Software Engineering COMP1035

Revision

Lecture 01 - 18

Back to Start

- Why do we have Software Engineering methodologies?
  - The Software Crisis – software was bad and worse, behind schedule.
- Why is having a Software Engineering approach important?
  - Cost and Quality!
  - Systematic approach, appropriate tools
- What are the four main aspects of Software Engineering?
  - Requirements & Specifications, Development, Validation and Evolution.

Back to Start

- What SE methodologies exist?
  - Waterfall – needs ”perfect requirements”.
  - V-Model – not account for revision or refactoring.
  - Iterative Model – too much doing, not enough planning.
  - Agile – Challenge for large projects even for experienced Agile manager.

- What are problems cheapest and most expensive to fix?
  - Requirement Time vs Maintenance.

Requirements vs Specifications

- What's the difference?
  - Requirements: Software must provide (stakeholder).
  - Specification: What software must do to meet user requirements.

- How do you do requirements gathering well? (Investigating?)
  - Research, Surveys, Focus Group, Market Research, Web Metrics/Log.
  - Advanced – Technology Tours, Ethnography.

- What's the difference between Functional & Non-Functional Requirements?
  - Expected Function vs Constraints on the Software.

Requirements vs Specifications

- How can you model requirements? Users, tasks, etc.?
  - PPT, UML, Codes?

- What can you use UML for?
  - Shows complex decision process;
  - Types of UML?
    - Context Diagram
    - Activity Diagram
    - Use Case Diagram
    - Sequence Diagram
    - Class Diagram
    - State Diagram.

Design

- Major approaches to writing specifications?
  - Should be tied to requirement(s).
- Types of specification notations?

Notation	Description
Natural language sentences	The Specification are written using numbered sentences in natural language. Each sentence should express one Specification
Structured natural language	The Specification are written in natural language on a standard form or template. Each field provides information about an aspect of the Specification
Graphical notations	Graphical models, supplemented by text annotations, are used to define the functional Specification for the system. UML (unified modeling language) use case and sequence diagrams are commonly used.
Mathematical specifications	These notations are based on mathematical concepts such as finite-state machines or sets. Although these unambiguous specifications can reduce the ambiguity in a requirements document, most customers don't understand a formal specification. They cannot check that it represents what they want, and they are reluctant to accept it as a system contract. (I discuss this approach, in Chapter 10, which covers system dependability.)

Design

- Why do we create prototypes?
  - Specifications are hard to understand – bad for conveying overall idea.
  - Prototype is a way of show how all specifications work together – easy to show people and for discussion.

- Types of Prototypes?
  - **Low fidelity**: Capture point and functions.
  - **High fidelity**: To agree on final designs.

Preparations

- Understand the **diagrams**
  - What can you understand from the diagrams?
  - Draw a diagram based on the descriptions.

- Understand **Requirements vs Specifications**
  - Differences
  - Documentations/Modelling
  - Prototyping

Test Plans

- Why produce Test Plans?
  - Verified if something has been built.
  - Used for **Test Development Plan** (TDD) – part of design phase.

- Type of test plans?
  - Development
    - Unit testing – see if a method/class functions properly.
  - System/Integration
    - Test if software meets the specifications; test that cause one class to use another
  - Acceptance Test Plans
    - Test if software meets the requirements.

Coding Conventions

- We will Aim:
  - Making code easier for everyone to understand
  - Producing software that's built by 1 team - not 20 individuals
  - Setting quality standards

- Method:
  - We will all name variables like this
  - We will all write comments like this
  - We will organize the contents of a class like this
  - We will name files like this etc.

Debugging

- Debugging is to locate and remove the cause of bugs
  - Where do you want to set a breakpoint?
  - What do you trace?
  - What do you printout?

- Strategies help to do this
  - Find ways to exclude possible causes
  - Be systematic
  - Keep a log of what you've excluded

Test-Driven Development

- Testing Methods
  - White Box Testing, Black Box Testing
- Testing Processes
  - Automation, manual
- Test Driven Development

The Three Rules of TDD

- You are not allowed to write any production code unless it is to make a failing unit test pass. (**Create a unit test that fails**.)
- You are not allowed to write any more of a unit test than is sufficient to fail; and compilation failures are failures. (**Write the unit tests that are complied and sufficiently good enough**.)
- You are not allowed to write any more production code than is sufficient to pass the one failing unit test. (**Write the production codes that pass the unit tests**.)

Testing Metrics

Code Coverage - to verify the extent to which the code has been executed.

Test Coverage – to monitor the number of tests that have been executed.

Code Coverage (Statement Coverage)

- Ensure that each code statement is executed once.

