1. Fundamentals of testing

What is Software Testing?

Software testing is a process of executing a program or application with the intent of finding the software bugs.

- It can also be stated as the **process of validating and verifying** that a software program or application or product:
  - Meets the business and technical requirements that guided it's design and development
  - Works as expected
  - Can be implemented with the same characteristic.

Let's break the definition of **Software testing** into the following parts:

1) Process: Testing is a process rather than a single activity.

2) All Life Cycle Activities: Testing is a process that's take place throughout the Software Development Life Cycle (SDLC).

- The process of designing tests early in the life cycle can help to prevent defects from being introduced in the code. Sometimes it's referred as **"verifying the test basis via the test design"**.
- The **test basis** includes documents such as the requirements and design specifications.

3) Static Testing: It can test and find defects without executing code. Static Testing is done during verification process. This testing includes reviewing of the documents (including source code) and static analysis. This is useful and cost effective way of testing. For example: reviewing, walkthrough, inspection, etc.

4) Dynamic Testing: In dynamic testing the software code is executed to demonstrate the result of running tests. It's done during validation process. For example: unit testing, integration testing, system testing, etc.

5) Planning: We need to plan as what we want to do. We control the test activities, we report on testing progress and the status of the software under test.

6) Preparation: We need to choose what testing we will do, by selecting test conditions and designing test cases.

7) Evaluation: During evaluation we must check the results and evaluate the software under test and the completion criteria, which helps us to decide whether we have finished testing and whether the software product has passed the tests.

8) Software products and related work products: Along with the testing of code the testing of requirement and design specifications and also the related documents like operation, user and training material is equally important.

Why is software testing necessary?

Software Testing is necessary because we all make mistakes. Some of those mistakes are unimportant, but some of them are expensive or dangerous. We need to check everything and anything we produce because things can always go wrong – humans make mistakes all the time.

Since we assume that our work may have mistakes, hence we all need to check our own work. However some mistakes come from bad assumptions and blind spots, so we might make the same mistakes when we check our own work as we made when we did it. So we may not notice the flaws in what we have done.

Ideally, we should get someone else to check our work because another person is more likely to spot the flaws.

There are several reasons which clearly tells us as why Software Testing is important and what are the major things that we should consider while testing of any product or application.

Software testing is very important because of the following reasons:

1. Software testing is really required to point out the defects and errors that were made during the development phases.
2. It's essential since it makes sure of the Customer's reliability and their satisfaction in the application.
3. It is very important to ensure the Quality of the product. Quality product delivered to the customers helps in gaining their confidence.
4. Testing is necessary in order to provide the facilities to the customers like the delivery of high quality product or software application which requires lower maintenance cost and hence results into more accurate, consistent and reliable results.
5. Testing is required for an effective performance of software application or product.
6. It's important to ensure that the application should not result into any failures because it can be very expensive in the future or in the later stages of the development.
7. It's required to stay in the business.

What are software testing objectives and purpose?

Software Testing has different goals and objectives.The major objectives of Software testing are as follows:

- Finding defects which may get created by the programmer while developing the software.
- Gaining confidence in and providing information about the level of quality.
- To prevent defects.
- To make sure that the end result meets the business and user requirements.
- To ensure that it satisfies the BRS that is Business Requirement Specification and SRS that is System Requirement Specifications.
- To gain the confidence of the customers by providing them a quality product.

Software testing helps in finalizing the software application or product against business and user requirements. It is very important to have good test coverage in order to test the software application completely and make it sure that it's performing well and as per the specifications.

While determining the coverage the test cases should be designed well with maximum possibilities of finding the errors or bugs. The test cases should be very effective. This objective can be measured by the number of defects reported per test cases. Higher the number of the defects reported the more effective are the test cases.

Once the delivery is made to the end users or the customers they should be able to operate it without any complaints. In order to make this happen the tester should know as how the customers are going to use this product and accordingly they should write down the test scenarios and design the test cases. This will help a lot in fulfilling all the customer's requirements.

Software testing makes sure that the testing is being done properly and hence the system is ready for use. Good coverage means that the testing has been done to cover the various areas like functionality of the application, compatibility of the application with the OS, hardware and different types of browsers, performance testing to test the performance of the application and load testing to make sure that the system is reliable and should not crash or there should not be any blocking issues. It also determines that the application can be deployed easily to the machine and without any resistance. Hence the application is easy to install, learn and use.

What is Defect or bugs or faults in software testing?

