FUNDAMENTALS OF SOFTWARE QUALITY

INTE-E3 – SYSTEM TESTING AND AUTOMATION

TOPIC OUTLINE

- Understand the fundamentals of Software Quality
- Define quality assurance and quality control
- Determine the differences between QA, QC, and Testing.

History of Software Failures

- Intel Pentium microprocessor bug which referred to a floating-point problem on an Intel microprocessor back in 1994.
- The Ariane 5 launcher disaster was due to an operand error that resulted from the conversion of a 64-bit floating-point number to a 16-bit signed integer number.

Background to Software Quality

- Customers today have very high-quality and reliability expectations and expect companies to adhere to very high standards.
- There are many quality software products in the marketplace; however, the task of consistently producing high-quality software products is non-trivial.
- Even the most respected organizations occasionally deliver software that contains defects, or ship products late due to quality problems.
- Defects may cause minor irritation to a customer, loss of credibility, or lead to injury or loss of life.

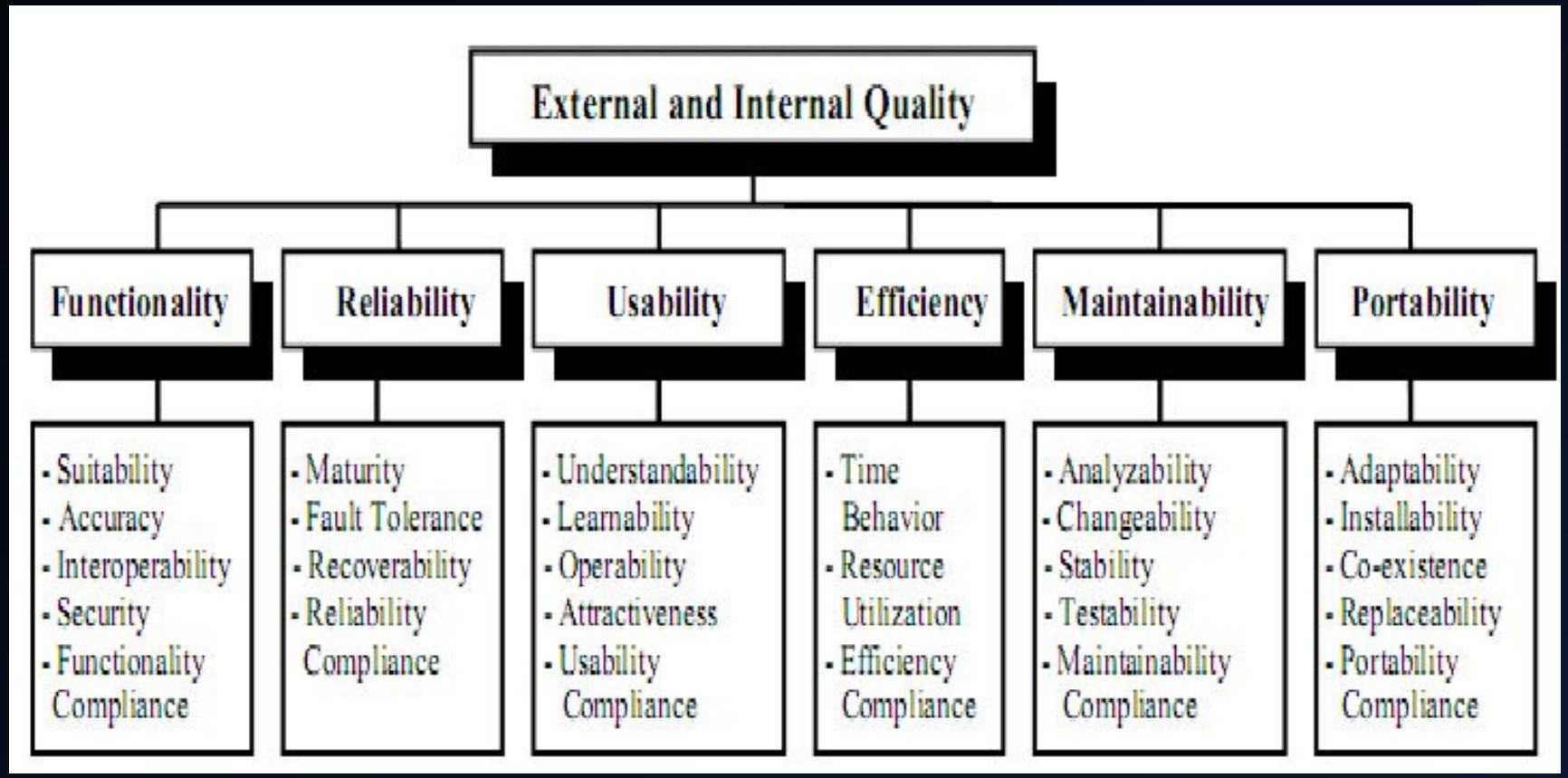
Background to Software Quality cont.