Source code

```
Prints (int a, int b) {                              ------------  Prin
tsum is a function
    int result = a+ b;
    If (result> 0)
        Print ("Positive", result)
    Else
        Print ("Negative", result)
    }                                              -----------  End o
f the source code
```

```
Prints (int a, int b) {
int result = a+ b;
If (result> 0)
     Print ("Positive", result)
Else
     Print ("Negative", result)
}
```

Senario1 : a=3,b=9

Number of executed statements 5.

Number of total statements 7.

Statement coverage = 5/7.

```
Prints (int a, int b) {
int result = a+ b;
If (result> 0)
     Print ("Positive", result)
Else
     Print ("Negative", result)
}
```

Senario2 : a=-3,b=-9

Number of executed statements 6.

Number of total statements 7.

Statement coverage = 6/7.

Senario1 & Senario2

Statement coverage = 7/7=100%.

Code Coverage (Condition Coverage)

- Ensure that each Boolean sub-expression is executed once.

Source code

```
Prints (int a, int b) {                                    ------------  Prin
tsum is a function
    int result = a+ b;
    If (result> 0)
        Print ("Positive", result)
    Else
        Print ("Negative", result)
    }                                                     -----------  End o
f the source code
```

```
Prints (int a, int b) {
int result = a+ b;
If (result> 0)
     Print ("Positive", result)
Else
     Print ("Negative", result)
}
```

Senario1 : a=3,b=9

The first condition result>0 is fulfilled.

Condition coverage = 1/2.

```
Prints (int a, int b) {
int result = a+ b;
If (result> 0)
     Print ("Positive", result)
Else
     Print ("Negative", result)
}
```

Senario2 : a=-3,b=-9

The second condition result<0 is fulfilled.

Condition coverage = 1/2.

Senario1 & Senario2

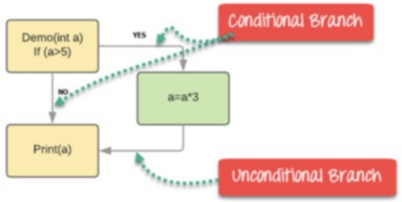
Condition coverage = 2/2=100%.

Code Coverage (Path Coverage)

- Ensure that each branch of each control structure is executed once.

Source code

```
Demo(int a) {
     If (a> 5)
        a=a*3
     Print (a)
    }
```



Senario1 : a=6

The condition (a>5) is fulfilled.

path coverage = 2/3=67%.

Senario2 : a=3.

The condition (a>5) is not met.

path coverage = 1/3=33%.

Senario1 & Senario2

Path coverage = 3/3=100%.

Testing Coverage

- Simple case:
  - If there are 100 test cases and 30 of those are executed, test coverage = 30/100

- Associated with requirement:
  - If there are 10 requirements and 100 tests created – when these 100 tests target all of the 10 requirements and don't leave out any, test coverage = 10/10
  - When only 80 of the created tests are executed and target only 6 of the requirements, test coverage = 6/10
  - When only 90 tests relating to 8 requirements are executed and the rest of them are not, test coverage = 8/10

Comparisons of Different Testing

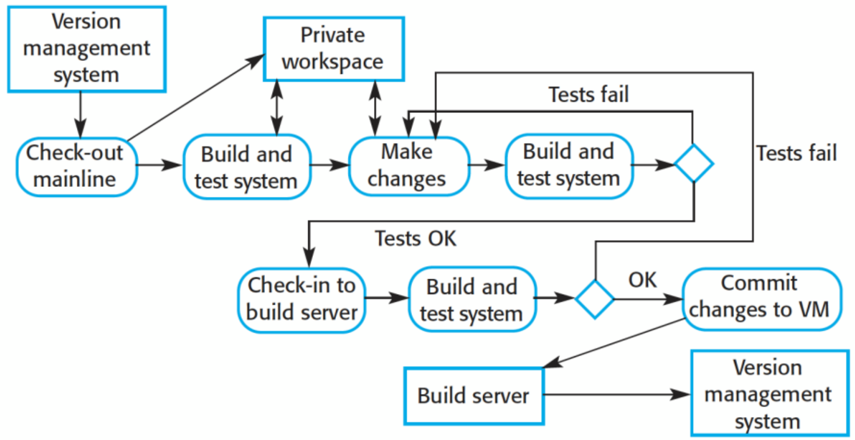
	Unit Testing	(Subsystems) Integration Testing	(Full System) Release Testing	(Customer) Acceptance Testing
What to test	Individual pieces (e.g., classes)	Combinations of pieces (subsystems)	Full system	Full system
Input	Functional specification of unit (unit test case)	Functional specification of subsystem	Full functional and non-functional specifications	User requirements
Output	Pass/Fail	Bug reports,	1) Validation reports 2) Sign off for acceptance tests	1) Acceptance reports 2) Sign off for end of contract
By who	Developer	Development team	QA team (Testing team)	QA team (Testing team) and customer
Frequency	Many per day	Preiodically e.g., end of a sprint	Prior to showing client	Prior to use
Difficulty	Easy	Difficult	Difficult	Usually, Difficult
Speed	Very fast (few seconds or less)	Relatively slow (few minutes or more)	Slow	Usually, Slow

Configuration Management

- Configuration Management (CM): track and control changes in the software.
  1. **Version Control**: keep track of the multiple versions of system components and ensure that changes made to components by different developers do not interfere with each other.
  2. **System Building**: assemble program components, data, and libraries, then compile and link these to create an **executable system**.
  3. **Change Management**: keep track of requests for changes to delivered software from customers and developers, working out the costs and impact, and deciding if and when the changes should be implemented.
  4. **Release Management**: Prepare software for external release and keep track of the system versions that have been released for customer use.