Definition:

- A defect is an error or a bug, in the application which is created. A programmer while designing and building the software can make mistakes or error. These mistakes or errors mean that there are flaws in the software. These are called defects.

- When actual result deviates from the expected result while testing a software application or product then it results into a defect. Hence, any deviation from the specification mentioned in the product functional specification document is a defect. In different organizations it's called differently like bug, issue, incidents or problem.

- When the result of the software application or product does not meet with the end user expectations or the software requirements then it results into a Bug or Defect. These defects or bugs occur because of an error in logic or in coding which results into the failure or unpredicted or unanticipated results.

Additional Information about Defects / Bugs:

While testing a software application or product if large number of defects are found then it's called Buggy.

When a tester finds a bug or defect it's required to convey the same to the developers. Thus they report bugs with the detail steps and are called as Bug Reports, issue report, problem report, etc.

This Defect report or Bug report consists of the following information:

- **Defect_ID** – Every bug or defect has it's unique identification number
- **Defect Description** – This includes the abstract of the issue.
- **Product Version** – This includes the product version of the application in which the defect is found.
- **Detail Steps** – This includes the detailed steps of the issue with the screenshots attached so that developers can recreate it.
- **Date Raised** – This includes the Date when the bug is reported
- **Reported By** – This includes the details of the tester who reported the bug like Name and ID
- **Status** – This field includes the Status of the defect like New, Assigned, Open, Retest, Verification, Closed, Failed, Deferred, etc.
- **Fixed by** – This field includes the details of the developer who fixed it like Name and ID

- **Date Closed** – This includes the Date when the bug is closed
- **Severity:** Based on the severity (Critical, Major or Minor) it tells us about impact of the defect or bug in the software application
- **Priority:** Based on the Priority set (High/Medium/Low) the order of fixing the defect can be made.

What is a Failure in software testing?

If under certain environment and situation defects in the application or product get executed then the system will produce the wrong results causing a failure.

Not all defects result in failures, some may stay inactive in the code and we may never notice them. Example: Defects in dead code will never result in failures.

It is not just defects that give rise to failure. Failures can also be caused because of the other reasons also like:

- Because of the environmental conditions as well like a radiation burst, a strong magnetic field, electronic field or pollution could cause faults in hardware or firmware. Those faults might prevent or change the execution of software.
- Failures may also arise because of human error in interacting with the software, perhaps a wrong input value being entered or an output being misinterpreted.
- Finally failures may also be caused by someone deliberately trying to cause a failure in the system.

Difference between Error, Defect and Failure in software testing:

Error: The mistakes made by programmer is knowns as an ‘Error’. This could happen because of the following reasons:

- Because of some confusion in understanding the functionality of the software

- Because of some miscalculation of the values

- Because of misinterpretation of any value, etc.

Defect: The bugs introduced by programmer inside the code are known as a defect. This can happen because of some programatical mistakes.

Failure: If under certain circumstances these defects get executed by the tester during the testing then it results into the failure which is known as software failure.

Few points that are important to know:

- When tester is executing a test he/she may observe some difference in the behavior of the feature or functionality, but this not because of the failure. This may happen because of the wrong test data entered, tester may not be aware of the feature or functionality or because of the bad environment. Because of these reasons incidents are reported. They are known as incident report. The condition or situation which requires further analysis or clarification is known as incident. To deal with the incidents the programmer need to to the analysis that whether this incident has occurred because of the failure or not.
- It’s not necessary that defects or bugs introduced in the product are only by the software. To understand it further let’s take an example. A bug or defect can also be introduced by a business analyst. Defects present in the specifications like requirements specification and design specifications

can be detected during the reviews. When the defect or bug is caught during the review cannot result into failure because the software has not yet been executed.

- These defects or bugs are reported not to blame the developers or any people but to judge the quality of the product. The quality of product is of utmost importance. To gain the confidence of the customers it's very important to deliver the quality product on time.

From where do defects and failures in software testing arise?

Defects and failures basically arise from:

- Errors in the specification, design and implementation of the software and system
- Errors in use of the system
- Environmental conditions
- Intentional damage
- Potential consequences of earlier errors

Errors in the specification and design of the software:

Specification is basically a written document which describes the functional and non – functional aspects of the software by using prose and pictures. For testing specifications there is no need of having code. Without having code we can test the specifications. About 55% of all the bugs present in the product are because of the mistakes present in the specification. Hence testing the specifications can lots of time and the cost in future or in later stages of the product.

