AIR-1 Notes

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Handwritten notes by

Kartikay Kaushik

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IES Master classroom Student

Standards & Quality Practices

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1. Basic concepts and Quality → QA and QC
2. Quality Thinkers / approaches → TQM
3. Control charts.
4. Six Sigma → Process capability
5. Acceptance Sampling → AOQ, → benefits of sampling
6. Inventory Management → EOQ
7. Manufacturing
8. Maintenance
9. Construction and services.

Key concepts related to Quality

1) Degree of fitness for the use of customers. (whether it solves the intended purpose or not)

2) The product or service should meet the customers' expectation.

Expectations → Stated
Expectations → Implied → not clearly specified.

→ Both stated and implied expectation of the customers should be fulfilled.

3) The product / service should be cost-effective. → affordable to the target customers.

→ Using Lean manufacturing and Value engineering cost of manufactu can be reduced.

→ Wastages ↓ ⇒ Processes standardise ⇒ COM ↓ ⇒ Hence produd becomes more competitive

4) Product should conform to specifications (relevant to products only)

eg → 150 ± 0.2 cm → Specification Range.

USL = 150.2 cm → LSL = 149.8 cm

→ If the value of the products quality characteristics falls within USL and LSL then it is of acceptable quality otherwise we say that a defect has taken place.

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5) The product should be reliable → time oriented characteristic.

Reliability
- 1) should not fail
- 2) over a period of time
- 3) perform as per specified standards
- 4) under given operating time

6) The product should be durable → i.e. it should have a high effective life.

→ The product will become scrap after the durable period and it cannot be restored to its normal working condition even after performing the maintenance.

7) Aesthetics → appearance of product.
Tangibles → indicator of quality for services.
↳ environment or ambience in which service is provided.

8) The product should be serviceable - means that its after sale service should be easily available at a low cost.

9) The product / service should have a good perceived quality.
↳ brand image, advertisement → preconceived notion.

10) Quality is a relative term and it is not absolute, it varies with time location and from person to person. [Subjectivity]

11) Due to globalisation, the competition has increased and now the consumers have more choices, hence if a company has to survive in the market, then it will have to continuously improve the quality of it's products and services, in order to meet the changing requirements of the customers.

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(12) Productivity = Output / Input

⇒ If Quality ↑ ⇒ Productivity ↑

⇒ Types of Quality (Stages)

(1) Quality of Design → Most important.
(2) Quality of Conformance (Implementation)
(3) Quality of Performance

(1) Quality of Design (QOD)

→ Most critical of the three
→ Multi-functional. [Interdepartmental → involving various experts]
→ It is easier and less costly to incorporate quality into the product at an early stage of product development.
→ Robust Design → It is a good quality of design such that the product is able to perform satisfactorily under a wide range of operating conditions.

Quality of Design →
1) Market Survey
2) Concept Development
3) Detailed specification. (Output)

(2) Quality of Conformance (QoC)

→ It deals with whether the product conforms to the specifications finalized at the design stage.
→ Poor QoC ⇒ defects ↑ ⇒ Wastages and Cost of Manufacturing ↑

⇒ Inputs required

(a) Resources
(b) Skilled Manpower
(c) Technology and machines
(d) funds [should be less costly and easily available]
(e) Support of leadership / top management
(f) Participation of grassroot level workers.

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(9) → Heavy dependence on the supplier to provide the right quantity and quality of input materials.

③ Quality of Performance (QoP)

→ regular and adequate maintenance.
→ good after sales services
→ reliable products.

