflow	Description
Business modelling	The business processes are modelled using business **use cases.**
Requirements	**Actors** who interact with the system **are identified** and **use cases are developed** to model the system requirements.
Analysis and design	A design model is created and documented using **architectural models**, **component models**, **object models and sequence models**.
Implementation	The components in the system are implemented and structured into implementation sub-systems. **Automatic code generation** from design models helps accelerate this process.

Static workflows in the Rational Unified Process



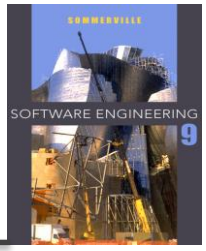
Workflow	Description
Testing	Testing is **an iterative process** that is carried **out in conjunction with implementation**. System testing follows the completion of the implementation.
Deployment	**A product release is created, distributed to users and installed in their workplace.**
Configuration and change management	This supporting workflow **managed changes to the system** (see Chapter 25).
Project management	This supporting workflow **manages the system development** (see Chapters 22 and 23).
Environment	This workflow is concerned with **making appropriate software tools available t**o the software development team.

The advantage in presenting dynamic and static views



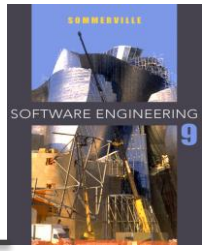
- is that phases of the development process are not associated with specific workflows.
- In principle at least, all of the RUP workflows may be **active at all stages of the process**.
- **In the early phases** of the process, most effort will probably be spent on workflows such as business modeling and requirements and,
- **in the later phases**, in testing and deployment

RUP good practice



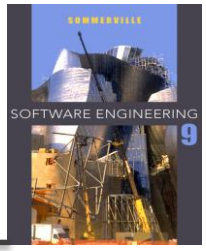
- ✧ Develop software iteratively
  - Plan increments based on customer priorities and deliver highest priority increments first.
- ✧ Manage requirements
  - Explicitly document customer requirements and keep track of changes to these requirements.
  - Analyze the impact of changes on the system before accepting them.
- ✧ Use component-based architectures
  - Organize the system architecture as a set of reusable components.

RUP good practice



- ✧ Visually model software
  - Use graphical UML models to present static and dynamic views of the software.
- ✧ Verify software quality
  - Ensure that the software meet's organizational quality standards.
- ✧ Control changes to software
  - Manage software **changes using a change management** system and **configuration management tools**.

Key points



- Processes should include activities to cope with change. This may involve a prototyping phase that helps avoid poor decisions on requirements and design.
- Processes may be structured for iterative development and delivery so that changes may be made without disrupting the system as a whole.
- The Rational Unified Process is a modern generic process model that is organized into phases (inception, elaboration, construction and transition) but separates activities (requirements, analysis and design, etc.) from these phases.