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Quality Assurance, Quality Control, Quality Testing, difference and implementation with Quality Function Deployment

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Abstract
The article provides overview of Quality Assurance, Quality Control, Quality Testing their overlap, differences, methods, benefits and tools. Four types of Quality Assurance, key components of Quality Control and different methodologies of testing are discussed. It covers the Quality Function Deployment in different phases and its implementation.

Keywords: Quality Assurance, Quality Control, Testing, Integration testing, PAM testing, Quality Function Deployment

I. DEFINITIONS

A. *Quality assurance (QA)*

Quality assurance (QA) is a systematic process that ensures products, services, or processes meet or exceed established quality standards. It involves activities aimed at preventing defects, identifying and resolving issues, and improving overall quality throughout the entire lifecycle of a product or service

Quality assurance is process oriented. It is all about preventing defects by ensuring the processes used to manage and create deliverables works. QA is about engineering processes that assure quality is achieved in an effective and efficient way.

For instance, if a defect is found and fixed, there is no guaranteeing it won't pop back up. The role of QA is to identify the process that allowed the error to occur and re-engineer the system so that these defects won't appear for the second time. The QA process verifies that the product will continue to function as the customer expects.

Examples of QA include process definition and implementation, training, audits and selection of tools.

B. *Quality control (QC)*

Quality control, alternatively, is product oriented. It is the function of software quality that determines the ending result is what was expected. Whereas QA is proactive, QC is reactive. QC detects bugs by inspecting and testing the product. This involves checking the product against a predetermined set of requirements and validating that the product meets those requirements.

Examples of QC include technical reviews, software testing and code inspections.

C. *Quality Testing*

Testing is a subset of QC. It is the process of executing a system in order to detect bugs in the product so that they get fixed. Testing is an integral part of QC as it helps demonstrate that the product runs the way it is expected and designed for.

II. QUALITY ASSURANCE

Quality assurance (QA) is truly having a moment. In the early days, QA was seen as a simple checklist item. A natural step to check that coding and testing has been done correctly to reflect the client's business requirements. But with today's advances in machine learning, artificial intelligence and cloud computing, software requirements are broader and deeper than ever before. Automation has made testing easier. DevOps is breaking down age-old silos. Quality assurance has a stronger influence on user experience than ever before.

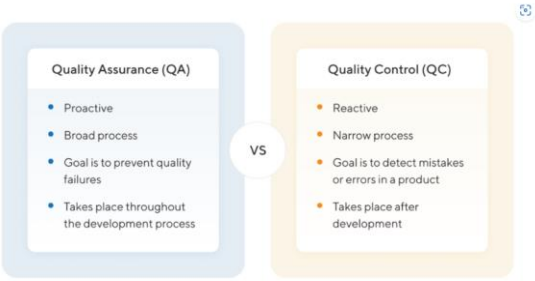

Fig. 1. From ProductPlan site – Quality assurance versus quality control

Quality assurance is the process of ensuring that the products and services meet the established quality standards. Quality assurance is an essential part of any business as it helps to identify defects, errors, and inconsistencies and provides corrective measures to fix them. There are four types of quality assurance measures that businesses use to improve their products and services.

A. *Process Quality Assurance*

Process quality assurance is a type of quality assurance that is concerned with the processes used to develop and produce a product or service. This type of quality assurance involves monitoring the processes to ensure that they are being executed efficiently and effectively while adhering to the established quality standards. Process quality assurance helps to identify weaknesses in the processes and provides recommendations on how to improve them.

1) *Difference between process quality assurance an quality control*

Quality control is aimed at identifying defects in the final product, while process quality assurance is focused on ensuring that the processes used to develop the product are efficient and effective. Quality control is reactive, while process quality assurance is proactive.

2) *Benefits*

Process quality assurance helps to improve the overall quality of the product or service. It ensures consistency in the development and production processes, reduces errors and defects, and enhances customer satisfaction.

B. *Product Quality Assurance*

Product quality assurance is a type of quality assurance that is concerned with the quality of the final product or service. This type of quality assurance involves ensuring that the product or service meets the established quality standards. Product quality assurance involves testing the product or service to identify any defects or errors and providing recommendations on how to fix them.

