On Quality Engineering

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Outline

- What is Quality
- Types and Classifications
- Areas and Characteristics
- Assessment and Planning
- Improvement and Control
- Qualitative and Quantitative
- A Roadmap for Quality Change

What is Quality?

- In the eyes of the beholder …
  - Fitness for use …
  - Customer satisfaction and loyalty …
- What and who is a customer?
  - Internal customers
  - External customers
  - Anyone affected by the product/service

Two approaches to Quality

- Little “q”
  - Traditional quality function
  - Reactive, finding issues, manufacturing
  - Control charts, acceptance sampling
- Big “Q”
  - New approach to Quality
  - Proactive, preventing, all services
  - Product as well as Process

Two Dimensions of Q

- Features
  - Affects Income (sales)
  - Reliability, ease of use, appearance, price
  - Refers to Quality of Design
- Freedom from Deficiencies
  - Affects production costs
  - Defects, failures, warranty, waste, etc.
  - Refers to Quality of Conformance

Two Types of Problems

- Sporadic Problems
  - Occur intermittently and randomly
  - SPC, Acceptance Sampling, etc.
  - Restoring the Status Quo
- Chronic Problems
  - Long Term and Costly
  - Continuous Improvement
  - Changing the Status Quo

Some Related Quality Areas (1)

- Quality and Productivity
  - Process assessments lead to
    - Process improvements
  - Help achieve higher efficiency by
    - Identifying time/waste reductions
  - And raise worker productivity
    - By streamlining the process

Some Related Quality Areas (2)

- Quality and Costs
  - Quality improvements imply
  - Less customer complaints
  - Increased sales, and
  - Decreased warranty costs
  - Smaller Inventory, and
  - Higher productivity

Some Related Quality Areas (3)

- Quality and Cycle Time (DFSS/DMAIC)
  - Less time to product development
    - Beats competition to marketplace
    - Bring higher sales and market share
  - Less time to manufacture products
    - Decreases inventory costs
    - Increases worker productivity
    - Brings higher revenues and sales

Three Quality Processes

- Quality Planning
  - Product and Process development; DFSS
- Quality Control
  - Define, Measure, Compare, Act; SPC
- Quality Improvement
  - Continuous improvement process
  - DOE, Lean, Six Sigma/DMAIC

Four Quality Assurance Areas (1)

- Quality Assessment
  - Review and Assessments of the
  - 0rganization's general "Q" procedures
  - And its "Quality Culture"
- Quality Planning
  - Review and Assessment of the
  - 0rganization's "Q" planning procedures

Four Quality Assurance Areas (2)

- Quality Control
  - Acceptance sampling
  - SPC procedures
- Quality Improvement
  - Experimental Design/DOE
  - Six Sigma/DMAIC, Lean
  - Continuous Improvement

Quality Assessment

- Cost of Poor Quality (COPC)
  - Appraisal, Scrap, Prevention, Warranties
- Standing in the Market Place
  - Benchmarking, field studies
- Quality Culture of the Organization
- Operation of its Quality Systems
  - ISO 9000; Baldrige

Cost of Poor Quality (COPC)

- Difficult to notice and/or recognize
- Product non conformities (defects)
- Inefficient production processes
- Lost opportunities (sales/revenues)
- Appraisal and Prevention Costs
- As well as Hidden Quality Costs:
  - Downtime, extra inventory, overtime

Reduction of COPC

- Pays for Quality Improvement costs
  - Reduces customer complaints
  - Increases customer loyalty
  - Increases reputation/customer base
  - Reduces warranty costs
  - Reduces production cycle
  - Reduces production costs

Quality Planning

- Identify Customers and their Needs
  - Benchmarking, surveys
- Develop the Product
  - Quality Function Deployment (QFD)
- Develop the Process
  - Design For Six Sigma (DFSS)
- Develop the Operational Phase

What is QFD?

- The voice of the customer
- A process that interprets and allows understanding of customer needs and expectations and product or service features and functions
- QFD was developed in late 1960′s by Professors Shigeru Mizuno and Yoji Akao

Why QFD?

- To prioritize spoken and unspoken customer wants, and needs

- To build and deliver a quality product or service by focusing various business functions toward achieving a common goal of customer satisfaction.

