Learning objectives

* To gain understanding of and clarity on what quality is
* To be able to describe the different types of inspection
* To be able to describe the different statistical methods of controlling quality
* To be able to apply statistical methods in quality control activities

Manufacturing-based perspective of Quality

- Quality in terms of conformance to specification
- based on the fact that a product must come from some process of bringing it to life
- Quality definitions
  - “conformance to specifications” Joseph Juran
  - “uniformity around a target” Kauru Ishikawa

Designing for quality

- Application of scientific approach to tolerance design
- Uses the concept of Taguchi Loss Function (advanced by Genichi Taguchi)
  - Taguchi considers quality in terms of loss to society from the time a product is shipped. The smaller the loss the more desirable a product is.
  - Any variation about a target value for a parameter causes loss to the customer which increases exponentially as the parameter value moves away from the target
  - \( L(y) = k(Y-T)^2 \) where \( Y \) is actual value, \( T \) is target value, and \( k \) is some constant

INSPECTION

- Elements of production (4Ms and 1 I)
  - Information in the form of work instruction
  - Materials in the form of parts and materials
  - Machinery to set up the Materials
  - Manpower to make things
  - Methods of making things as established
- A defect occurs if one or more of the elements is or are not correct.

INSPECTION - definition

- The act of examining, studying or checking if all the elements of production (i.e. the 4Ms and 1I) are or have been right.
Inspection methods

- Judgment inspection
  - Defectives products separated from good ones
  - Based on comparison with a standard
  - Emphasizes detection of defect (not reduction or elimination)
  - Based on philosophy that defect is inevitable and cannot be avoided, but can be prevented from reaching the customer
    - Errors by workers expected.

- Informative inspection
  - Investigates the causes of defects and feeds back the information to the appropriate processes
  - Cause of defect within one of the 5 elements is reduced or eliminated by directing attention to the errors that caused it
  - Types:
    - Self-checks
      - Successive inspection after the action by the worker
    - Source inspection
      - 100% inspection
      - Identifies factors that may cause errors

Defect handling objectives and strategies

- Defects not to leave the organization/plant
  - Strategy is to have more inspectors
  - Judgmental inspection method
  - Errors are made, defects separated by inspectors
  - Defective products reworked or scraped

- Decrease defects from production process
  - Strategy is to improve production process
  - Informative inspection method
  - Information on defects fed back to the process for improvement
  - Defective products reworked or scraped

Defect handling objectives and strategies (contd)

- Zero defects leave the production process
  - Strategy is to train production workers
  - Self-check technique of informative inspection
  - Within process feedback of error information cuts feedback time

- Right first time – no defects at any rate
  - Zero defects production methods strategy
  - Source inspection method
  - Errors eliminated before they cause defects.
    - Mistake-proofing

Poka-Yoke (Mistake proofing)

- Refined by Shingo at Toyota
- Involves 100% source inspection
- Uses simple devices and procedures called poka-yoke
  - Photo sensors
  - Trip switches
  - Fixtures to orient parts
  - Checklists
  - Kitting of parts

Examples

- Labeling Template
- Jig for Part Placement
- Guide Pins and Cutouts (that limit orientation)
- Correctly Oriented
- Incorrectly Oriented

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Examples (cont.)

- Limit Switches on Jig
- Proximity Sensor Detects Broken Bit

STATISTICAL METHODS OF QUALITY CONTROL

- Acceptance sampling
- Statistical process control

Acceptance Sampling

- Definitions
  - A form of inspection that is used to determine whether or not goods are coherent with a set standard of quality
  - A process that helps to determine whether to accept or reject the sample being observed

Risks of Acceptance Sampling

- Producers Risk
  - The risk associated with a producer rejecting a lot of materials that actually have good quality
  - Also referred to as a Type I Error
- Consumers Risk
  - The risk associated with a consumer accepting a lot of materials that actually have poor quality
  - Also referred to as a Type II Error

Application of Acceptance Sampling

- The decision to accept or reject the shipment is based on the following set standards:
  - Lot size = N
  - Sample size = n
  - Acceptance number = c
  - Defective items = d
    - If d <= c, accept lot
    - If d > c, reject lot
  - Quality standard can be specified in terms of Acceptance Quality Level (AQL) and Limiting Quality Level (LQL)
  - Sampling scheme specified in N,c

Acceptance Sampling Plan

- Mohamed owns and operates a manufacturing plant.
- He receives a shipment of 1,000 sheets of glass.
- Of the shipment, Mohamed chooses to sample 50 sheets.
- If more than 2 are defective, he is sending back the entire shipment to the supplier.
- Mohamed observes 5 defective sheets of glass
Acceptance Sampling Plan (contd)

Therefore, according to the set standards mentioned above:
- \( N = 1,000 \)
- \( n = 50 \)
- \( c = 2 \)
- \( d = 5 \)

Acceptance Sampling Plan

- What should Mohamed do in reference to the number of defective items observed?
  - Remember, if \( d > c \), reject lot
    - Since \( c = 2 \), and \( d = 5 \)…
    - Mohamed should reject the lot of 1,000 sheets of glass

Statistical Process Control

- There are two types of variations in any process output
  - Stable variation
    - Identified by the constant nature and randomness around a steady average
    - Variation is due to chance
    - Also known as “common cause variation”
    - This is the concept of “statistical control”
  - Unstable variation
    - A changing average, a series with inconsistent variation magnitude or some other systematic pattern
    - Prediction of expected extent of variation is not possible
    - An indication of a process “out of statistical control”

Control charts

- Identifies the nature of variation present:
  - If variation is stable variation only
    - Managers must redesign the process if it fails to meet requirement.
  - If unstable variation is present
    - The process is out of control and cannot be guaranteed to produce output that meets requirement
    - Make adjustment now to continue to expect an output that meets requirement
  - Be careful
    - The process may require adjustment

Quality standards

- Quality standards can be:
  - Sector specific standards
    - QS9000 standard
      - For automotive industry
      - Used by Ford, Chrysler, and General Motors only
    - TE9000 standard
      - Automotive tooling industry
    - MS9000 standard
      - Automotive tooling industry
    - AS9000 standard
      - Aerospace basic requirements
    - AS9100 standard
      - Aerospace model for quality assurance
Quality standards (contd)

- Sector specific standards
  - PS 9000 standard
    - Pharmaceuticals packaging
  - EN4600 standard
    - Medical devices quality assurance
  - ISO/TS 16949 standard
    - International automotive industry standard
  - SA8000 standard
    - Standard for social accountability

Quality standards

- General (ISO 9000)
  - ISO 9000:2005
    - A vocabulary standard
  - ISO 9001:2008
    - Specifies minimum requirements for meeting customer satisfaction
    - Specifies systems to meet regulatory requirements
    - Can be used for third party certification
  - ISO 9004:2000
    - Guideline standard for achieving continuous improvement and meeting requirements of all interested parties.

- Company-specific
  - Acceptance Quality Levels (AQL)
    - Based on acceptance sampling method
  - Zero defects,
  - Six Sigma

Reference Textbooks