Chapter 20

Quality Management

Quality Drivers

- Higher performance requirements
- Faster product development
- Higher technology levels
- Materials and processes pushed to the limit
- Lower contractor profit margins
- Fewer defects/rejects

Market Expectations

- Salability: the balance between quality and costs
- Produceability: the ability to produce the product with available technology and workers, and at an acceptable cost
- Social acceptability: the degree of conflict between the product or process and the values of society (i.e., safety, environment)
- Operability: the degree to which a product can be operated safely

Market Expectations (Continued)

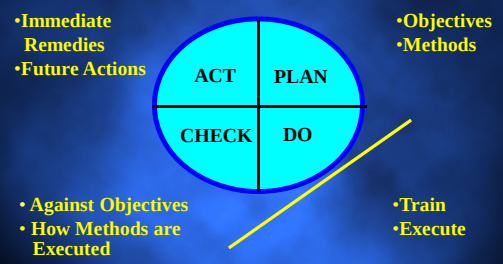
- Availability: the probability that the product, when used under given conditions, will perform satisfactorily when called upon
- Reliability: the probability of the product performing without failure under given conditions and for a set period of time
- Maintainability: the ability of the product to be retained in or restored to a performance level when prescribed maintenance is performed

Strategic Quality Management

- Quality is defined by the customer.
- Quality is linked with profitability on both the market and cost sides.
- Quality has become a competitive weapon.
- Quality is now an integral part of the strategic planning process.
- Quality requires an organization-wide commitment.

The Deming Cycle For Continuous Improvement

(Also Known as The Shewhart Cycle)



Degrees of Quality

- Structural (length, frequency)
- Sensory (taste, beauty, appeal)
- Time-oriented (reliability, maintainability)
- Commercial (warrantee)
- Ethical (courtesy, honesty)

Quality Expectations

- Quality policy
- Quality objectives
- Quality assurance
- Quality control
- Quality audit
- Quality program plan

Quality Policy

- Be a statement of principles, stating what, not how
- Promote consistency throughout the organization and across projects
- Provide and explanation to outsiders of how the organization views quality
- Provide specific guidelines for important quality matters
- Provide provisions for changing/updating the policy

Quality Objectives

- Be obtainable
- Define specific goals
- Be understandable
- State specific deadlines

Quality Assurance

- Identify objectives and standards
- Be multifunctional and prevention oriented
- Plan for collection and use data in a cycle of continuous improvement
- Plan for the establishment and maintenance of performance measures
- Include quality audits

Quality Control

- Select what to control
- Set standards that provide the basis for decisions regarding possible corrective action
- Establish the measurement methods used
- Compare the actual results to the quality standards
- Act to bring nonconforming processes and material back to the standard based on the information collected

Quality Control *(Continued)*

- Monitor and calibrate measuring devices
- Include detailed documentation for all processes

Quality Audit

- The planned quality for the project will be met.
- The products are safe and fit for use.
- All pertinent laws and regulations are followed.
- Data collection and distribution systems are accurate and adequate.
- Proper corrective action is taken when required.
- Improvement opportunities are identified.

Quality Plan

- Identify all of the organization's external and internal customers
- Cause the design of a process that produces the features desired by the customer
- Bring in suppliers early in the process
- Cause the organization to be responsive to changing customer needs
- Prove that the process is working and that quality goals are being met

Cost of Quality (COQ)
Definitions & Examples

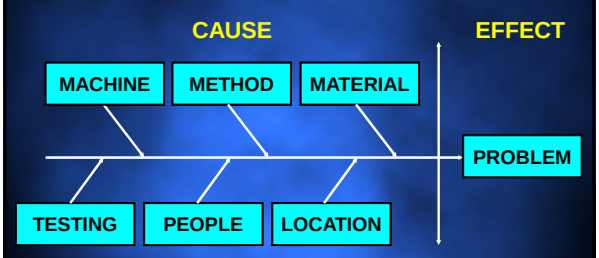
Prevention: cost associated with design and planning of a quality control (QC) program	Appraisal: costs involved in the direct appraisal of quality both in the plant and in the field	Internal failure: costs directly related to the occurrence of defective production within the plant	External failure: costs associated with the failure of a product or service in the field
• QC administration and systems planning • Quality training • Quality planning (QC engineering work) Incoming, in-process, final inspection, and test planning Special processes planning Quality data analysis and feedback Procurement planning Vendor surveys, audit and surveillance planning Reliability studies • Design and development of quality measurement and control equipment • Qualification of material	• Testing • Inspection • Quality audits • Incoming test and inspection and laboratory acceptance • Checking labor • Laboratory or other measurement service • Setup for test and inspection • Test and inspection material • Outside endorsements • Maintenance and calibration • Product engineering review and shipping release • Field Testing	• Scrap, at full shop cost • Rework, at full shop cost • Scrap and rework, fault of vendor • Material procurement • Factory contact engineering • QC investigations (of failures) • Material review activity • Repair and troubleshooting	• Complaints and loss of customer good will • Warranty cost • Field maintenance and product service • Returned material processing and repair • Replacement inventories • Strained distributor relations