⇒ Cost of Quality
- → 1) Prevention Cost
- → 2) Appraisal Cost

} Cost of conformance or Cost of Good Quality

- → 3) Internal failure cost
- → 4) External failure cost

} Cost of Non-conformance or failure or Cost of Poor quality

→ $COQ = CoC + CoNC$
→ $CoC = CoP + Co A$
→ $CoNC = CoIF + CoEF$

→ Cost of quality includes the cost incurred to prevent poor quality, check the quality of products and the losses resulting from Internal and External failures

① Prevention Cost

→ It involves the money spent in preventing the defects.
→ It includes the costs associated with planning, design review, training, quality assurance, supplier evaluation and effective implementation of the quality Management System.
→ As prevention cost increases, failure cost decreases
→ As the company invests more in prevention, it results in long term sustainable profits to the company because of improved brand image and increased sales.

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(2) Appraisal cost

→ As the cost of prevention increases, the cost of appraisal reduces.

→ The appraisal cost includes the cost associated with inspection of the product, testing equipment and salary of the related staff.

(3) Internal Failure Cost

→ It is the loss to the company if a part fails within the company itself

→ It includes the cost associated with scrap, reworking, failure analysis.

(4) External Failure cost

→ It is the loss to the company if a product becomes defective after reaching the customer.

→ It includes the cost associated with processing of customer complaints, delayed payments, returned products, product recall, and loss of future customers. because of damage to the product's image.

Q $CoF = 1500 + 120X$ where X = Percentage defects.

$CoC = \frac{3000}{X}$ Find $(COQ)_{min}$ and corresponding X.

$$CoQ = 1500 + 120X + \frac{3000}{X} \rightarrow \frac{d(coq)}{dx} = 120 - \frac{3000}{x^2} = 0$$

$$\Rightarrow x^2 = \frac{3000}{120}$$

$$\Rightarrow \boxed{x = 5\%}$$

$$\boxed{COQ_{min} = 2700}$$

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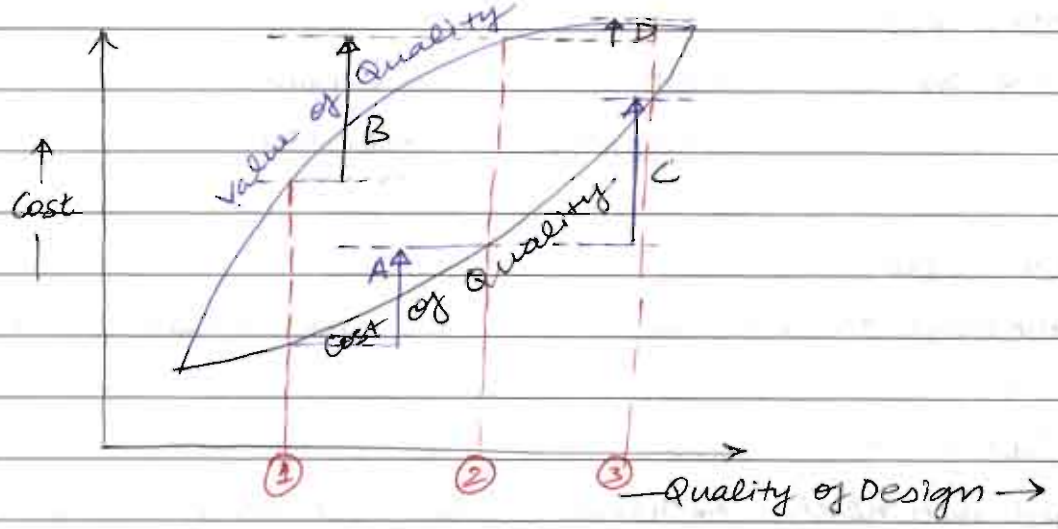
⇒ Balance between Value of quality and cost of quality

→ Value of quality is the returns gained by the company due to various quality related activities. The returns may be due to reduction in defects and due to increased sales and hence profit to the company.



→ If by improving quality from ① to ②
$\Delta VOQ > \Delta COQ$ i.e. $B > A$
then improvement in quality is justified

→ If by improving quality from ② to ③
$\Delta VOQ < \Delta COQ$ i.e. $D < C$
then improvement in quality is not justified.