Figure 25.12 Continuous integration

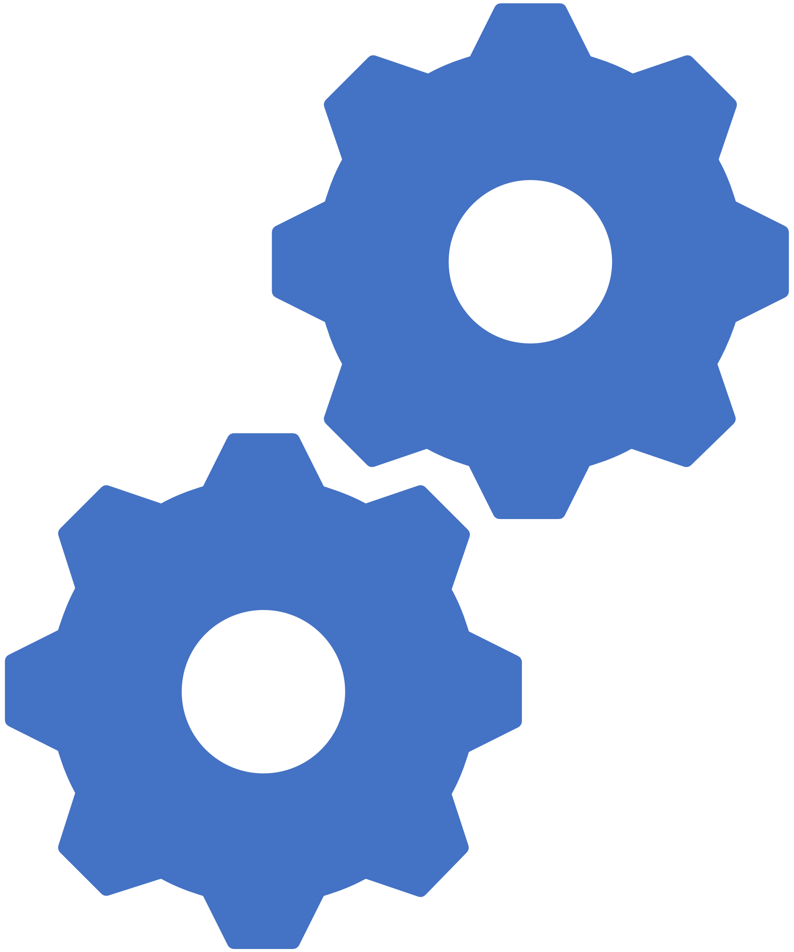
Continuous Integration: Workflow



- **Check out the mainline system** from the version management system into the developer's private workspace.
- **Build the system** and **run automated tests** to ensure that the built system passes all tests. If not, the build is broken, and you should inform whoever checked in the last baseline system. They are responsible for repairing the problem.
- **Make the changes** to the system components.
- **Build the system** in the **private workspace** and **re-run system tests**. If the tests fail, continue editing.
- Once the system has passed its tests, **check it into the build system** but **do not commit it** as a new system baseline.
- **Build the system** on the **build server** and run the tests. You need to do this in case others have modified components since you checked out the system. If this is the case, check out the components that have failed and edit these so that tests pass on your private workspace.
- If the system passes its tests on the build system, then **commit the changes** you have made as **a new baseline** in the system mainline.

Maintenance

- Maintenance involves:
  - **Correcting** errors which were not discovered in earlier stage of the life cycle
  - **Improving** the implementation of system units
  - **Enhancing** the system's services as new requirements are discovered
- Most of the lifetime of software engineering is the maintenance phase.