- QFD maximizes positive quality (ease of use), where as traditional quality system try to reduce negative quality (defects, poor service)

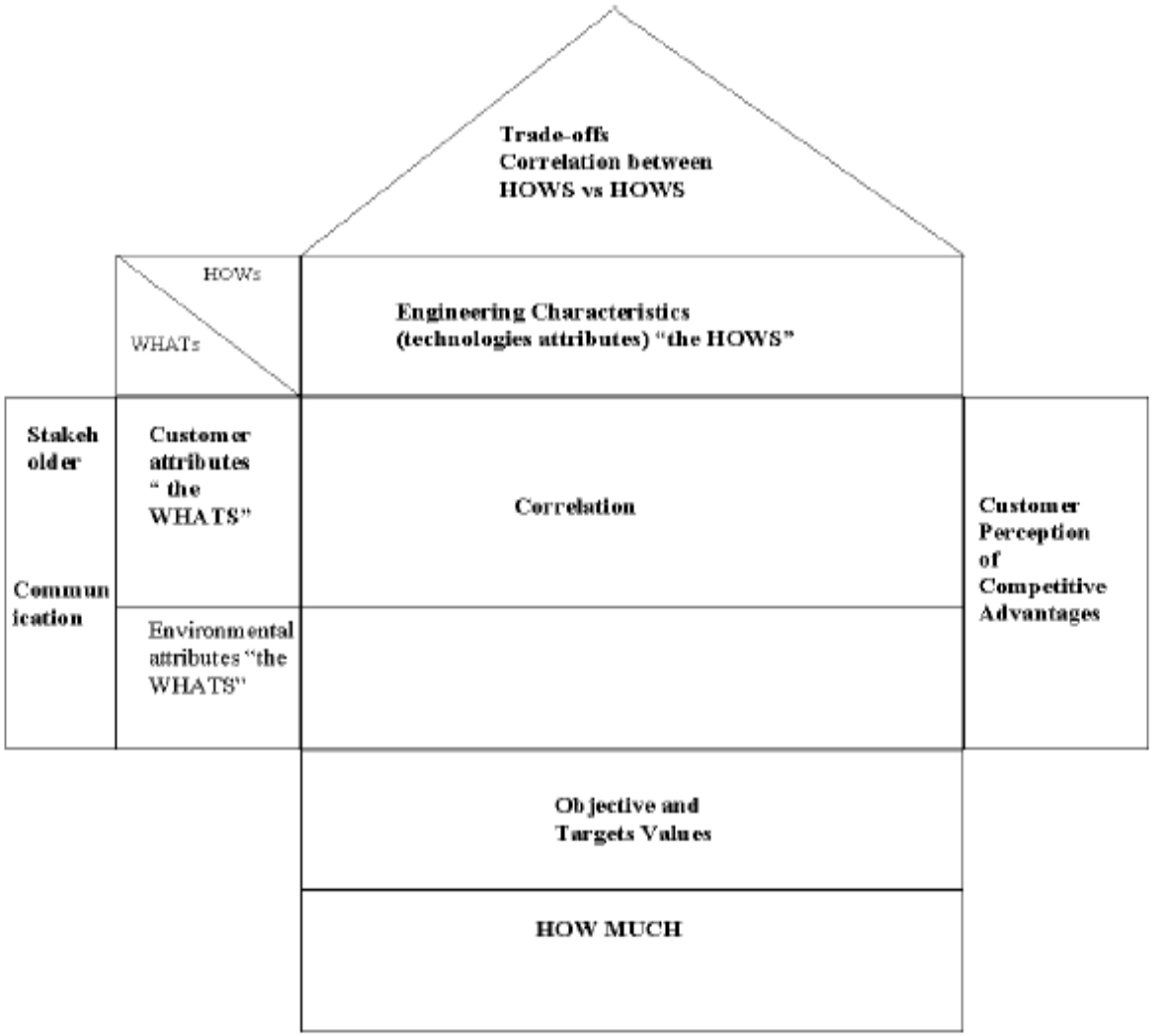
How QFD works - Methodology

- Quality Function Deployment methodology involves several sequential phases

- During each phase one or more matrices are prepared

- Matrices help to plan and communicate critical product and process planning and design information.