⇒ Evolution of concept of Quality

Phase I Before industrial Revolution

→ Less use of machines and technology
→ Low volume of production and less capital involved.
→ No institutionalized framework for maintaining quality
→ Quality dependent mainly on the skills of the individual involved.

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Phase 2 : After Industrial Revolution

→ Use of machines and technology and so rapid increase in the volume of production and the capital involved.
→ A separate dept of quality control was established to ensure the quality of final output.
→ The approach was inspection based quality control
→ There was no emphasis on satisfaction and motivation of the workers
→ It focuses on only product and is a reactive approach (post mortem) ↗ and not the process
→ Treated Quality as an isolated entity and not as a holistic value. Industrial Revolution was also the main cause of colonization

Phase 3 : After World War II

→ There was a radical shift in the approach towards quality from technical to human aspects and employee satisfaction and participation were considered essential for achieving the overall quality goals of the organization.
→ Focus on process and is a preventive approach.
→ TQM, Six Sigma, TPM, Kaizen, JIT were developed in Japan

⇒ Terms associated with Quality

① Quality Policy and objective

→ It is the overall intention and direction of a company towards quality
→ It should be clearly expressed and communicated by the top management of the company
→ It is a general statement made by the company and it forms the basis for framing the quality objectives of the organization
→ The quality objectives are derived from the quality policy and these should be specific, time oriented, measurable and realistic

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(2) Quality Assurance (QA) and Quality Control (QC)

	QA	QC
	Process focussed	product focussed
	Preventive	finds defects
	Proactive	Reactive
Tools ⇒	Quality Audit	Quality Inspection

→ QA provides confidence to the management, customers and the regulating bodies that correct procedures are being followed.

(3) Quality Audit (compliance with SOPs)

→ It is a systematic and independent examination to determine that whether the quality activities are in compliance with the planned arrangements and whether these arrangements are effective or not (SOPs)

Quality Audit →
- 1st Party (Internal Audits)
- 2nd Party
- 3rd Party

[External Audits]

(a) 1st Party Audit

→ It is an internal audit conducted by the employees of the organization itself.

→ It checks that whether the quality management system is working effectively or not and report the conformities and non-conformities to the top management

→ eg - Management Department may audit operations department of an organization.