1) *Benefits*

Product quality assurance helps to improve customer satisfaction, reduces the risk of product recalls, enhances the brand reputation, and increases the likelihood of repeat business.

2) *Tools*

The tools used in product quality assurance include statistical process control, root cause analysis, Pareto charts, and Six Sigma.

C. *Quality Planning*

Quality planning is a type of quality assurance that is concerned with the planning and development of the quality standards that will be used during the product development and production processes. Quality planning involves analyzing the customer needs and requirements and developing a plan to meet these requirements while adhering to established quality standards.

1) *Importance*

Quality planning helps to ensure that the product development and production processes are efficient and effective and meet the customer needs and requirements. It helps to reduce the risk of errors and defects, increases customer satisfaction, and enhances the brand's reputation.

2) *Tools*

The tools used in quality planning include quality function deployment, failure mode and effects analysis, and design of experiments.

D. *Quality Improvement*

Quality improvement is a type of quality assurance that is concerned with continuously improving the quality of the product or service. This type of quality assurance involves identifying opportunities for improvement, developing a plan to implement the improvements, and monitoring the progress of the improvements.

1) *Benefits*

Quality improvement helps to reduce the risk of errors and defects, enhance customer satisfaction, and increase brand reputation. It also helps to reduce costs and increase productivity.

2) *Tools*

The tools used in quality improvement include Six Sigma, total quality management, lean manufacturing, and Kaizen.

Fig. 2. From qcsvservices.com – Framework of Quality assurance

III. QUALITY CONTROL

Quality does not have a singular definition. Despite the relative meaning of "value," quality control is the process by which products/services are tested and measured to ensure they meet a standard. Through this process, a business can evaluate, maintain, and improve product quality. The primary objective of Quality Control is to identify and correct any deviations from the established quality standards. This process involves monitoring and inspecting products or services at various stages of production or delivery to ensure that they meet the desired level of quality. QC is also concerned with preventing defects or errors from occurring in the first place by implementing measures to control and improve the production or service delivery processes.

Ultimately, there are two crucial goals of quality control:
(1) to ensure that products are as uniform as possible and
(2) to minimize errors and inconsistencies within them.

A. Key Components of Quality Control

1. Inspection: Regularly examining products, materials, or services to identify defects, non-compliance, or deviations from quality standards.
2. Testing: Conducting various tests and measurements to assess the performance, functionality, or characteristics of products or services.
3. Statistical Process Control (SPC): Employing statistical techniques to monitor and control the production processes, ensuring that they remain within acceptable quality limits.
4. Documentation and Records: Keeping detailed records of inspections, tests, and corrective actions taken to maintain traceability and accountability.
5. Corrective Action: Implementing appropriate measures to address any identified quality issues and prevent their recurrence.
6. Training and Education: Providing employees with the necessary skills and knowledge to maintain quality standards effectively.

7. Continuous Improvement: Constantly analyzing data and feedback to identify areas for improvement and enhancing the overall quality management system.

B. *Difference between QA and QC*

Quality Control is closely related to another quality management concept called Quality Assurance (QA). While QC focuses on detecting and correcting defects, QA concentrates on preventing them from occurring in the first place by setting up robust processes and procedures. Together, QC and QA form the backbone of an organization's quality management system, helping to ensure that products and services consistently meet or exceed customer expectations and regulatory requirements.

Fig. 3. Pictorical representatin of quality control and quality assurance taken from asq.org

C. *Quality Control Process*

Normally, quality testing is part of every stage of a manufacturing or business process. Employees frequently begin testing using samples collected from the production line, finished products, and raw materials. Testing during various production phases can help identify the cause of a production problem and the necessary corrective actions to prevent it from happening again.

Customer service reviews, questionnaires, surveys, inspections, and audits are a few examples of quality testing procedures that can be used in non-manufacturing businesses. A company can use any procedure or technique to ensure that the final product or service is safe, compliant, and meets consumer demands.