- The late delivery of a product leads to extra costs, and it may adversely affect the customer's revenue, profitability, and business planning.
- Consequently, it is essential to have a robust process to consistently develop high-quality software on time and within budget.
- The influential papers by Fred Brooks in Brooks (1975, 1986) suggest that there is no silver bullet to do this, and that instead, the focus needs to be on incremental improvement to processes and tools.

What is Software Quality?

- There are various definitions of quality:
- According to Philip Crosby quality defined as "*conformance to the requirements*".
- Juran defined quality as "*fitness for use*".
- *ISO 9126 (ISO/IEC 1991)* which indicate the extent to which a software product may be judged to be of a high quality by the customers.

ISO/IEC 9126


External and Internal Quality
Functionality
Reliability
Usability
Efficiency
Maintainability
Portability
- Suitability
- Accuracy
- Interoperability
- Security
- Functionality Compliance
- Maturity
- Fault Tolerance
- Recoverability
- Reliability Compliance
- Understandability
- Learnability
- Operability
- Attractiveness
- Usability Compliance
- Time Behavior
- Resource Utilization
- Efficiency Compliance
- Analyzability
- Changeability
- Stability
- Testability
- Maintainability Compliance
- Adaptability
- Installability
- Co-existence
- Replaceability
- Portability Compliance

ISO/IEC 25010

- The quality model determines which quality characteristics will be taken into account when evaluating the properties of a software product.
- The quality of a system is the degree to which the system satisfies the stated and implied needs of its various stakeholders, and thus provides value.

Early Quality Management

- In the Middle Ages, a craftsman was responsible for the complete development of a product from its conception to delivery to the customer.
- This led to a strong sense of pride and ownership of the quality of the product, and apprentices joined craftsmen to learn the skills of the trade.
- In the Industrial Revolution, labour became highly organized with workers responsible for a particular part of the manufacturing process.

Total Quality Management

- Total quality management (TQM) is a modern approach to quality management.
- TQM involves customer focus, process improvement, developing a culture of quality within the organization and developing a measurement and analysis program.
- It is a holistic approach and requires that all functions, in the organization, follow high standards.

Software Quality Control

- Software quality control is concerned with activities to ensure that the end product satisfies the functional and non-functional requirements and is fit for purpose.
- Software testing consists of “white box” or “black box” testing techniques, and the testing activities include unit, system, performance, and acceptance testing.
- The verification and validation activities involve the execution of the defined tests and the correction of any failed or blocked tests.

History of Quality

- Quality Pioneers:
  - Walter Shewhart
  - W. Edwards Deming
  - Joseph Juran
  - Philip Crosby
  - Watts Humphrey (Father of software quality)

Shewhart

- Walter Shewhart was Statistician at AT&T Bell Laboratories (or Western Electric Co. as it was known in the 1920s).
- He is regarded as Founder of statistical process control (SPC), which remains important today in monitoring and controlling a process.
- Shewhart's ideas were applied to the Capability Maturity Model (CMM) in the late 1980s as a way to control key software processes.
- Author of book "The Economic control of quality of manufactured product"