THREE Types of Change

Fault Repairs

to fix coding errors

usually cheap to fix

do not involve much redesign

Environmental Adaption

e.g., updates for new OS

bit more expensive to fix (many changes)

but do not involve much redesign

Functionality Addition

to meet business changes

much more expensive

often involves redesign

Process/Project Management

- Deliver good quality product
- Use good reliable methods
- Reducing as much risk as possible
- Plan / budget / manage a project based on these

Quality Assurance

- Quality Assurance is a lot more than release/acceptance testing
- Quality Assurance - is about planning for high quality goals
- Quality Assurance - is about everyone aiming for high quality
- Quality Assurance - is about inspecting for quality at each stage
- Quality Assurance - is about taking / learning from metrics of software quality - and process quality

Agile Methods

1. Our highest priority is to satisfy the customer through **early and continuous delivery** of valuable software.
2. Welcome changing requirements, even late in development. Agile processes **harness change for the customer's competitive advantage**.
3. **Deliver working software frequently**, from a couple of weeks to a couple of months, with a **preference to the shorter timescale**.
4. **Businessmen and developers must work together daily** throughout the project.
5. Build projects around motivated individuals. Give them the **environment and support they need and** trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is **face-to-face conversation**.

Agile Methods

7. **Working software is the primary measure of progress**.
8. Agile processes promote **sustainable development**. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. **Continuous attention** to technical excellence and good design enhances agility.
10. **Simplicity** — the art of maximizing the amount of work not done — is essential.
11. The best architectures, requirements, and designs **emerge from self-organizing** teams.
12. At regular intervals, **the team reflects on how to become more effective**, then tunes and adjusts its behavior accordingly.

Scrum vs Kanban vs XP

- All three framework are designed to uphold the Agile Principles
  - they just have different focuses
- Scrum is about optimising by time and delivery
- Kanban is about speed of delivery
- XP is about team effectiveness

Agile vs Traditional – Comparison

Traditional Methods	Agile Methods
Waterfall, V-Model	Spiral, Iterative Models
Requirements Tables	User Stories, Personas
Detailed UML/Specs	Rapid Prototyping
Integration Testing Phase	TDD, Paired Coding
Formal User Testing	Frequent Client Interaction
Separate Skill Teams	Integrated skills teams

Waterfall Pros

- Forward & backward **planning and implementation is easy**.
- The waterfall model is simple to use and easy to understand. It does not require any special training for project managers or employees. It has an **easy learning curve**.
- Being rigid in nature, it is **easy to manage** the waterfall cycle. Each phase has fixed deliverables and a review process.
- **Less complexity** as the phases does not overlap.
- Works **well for small projects** where we have fixed and crystal-clear requirements.
- Processes and results are **well-documented**.
- It is **easy to measure the progress** as the start and endpoints of each phase are predetermined.
- There are **no financial surprises**. Once the requirements are fixed, the final cost can be calculated before starting the development.

Waterfall Cons

- As all the requirements must be clearly known before starting the development, it **delays the project**.
- **Requires extensive research** into the user needs.
- Low flexibility makes it **difficult to accommodate any such changes**, especially when the product needs to be re-engineered to a large extent.
- **Slow delivery times**. The customer is not able to see the product until it is fully completed.
- The **client is not informed** well about the health of the project.
- **High risk and uncertainty** are involved in the waterfall model as there is too much room for issues to remain unnoticed until the project comes near to completion.
- It is difficult to **measure the progress** within each phase.

Agile Pros

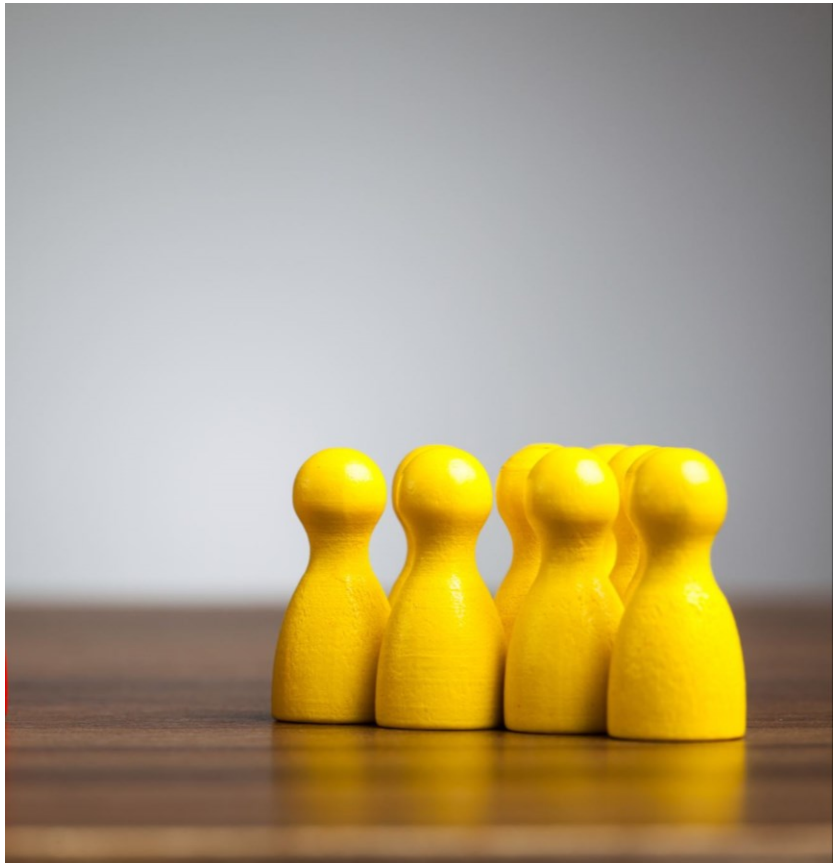
- **Great adaptability.** Agile is very flexible in dealing with the changes in customer needs and priorities.
- Allows to **constantly refine and re-prioritize the overall product backlog.**
- Agile methodology offers a great degree of **stakeholder engagement**.
- Fixed schedule sprints of one to four weeks allow for **early and predictable delivery**.
- Valuable **customer feedback** is gained **early** in the project and changes to the product can be made as required.
- By producing **frequent builds**, any misalignment with the customer requirements can also be detected and fixed early.
- Agile **promotes teamwork**.
- In an agile project, there is room for **continuous improvement**.

