Q.5) What is Quality ?

Ans :- Quality From

(a) A customer view point fit for other customers needs

(b) Producer's view point meeting re

"Quality of software is reasonably bug delivered on time, within budget requirement and/or expectations ar maintainable".

Q.6) What is Quality Assurance (QA) Quality Control (QC) ?

Ans :-

"How will you test a cup of tea?"
Just by having a sip of it. Means we are testing the 'product' (Here product is tea) i.e. what Quality control (QC) is. It is the 'product' checking. Suppose tea tastes bitter then the 'process' will be checked that whether tea has been boiled more than required duration means there is fault in the 'process'. Verifying 'process' is Quality Assurance (QA).

Quality Assurance (QA) activities are work as process oriented. They measure the process, identify deficiencies and suggest improvement. The output of Quality control activities is often the input to Quality Assurance activities.

'Audits' are an example of QA activity which looks at whether and how the process being followed. The end result may be suggested improvement or better compliance with the process.

QA consist of a set of auditing and reporting functions that assess the effectiveness of Quality control activities. The goal of Quality Assurance is to provide management with data processing to be informed about product Quality, there by gaining insight and confidence that product Quality is meeting its goal.

Quality Control (QC) activities are work as product oriented. They measures the product. The direct result of these activities are changes the product. Unit testing, coding are example of QC activities since they usually result in changes to the product, not the process.

(*) 1.2) Quality Factors :-

(1) Maintainability :- The effort required to locate and fix an error in program.

(2) Integrity :- The extent to which access to software or data by unauthorized persons can be controlled.

(3) Correctness :- The extent to which program satisfies its specification and fulfils the customer missing objectives.

(4) Efficiency :- The amount of computing resources and code required by program to perform its f...

(5) Usability :- The effort required to learn, operate, prepare input for and interpret out-put of a program.

(6) Reliability :- The extent to which a program can be expected to perform its intended fun... with required precision.

(7) Flexibility :- The effort required to modify an operational program.

(8) Inter-Operability :- The effort required to couple one system to another.

(9) ReUsability :- The extent to which a program or part of program can be reused in oth... application related to scope of functions that the program performs.

(10) Testability :- The effort required to test a prog... to ensure that it performs its intended functions.

M = Maintability
I = Integrity
C = Correctness
E = Efficiency

U = Usability
R = Reliability

FL = Flexibility
I = Interportability
R = ReUsability
T = Testability

[Quality factor can be Remembered as
MICE U R FLIRT]

1.3) Software Quality Metrics :-

Q.1) What is Metric ?

Ans :- A standard of measurement Software metric are the statistics describing the structure or content of Program. A metric should be real objective measurement of something such as no. of bug per Line of code.

Software Metric :- It refers to a broad range of measurement for computer software. measurement can be applied to the software process with the intent of improving it on continiouse basis. measurement can be used throughout a software project to assist estimation, quality control, productivity assesment, and project control.

Finally measurement can be used by software engineers to help asess the quality of technical

work products and to assist in technical decision making as project proceeds.

A 'Measure' provides a quantitative indication of the extent, amount dimensions, capacity or size of some attribute of a product or process.

"Metric" defines as "A quantitive measure of degree to which a system, component or process possesses a given attribute".

When a single data point has been collected (e.g. the no. of errors uncovered in the review of a single module), a measures has been established, measurement occurs as the result of the collection of one or more data points. (e.g. A number of module reviews are investigated to collect measures of the number of errors found during each review). A software metric relates the individual measures in some way e.g. The average number of errors found per review ~~(or) the average no. of errors found per review~~ (or) the average no. of errors found per person-hour expended on reviews

(*) Product and Process :- If the process is weak, the end product will undoubtedly suffer But an obsessive over-reliance on process is also dangerous.

(*) 1.4) Process Improvement :-

The SEI Process, Capability Maturity Model (CMM), ISO, Six-Sigma :-

(*) SEI :- Many organizations have developed classification schemes to evaluate the maturity of software development methodology; one of the most successful was developed by Software Engineering Institute (SEI) under grant from U.S. Department of Defense. The SEI methodology has itself mature over time and now refered to as CMMI (Capability Maturity Model Integrated).

Q) Explain ISO in detail -

(*) ISO :- (International Organisation for Standardization)
The ISO 9001 : 2000 standard concerns quality system that are assessed by outside auditors and it applies to many kind of production and manufacturing organizations, not just software.