A skeleton for a House of Quality



Quality Control

- Addresses Sporadic Problems
  - Acceptance Sampling
  - Supplier Relations
  - Supply Chain Management
  - Metrics and Measurements
  - Gage R & R Studies
  - SPC Charts and Methodology

Quality Control Charts

- A systematic plot and analysis of Product and Process Performance Measures (PM)

- Two types of PM in quality control
  - First type is Quantitative (e.g. Speed, Temperature)
  - Charts to analyze these are called Variable Charts
  - Second type is Qualitative (e.g. Pass./ Fail, Good/Bad
  - Charts to analyze these are called Attribute Charts

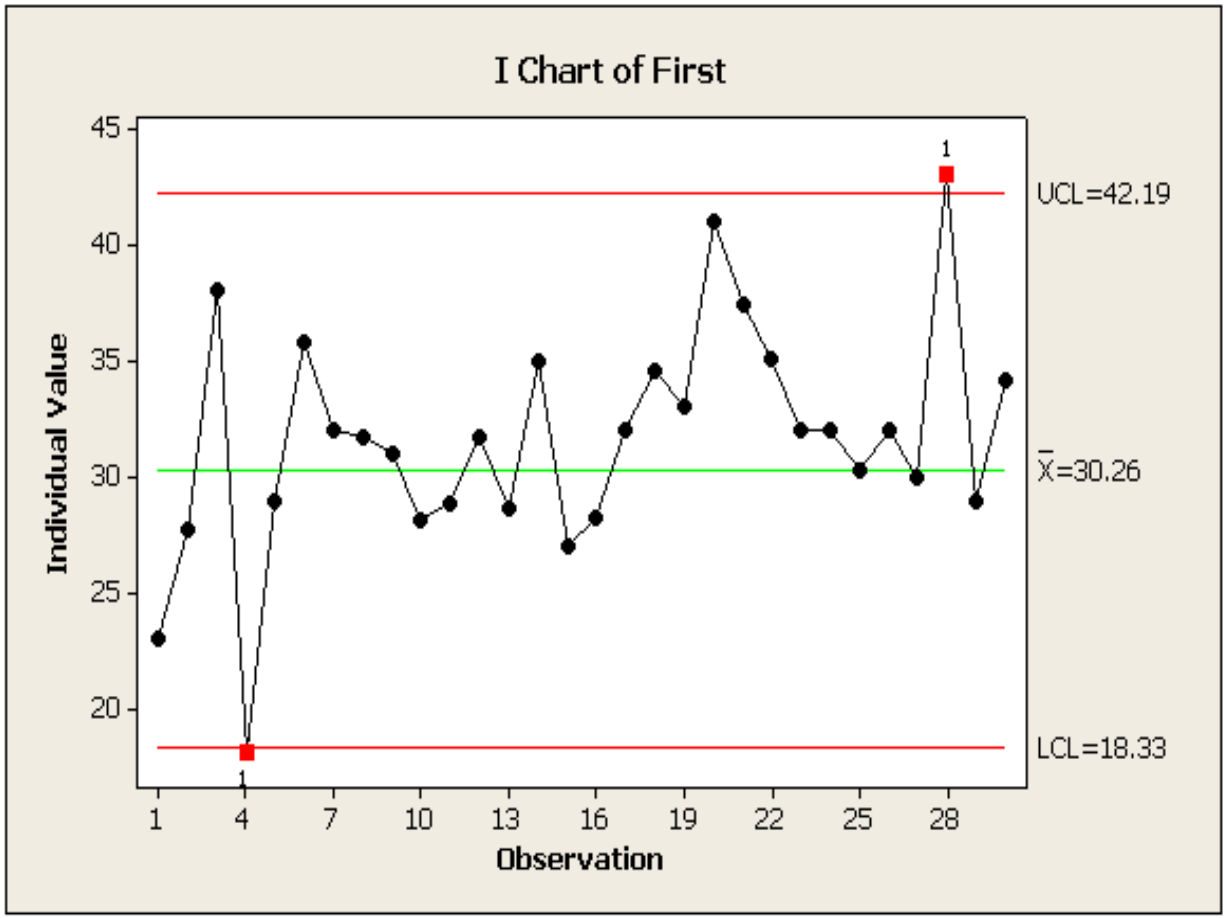
Types of Control Charts (1)

- Variable Charts
  - Measurements are quantitative and are taken continuously (e.g. sizes, weights etc)
  - Uses summaries: means, variances, ranges etc;
  - They are plotted sequentially in time
  - Examples of Variable charts
    - Mean and Range Chart
    - Cumulative Sum (CUSUM) Chart