Errors in use of the system:

Errors in use of the system or product or application may arise because of the following reasons:

- Inadequate knowledge of the product or the software to the tester. The tester may not be aware of the functionalities of the product and hence while testing the product there might be some defects or failures.

- Lack of the understanding of the functionalities by the developer. It may also happen that the developers may not have understood the functionalities of the product or application properly. Based on their understanding the feature they will develop may not match with the specifications. Hence this may result into the defect or failure.

Environmental conditions:

Because of the wrong setup of the testing environment testers may report the defects or failures. As per the recent surveys it has been observed that about 40% of the tester's time is consumed because of the environment issues and this has a great impact on quality and productivity. Hence proper test environments are required for quality and on time delivery of the product to the customers.

Intentional damage:

The defects and failures reported by the testers while testing the product or the application may arise because of the intentional damage.

Potential consequences of earlier errors:

Errors found in the earlier stages of the development reduce our cost of production. Hence it's very important to find the error at the earlier stage. This could be done by reviewing the specification documents or by walkthrough. The downward flow of the defect will increase the cost of production.

When do defects in software testing arise?

Because of the following reasons the software defects arise:

- The person using the software application or product may not have enough knowledge of the product.

- Maybe the software is used in the wrong way which leads to the defects or failures.

- The developers may have coded incorrectly and there can be defects present in the design.

- Incorrect setup of the testing environments.

To know when defects in software testing arise, let us take a small example with a diagram as given below.

We can see that **Requirement 1** is implemented correctly – we understood the customer's requirement, designed correctly to meet that requirement, built correctly to meet the design, and so deliver that requirement with the right attributes: functionally, it does what it is supposed to do and it also has the right non-functional attributes, so it is fast enough, easy to understand and so on.

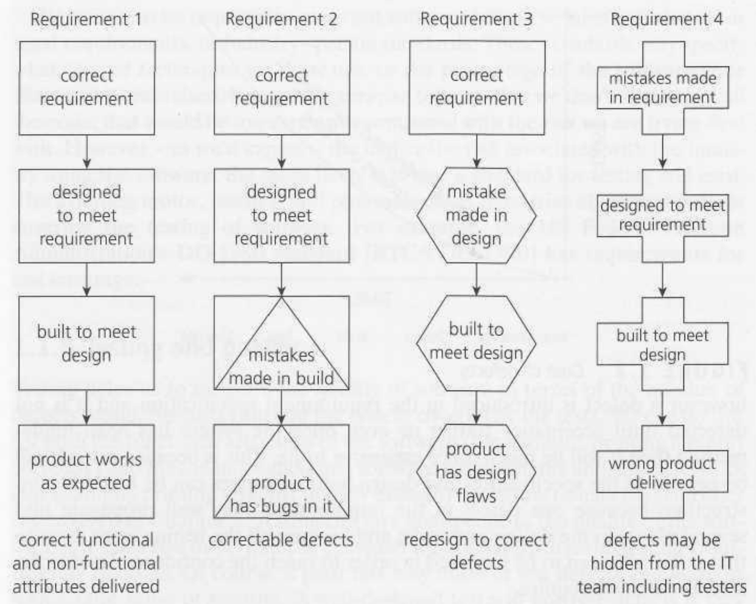


FIGURE 1.1 Types of error and defect

With the other requirements, errors have been made at different stages. **Requirement 2** is fine until the software is coded, when we make some mistakes and introduce defects. Probably, these are easily spotted and corrected during testing, because we can see the product does not meet its design specification.

The defects introduced in **Requirement 3** are harder to deal with; we built exactly what we were told to but unfortunately the designer made some mistakes so there are defects in the design. Unless we check against the requirements definition, we will not spot those defects during testing. When we do notice them they will be hard to fix because design changes will be required.

The defects in **Requirement 4** were introduced during the definition of the requirements; the product has been designed and built to meet that flawed requirements definition. If we test the product meets its requirements and design, it will pass its tests but may be rejected by the user or customer. Defects reported by the customer in acceptance test or live use can be very costly. Unfortunately, requirements and design defects are not rare; assessments of thousands of projects have shown that defects introduced during requirements and design make up close to half of the total number of defects.

What is the cost of defects in software testing?

The cost of defects can be measured by the impact of the defects and when we find them. Earlier the defect is found lesser is the cost of defect. For example if error is found in the requirement specifications then it is somewhat cheap to fix it. The correction to the requirement specification can be done and then it can be re-issued. In the same way when defect or error is found in the design then the design can be corrected and it can be re-issued. But if the error is not caught in the specifications and is not found till the user acceptance then the cost to fix those errors or defects will be way too expensive.