Shewhart Model

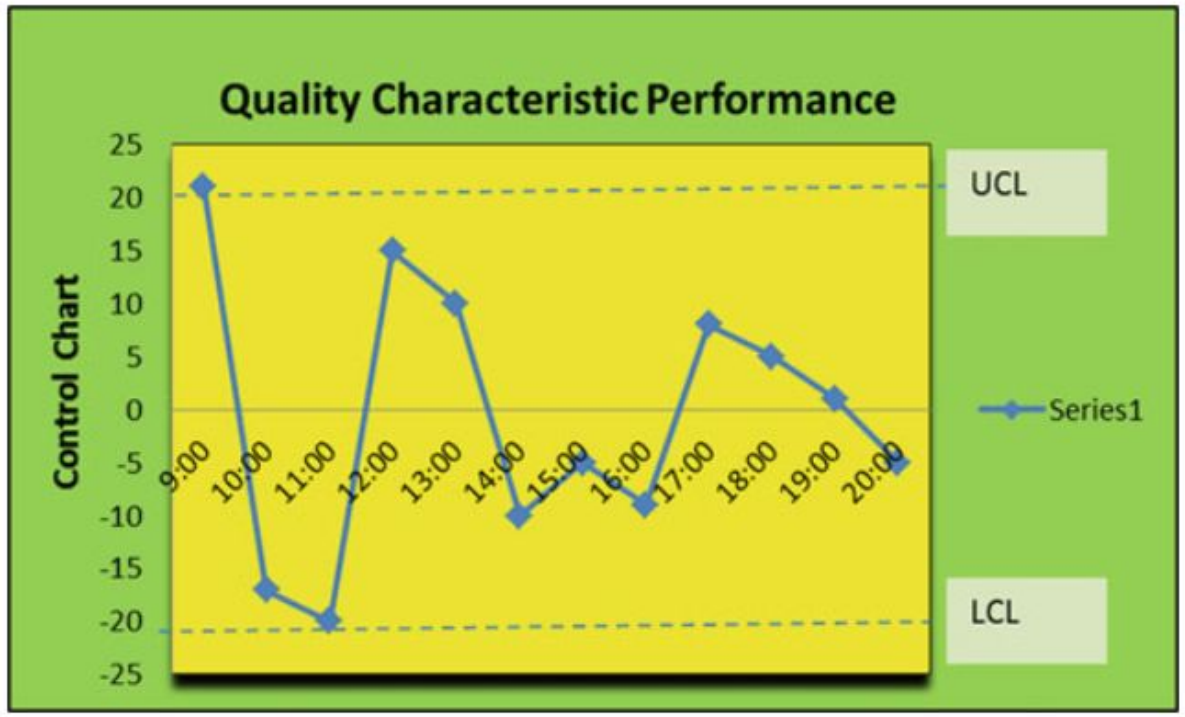
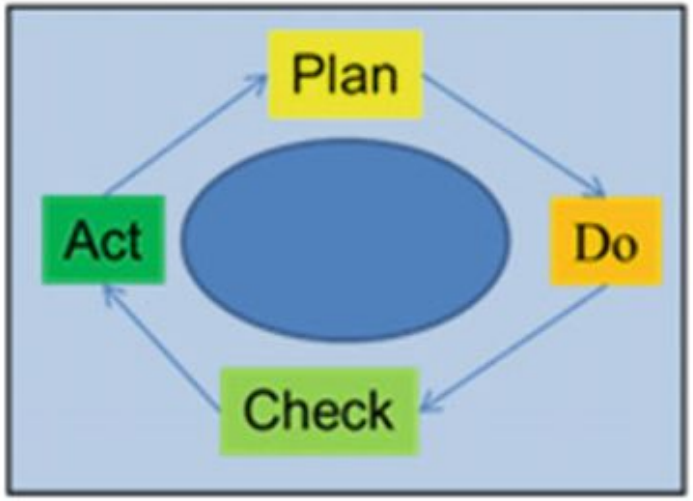