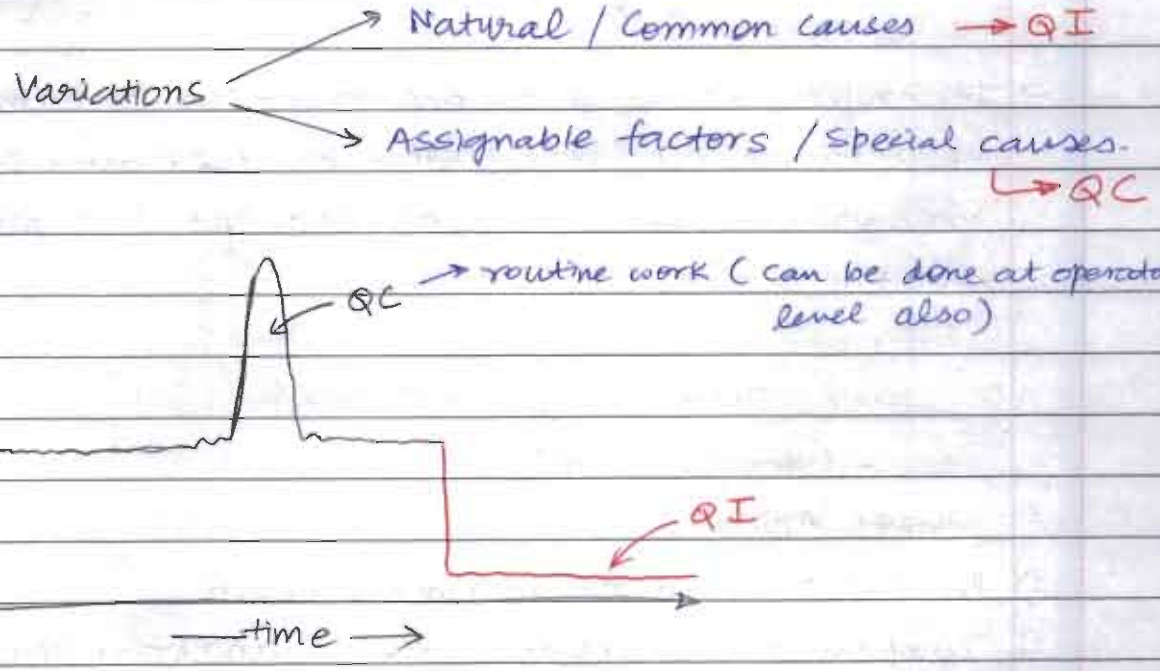
(b) 2nd Party Audit

→ It is an external audit, conducted by the customer organization on a supplier organization. It provides confidence to the customer organization in the supplier's ability to provide materials of right Quality

(c) 3rd Party Audit

→ It is an external audit carried ~~out~~ out by an organization independent of the customer supplier relations. It may result in certifications or awards.

⇒ Quality Improvement



→ Quality Improvement involves using better systems, working methods, machines, materials and workers. This requires the support of top management.

→ The methods of quality improvement are:

① PDCA cycle

② Benchmarking

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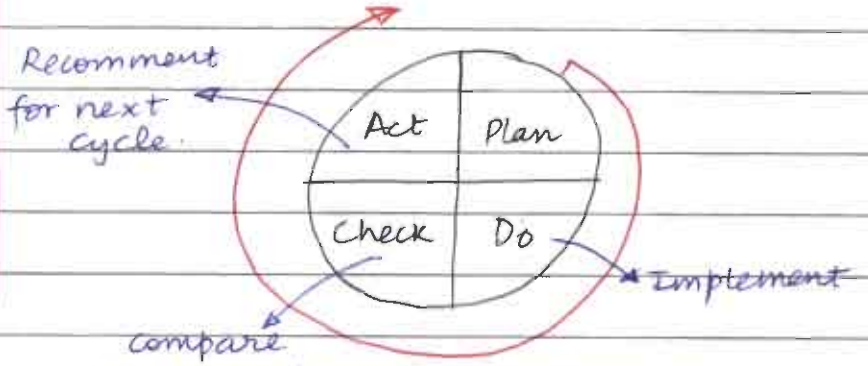
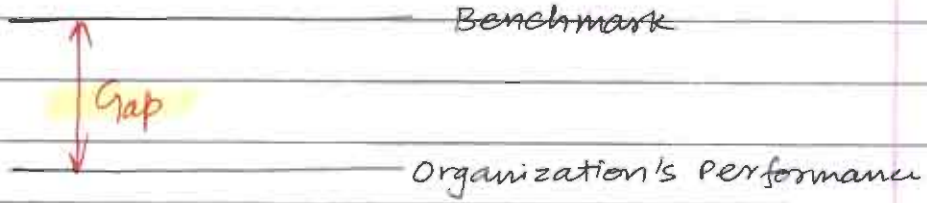
① → In PDCA cycle, involves 4 components



② → Benchmarking → Requires quantification of performances.



→ It involves comparing the organizations' performance with the benchmark i.e. best existing practice. Subsequently, the organization can identify the gap b/w both performances and try to overcome that gap.

Chapter-2 Quality Thinkers

(good change)

⇒ Kaizen Approach

1) Process based continuous improvement.
2) Involvement of everyone in the organization and all departments
3) Emphasis on human aspects.
4) Important role of leadership.
5) It involves only small changes by everyone in the organization in their daily operations. Hence it is different from innovation.
6) It is a disciplined approach which reduces wastages and improves productivity
7) It is not limited to any particular department

8) It is a continuous activity.

⇒ Quality Thinkers

① Ishikawa → Quality circle
→ 7 Quality control tools. → help to recognise and analyse the pattern of defect occurrence.