It covers documentation, design, development, production, testing, Installation, servicing and other processes.

To be ISO 9001 certified, a third-party auditor assesses an organization and certification is typically good for 1-2 year after which complete reassessment is required. Note that "ISO certification does not necessarily indicate quality product. It indicates only that documented processes are followed."

"Say what you do, do what you say, and able to show what you have done".

ISO 9000 describes quality Assurance element in generic terms that can be applied to any business regardless of the product services offered. To become registered to one of the Quality Assurance system models contained in 9000 a company's quality system and

operations are scrutinized by third party auditors for compliances to the standard and for effective operations.

The ISO 9000 Quality Assurance models treat an enterprise as a network of interconnected process.

The ISO 9000 describes the element of Quality Assurance system in genral terms. These elements include the organizational structure, procedures, processes and resources need to implement Quality Planning, Quality control, Quality Assurance and Quality improvement.

However ISO 9000 does not describe how an organization should implement these Quality system elements.

ISO-9001 is the Quality Assurance standard that applies to software Engineering. The standard contains 20 requirements that must be present for an effective quality assur. system. Because the ISO-9001 standard is applicable to all engineering disciplines, a special set of ISO guidlines (ISO-9000-3) have been developed to help interpret the standard for use in software process. The 20 requirements by ISO 9001 address the following topics.

1) Management Responsibility
2) Quality System
3) Contract review
4) Design control
5) Document and data control

6) Purchasing
7) Control of Customer supplied product.
8) Product identification and traceability
9) Process control
10) Inspection and testing
11) Control of Inspection, measuring and test equipment
12) Inspection and test status.
13) Control of Non-Conforming product.
14) Corrective and preventive action.
15) Handling storage, packing, preservation and delivery.
16) Control of quality records.
17) Internal quality audits.
18) Training
19) Servicing
20) Statistical techniques.

ISO 9000 works well for two Reason :-

(a) It targets the development process not the product. It's concerned about the way an organization goes about its work. It does not attempt to define the quality levels

(b) ISO 9000 indicates only what the process requirements are, not how they are to be achieved.

For Example :- The standard says that the software team should plan and perform product design reviews, but it doesn't say how that requirement should be accomplished. Performing design reviews is a good exercise that a responsible design team should do, but exactly how the design review is to be organized and run is upto the individual team creating the product. ISO 9000 tells you what to do but not how to do it.

The sections of ISO 9000 standard that deal with software are ISO 9001 and ISO 9... ISO 9001 is for business that design, develop, produce, install and service products. ISO 9000-3 is for business that develop, supply, install and maintain computer software.

Some of the requirement in ISO 9000-3 :-

1) Develop detailed Quality plans and procedures to control configuration management, Product verification and validation (testing), Nonconformities (bugs) and corrective actions (fixes)
2) Prepare and receive approval for a software development plan that includes a definition of the project, a list of the product's objectives, a project schedule, project specifications, a description of how the project is orgnized, a discussion of risk, assumption and strategies for controlling it
3) Communicate the specification in terms that make it easy for the customer to understand and to validate during testing.
4) Plan, develop, document and perform software design made over the product life cycle.
5) Develop and document software test plans.
6) Develop method to test whether the software meets the customer requirements.
7) Perform software validation and acceptance test
8) Maintain records to test results.
9) Control how software bugs are investigated and resolved.
10) Prove that the product is ready before its release
11) Develop procedures to control the software release process.

12) Identify and define what quality Information should be collected.

13) Use statistical techniques to analyze the software development process.

14) Use statistical techniques to evaluate product quality.

Q. What is CMM ? Explain its Level :-

⊛ Capability Maturity Model (CMM) :- The Capability Maturity Model (CMM) is a model for judging the maturity of software processes of an organization and for identifying the key practices that are required to increase the maturity of these processes.

(CMMI) :- C = Capability, M = Maturity, M = Model
I = Integrated.

There are diff^n CMM

SW-CMM :- Software Engineering

SE - CMM :- System Engineering

IPPD - CMM :- Integrated process and Product Development

SS :- Supplier Sourcing.

Purpose of CMMI :-

(1) CMMI integrates the software, System Engineering IPPD and supplier sourcing deciplines

(2) means to improve your organization ability to manage the development, acquisition and maintenance the product and services.