D. *QC Is Different by Industry*

Quality Control (QC) is an indispensable aspect of various industries, ensuring that products and services adhere to predefined standards. In the manufacturing sector, QC involves rigorous inspection and testing of raw materials, intermediate components, and final products to maintain consistent quality and minimize defects. In the food industry, QC guarantees the safety and integrity of consumables through thorough testing for contaminants and adherence to health regulations.

In the pharmaceutical sector, QC plays a critical role in verifying the potency and purity of drugs, ensuring they are safe for consumption. Additionally, in the software industry, QC involves extensive testing of applications and programs to identify bugs and errors before release, guaranteeing a smooth user experience. Across all industries, QC is a fundamental process that enhances customer satisfaction, boosts efficiency, and fosters a reputation for reliability.

IV. TESTING

Software testing is traditionally divided up into stages. These start with unit testing, which is performed as functions are developed. You then move onto integration testing, where several functions are tested as a complete functional unit. Next comes system testing. This is where you test your complete software for functionality and bugs. Finally, some form of acceptance testing is needed, where you verify that the software does what the end-user needs. Regression testing and progression testing are typically a part of your system testing.

A. Regression testing

Regression testing is vital any time you change or update your software. The idea is to make sure that your new changes haven't broken any existing features. There are a few different things you are trying to answer.

1. Does the software function as expected?
2. Have any previously-fixed bugs re-emerged?
3. Have any previously undiscovered bugs been triggered?

Typically, regression testing involves running a selected set of your existing tests. The skill lies in selecting the best set of tests to fully answer the questions above.

1) Importance

Regression testing is one of the most important forms of testing for any software. There is nothing worse than releasing a new update with some exciting new features, only to find that the software is buggy. Users can be really quick to condemn buggy software. Especially if they see an old bug re-emerging. For a user, triggering a bug suggests two things. Either, they have been shipped broken software, which looks careless. Or, if they are not a confident user, they may think they did something wrong, which provides for a bad user experience. In both cases, it damages reputation.

B. Progression testing

Progression testing is a less frequently used term. As the term implies, it's to some degree, the opposite of regression testing. Progression testing is about testing new features, rather than existing features. So, it is about expanding your overall testing. Progression testing takes a few forms.

1) Creating tests for new features

Each time a new feature is developed or update is made to an existing feature, new tests need to be created that verify it is working. These tests focus on the specific functionality of the new feature. For

instance, does it display correctly in the UI? Is the application logic for it working correctly? How well does it handle errors or unexpected inputs?

2) Exploratory Testing

Modern software applications very complex. Consequently, there are often millions of ways that a user can navigate through the application. Ideally, testing every one of these is ideal but that is simply unrealistic within reasonable time constraints. However, there is a need to make sure testing is performed for the ones most likely to cause problems. This is where we turn to exploratory testing. Here, an experienced tester takes the application and tries to trigger problems based on her knowledge of the app and common bugs. For instance, testing how a mobile application reacts when you change from cellular data to WiFi.

3) Bug Hunting

The final form of progression testing is hunting for new bugs. All too often, users will be the first people to trigger a bug. They might submit a bug report or contact your support team. But often one will only know about the bug from the application and system logs. Here, the priority is to work out what are the steps needed to recreate the bug. Once those are known, then developers have a definite target for debugging.

C. How to move from Progression to regression

Typically, progression tests end up being added to your regression test suite. For instance, if you have identified a bug, you need to test for it again in the future. This applies to bugs found during testing and bugs found in the wild. And needless to say, you always need to be testing the existing features in your app. So, tests developed for new features become regression tests for existing features. Often, during this process, the test migrates from being a manual test to being automated.

V. QUALITY FUNCTION DEPLOYMENT

Quality Function Deployment (QFD) is a process and set of tools used to effectively define customer requirements and convert them into detailed engineering specifications and plans to produce the products that fulfill those requirements. QFD is used to translate customer requirements into measurable design targets and drive them from the assembly level down through the sub-assembly, component and production process levels. QFD methodology provides a defined set of matrices utilized to facilitate this progression.

QFD was first developed in Japan by Yoji Akao in the late 1960s while working for Mitsubishi's shipyard. It was later adopted by other companies including Toyota and its supply chain. In the early 1980s, QFD was introduced in the United States mainly by the big three automotive companies and a few electronics manufacturers. Acceptance and growth of the use of QFD in the US was initially rather slow but has since gained popularity and is currently being used in manufacturing, healthcare and service organizations.