Fig. 1.2 Shewhart's control chart

Shewhart's PDCA Cycle

Table 1.2 Shewhart cycle

Step	Description
Plan	This step identifies an improvement opportunity and outlines the problem or process that will be addressed – Select the problem to be solved – Describe current process – Identify the possible causes of the problem – Find the root cause – Develop an action plan to correct the root cause
Do	This step involves carrying out the improvement actions, and it may involve a pilot of the proposed changes to the process
Check	This step involves checking the results obtained to determine their effectiveness
Act	This step includes the analysis of the results to adjust process performance to achieve the desired results



Deming

- W. Edwards Deming was a major figure in the quality movement.
- Deming argued that it is not sufficient for everyone in the organization to be doing one's best: instead, what is required is that there be a consistent purpose and direction in the organization.
- Author of Book "Out of the crisis"

Deming cont.

- Deming’s proposed 14 principles to transform the western style of management of an organization to a quality and customer-focused organization. These include:
  - Constancy of purpose
  - Quality built into the product
  - Continuous improvement culture.

Deming 14-step programme

1. Constancy of purpose
2. Adopt new philosophy
3. Build quality in
4. Price and quality
5. Continuous improvement
6. Institute training
7. Institute leadership
8. Eliminate fear
9. Eliminate barriers
10. Eliminate slogans
11. Eliminate numerical quotas
12. Pride of work
13. Self improvement
14. Take action

Deming cont.

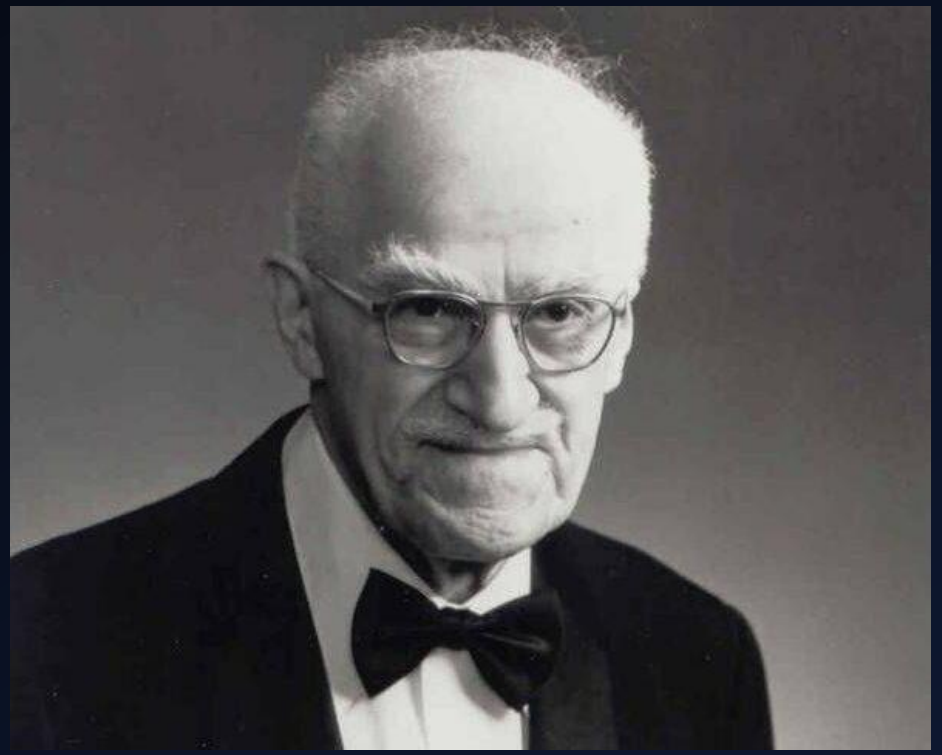
- Deming argued that there are several diseases that afflict companies in the western world that prevent them for achieving high-quality results.
- The "five deadly diseases"

