

Chapter 2: What is Software Testing

- At the end of this chapter ,the students should be able to achieve the following basic objectives
 - To identify testing in different context in software testing and quality assurance
 - To discuss about basics of software testing
 - to define about software testing process

Software Testing Basics

- In any profession it is a must that you have a firm understanding of the basic concepts of the profession.
- We will therefore briefly review the most important issues in testing to make sure that the fundamentals are present in our minds at all times.

Definitions in Testing

- what is testing all about?
- Most of us have an idea of what testing is something about finding errors.
- But further than that the confusion is fairly big.
- Let's try to seek help in **the standards**.
 - IEEE 610 (Software Engineering Terminology): “The process of **operating a system** or **component** under **specified conditions**, **observing or recording the results**, and making an evaluation of **some aspect of the system** or **component**.”
 - IEEE 829 (Test Documentation): “The process of **analyzing a software item to detect the difference** between existing and required conditions (that is, bugs) and to evaluate the features of the software items.”

Definitions in Testing Cont.

- BS 7925-1 (Software Testing–Vocabulary): “Process of exercising software to verify that it satisfies requirements and to detect errors.”
- ISTQB(International Software Testing Qualifications Board) Glossary of Terms used in Software Testing V 1.0: “**The process consisting of all life cycle activities**, both **static** and **dynamic**, concerned with **planning**, **preparation** and **evaluation of software products** and related work products to determine that they satisfy **specified requirements**, to demonstrate that they are fit for purpose and to **detect defects**.”

Definitions in Testing Cont.

- There is one term they all agree on: **process**.
 - Testing is a process.
- what does that process entail? IEEE 610 and BS 7925-1, respectively, talk about “**operating**” and “**exercising**”; that is, the idea that testing requires the software to run on a computer.
- This is **what is also called “dynamic testing.”** IEEE 829 broadens the idea to “analyzing,” thus including “**static testing.**” And
- ISTQB takes the full step and includes both “**dynamic and static.**” Testing is both dynamic and static.

Definitions in Testing Cont.

- we have to conclude: Testing can be done on **any work product** or **product** (where the difference is that work products are not delivered to the customer).
- Testing gathers information about the **quality of the object under test**.
- The quality is the amount of fulfillment of expectations..
- The product that should fulfill these expectations.
- The question is: Does it?
 - We test to be able to answer that question.

Testing Processes

- A process is a series of activities performed to fulfill a **purpose** and **produce a tangible output** based on a given input.
 - The tangible output is the way of communicating how the purpose of the process has been fulfilled.
- The process view on software development is gaining more and more interest.
- **Process models** are defined to assist organizations in process improvement that is, in making their work more **structured** and **efficient**.
- Like all processes the test process can be viewed at **different levels of detail**.

Processes in General

- Processes can be described and hence monitored and improved.
- A process description must always include:
 - A definition of the input
 - A list of activities—the procedure
 - A description of the output
- For a more comprehensive and more useful process description the following information could also be included:
 - **Entry criteria**—What must be in place before we can start?
 - **Purpose**—A description of what must be achieved ?
 - **Role**—Who is going to perform the activities?

Processes in General Cont.

- **Methods, techniques, tools**—How exactly are we going to perform the activities?
- **Measurements**—What metrics are we going to collect for the process?
- **Templates**—What should the output look like?
- **Verification points**—Are we on the right track?
- **Exit criteria**—What do we need to fulfill before we can say that we have finished?