Check Sheets

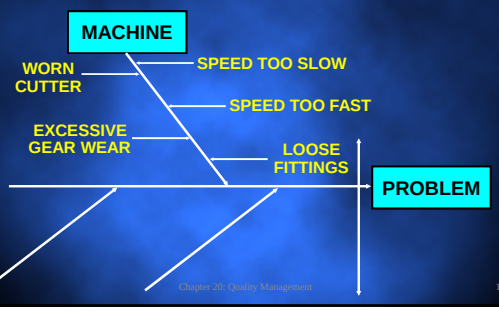
- Agree on what is being observed
- Decide on time period
- Design form
- Collect data

Problem	Month			Total
	1	2	3	
A	||	||	|	5
B	|	|	|	3
C	||||	||	||||	12
TOTAL	8	5	7	20

Cause-And-Effect Analysis



Cause-And-Effect Analysis
(With "Bones" Inserted)



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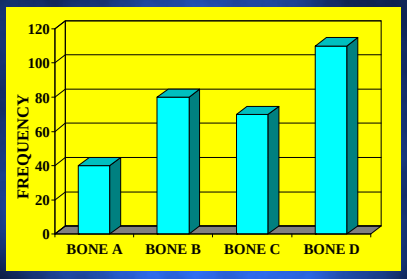
Histogram



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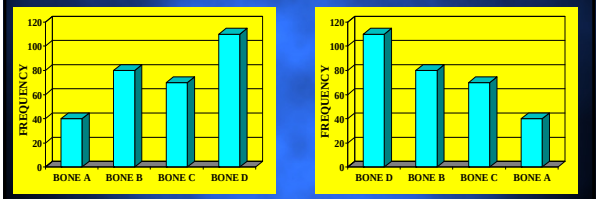
From Histogram To Pareto

Histogram → Pareto (Chosen Few)



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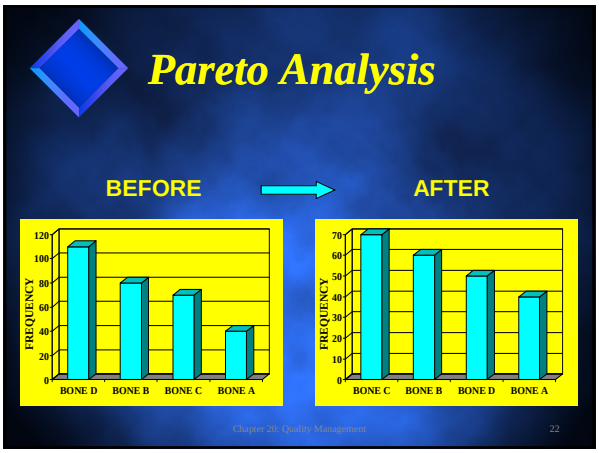
Pareto Analysis
BEFORE
AFTER
FREQUENCY
120
100
80
60
40
20
0
BONE D
BONE B
BONE C
BONE A
FREQUENCY
70
60
50
40
30
20
10
0
BONE C
BONE B
BONE D
BONE A
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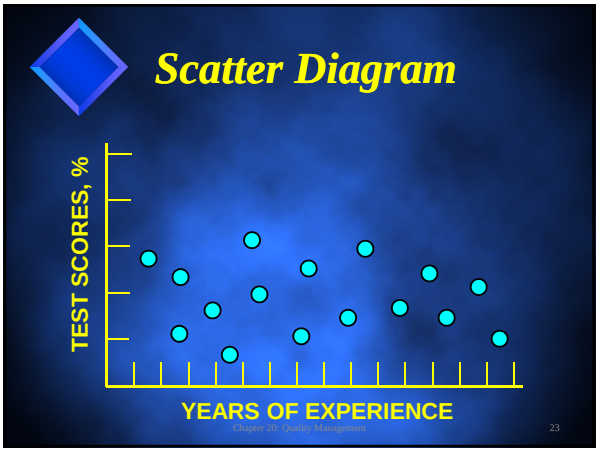
Scatter Diagram
TEST SCORES, %
YEARS OF EXPERIENCE
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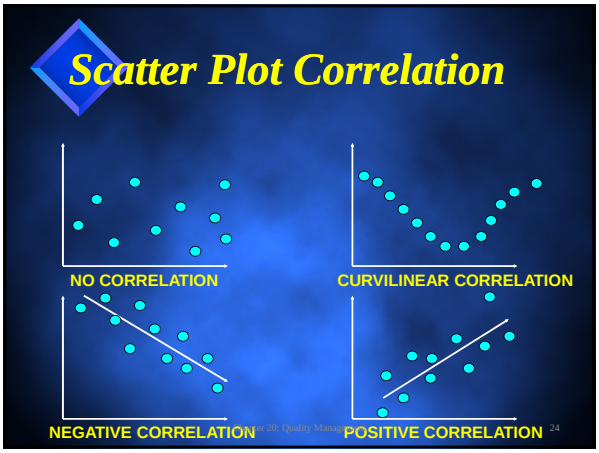
Scatter Plot Correlation
NO CORRELATION
CURVILINEAR CORRELATION
NEGATIVE CORRELATION
POSITIVE CORRELATION
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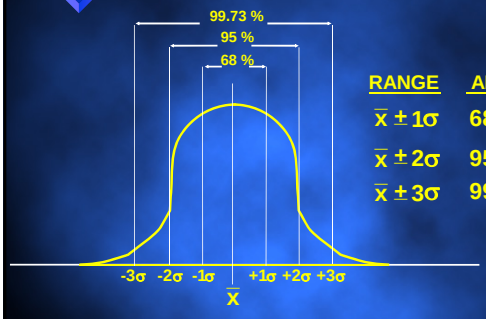
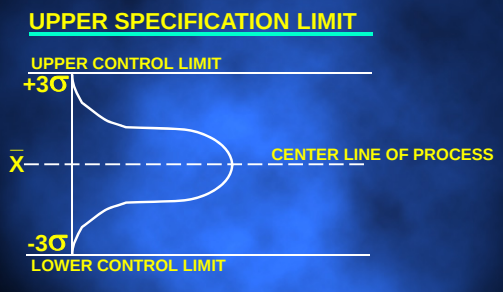
Scatter Charts That Correlate Well Are Also Referred To As Trend Charts.