Table 1.4 Deming—five deadly diseases

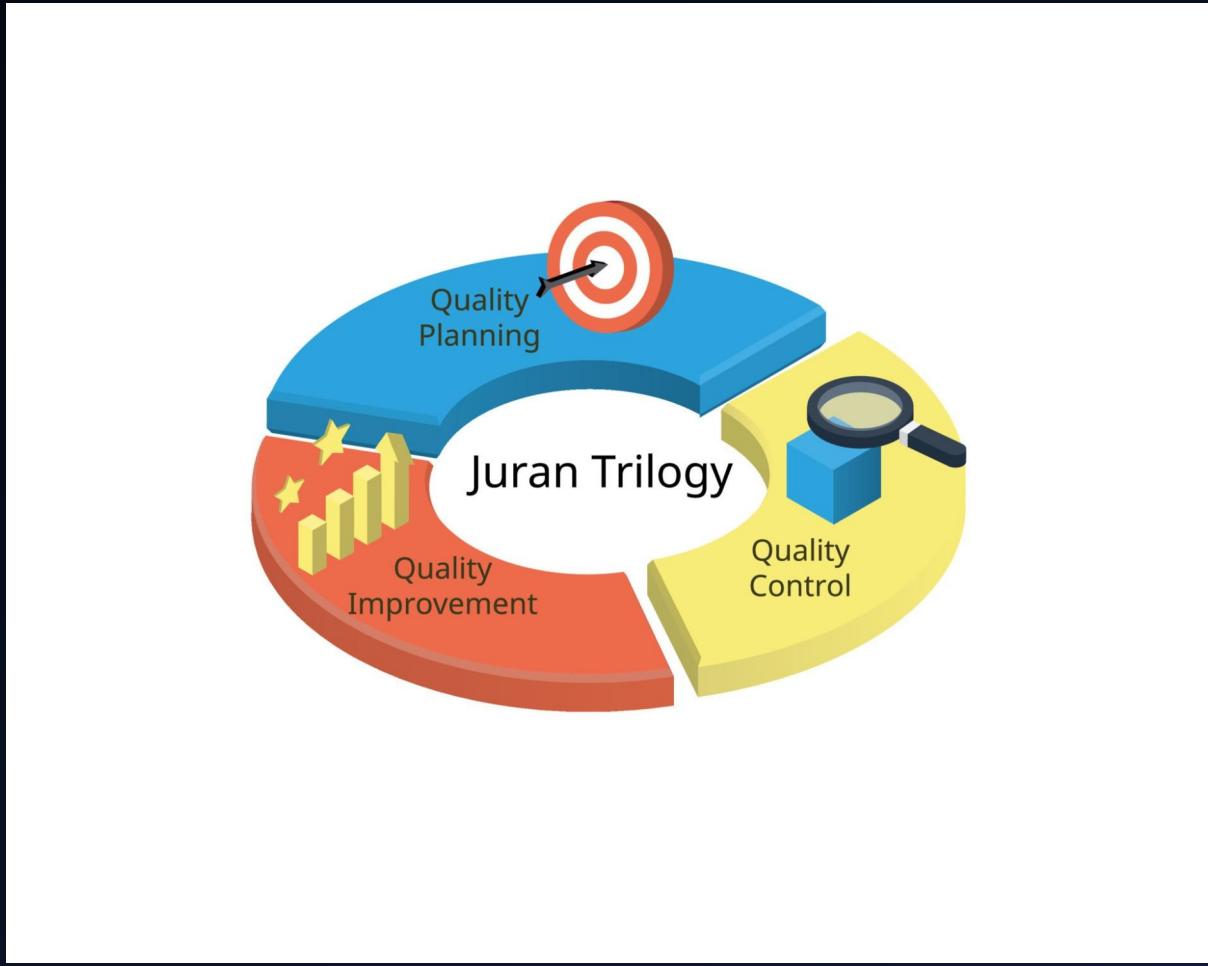
Disease	Description
Lack of constancy of purpose	Management is too focused on short-term thinking rather than long-term improvements
Emphasis on short-term profit	A company should aim to become the world's most efficient provider of product/service. Profits will then follow
Evaluation of performance	Deming is against annual performance appraisal and rating
Mobility of management	Mobility of management frequently has a negative impact on quality
Excessive measurement	Excessive management by measurement

Juran

- Joseph Juran defined quality as "fitness for use" and argued that quality issues are the direct responsibility of management.
- Management must ensure that quality is planned, controlled, and improved.
- The trilogy of quality planning, control, and improvement is known as the "Juran Trilogy"



Juran Trilogy



Juran cont.