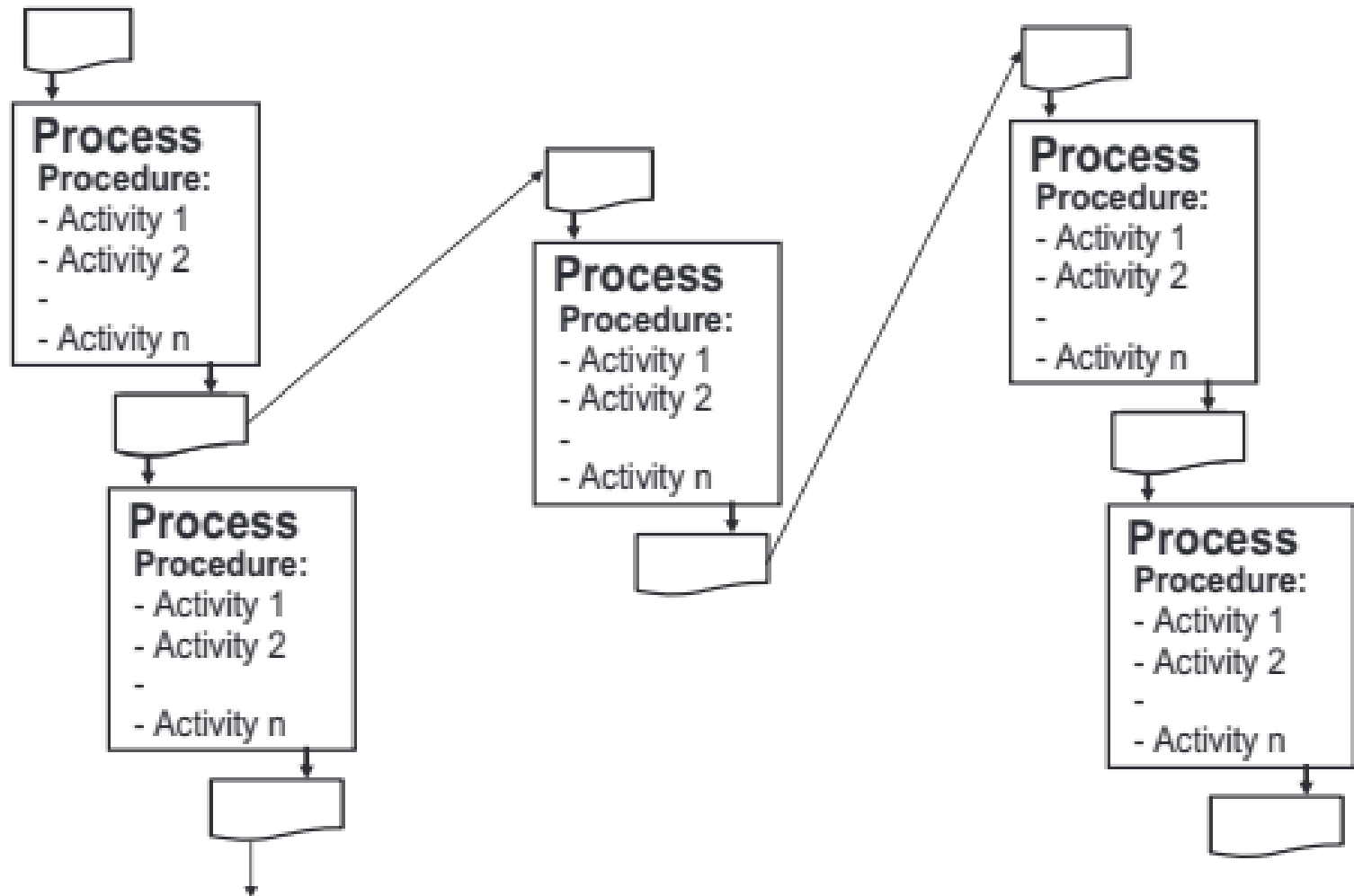
Monitoring Processes

- For testing processes it is of course important for the **test leader** to know how the testing is performed and progressing.
- processes should be the target processes for **improvement activities** and to be able to **predict** and later **determine the effect of process improvement activities**

Processes Depend on Each Other

- The input to a process must be the output from one or more proceeding processes
- The output from a process must be the input to one or more other processes.
- even the final product, which is the input to the maintenance process.
- A process model could be in a textual form or it could be graphical, as shown in the following figure.
- Here, for example, the output from the top left process serves as input to the top-middle process and to the lower-left process.

Processes Depend on Each Other Cont.



The Overall Generic Test Process

- The generic test process defined in the ISTQB foundation
- syllabus can be described like this:
- The purpose of the test process is to provide information to assure the quality of the product, decisions, and the processes for a testing assignment.
- The inputs on which this process is based are:
 - Test strategy
 - Project plan
 - Master test plan
 - Information about how the testing is progressing



The Overall Generic Test Process Cont.

- The activities are:

- Test planning and control

- Test development



- Test analysis and design

- Test implementation and execution

- Evaluating exit criteria and reporting

- Test closure activities

The Overall Generic Test Process Cont.