The Bell-Shaped Curve



RANGE	AREA
$\bar{x} \pm 1\sigma$	68 %
$\bar{x} \pm 2\sigma$	95 %
$\bar{x} \pm 3\sigma$	99.73 %

Control Chart



Normal Distribution Attributes

SPECIFICATION RANGE (+/-σ)	PERCENT WITHIN RANGE	DEFECTS PER BILLION PARTS
1	68.27	317,300,000
2	95.45	45,400,000
3	99.73	2,700,000
4	99.9937	63,000
5	99.999943	57
6	99.9999998	2

Common Cause Variability

- ***Common cause variability or variation:*** **This source of random variation is always present in any process. It is that part of the variability inherent in the process itself. The cause of this variation can be corrected only by a management decision to change the basic process.**

Common Cause Variability

(Continued)

- ***Special cause variability or variation:*** **This variation can be controlled at the local or operational level. Special causes are indicated by a point on the control chart that is beyond the control limit or by a persistent trend approaching the control limit.**

Process Capability

$$C_p = \frac{USL - LSL}{6\sigma}$$

Capability Index

$$C_{p_k} = \frac{|CL - NEAREST\ SPEC\ LIMIT|}{3\sigma}$$

Sampling Plans

- Single sampling: This is the acceptance or rejection of a lot based upon one sampling run.
- Double sampling: A small sample size is tested. If the results are not conclusive, then a second sample is tested.
- Multiple sampling: This process requires the sampling of several small lots.

Sampling Risks

- Producer's risk: This is called the α (alpha) risk or type I error. This is the risk to the producer that a good lot will be rejected.
- Consumer's risk: This is called the β (beta) risk or type II error. This is the consumer's risk of accepting a bad lot.

Quality Circle Elements

- They give a team effort.
- They are completely voluntary.
- Employees are trained in group dynamics, motivation, communications, and problem solving.
- Members rely upon each other for help.
- Management support is active but as needed.
- Creativity is encouraged.
- Management listens to recommendations.

Quality Benefits

- Improved quality of products and services
- Better organizational communications
- Improved worker performance
- Improved morale

Cost of Waste

- Rejects of completed work
- Design flaws
- Work in progress
- Improperly instructed manpower
- Excess or noncontributing management (who still charge time to the project)
- Improperly assigned manpower
- Improper utilization of facilities
- Excessive expenses that do not necessarily contribute to the project (i.e., unnecessary meetings, travel, lodgings, etc.)