Agile Cons

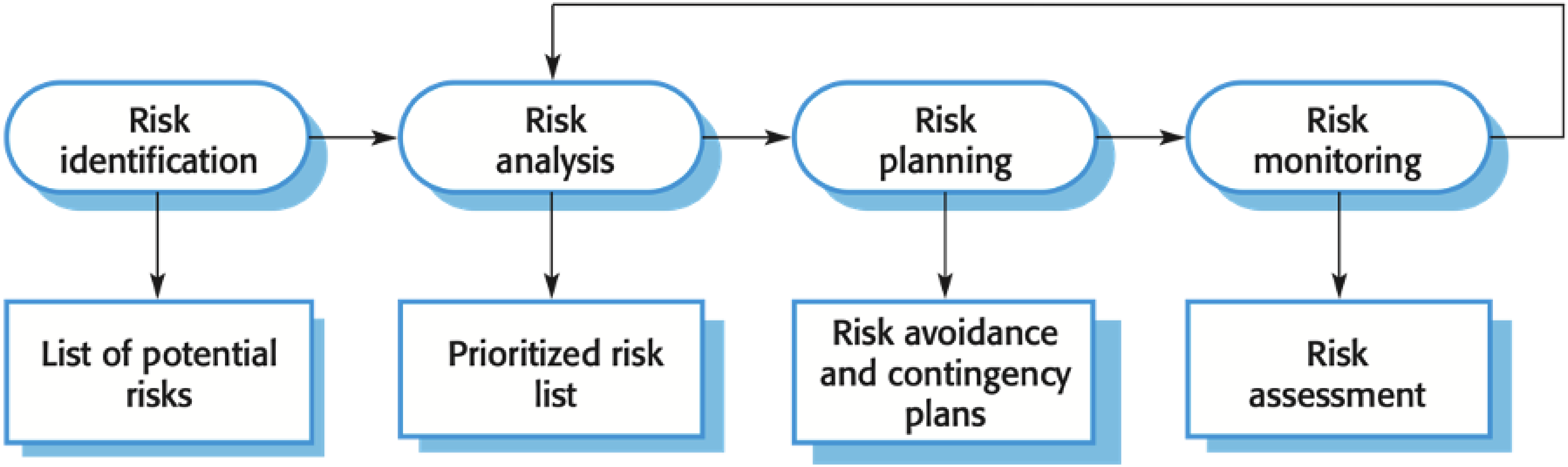
- It is often seen that Agile teams have a **tendency to neglect documentation**.
- If the initial architecture and design are weak, then **frequent refactoring** is required.
- When compared to the waterfall, Agile is **difficult to practice**. The team members must be well versed in Agile concepts.
- Due to time-boxed delivery and frequent re-prioritization, there are chances for a few features to not get delivered in the allocated timeline. This can lead to **additional sprints and additional costs**.

Risks, Opportunities, and Problems

- A **risk** is the probability of unwanted consequences of an event and decision
- An **opportunity** is the probability of exceeding expectations. A risk is the probability of failing to meet expectations
- A **risk** is **not** a problem. A risk is a potential problem over which we have some choices.
- Causes of Risks:
  - Uncertainty in time
  - Uncertainty in control
  - Uncertainty in information
- There is no software project without risks…



Risk Management Workflow



Risk Planning

- You should choose a strategy for the risks
- **Avoidance strategies** - actions taken to reduce the risk happening
- **Minimization strategies** - reducing the impact if it happens
- **Contingency plans** - what you will do/change if it happens
- Avoidance is always the best strategy, if possible.
  - it's often worth taking pre-emptive actions to avoid risks.