(3) Asses organizational maturity process

(4) Yard stick for current practices

(5) Identifies priorities for improvement

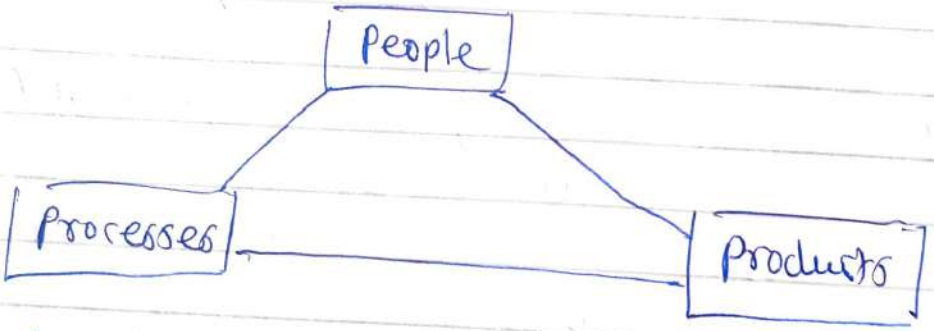
(6) Guide the implementation of these improvement.

CMM - SE (System Engineering) :- Designing, Implementing, deploying systems which typically

includes (1) Hardware (2) Software (3) People (4) applicable Policies.

CMM - Integrated product and Process Development :-
It is systematic approach that achieves a timely collaboration of relevant stakeholders throughout the life of ~~Proc~~ product to better, satisfy customer needs, expectation and requi...

Why CMM ?
1) An Integrated model
2) A more mature model, project management areas (Metrics, Risk)
3) Software Engineering areas.
4) Organizational level process CMM is become obsol...



(*) The Levels in CMM :-

1) (a) Level 1 ie. Intial Level :-
Where process is unpredictable, poorly control and reactive, characterized by chaos or confusion, periodic panics and Heroic effort required by individuals to succes... complete projects where success may not be repeatable.

The process area (eg Require management) is not performed and does not achieve all goals and objectives defined by the CMM.

2] Level 2 is Repeatable :- Process characterized for projects and is often reactive, successful practices can be repeated. Basic project management process are established to track cost, schedule and functionality. The Level 2 ie Repeated Level involved:

(a) Requirement Management :-

Address the process needs for obtaining the project requirements and executing the project requirement, & project based on them. The requirements from the basis for project planning and project monitoring activities and acceptance criteria as well.

(b) Project planning :-

Comprimises of developing the project plan, obtaining commitment to the plan and maintaining the plan project planning for estimation, Resources, Deliverables, Quality Assurance and configuration management.

(c) Project monitoring and control :-

Project plans forms the basis for the project ~~planning~~ monitoring and controlling activities. The project progress is monitored against the plan. The analysis of planned Vs actual facilities early detection of slippages and implementation of corrective action.

(d) Process and Product QA (PPQA) :-

The practices in PPQA ensure that processes are implemented in projects while the practices in the verification process area ensure that the product meet the specified requirements. These two process area may on occasion address the same artifact but from perspectives.

(e) Configuration Management :- process area address

configuration identification, configuration control, configuration status accounting and configuration audits. Changes are controlled as per defined processes. The traceability matrix plays a major role during this.

For ex : Microsoft Visual source safe is one configuration management tool

(f) Supplier aggreement management and

(g) Measurement of analysis.

3] Level 3 ie Defined :- Process characterized for organization and proactive. It is standard software development and maintenance process are integrated throughout an organization. Training programs are used to ensure understanding and compliance

The Level 3 ie Defined level involve →

(a) Verification :- Verification encompasses the review of artifacts at various phase of the project life cycle.

(b) Validation :- Validation confirms the implementation of requirements as stated in functional or technical specification document

(c) Integrated project management :-

This address deriving the project specific process from organizational process and project knowledge base further involvement of relevant stakeholder is ensured to enable proper timely communication during project execution, project data and learning from project are contributed to project knowledge base.

(d) Risk Management :- Based on probability impact and severity of risk, the overall risk is calculated for each percieved risk and documented in the project plan. The Disaster recovery is also identified as a risk.

(e) Integrated Teaming :- Address the constitution and function of team to cater the needs of project execution. The interface among team members enable them to deliver the work product in a cohesive way. This is in addition to the individual responsibilities that are assigned with.