If the error is made and the consequent defect is detected in the **requirements phase** then it is relatively cheap to fix it.

Similarly if an error is made and the consequent defect is found in the **design phase** then the design can be corrected and reissued with relatively little expense.

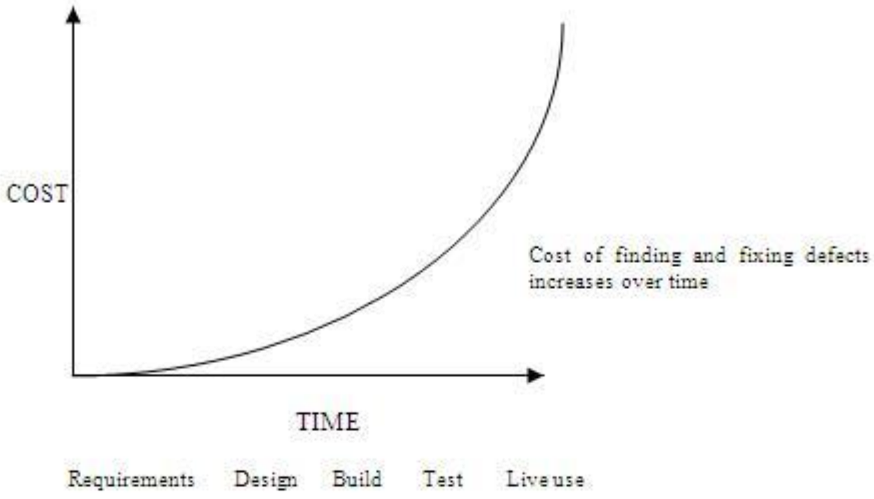


FIGURE 1.2

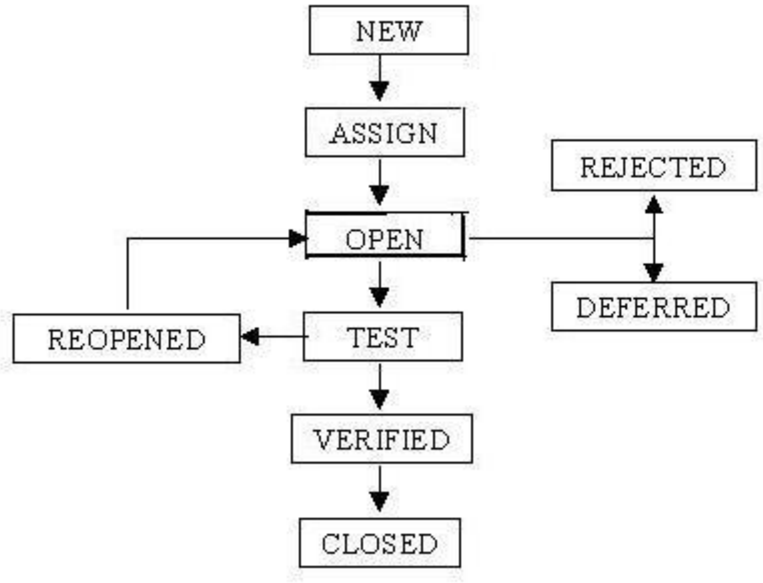
The same applies for **construction phase**. If however, a defect is introduced in the requirement specification and it is not detected until acceptance testing or even once the system has been implemented then it will be much more expensive to fix. This is because rework will be needed in the specification and design before changes can be made in construction; because one defect in the requirements may well propagate into several places in the design and code; and because all the testing work done-to that point will need to be repeated in order to reach the confidence level in the software that we require.

It is quite often the case that defects detected at a very late stage, depending on how serious they are, are not corrected because the cost of doing so is too expensive.

What is a Defect Life Cycle or a Bug lifecycle in software testing?

Defect life cycle is a cycle which a defect goes through during its lifetime. It starts when defect is found and ends when a defect is closed, after ensuring it's not reproduced. Defect life cycle is related to the bug found during testing.