Types of Control Charts (2)

- Attribute Charts
  - Measurements are qualitative, such as:
    - Defective or not , pass or fail, etc
  - Examples of Attribute charts:
    - Percent Defectives Chart
    - Number of Defectives Chart

Control Chart for Number of Errors



Quality Improvement

- Addresses Chronic Problems
  - Changes the Status Quo
  - Not detected by SPC
  - Design of Experiments
  - Six Sigma Methodology
  - Lean Manufacturing
  - Continuous Improvement

Six Sigma Methodology

- Six Sigma (6σ) is a collection of engineering and statistical concepts and techniques

- Focuses on reducing variation in processes and preventing deficiencies in products

- Accuracy 99.9996% - Approximately Four PPM Defectives

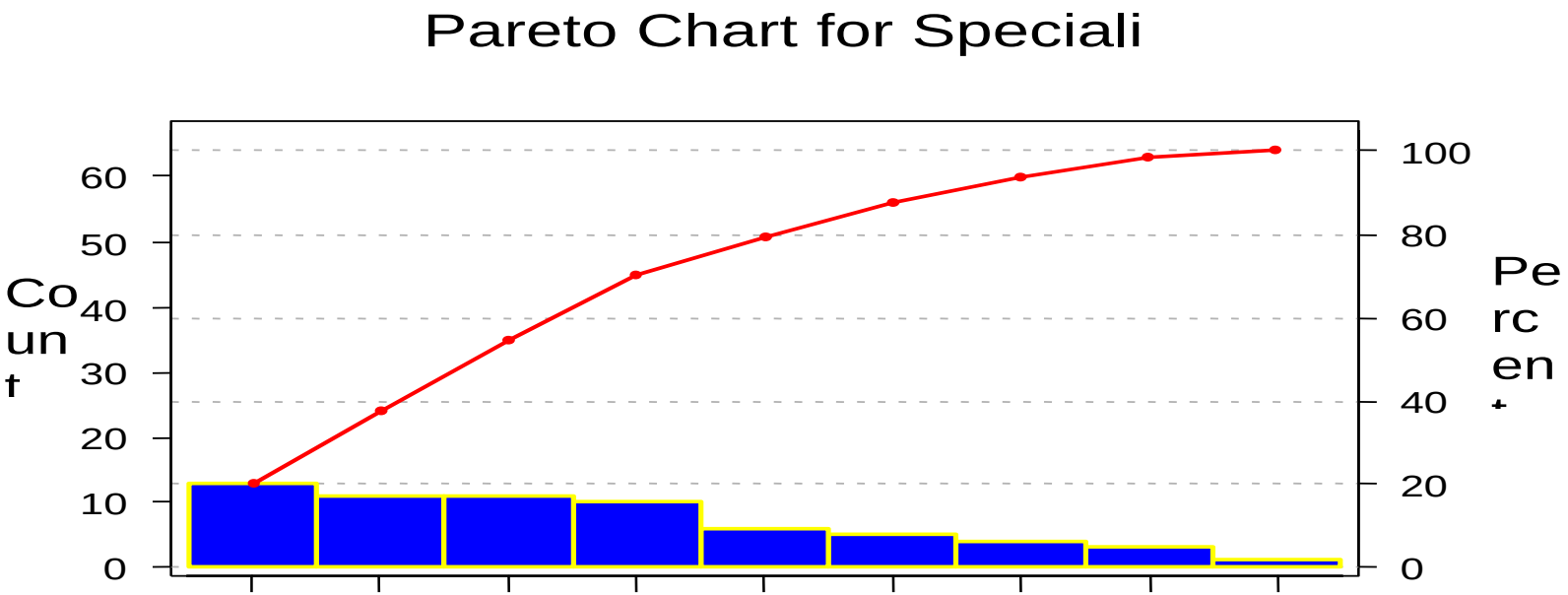
Six Sigma Phases

- 1. Define: identify the areas
- 2. Measure: data collection
- 3. Analyze: relevant information
- 4. Improve: selected areas
- 5. Control: manage changes