- Juran defined an approach to achieve a new quality performance level that is termed “Breakthrough and Control”.

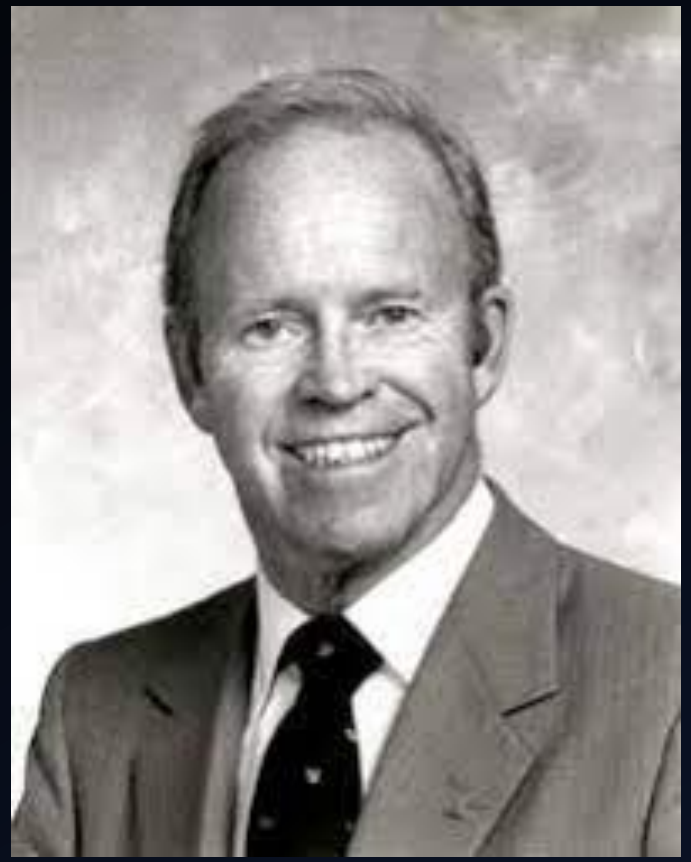
Table 1.6 Juran’s breakthrough and control

Step	Description
Breakthrough in attitude	This involves developing a favourable attitude to quality improvement
Pareto	This involves identifying the key areas affecting quality
Organization	This involves analysing the problem and coordinating a solution
Control	This is concerned with achieving performance at the new level
Repeat	This leads to continuous improvement with new performance levels set, and new breakthroughs made to achieve higher performance levels

Juran 10-step programme for Quality Planning

1. Identify customers
2. Determine customer needs
3. Translate
4. Units of measurement
5. Measurement programme
6. Develop product
7. Optimize product design
8. Develop process
9. Optimize process capability
10. Transfer

Crosby



- Philip Crosby design the Capability Maturity Model (CMM), which was developed by the Software Engineering Institute.
- Author of book “Quality is Free” outlines his philosophy of doing things right the first time, i.e. the zero defects (ZD) program.
- Quality is defined as “conformance to the requirements”, and he argues that people have been conditioned to believe that error is inevitable.

Capability Maturity Model (CMM)

Crosby’s 14-step programme

1. Management commitment
2. Quality improvement team
3. Quality measurement
4. Cost of quality evaluation
5. Quality awareness
6. Corrective action
7. Zero defects program
8. Supervisor training
9. Zero defects day
10. Goal setting
11. Error cause removal
12. Recognition
13. Quality councils
14. Do it over again

Humphrey

- Watts Humphrey was an American software engineer and vice-president of technical development at IBM.
- Considered the father of software quality.
- Addressing the problems of software development including schedule delays, cost overruns, software quality, and productivity.
- He was born in Michigan in 1927 and served in the US Navy and completed a bachelor's degree in physics at the University of Chicago in 1949.