➢ Quality Circle

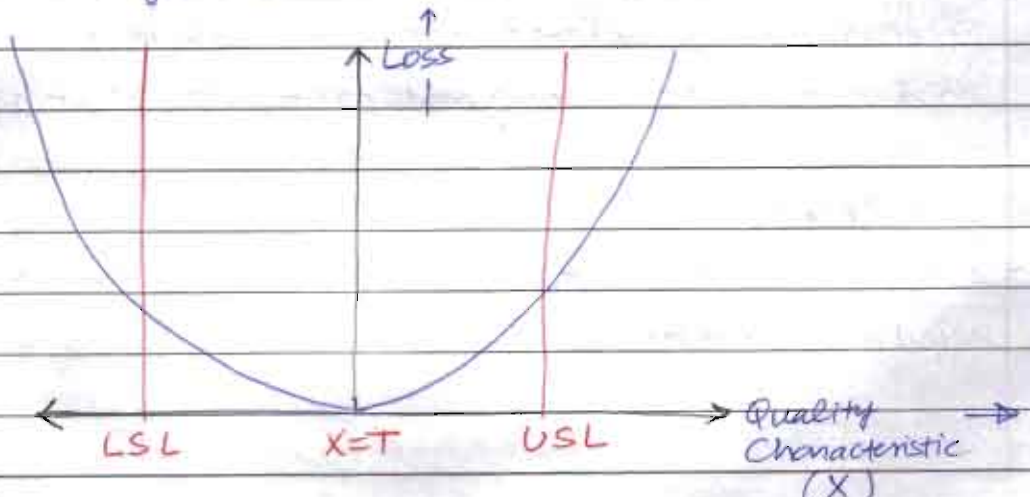
→ It is a voluntary group of workers who regularly meet to identify, analyse and solve quality related problems.
→ These workers perform similar types of works.
→ It increases awareness about quality among the workers
→ Workers are trained by professionals in industry and motivated to ensure their participation and their contribution is recognized.
→ Workers get the opportunity to realise their hidden potential
→ It improves the communication and increases the morale of workers

② Taguchi → Loss function
→ Robust Design.

⇒ Loss Function

$$\text{Loss, } L = C(X-T)^2$$

where C ≡ constant
X ≡ value of Quality characteristic
T ≡ Target value.



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→ Each product has a target value and the manufacturer should try to meet the target value rather than being within USL and LSL.

→ The traditional concept in Quality is that if the product's Quality characteristic value falls anywhere within the USL and LSL, then it is equally acceptable. This approach is called Goal Post Mentality.

→ Taguchi's theory is opposite to this.

→ According to Taguchi, the customer dissatisfaction keeps on increasing as the product deviates from the target value and it is not sudden as was in the traditional methods.

Q. $L = 8500(x-T)^2$

Specification (in cm) = 6 ± 0.25 cm

Quality characteristic value = 6.3 cm.

Loss = $8500(0.3)^2 = 8500 \times 0.09 = 765$

(3) Crosby → Quality is free
→ Zero Defect

⇒ Quality is free

→ Quality is free because the initial expenditure in the various quality related activities can be recovered later on due to increased sales and profits to the company.

⇒ Zero Defect

→ Zero Defect is a management strategy aimed at prevention of defects by motivating the workers

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④ Deming → Principles for transformation of management
→ PDCA cycle.

⇒ Principles for transformation of management

→ According to Deming, most of the quality related problems take place due to flaws in the system and the responsibility for changing the system lies with the management. Hence the management should be transformed.