Main Qualitative Analyses

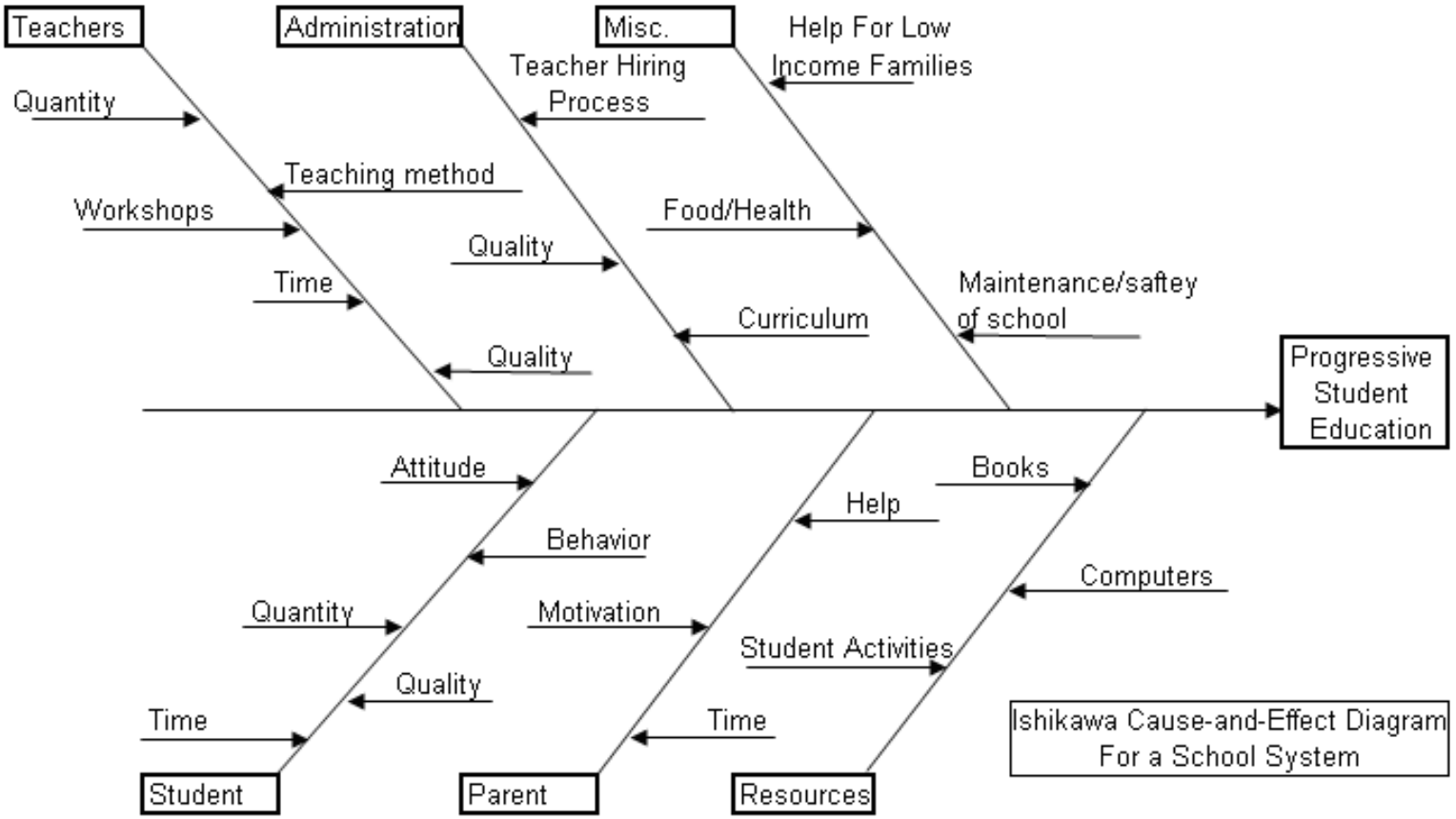
- Pareto charts
  - Relevant Few
- Ishikawa Charts
  - Factors impacting response
- Affinity Diagrams
  - Groupings of similar
- Check Lists
  - Order and inclusion

Example of Pareto



Specialty	Q&R	ME	Chem	IE	Unkn	EE	Materials	Civil	Others
Count	13	11	11	10	6	5	4	3	1
Percent	20.3	17.2	17.2	15.6	9.4	7.8	6.2	4.7	1.6
Cum %	20.3	37.5	54.7	70.3	79.7	87.5	93.7	98.4	100.0