Miscellaneous Quality Gurus

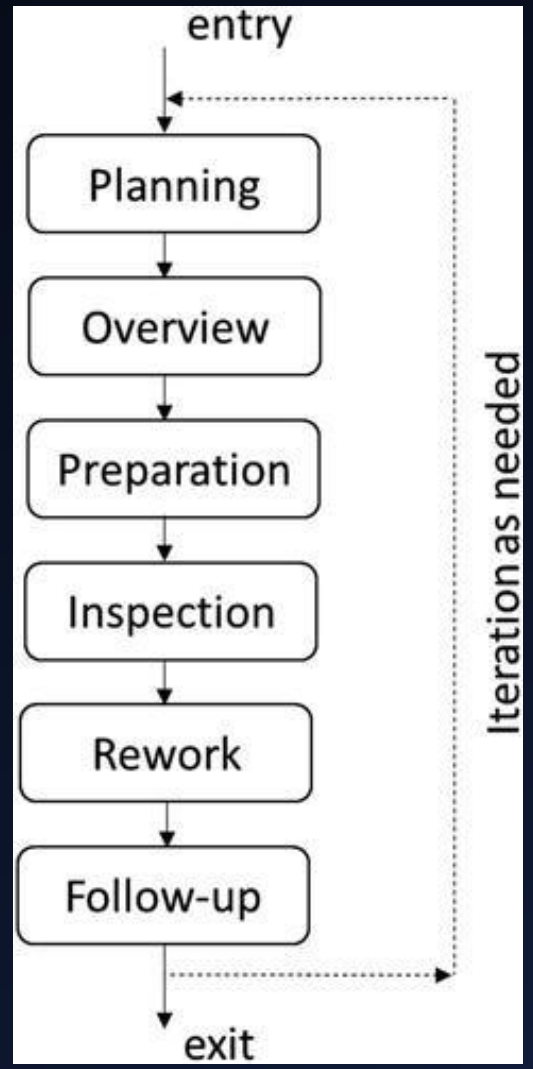
- Shingo - developed his own version of zero defects termed “Poka-yoke” (or defects = 0)
- Genichi Taguchi’s define quality as “the loss a product causes to society after being shipped, other than losses caused by its intrinsic function”.
- Kaoru Ishikawa (quality control circles (QCCs)). A quality control circle is a small group of employees who do similar work and meet regularly to identify and analyse work-related problems.
- Armand Feigenbaum did work in total quality control which concerns quality assurance applied to all functions in the organization.

Modern Software Quality Management

- Project management
- Estimation
- Risk management
- Requirements' development and management
- Design and development
- Software development lifecycles
- Quality assurance/management
- Software inspections
- Software testing
- Supplier selection and management
- Configuration management
- Customer satisfaction process
- Continuous improvement.

Software Inspection

- The Fagan inspection process was developed by Michael Fagan of IBM (Fagan1976), and it aims to identify and remove errors in work products.
- The process mandates that requirement documents, design documents, source code, and test plans all be formally inspected by experts independent of the author of the deliverable.
- There are various roles:
  - Moderator
  - Reader
  - Author
  - Tester