- The output consists of:

- Level test plan
- Test specification in the form of test conditions, test design, test cases, and test procedures and/or test scripts
- Test environment design and specification and actual test environment including test data
- Test logs
- Progress reports
- Test summary report
- Test experience report



The Overall Generic Test Process Cont.

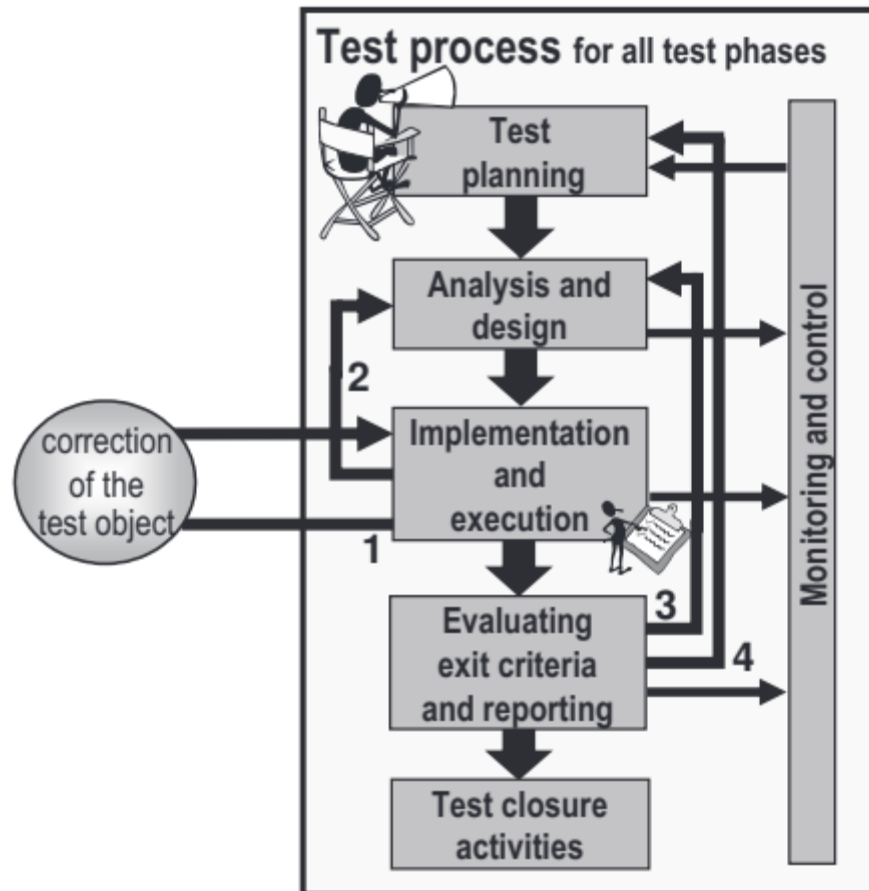
- The generic test process is applicable for
 - the dynamic and static testing.
 - the development and maintenance of a product.
- For dynamic testing
 - Component testing
 - Integration testing
 - System testing
 - Acceptance testing
- For static test
 - reviews,
 - static analysis (automated static test)

The Overall Generic Test Process Cont.

- There are dependencies between software process based on outputs.
- Some of them are described in the following sections.
- ❖ *The test activities need not be performed in strict sequential order.*
 - Test planning and control are constant activities in the sense that they are not just done once in the beginning of the test assignment.
 - Monitoring of the process should be done on an ongoing basis, and controlling and re-planning activities performed when the need arises.
 - Sometimes test analysis and design is performed in parallel with test implementation and execution.

The Overall Generic Test Process Cont.

- ❖ *The generic test process is iterative—not a simple straightforward process.*
 - we'll have to perform the activities more than once in an iterative way before the exit criteria have been fulfilled.



The Overall Generic Test Process Cont.

- The resulting iterations may be:
 1. The defect is in the test object.
 - A calculation does not give the expected result, and it appears that the algorithm for the calculation has been coded wrongly.
 - When the defect has been corrected we must retest the software using the test procedure that encountered the failure in the first place.
 - We'll probably also perform some regression testing.
 2. The defect is in the test procedure
 - A calculation does not give the expected result, but here it appears that the test case was wrong.

The Overall Generic Test Process Cont.