(f) Organization Environment for Integration :-
Which address provision of work environment that cultivates excellence at both individual and team level. The shared vision at the organizational level is established and maintained.

The skill required to increase the productivity and performance are imparted by means of class-room (or) on job training.

(g) Organization Process Focus and organization process definition (OPF & OPD) :-
OPF & OPP are process area of level 3 which address maintenance of processes and other assets that could be useful in subsequent project execution.

(h) Organization Training :-
The training needs for associates are identified at project planning stage and also performance appraisals.

The training may also be arranged and conducted for the topic which cover QMS (Quality Management System) and software Engineering topics.

4] Level 4 ie. Managed :- Process measured and controlled. Metric are used to track productivity, processes & products. Project performance is predictable and Quality consistantly high.

Level 4 involved :-

(a) Organizational process performance (OPP) :-
OPP process area whose objective is to establish and maintain a quantitative understanding of the performance of organ standard process and provide process perform data, baseline and models to quantitively manage the organizational projects.

(b) Quantitative project management :-
Quantitative objectives for Quality and process performance are established and used as criteria in managing the process

5] Level 5 ie. Optimizing :- ~~Process measured and controlled; Metric are~~
The focus is on continious process improvement. The impact of new processes and technologies can be predicted and effectively implemented when required. The process area is adopted and optimized using Quantitative means to meet changing customer needs and to continually improve the efficiency of the process area under consideration. This level involve Casual Analysis and Resolution, Organizational innovation & deployment.

In 1986, Carnegie Mellon University's Software Engineering Institute (SEI) started working on Five level for measuring what was initially referred to as Software process maturity and later known as Software Capability maturity.

1) Initial Level (Workship the Hero)
2) Repeatable level (Plan the work)
   - Software configuration management
   - Software Quality Assurance
   - Software subcontract management
   - Software project tracking and oversight
   - Software project planning
   - Requirement management
3) Defined Level (Work the Plan)
   - peer Reviews
   - Intergroup Co-ordination
   - Software product engineering
   - Integrated Software management
   - Training Program
   - Organization process Definition
   - organization process focus
4) Managed Level (Measure the Work)
   - Software Quality management
   - Quantitative process management
5) Optimizing Level (Work the measure)
   - Process change management
   - ~~Technolg~~ Technology change management
   - Defect Prevention

PCMM :- People Capability Maturity Model where o
Focus on quality and helps them to integrate
people, processes and Technologies to promote a
culture of Excellence and Innovation
- It helps match Changing customer
needs with available competencies
- Gives on time, on budget project
Deliveries regardless of project size
and complexity.