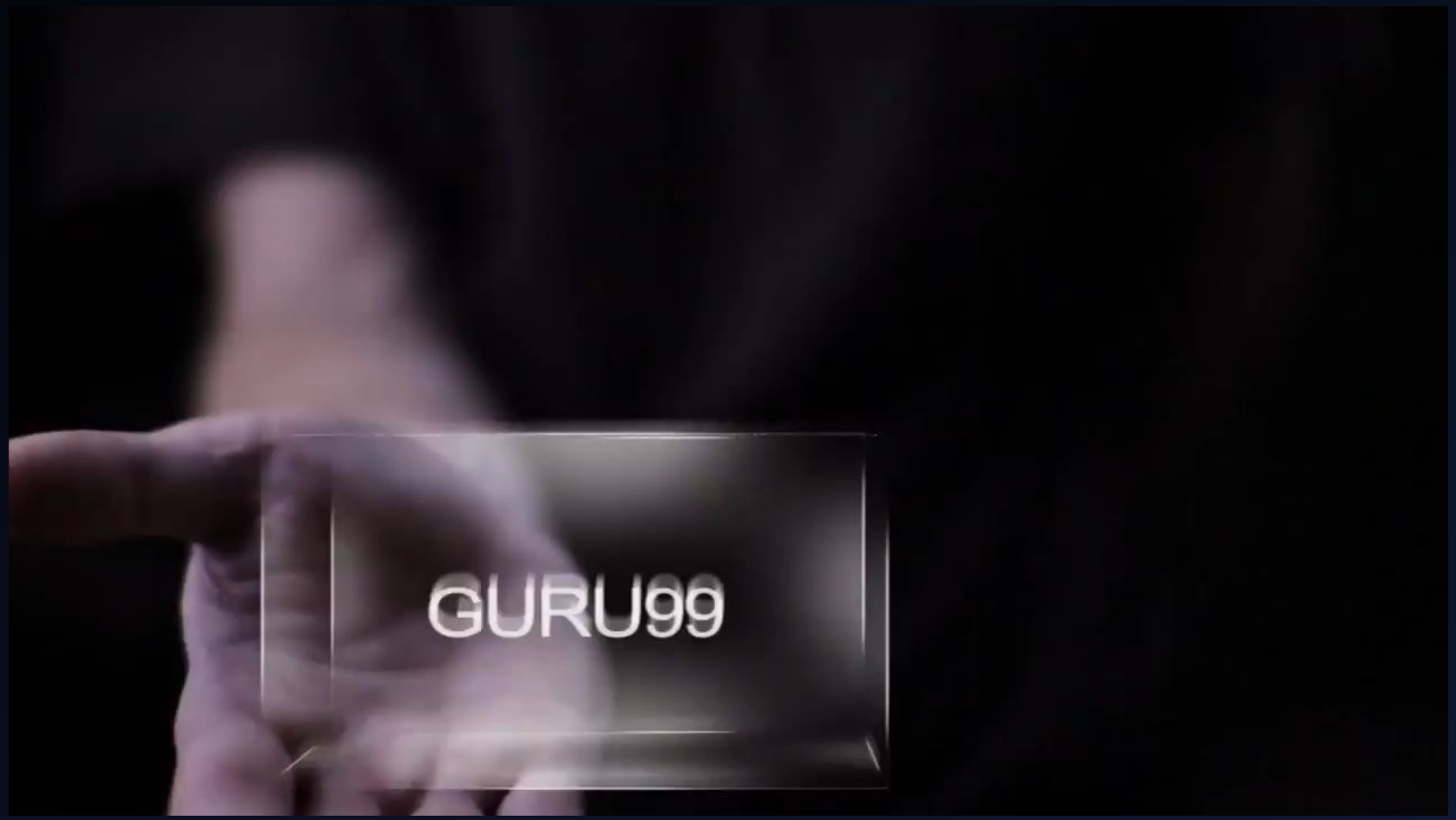


Software Testing

- Software testing plays a key role in verifying that the software is fit for purpose, and two key types of software testing are black box and white box testing.
- White box testing involves checking that every path in a module has been tested and involves defining and executing test cases to ensure code and branch coverage.
- The goal of black box testing is to verify the functionality of a module or feature or the complete system itself.

Software Quality Assurance

- The software quality assurance department provides visibility into the quality of the work products being built and the processes being used to create them.
- Its activities include audits of the various groups involved in software development.
- Its key responsibilities are:
  - Promotes quality in organization
  - Conducts audits to verify compliance
  - Reports audit results to management
  - Provides visibility to management on processes followed
  - Facilitates software process improvement
  - Release sign-offs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Seatwork:

In your own words,

Differentiate the Software Quality Assurance, Quality Control, and Software Testing

Assignment:

Research one(1) Software Failures recorded in History and make a short reflection paper