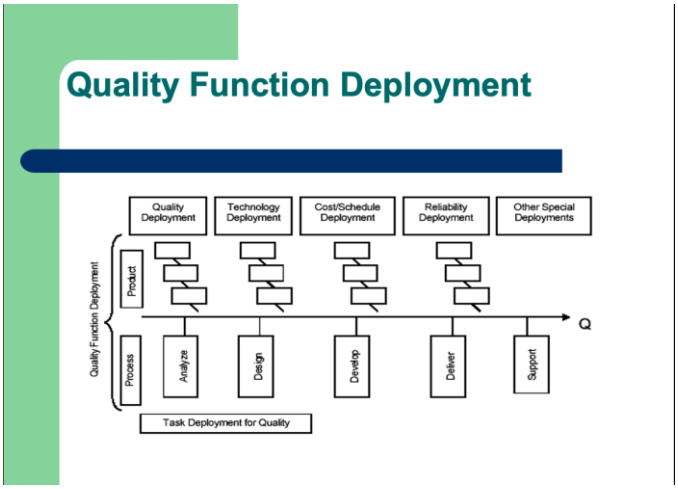

Fig. 4. Quality Function Deployment overview taken from CBOK for Certifited Software Quality Assurance (CSQA)

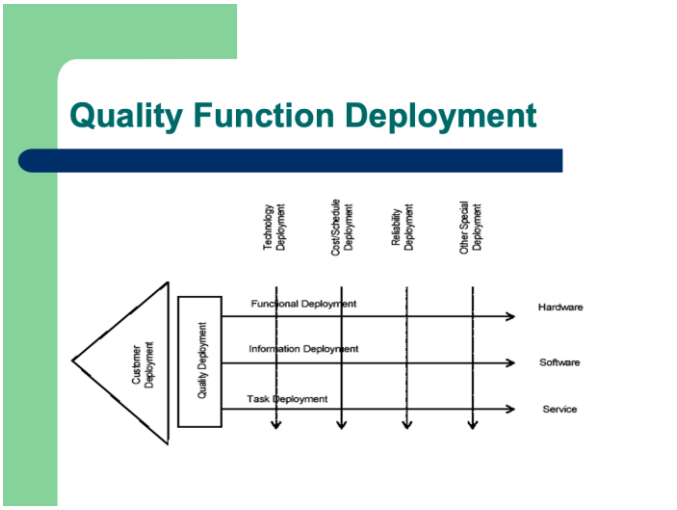

Fig. 5. Quality Function Deployment in action taken from CBOK for Certifited Software Quality Assurance (CSQA)

A. *Functional deployment*

- **Customer Deployment** involves determining which types of customers for which the organization is trying to provide a product or service.
- **Quality Deployment** has tools and techniques for the exploration and specification of high-value customer requirements

B. *Horizontal deployment*

- **Functional Deployment** drives the design of the hardware aspects of the product or service.
- **Information Deployment** handles the information (or data and processing) aspects of the product or service.
- **Task Deployment** addresses the detailed activities required to satisfy the customers, such as professional patient care.

C. Vertical deployment

- **Technology Deployment** seeks to systematically and rapidly deploy new technologies into the design and development of new products or services.
- **Cost and Schedule Deployment** sets customer-derived cost and schedule targets and seeks the necessary adjustments during product development to meet those targets.
- **Reliability Deployment** is a systematic way of looking to failure modes and faults to prevent or ameliorate the effects of failures, and design in reliability.
- **Other Special Deployments** are used to address additional concerns of customers, stakeholders, or the development organization.

Conclusion: **Quality assurance plays a critical role in ensuring that the products and services meet the established quality standards. The four types of quality assurance, namely process quality assurance, product quality assurance, quality planning, and quality improvement, provide businesses with the tools and techniques to improve their products and services continually. By implementing these quality assurance measures, businesses can enhance customer satisfaction, reduce the risk of errors and defects, and increase the likelihood of repeat business.**

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