The bug has different states in the Life Cycle. The Life cycle of the bug can be shown diagrammatically as



follows:

Bug or defect life cycle includes following steps or status:

1. **New:** When a defect is logged and posted for the first time. It's state is given as new.
2. **Assigned:** After the tester has posted the bug, the lead of the tester approves that the bug is genuine and he assigns the bug to corresponding developer and the developer team. It's state given as assigned.
3. **Open:** At this state the developer has started analyzing and working on the defect fix.
4. **Fixed:** When developer makes necessary code changes and verifies the changes then he/she can make bug status as 'Fixed' and the bug is passed to testing team.
5. **Pending retest:** After fixing the defect the developer has given that particular code for retesting to the tester. Here the testing is pending on the testers end. Hence its status is pending retest.
6. **Retest:** At this stage the tester do the retesting of the changed code which developer has given to him to check whether the defect got fixed or not.
7. **Verified:** The tester tests the bug again after it got fixed by the developer. If the bug is not present in the software, he approves that the bug is fixed and changes the status to "verified".
8. **Reopen:** If the bug still exists even after the bug is fixed by the developer, the tester changes the status to "reopened". The bug goes through the life cycle once again.
9. **Closed:** Once the bug is fixed, it is tested by the tester. If the tester feels that the bug no longer exists in the software, he changes the status of the bug to "closed". This state means that the bug is fixed, tested and approved.
10. **Duplicate:** If the bug is repeated twice or the two bugs mention the same concept of the bug, then one bug status is changed to "duplicate**".**
11. **Rejected:** If the developer feels that the bug is not genuine, he rejects the bug. Then the state of the bug is changed to "rejected".

12. **Deferred:** The bug, changed to deferred state means the bug is expected to be fixed in next releases. The reasons for changing the bug to this state have many factors. Some of them are priority of the bug may be low, lack of time for the release or the bug may not have major effect on the software.
13. **Not a bug:** The state given as “Not a bug” if there is no change in the functionality of the application. For an example: If customer asks for some change in the look and field of the application like change of colour of some text then it is not a bug but just some change in the looks of the application.

What is the difference between Severity and Priority?

There are two key things in defects of the software testing. They are:

1) Severity

2) Priority

What is the difference between Severity and Priority?

1) Severity:

It is the extent to which the defect can affect the software. In other words it defines the impact that a given defect has on the system. **For example:** If an application or web page crashes when a remote link is clicked, in this case clicking the remote link by an user is rare but the impact of application crashing is severe. So the severity is high but priority is low.

Severity can be of following types:

- **Critical:** The defect that results in the termination of the complete system or one or more component of the system and causes extensive corruption of the data. The failed function is unusable and there is no acceptable alternative method to achieve the required results then the severity will be stated as critical.
- **Major:** The defect that results in the termination of the complete system or one or more component of the system and causes extensive corruption of the data. The failed function is unusable but there exists an acceptable alternative method to achieve the required results then the severity will be stated as major.
- **Moderate:** The defect that does not result in the termination, but causes the system to produce incorrect, incomplete or inconsistent results then the severity will be stated as moderate.
- **Minor:** The defect that does not result in the termination and does not damage the usability of the system and the desired results can be easily obtained by working around the defects then the severity is stated as minor.
- **Cosmetic:** The defect that is related to the enhancement of the system where the changes are related to the look and field of the application then the severity is stated as cosmetic.

2) Priority:

Priority defines the order in which we should resolve a defect. Should we fix it now, or can it wait? This priority status is set by the tester to the developer mentioning the time frame to fix the defect. If high priority is mentioned then the developer has to fix it at the earliest. The priority status is set based on the customer requirements. **For example:** If the company name is misspelled in the home page of the website, then the priority is high and severity is low to fix it.

Priority can be of following types:

- **Low:** The defect is an irritant which should be repaired, but repair can be deferred until after more serious defect have been fixed.
- **Medium:** The defect should be resolved in the normal course of development activities. It can wait until a new build or version is created.
- **High:** The defect must be resolved as soon as possible because the defect is affecting the application or the product severely. The system cannot be used until the repair has been done.

Few very important scenarios related to the severity and priority which are asked during the interview:

High Priority & High Severity: An error which occurs on the basic functionality of the application and will not allow the user to use the system. (Eg. A site maintaining the student details, on saving record if it, doesn't allow to save the record then this is high priority and high severity bug.)

High Priority & Low Severity: The spelling mistakes that happens on the cover page or heading or title of an application.

High Severity & Low Priority: An error which occurs on the functionality of the application (for which there is no workaround) and will not allow the user to use the system but on click of link which is rarely used by the end user.

Low Priority and Low Severity: Any cosmetic or spelling issues which is within a paragraph or in the report (Not on cover page, heading, title).

What are the principles of testing?