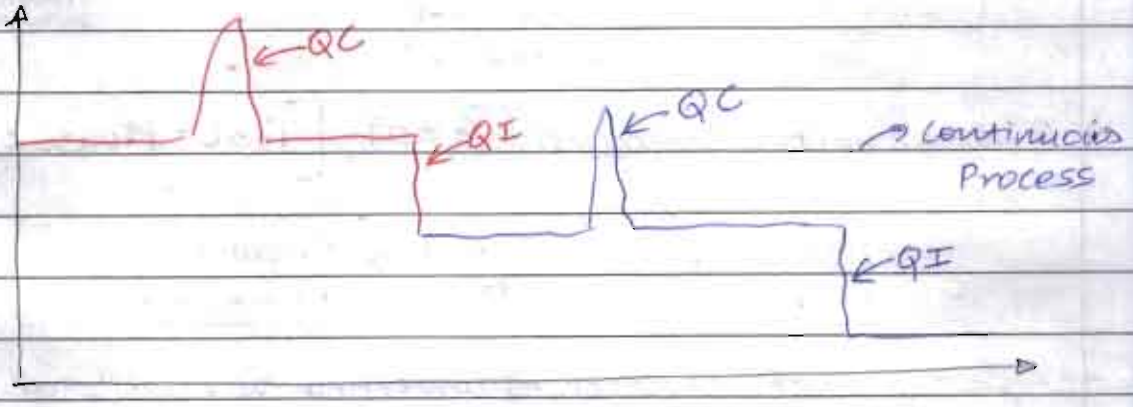
→ For a continuously improving the quality outcomes of the organization, Deming has given a theory of profound knowledge.

→ It consists of the following: → System works as a unit.

① Appreciation for the system and the theory of optimization
② Knowledge about variation → various quality defects that can occur
③ Theory of knowledge
④ Knowledge of Psychology → to understand psyche of workers

⑤ Feigenbaum → TQM or TQC

⑥ Juran → Quality Trilogy → Quality Planning
→ Quality Control
→ Quality Improvement



⇒ Total Quality Management (TQM)

→ It is a culture based on continuous improvement of process. It is total because it includes all departments and all the employees of the organization.

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→ There should be long term relationship b/w the customer and supplier organizations based on mutual trust. There is emphasis on systems approach and organization is considered as a system.

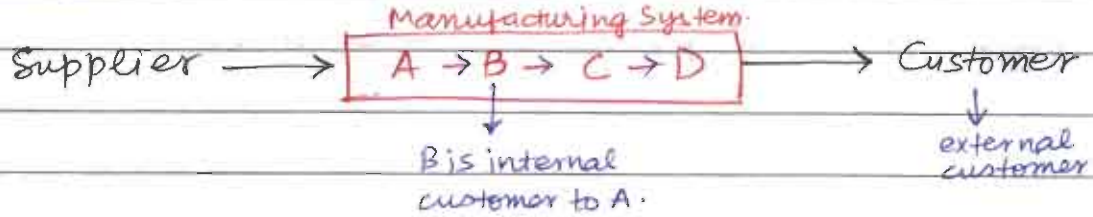
→ There should be fact based decision making and any arbitrary ness should be avoided.

→ There should be focus on customers as the customers expectations are rapidly changing i.e. dynamic and the competition is continuously increasing.

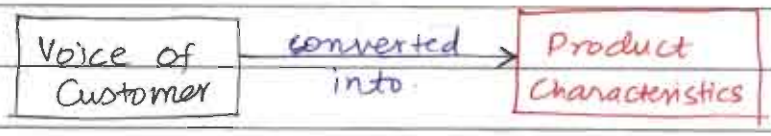
→ There is a significant role of leadership as it provides the required resources, frames policies and empowers people.

→ Employee satisfaction, participation, motivation, sense of belongingness, training, teamwork, communication and recognition of their work are essential to achieve TQM.

→ The expectations of both internal and external customers should be met.



→ Quality Function Deployment (QFD) [Tool - House of Quality]



→ It is a systematic approach of converting the qualitative customer's expectations into quantitative engineering characteristics of the product.

→ It is a multi-functional approach as it involves experts from different departments at the stage of planning and design.

→ It is proactive in nature as it looks at the complete cycle of product development at an early stage and hence