Project Planning

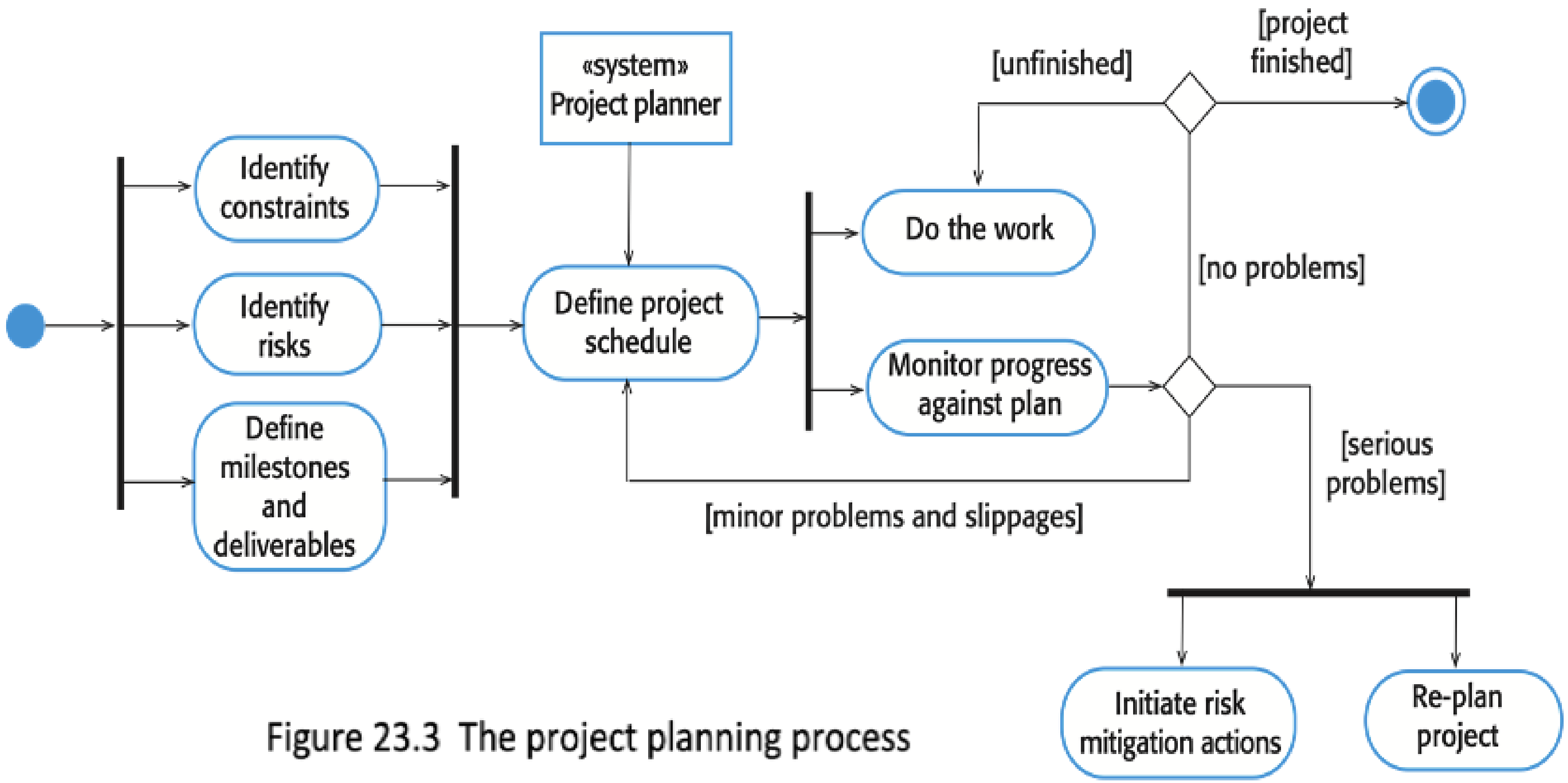
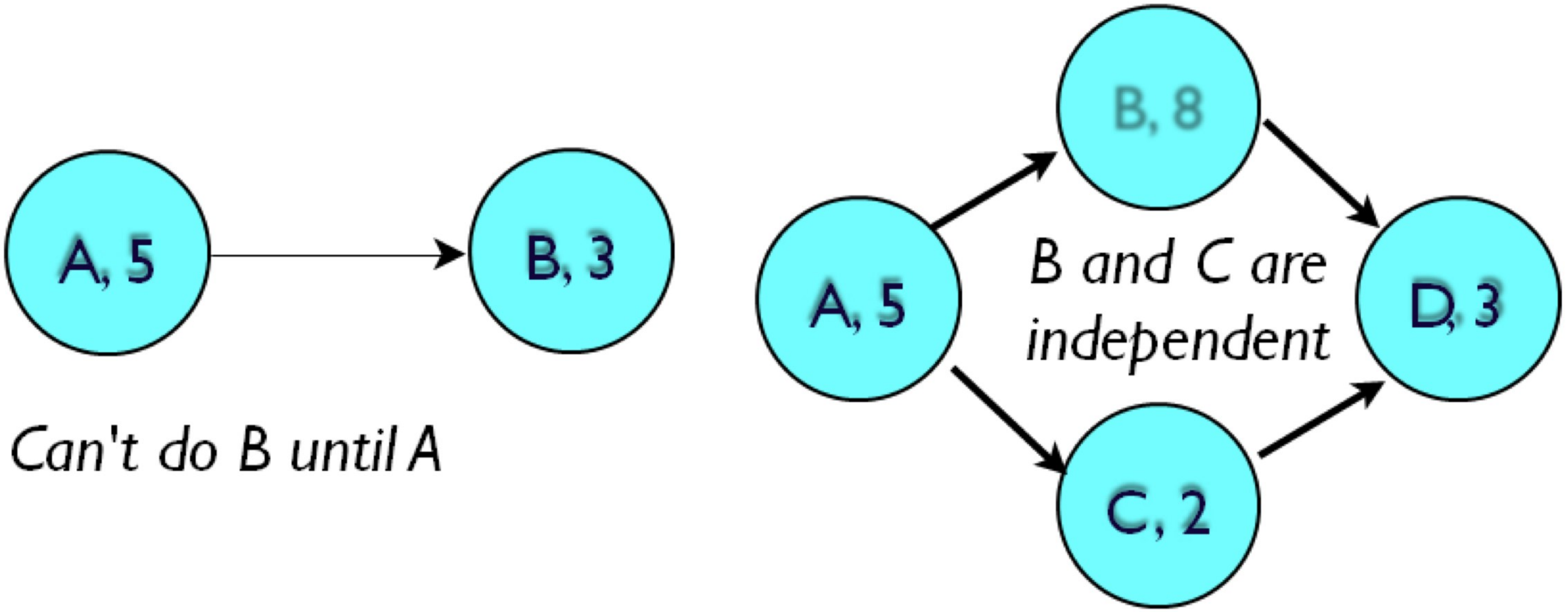