- The defect must be corrected and the new test case(s) must be executed.
- This iteration usually goes back to the analysis and design activity.
- The second activity from which an iteration may occur is the evaluation of the exit criteria.
- This is where we find out if the exit criteria are not met.
- The resulting iteration in this situation may be:

The Overall Generic Test Process Cont.

3. More test cases must be specified to increase coverage, and these must then be executed.

- In the checking it turns out that the decision coverage for a component is only 87%. One more test case is designed and when this is executed the coverage reaches 96%.

4. The exit criteria are relaxed or strengthened in the test plan.

The coverage is found to be too small because of an-error handling routine

that is very hard to reach. The required coverage for the component is relaxed to 85%.

Other Testing Processes

- The test process defined in the ISTQB syllabus is just one example of a possible testing process.
- Each organization **should create its own test process** suitable for the **specific circumstances in the organization**.
- **A test process** may be created from **scratch** or it may be created as **a tailoring of a standard process**.
- The various **process improvement models** that exist provide **frameworks for processes**.
 - One of the test specific models, **Test Process Improvement Model (TPI)**, defines a list of 20 key areas.

Other Testing Processes Cont.

- The 20 key areas are grouped into four so-called **cornerstones** as follows:
 - **Life cycle**:-Test strategy, life cycle model, moment of involvement
 - **Techniques**:-Estimating and planning, test specification techniques, static test techniques, metrics
 - **Infrastructure**:-Test tools, test environment, office environment
 - **Organization**:-Commitment and motivation, test functions and training, scope of methodology, communication, reporting, defect management, testware management, test process management, evaluating, low-level testing


Other Testing Processes Cont.

- Another process model is the Critical Testing Processes (CTP).
- This model also defines a number of process areas.
- In this model the process areas are grouped into four classes:
 - **Plan**:-Establish context, analyze risks, estimate, plan
 - **Prepare**:-Grow and train team, create testware, test environment, and test processes
 - **Perform**:-Receive test object(s), execute and log tests
 - **Perfect**:-Report bugs, report test results, manage changes

Test Planning and Control

- The purpose of the test planning process is
 - to verify the mission of the testing,
 - to define the objectives of the testing, and
 - to make the necessary decisions to transform the test strategy into an operational plan for the performance of the actual testing task at hand.
- The planning must first be done at the overall level resulting in a master test plan.
- The detailed planning for each test level is based on this master test plan.
- Identical planning principles apply for the overall planning and the detailed planning.

Test Planning and Control Cont.

- The purpose of the **control part** is
 - to ensure that the planned activities are on track by **monitoring what is going on** and
 - take **corrective actions** as appropriate.
- The inputs on which this process is based are:
 - ➤ Test strategy
 - Master test plan
 - Information about how the testing is progressing

Test Planning and Control Cont.

- The activities are:

- Verify the mission and define the objectives of the testing

- Decide and document how the general test strategy and the project test plan apply to the specific test level: what, how, where, who



- Make decisions and initiate corrective actions as appropriate as the testing progresses.

- The output consists of:



- Level test plan

Test Planning and Control Cont.

- Test planning and control phase consists of the following contents .
 - Input to Test Planning and Control
 - Documentation of Test Planning and Control
 - Activities in Test Planning
 - Defining Test Object and Test Basis
 - Defining the Approach
 - Defining the Completion Criteria
 - Defining Work Products and Their Relationships
 - Scoping the Test Effort
 - Activities in Test Control
 - Metrics for Test Planning and Control

Input to Test Planning and Control

- The decisions to make in the test planning and control process are guided by the expected contents of the test plan.
- Don't get it wrong:
 - The decisions are not made for the purpose of writing the plan, but for the purpose of getting agreement and commitment of all the stakeholders in the test to be performed.
- The planning and control of the test are continuous activities.
 - The initial planning will take **place first**.
 - Information from monitoring what is going on as the testing progresses **may cause controlling actions to be taken**.
 - These actions will usually involve **new planning** and **necessary corrections to be made** in the plan when **it no longer reflects the reality**

Documentation of Test Planning and Control

- A template could be based on the [IEEE 829 standard](#). This standard suggests the following contents of a test plan.
- Test plan identifier
 1. Introduction (scope, risks, and objectives)
 2. Test item(s) (test object(s))
 3. Features to be tested
 4. Features not to be tested
 5. Approach (targets, techniques, templates)
 6. Item pass/fail criteria (exit criteria including coverage criteria)
 7. Suspension criteria and resumption requirements
 8. Test deliverables (work products)

Documentation of Test Planning and Control

Cont.