Principles of Testing

There are seven principles of testing. They are as follows:

1) Testing shows presence of defects: Testing can show the defects are present, but cannot prove that there are no defects. Even after testing the application or product thoroughly we cannot say that the product is 100% defect free. Testing always reduces the number of undiscovered defects remaining in the software but even if no defects are found, it is not a proof of correctness.

2) Exhaustive testing is impossible: Testing everything including all combinations of inputs and preconditions is not possible. So, instead of doing the exhaustive testing we can use risks and priorities to focus testing efforts. For example: In an application in one screen there are 15 input fields, each having 5 possible values, then to test all the valid combinations you would need 30 517 578 125 (5^{15}) tests. This is very unlikely that the project timescales would allow for this number of tests. So, accessing and managing risk is one of the most important activities and reason for testing in any project.

3) Early testing: In the software development life cycle testing activities should start as early as possible and should be focused on defined objectives.

4) Defect clustering: A small number of modules contains most of the defects discovered during pre-release testing or shows the most operational failures.

5) Pesticide paradox: If the same kinds of tests are repeated again and again, eventually the same set of test cases will no longer be able to find any new bugs. To overcome this "Pesticide Paradox", it is really very important to review the test cases regularly and new and different tests need to be written to exercise different parts of the software or system to potentially find more defects.

6) Testing is context depending: Testing is basically context dependent. Different kinds of sites are tested differently. For example, safety – critical software is tested differently from an e-commerce site.

7) Absence – of – errors fallacy: If the system built is unusable and does not fulfil the user's needs and expectations then finding and fixing defects does not help.

What is fundamental test process in software testing?

Testing is a process rather than a single activity. This process starts from test planning then designing test cases, preparing for execution and evaluating status till the test closure. So, we can divide the activities within the fundamental test process into the following basic steps:

1) Planning and Control
2) Analysis and Design
3) Implementation and Execution
4) Evaluating exit criteria and Reporting
5) Test Closure activities

1) Planning and Control:

Test planning has following major tasks:
i. To determine the scope and risks and identify the objectives of testing.
ii. To determine the test approach.
iii. To implement the test policy and/or the **test strategy**. (Test strategy is an outline that describes the testing portion of the software development cycle. It is created to inform PM, testers and developers about some key issues of the testing process. This includes the testing objectives, method of testing, total time and resources required for the project and the testing environments.).
iv. To determine the required test resources like people, test environments, PCs, etc.
v. To schedule test analysis and design tasks, test implementation, execution and evaluation.
vi. To determine the **Exit criteria** we need to set criteria such as **Coverage criteria.** (Coverage criteria are the percentage of statements in the software that must be executed during testing. This will help us track whether we are completing test activities correctly. They will show us which tasks and checks we must complete for a particular level of testing before we can say that testing is finished.)

Test control has the following major tasks:
i. To measure and analyze the results of reviews and testing.
ii. To monitor and document progress, test coverage and exit criteria.
iii. To provide information on testing.
iv. To initiate corrective actions.
v. To make decisions.

2) Analysis and Design:

Test analysis and Test Design has the following major tasks:
i. To review the **test basis.** (The test basis is the information we need in order to start the test analysis and create our own test cases. Basically it's a documentation on which test cases are based, such as requirements, design specifications, product risk analysis, architecture and interfaces. We can use the test basis documents to understand what the system should do once built.)

ii. To identify test conditions.
iii. To design the tests.
iv. To evaluate testability of the requirements and system.
v. To design the test environment set-up and identify and required infrastructure and tools.

3) Implementation and Execution:

During test implementation and execution, we take the test conditions into **test cases** and procedures and other **testware** such as scripts for automation, the test environment and any other test infrastructure. (Test cases is a set of conditions under which a tester will determine whether an application is working correctly or not.)
(Testware is a term for all utilities that serve in combination for testing a software like scripts, the test environment and any other test infrastructure for later reuse.)

Test implementation has the following major task:
i. To develop and prioritize our test cases by using techniques and create **test data** for those tests. (In order to test a software application you need to enter some data for testing most of the features. Any such specifically identified data which is used in tests is known as test data.)
We also write some instructions for carrying out the tests which is known as **test procedures.**
We may also need to automate some tests using **test harness** and automated tests scripts. (A test harness is a collection of software and test data for testing a program unit by running it under different conditions and monitoring its behavior and outputs.)
ii. To create test suites from the test cases for efficient test execution.
(Test suite is a collection of test cases that are used to test a software program to show that it has some specified set of behaviours. A test suite often contains detailed instructions and information for each collection of test cases on the system configuration to be used during testing. Test suites are used to group similar test cases together.)
iii. To implement and verify the environment.