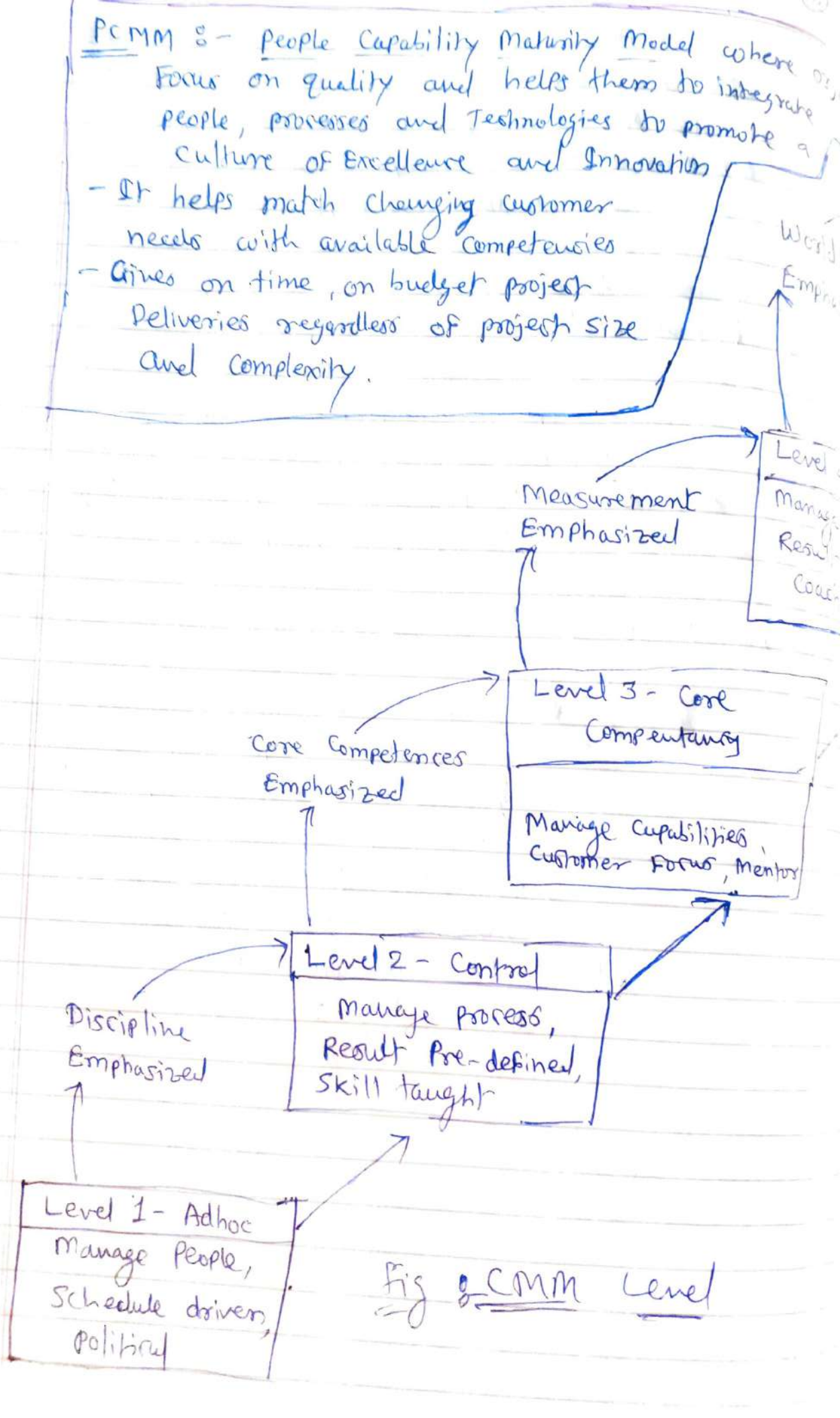
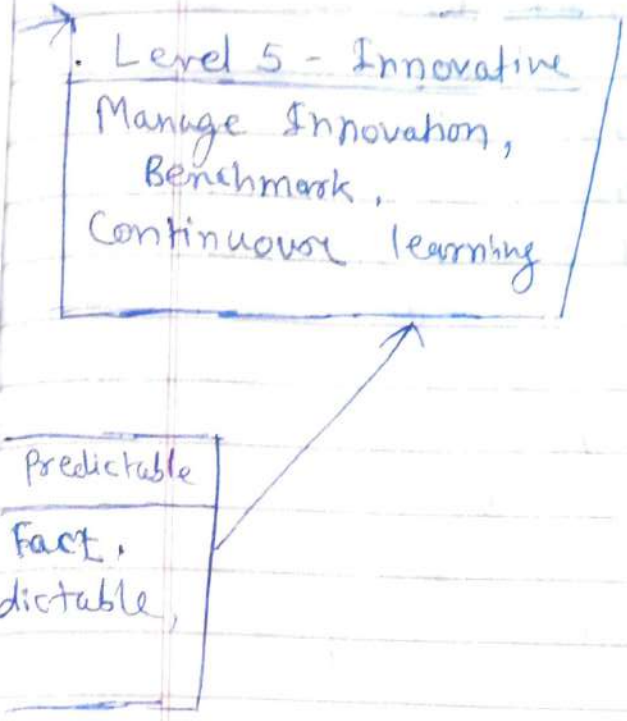
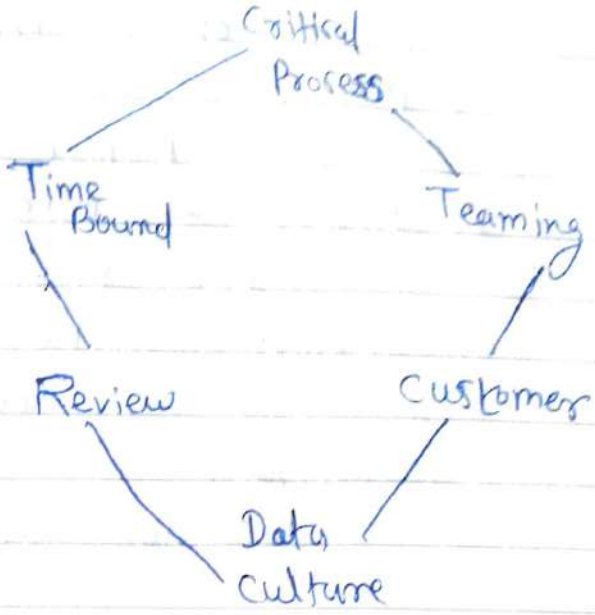