9. Testing tasks (analysis, design, implementation, execution, evaluation, reporting, and closure; all broken down into more detailed activities in an appropriate work break down structure)
 10. Environmental needs
 11. Responsibilities
 12. Staffing and training needs
 13. Schedule
 14. Risks and contingencies
- The level test plan produced and maintained in this process is input to all the other detailed test processes.
 - They all have the level test plan as their reference point for information and decisions.

Activities in Test Planning

- The planning of the acceptance testing can start as soon as a draft of the user requirements is available.
- Early planning has a number of advantages. It provides for example :-
 - time to do a proper planning job,
 - adequate time to include the stakeholders,
 - early visibility of potential problems, and
 - means of influencing the development plan (e.g., to develop in a sequence that expedites testing).
- The test planning for a test level must verify the mission and define the objectives.
 - that is the goal or purpose, for the testing assignment.
- Based on this the more detailed planning can take place.

Activities in Test Planning Cont.

❖ Defining Test Object and Test Basis

- The test planning must identify the test basis and define what it is we are going to test in relation to this.
- This includes determination of the coverage to achieve for the appropriate coverage item(s).
- The expected coverage must be documented in the level test plan as (part of) the completion criteria.
- The coverage items depend on the test basis.
- Examples of the most common test basis and corresponding coverage items are listed in the following table.

Activities in Test Planning Cont.

Test level	Test basis	Coverage items
Component testing	<ul style="list-style-type: none">▸ Requirements▸ Detailed design▸ Code	<ul style="list-style-type: none">▸ Statements▸ Decisions▸ Conditions
Component integration testing	<ul style="list-style-type: none">▸ Architectural design	<ul style="list-style-type: none">▸ Internal interfaces▸ Individual parameters▸ Invariants
System testing	<ul style="list-style-type: none">▸ Software requirements specification	<ul style="list-style-type: none">▸ Requirements:<ul style="list-style-type: none">- functional- nonfunctional
System integration testing	<ul style="list-style-type: none">▸ Product design	<ul style="list-style-type: none">▸ External interfaces▸ Individual parameters▸ Invariants
Acceptance testing	<ul style="list-style-type: none">▸ User requirements specification▸ User manual	<ul style="list-style-type: none">▸ Requirements expressed as<ul style="list-style-type: none">- use cases- business scenarios

Activities in Test Planning Cont.

Static test	Documents the static test is based on	<ul style="list-style-type: none">PagesRequirementsTest cases
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- Standards, both **internal** and **external** to the organization, may also be used as the test basis.

❖ Defining the Approach

- The approach must at least cover:
 - The test **methods**(static and dynamic) and **test techniques** to use.
 - The **structure of the test specification to be produced** and **used**
 - The tools to be used
 - The **interface** with configuration management
 - Measurements to collect
 - Important **constraints**, such as availability or “fixed” deadline

Activities in Test Planning Cont.

❖ Defining the Completion Criteria

- The completion criteria are derived from the **strategy** and should be based on **a risk analysis**
 - the **higher the risk**, the **stricter the completion criteria**;
 - the lower the risk the **less demanding** and specific the completion criteria.
- It is important to **decide** up front which **completion criteria should be fulfilled** before the test may be **stopped**.
- The completion criteria guide the **specification of the test** and **the selection of test case design techniques**.

Activities in Test Planning Cont.

- The most appropriate completion criteria vary from test level to test level.
- Completion criteria for the test may be specified as follows:
 - Specified coverage has been achieved
 - Specified number of failures found per test effort has been achieved
 - No known serious faults
 - The benefits of the system are bigger than known problems
- Coverage is a very often used measurement and completion criteria in testing.
- Test coverage is the degree, expressed as a percentage, to which the coverage items have been exercised by a test.

Activities in Test Planning Cont.

- Examples of combinations of completion criteria for each of the test levels may be:
 - Component testing
 - 100% statement coverage
 - 95% decision coverage
 - No known faults
 - Integration testing (both for components and systems)
 - 90% parameter coverage
 - 60% interface coverage
 - No known faults
 - System testing
 - 90% requirement coverage
 - 100% equivalence class coverage for specific requirements
 - No known failures of criticality 1 or 2
 - Stable number of failures per test hour for more than 20 test hours
 - Acceptance testing
 - 100% business procedure coverage
 - No known failures of criticality 1

Activities in Test Planning Cont.