Test execution has the following major task:
i. To execute test suites and individual test cases following the test procedures.
ii. To re-execute the tests that previously failed in order to confirm a fix. This is known as **confirmation testing or re-testing.**
iii. To log the outcome of the test execution and record the identities and versions of the software under tests. The **test log** is used for the audit trial. (A test log is nothing but, what are the test cases that we executed, in what order we executed, who executed that test cases and what is the status of the test case (pass/fail). These descriptions are documented and called as test log.).
iv. To Compare actual results with expected results.
v. Where there are differences between actual and expected results, it report discrepancies as Incidents.

4) Evaluating Exit criteria and Reporting:

Based on the risk assessment of the project we will set the criteria for each test level against which we will measure the “enough testing”. These criteria vary from project to project and are known as **exit criteria**.
Exit criteria come into picture, when:
– Maximum test cases are executed with certain pass percentage.
– Bug rate falls below certain level.
– When achieved the deadlines.

Evaluating exit criteria has the following major tasks:
i. To check the test logs against the exit criteria specified in test planning.
ii. To assess if more test are needed or if the exit criteria specified should be changed.
iii. To write a test summary report for stakeholders.

5) Test Closure activities:

Test closure activities are done when software is delivered. The testing can be closed for the other reasons also like:

- When all the information has been gathered which are needed for the testing.
- When a project is cancelled.
- When some target is achieved.
- When a maintenance release or update is done.

Test closure activities have the following major tasks:
i. To check which planned deliverables are actually delivered and to ensure that all incident reports have been resolved.
ii. To finalize and archive testware such as scripts, test environments, etc. for later reuse.
iii. To handover the testware to the maintenance organization. They will give support to the software.
iv To evaluate how the testing went and learn lessons for future releases and projects.

What is the Psychology of testing?

In this section we will discuss:

- The comparison of the mindset of the tester and the developer.
- The balance between self-testing and independent testing.
- There should be clear and courteous communication and feedback on defects between tester and developer.

Comparison of the mindset of the tester and developer:

The testing and reviewing of the applications are different from the analysing and developing of it. By this we mean to say that if we are building or developing applications we are working positively to solve the problems during the development process and to make the product according to the user specification. However while testing or reviewing a product we are looking for the defects or failures in the product. Thus building the software requires a different mindset from testing the software.

The balance between self-testing and independent testing:

The comparison made on the mindset of the tester and the developer in the above article is just to compare the two different perspectives. It does not mean that the tester cannot be the programmer, or that the programmer cannot be the tester, although they often are separate roles. In fact programmers are the testers. They always test their component which they built. While testing their own code they find many problems so the programmers, architect and the developers always test their own code before giving it to anyone. However we all know that it is difficult to find our own mistakes. So, programmers, architect, business analyst depend on others to help test their work. This other person might be some other developer from the same team or the Testing specialists or professional testers. Giving applications to the testing specialists or professional testers allows an independent test of the system.

This degree of independence avoids author bias and is often more effective at finding defects and failures.

There is several level of independence in software testing which is listed here from the lowest level of independence to the highest:
i. Tests by the person who wrote the item.
ii. Tests by another person within the same team, like another programmer.
iii. Tests by the person from some different group such as an independent test team.
iv. Tests by a person from a different organization or company, such as outsourced testing or certification by an external body.

Clear and courteous communication and feedback on defects between tester and developer: We all make mistakes and we sometimes get annoyed and upset or depressed when someone points them out. So, when as testers we run a test which is a good test from our viewpoint because we found the defects and failures in the software. But at the same time we need to be very careful as how we react or report the defects and failures to the programmers. We are pleased because we found a good bug but how will the requirement analyst, the designer, developer, project manager and customer react.

- The people who build the application may react defensively and take this reported defect as personal criticism.
- The project manager may be annoyed with everyone for holding up the project.
- The customer may lose confidence in the product because he can see defects.

Because testing can be seen as destructive activity we need to take care while reporting our defects and failures as objectively and politely as possible.

The balance between self-testing and independent testing

What is independent testing? It's benefits and risks

The degree of independence avoids author bias and is often more effective at finding defects and failures.