Fig :- CMM Level

Six Sigma -





Q Explain Six Sigma :-

(X) Six Sigma for Software Engineering :-

Six Sigma is the most widely used strategy for Statistical Quality Assurance in industry today. Originally popularized Motorola, in 1980. The Six Sigma strategy "Is a rigorous and disciplined methodology that uses data and statistical analysis to measure and improve a company's operational performance by identifying and eliminating 'Defects' in manufacturing and service related process".

The term "Six Sigma" is derived from Six standard deviation - 3.4 defects per million occurrences.

Six Sigma defined 5 core steps

DMAIC - Define, Measure, Analyze, Improve, Control

1) Define - Customer requirement, deliverables and project goals via well define methods of customer communication

2) Measure - The existing process and its output to determine current quality performance

3) Analyze - Defect matrics and determine the vital few causes.

4) Improve - The process by eliminating the root cause of defects

5) Control - The process to ensure the future does not reintroduce the cause of defects

1) Define :- Determine Benchmarks
Set Baseline
Determine Customer Requirement
Get Customer commitment
Map Process Flow

2) Measure :- Develope Defect Management
Develope Data collection process
Collect Data
Create Forms
Compile and Display Data

3) Analyze :- Verify Data
Draw conclusion from data
Test Conditions
Determine root causes
Map causes to effect.

4) Improve :- Create Improvement Ideas
Create models
Experiment
Set Goals
Create Problem statement
Create Solution statement
Implement Improvement method

5) Control :- Monitor Improvement Process
Measure improvement- statistically
Asses Effectiveness
Make needed adjustment.

(*) Building Blocks of SQA :-

1) Standards and procedures are the building blocks of SQA task. These provide the framework from which the software evolves.

2) Standards are the pre-established criteria to which the software products are compared &

3) Procedure are the established criteria which the software development and control processes are compared.

4) Therefore, Standards for product evaluation and procedure for process monitoring

5) Thus, proper documentation of standards and procedures is necessary to guide the SQA group in monitoring the process and evaluating the product.

6) There are various types of standards :-
   (a) Document standards
   (b) Design standards
   (c) Code standards

7) Procedure are explicitly stated criteria or steps that must be followed in carrying out a process. All processes must have documented procedures.

2] Software Quality Assurance

Need for SQA, SQA Activities, Planning & Standards

The SQA person's main responsibility examine and measure the current software development process and find ways to improve with a goal of preventing bugs from ever occurring.

The SQA group serves as the customer in-house representative i.e. The people who perform SQA must look at the software from the customer's point of view.

The SQA group that has responsibility for Quality Assurance, planning, oversight, record keeping, analysis and reporting.

SQA Activities :-

The SQA group is to assist the software team in achieving a high quality end product.

I] The SQA plan provides a road map for instituting software quality assurance developed by the SQA group. The SQA plan identifies

(1) Purpose and scope of the plan
(2) A description of all software engineering work products (e.g. models, document, source code)
(3) All applicable standards and practices that are applied during software process.
(4) SQA actions and tasks (Review & Audit) & their placement throughout the s/w process.
(5) The tools and method that support SQA actions & tasks.
(6) Software configuration management procedure
(7) Methods for assembling

(8) Organization role and responsibility relative to product Quality.

[I] SQA participates in the development of project's software process descriptions

[II] SQA Group review software engineering activities to verify compliance with defined software process - The SQA group identifies documents and track deviations from the process and verifies that corrections have been made.

[IV] Audit designated software work products to verify compliance with those defined as a part of software process
The SQA group reviews selected work products, identifies documents and track deviations, verifies that corrections have been made, periodically report the result of its work to the project management.

[V] Ensure that deviations in software work and work products are documented and handled according to a documented procedure.

[VI] Records, ~~and~~ Non-Compliance (NC) and reports to senior management, Non-Compliance items are tracked until they are resolved.

(*) Standards :-
1) Standards are mandatory ways of doing things. These are also described by experts in respective Fields.
2) Over ruling of standards is a punishable offence. It may lead to Non-conformance during reviews and audits.