Figure 23.3 The project planning process

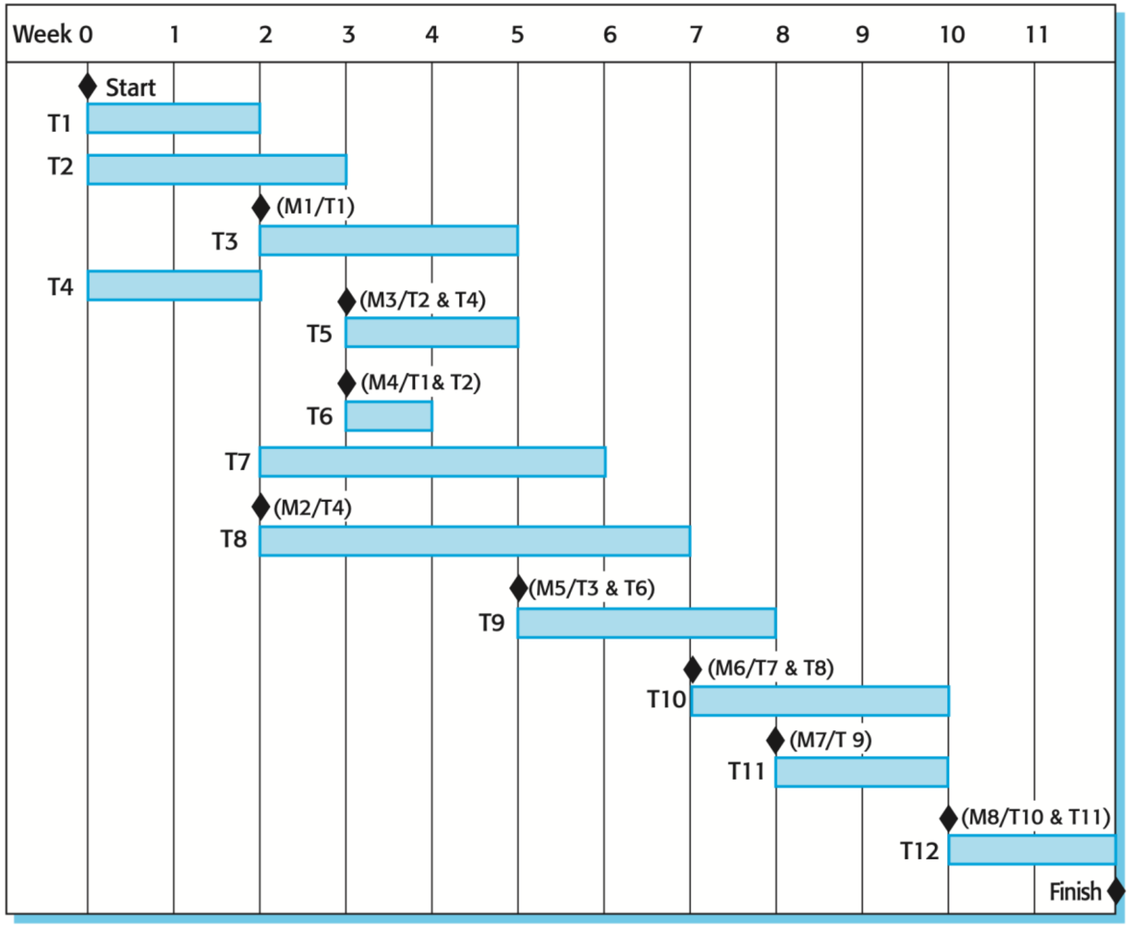
Planning Diagrams

- PERT (1958) - tasks and dependencies
- Critical Path Method (1960) - risk analysis
- Gantt Chart (1910) - adding time to the tasks/dependencies
- Staff Allocation charts - who can do the tasks/dependencies

PERT Charts



Gantt Charts



Staff-Allocation Charts

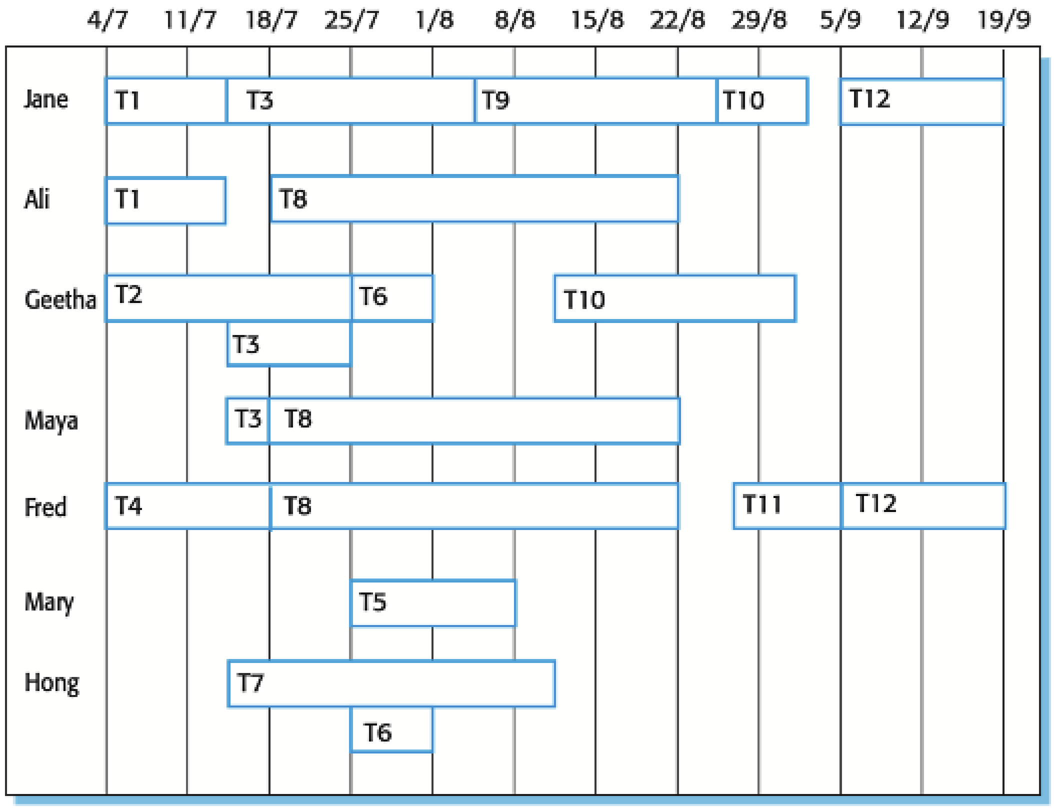


Figure 23.7 Staff allocation chart

Cost Estimation

- Experience-based techniques
  - based on experience of prior similar projects
  - based on managers familiarity with work involved

- Algorithmic Cost modelling
  - mathematical calculations based on
    - estimated amount of effort
    - experience-based constants
    - e.g., COCOMO II
    - although often as much as 25%~400% wrong

Reference – Textbook

- Chapter 1
- Chapter 2 – 2.1, 2.2
- Chapter 3
- Chapter 4 – 4.1, 4.2, 4.3, 4.4
- Chapter 5 – 5.1, 5.2, 5.3, 5.4
- Chapter 7 – 7.1, 7.2, 7.3
- Chapter 8
- Chapter 9
- Chapter 22 – 22.1
- Chapter 23 – 23.1, 23.2, 23.3

Exam

- **Date**: 23rd May 2023
- **Time**: 9:30 am to 10:30 am
- **Venue**: TB226 and TB329
- **Weight**: 50%

SET/SEM

- Please spend 5 minutes to complete the SET/SEM.
  - https://bluecastle-cn-surveys.nottingham.ac.uk


THANK
YOU