There is several level of independence which is listed here from the lowest level of independence to the highest:
i. Tests by the person who wrote the item.
ii. Tests by another person within the same team, like another programmer.
iii.Tests by the person from some different group such as an independent test team.
iv.Tests by a person from a different organization or company, such as outsourced testing or certification by an external body.

When we think about how independent the test team is? It is really very important to understand that independence is not an either/or condition, but a range:

- At one end of the range lies the absence of independence, where the programmer performs testing within the programming team.
- Moving toward independence, we find an integrated tester or group of testers working alongside the programmers, but still within and reporting to the development manager.
- Then moving little bit more towards independence we might find a team of testers who are independent and outside the development team, but reporting to project management.
- Near the other end of the continuum lies complete independence. We might see a separate test team reporting into the organization at a point equal to the development or project team. We might find specialists in the business domain (such as users of the system), specialists in technology (such as database experts), and specialists in testing (such as security testers, certification testers, or test automation experts) in a separate test team, as part of a larger independent test team, or as part of a contract, outsourced test team.

Benefits of independence testing:

- An independent tester can repeatedly find out more, other, and different defects than a tester working within a programming team – or a tester who is by profession a programmer.
- While business analysts, marketing staff, designers, and programmers bring their own assumptions to the specification and implementation of the item under test, an independent tester brings a different

set of assumptions to testing and to reviews, which often helps in exposing the hidden defects and problems

- An independent tester who reports to senior management can report his results honestly and without any concern for reprisal that might result from pointing out problems in coworkers' or, worse yet, the manager's work.
- An independent test team often has a separate budget, which helps ensure the proper level of money is spent on tester training, testing tools, test equipment, etc.
- In addition, in some organizations, testers in an independent test team may find it easier to have a career path that leads up into more senior roles in testing.

Risks of independence and integrated testing:

- There is a possibility that the testers and the test team can get isolated. This can take the form of interpersonal isolation from the programmers, the designers, and the project team itself, or it can take the form of isolation from the broader view of quality and the business objectives (e.g., obsessive focus on defects, often accompanied by a refusal to accept business prioritization of defects).
- This leads to communication problems, feelings of unfriendliness and hostility.
- Lack of identification with and support for the project goals, spontaneous blame festivals and political backstabbing.
- Even well-integrated test teams can suffer problems. Other project stakeholders might come to see the independent test team – rightly or wrongly – as a bottleneck and a source of delay. Some programmers give up their responsibility for quality, saying, 'Well, we have this test team now, so why do I need to unit test my code?'

What is Software Quality?

Quality software is reasonably bug or defect free, delivered on time and within budget, meets requirements and/or expectations, and is maintainable.

ISO 8402-1986 standard defines quality as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs."

Key aspects of quality for the customer include:

- Good design – looks and style
- Good functionality – it does the job well
- Reliable – acceptable level of breakdowns or failure
- Consistency
- Durable – lasts as long as it should
- Good after sales service
- Value for money

Good design – looks and style:

It is very important to have a good design. The application or product should meet all the requirement specifications and at the same time it should be user friendly. The customers are basically attracted by the good looks and style of the application. The right color combinations, font size and the styling of the texts and buttons are very important.

Good functionality – it does the job well:

Along with the good looks of the application or the product it’s very important that the functionality should be intact. All the features and their functionality should work as expected. There should not be any deviation in the actual result and the expected result.

Reliable – acceptable level of breakdowns or failure:

After we have tested for all the features and their functionalities it also very important that the application or product should be reliable. For example: There is an application of saving the students records. This application should save all the students records and should not fail after entering 100 records. This is called reliability.

Consistency:

The software should have consistency across the application or product. Single software can be multi dimensional. It is very important that all the different dimensions should behave in a consistent manner.

Durable – lasts as long as it should:

The software should be durable. For example if software is being used for a year and the number of data has exceed 5000 records then it should fail if number of records increases. The software product or application should continue to behave in the same way without any functional breaks.

Good after sales service:

Once the product is shipped to the customers then maintenance comes into the picture. It is very important to provide good sales services to keep the customers happy and satisfied. For example if after using the product for six months the customer realizes to make some changes to the application then those changes should be done as fast as possible and should be delivered to the customers on time with quality.

Value for money:

It’s always important to deliver the product to the customers which have value for money. The product should meet the requirement specifications. It should work as expected, should be user friendly. We should provide good services to the customers. Other than the features mentioned in the requirement specifications some additional functionality could be given to the customers which they might not have thought of. These additional functionalities should make their product more user friendly and easy to use. This also adds value for money.