3) Standards must be written to avoid any misunderstanding or loss of communication.

(*) Quality Planning at Organisation Level :-

An organisation creates quality plan at the organisation level for achieving quality objectives, goals, its vision and missions. Quality planning includes establishing missions, policies and strategies at organisation level along with objectives and goals to achieve the vision. It must set a framework for defining and implementation of good processes, practices recruiting people, infrastructure, Hardware and Software. There should be an ~~approas~~ appraisal of Quality achieved as against expected results at planned intervals and actions must be initiated in case of any deviation

(*) Quality Planning at Project Level :-

Project should ~~be~~ plan for quality at project level. These generally strategic-level quality plans with details of responsibilities and actions. Project plan must define all aspects of Quality plan at project level and may have a relation with the organisation's Quality Planning

The Quality objectives of the project may be inherited from organisation level objectives or may be defined separately for the project.

Read Reliability measures and models

Software Reliability :

It is defined as "The Probability of free operations of a computer program in a environment for specified time".

Software Reliable when it performs its intended function with required precision

- The level of accuracy and completeness expected in the operational environment is established.
- Data integrity controls are implemented in accordance with design
- Manual, regression and functional test are performed to ensure the data integrity controls work.
- The completeness of system installation is verified.
- The accuracy requirements are maintained as the applications are updated.

Measure of Reliability :-

$$MTBF = MTTF + MTTR$$

Where

MTBF = Mean Time Between Failure
MTTF = Mean Time To Failure
MTTR = Mean Time To Repair

Software Availability is the probability that program is operating according to requirements a given point in time is defined as

$$\text{Availability} = [MTTF / (MTTF + MTTR)] \times 100\%$$

Software Reliability uses statistical analysis to determine the likelihood that software failure will occur.

Software safety is software quality assurance activity that focuses on the identification and assessment of potential hazards that cause an entire system to fail.

Software Reliability Models :-

There are 2 software reliability models.

1) Reliability Growth model 2) Reliability prediction model.

1) Reliability Growth Model :-

A reliability growth model is model of how the system reliability changes overtime during the testing process. As system failures are discovered the underlying faults causing these failures are repaired so that reliability of the system should improve during system testing and Debugging.

To predict reliability, the conceptual reliability growth model must then to be translated into a mathematical model.

Although several different reliability growth models have been proposed in this text we will discuss only 2 very simple reliability models.

a) Jelinski and Moranda Model :-

This is a simplest reliability growth model is also known as step function model or equal step model. It is assumed that reliability increases by a constant increment each time an error is detected and repaired.

The above figure simple model of reliability which implicitly assumes that all error contributes equally to reliability growth is highly unrealistic since, we already know that corrections of different