❖ Defining Work Products and Their Relationships

- The number of deliverables, their characteristics, and estimates of their sizes must be defined.
- this is used as input for the detailed estimation and scheduling of all the test activities.
- Typical deliveries or work products from a test level are:
 - Level test plan(s):-is/are the plan being specified in this process.
 - Test specification(s):-is a collective term for the result of the test design and implementation activities.
 - Test environment(s)
 - Test logs and journals
 - Test reports

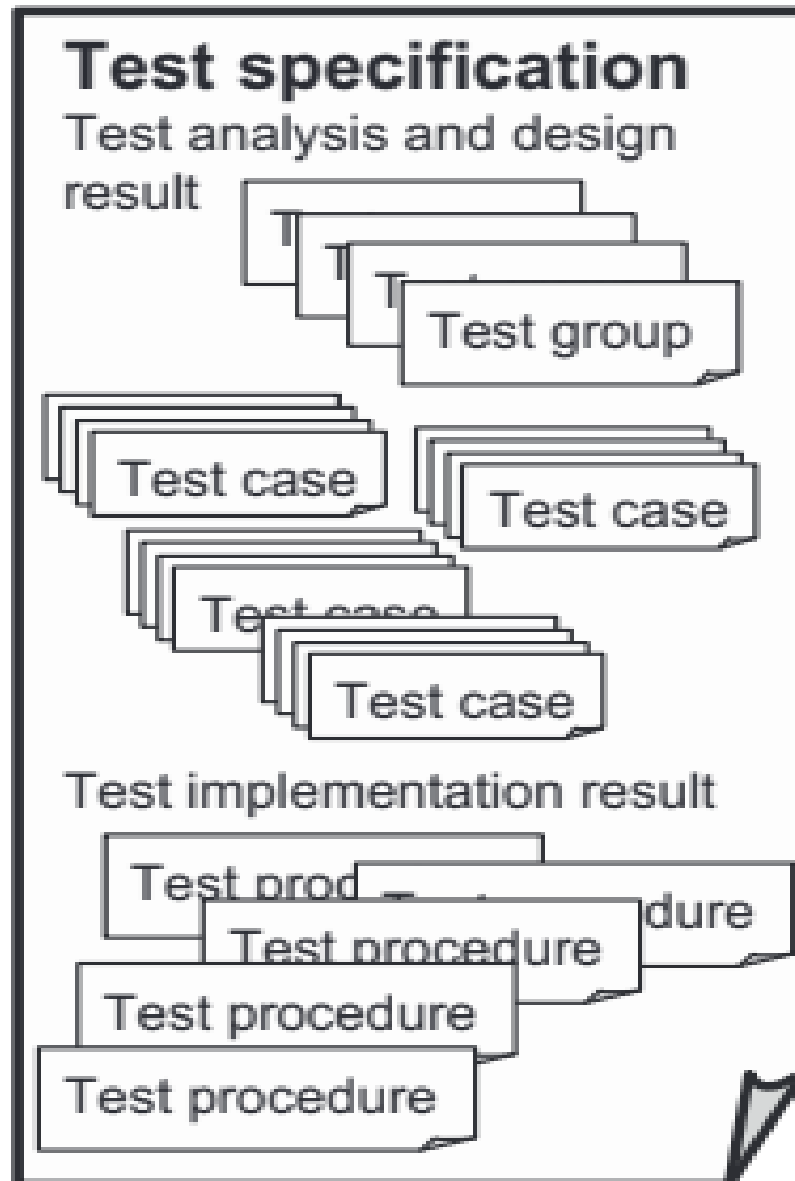
Activities in Test Planning Cont.

- It is important that the structure of the test specification is outlined in the level test plan.
- Test specifications may be structured in many ways.
 - Each organization must figure out which structure is the most suitable for them.
- The structure shown and explained here is based on the structure suggested in IEEE 829. A full test specification may consists of:
 - A test design consisting of a number of test groups (or designs) with test conditions and high-level test cases derived from the basis documentation.
 - ✓ The relationships between the elements in the basis documentation and the high-level test cases are many-to-many relationships.

Activities in Test Planning Cont.

- A number of low-level test cases extracted from the high-level test cases and being made explicit with precise input and output specifications .
- A number of test procedures each encompassing a number of test cases to be executed in sequence.
 - The relationships between high-level test cases and test procedures may also be complicated and include many-to-many relationships.

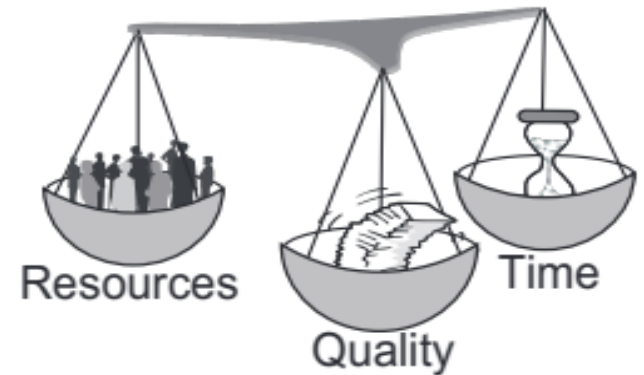
Activities in Test Planning Cont.



Activities in Test Planning Cont.

❖ Scoping the Test Effort

- exhaustive testing is a utopian goal.
- We have three mutually dependent parameters that we as testers need to balance.
- The parameters are:
 - Time: The available calendar time
 - Resources: The available people and tools
 - Quality: The quality of the testing
- These parameters form what we call the quality triangle, that is the triangle for the quality of work we can deliver.
- The basic principle of the quality triangle is: It is not possible to change one of the parameters and leave the other two unchanged—and still be in balance!
 - Test coverage is a measure for the quality of the test.



Activities in Test Planning Cont.

Work Breakdown Structure

- The overall tasks are **planning**, **monitoring**, **control**, **analysis**, **design**, **implementation**, **execution**, **evaluation**, **reporting**, and **closure**.
 - all broken down into more **detailed activities** in **an appropriate work breakdown** structure.
- The tasks, together with **resources** and **responsibilities**, are **input items** to the **test schedule**.
- **A list** and **a description** of every single task must therefore be produced.

Activities in Test Planning Cont.

- Be conscientious: remember to remember EVERYTHING!
- Be as detailed as necessary to get a precise estimate.

Defining Test Roles

- The roles to handle the testing tasks may be:
 - Test leader (manager or responsible)
 - Test analyst/designer
 - Test executer
 - Reviewer/inspector
 - Domain expert
 - Test environment responsible
 - (Test)tool responsible

Activities in Test Planning Cont.

- Test teams are formed by all these roles.
- We need different teams depending on which test phase we are working in, but the principles are the same:
 - All relevant roles must be present and filled in the team
 - A role can be filled by one person or more people, depending on the size of the testing assignment at hand
 - One person can fill one role or more roles, again depending on the size.
- The roles each require a number of specific skills.
- If these skills are not available in the people, you must describe any training needs here.
- The training should then be part of the activities to put in the schedule.

Activities in Test Planning Cont.

+ Producing the Schedule

- the staffing and the estimates are brought together and transformed into a schedule.
- Risk analysis may be used to prioritize the testing for the scheduling:
 - the higher the risk, the more time for testing and the earlier the scheduled start of the testing task.
- The result of this is a schedule that shows precisely
 - who should do
 - what at which point in time and for how long.
- Estimations for all the tasks are input to the scheduling.
- Once the tasks are estimated they can be fitted into the project time line.
- The schedule is also based on the actual people performing the tasks, the people's efficiency, and their availability.

Activities in Test Control

- The control part of test management is about staying in **control** and **making necessary corrections to the plan** when it no longer reflects the reality.
- **Measurements** are collected in the **test monitoring activities** for all the **detailed activities** in the test processes,
 - these measurements are analyzed to understand and follow the actual progress of the planned test activities and the resulting coverage.
- **Decisions** must be made if things are **deviating** significantly from the plan, and **corrective actions may be necessary**

Metrics for Test Planning and Control

- Metrics to be defined for the monitoring and control of the test planning and control activities themselves may include:
 - Number of tasks commenced over time
 - Task completion percentage over time
 - Number of tasks completed over time
 - Time spent on each task over time
- This will of course have to be compared to the estimates and schedule of the test planning and control activities.