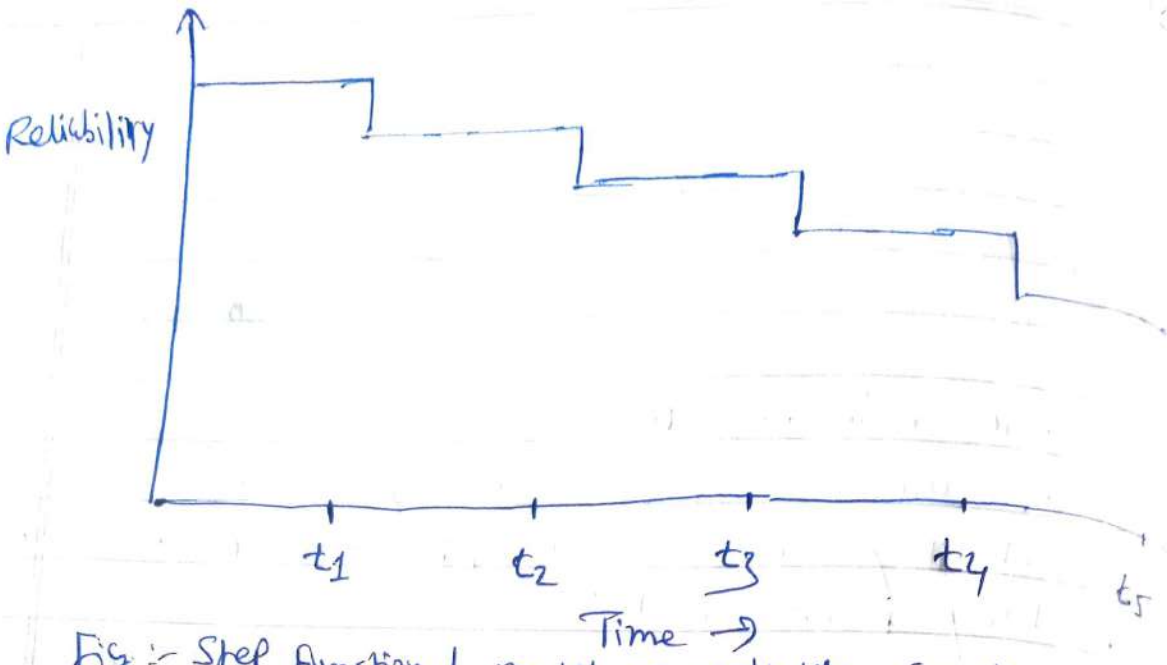


Fig :- Step functional model of reliability Growth

errors contribute differently to reliability growth.

Simple equal-step model but does not reflect real

(b) Littlewood and verrall's model :-

This model allows for negative reliability growth to reflect the fact that when a repair is carried out, it may introduce additional errors. It also models the fact that as errors are repaired the average improvement in reliability per repair decreases. This model is also known as random step-function model as shown in fig

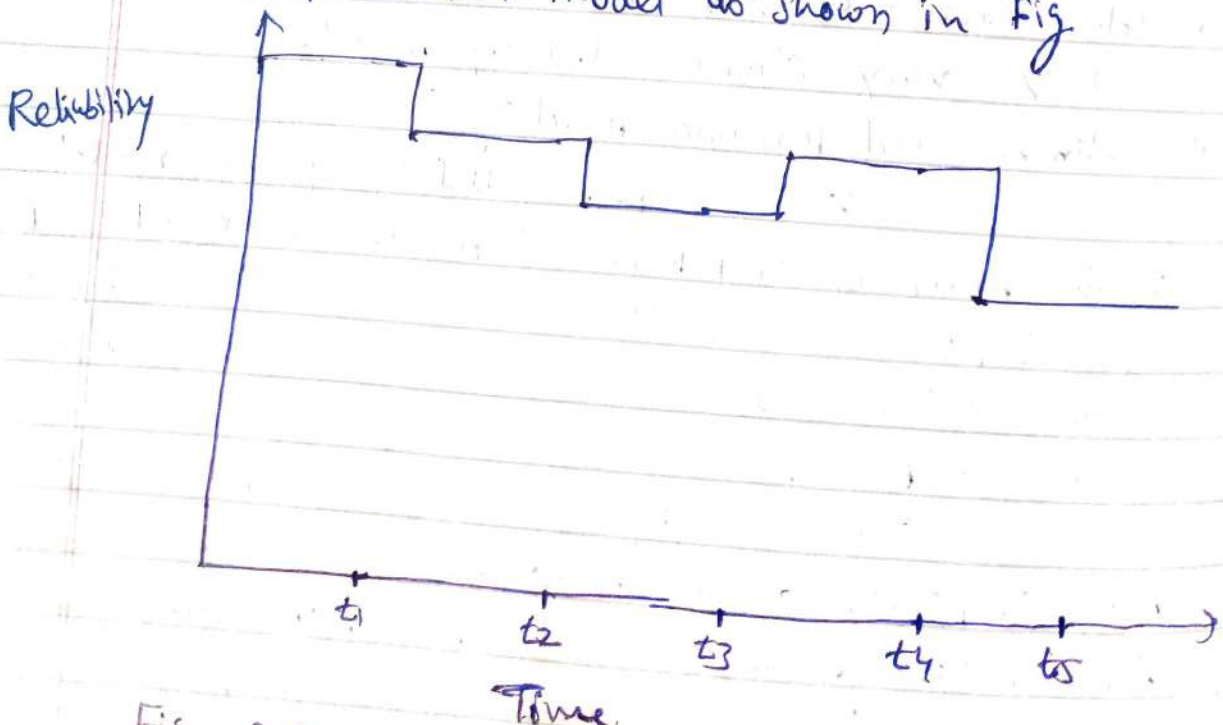


Fig A Random-Step function model for reliability growth

It treats an error's contribution to reliability improvement to be an independent random variable having Gamma distribution.

This model takes problem into account by introducing a random element into the reliability growth improvement effected by a software repair.