Ishikawa or Fishbone Chart



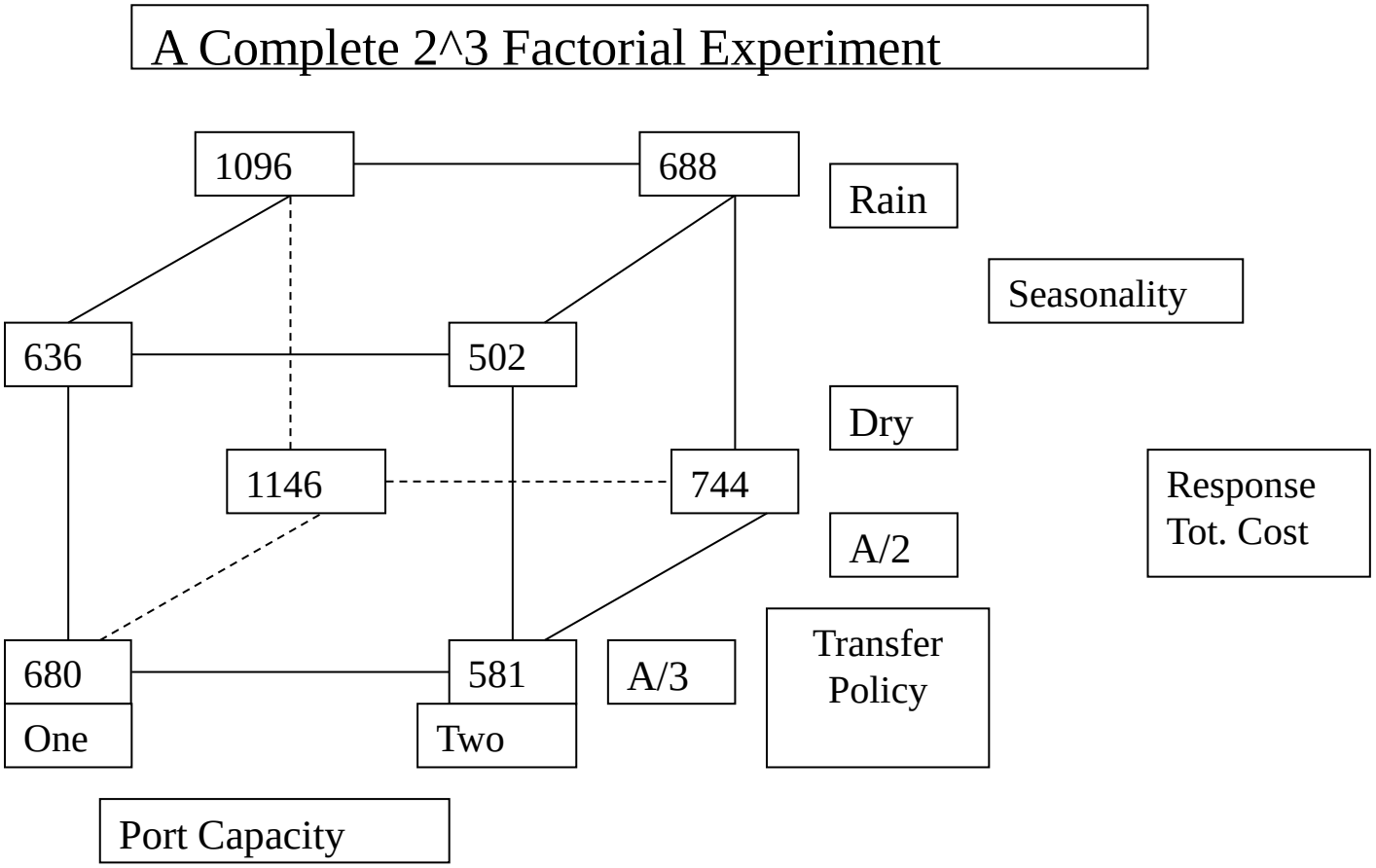
Main Quantitative Data Analyses

- Statistical analyses
  - Estimation and Testing
  - Regression, ANOVA,
  - Design of Experiments
- Operations research
  - System performance and optimization
  - Simulation modeling and analysis

Types of Statistical Analyses

- Estimation and Testing
  - CI, Hypothesis tests, data analysis
- Regression, ANOVA,
  - modeling, estimation, forecasting
- Design of Experiments
  - Factor screening, RSM

DOE Example



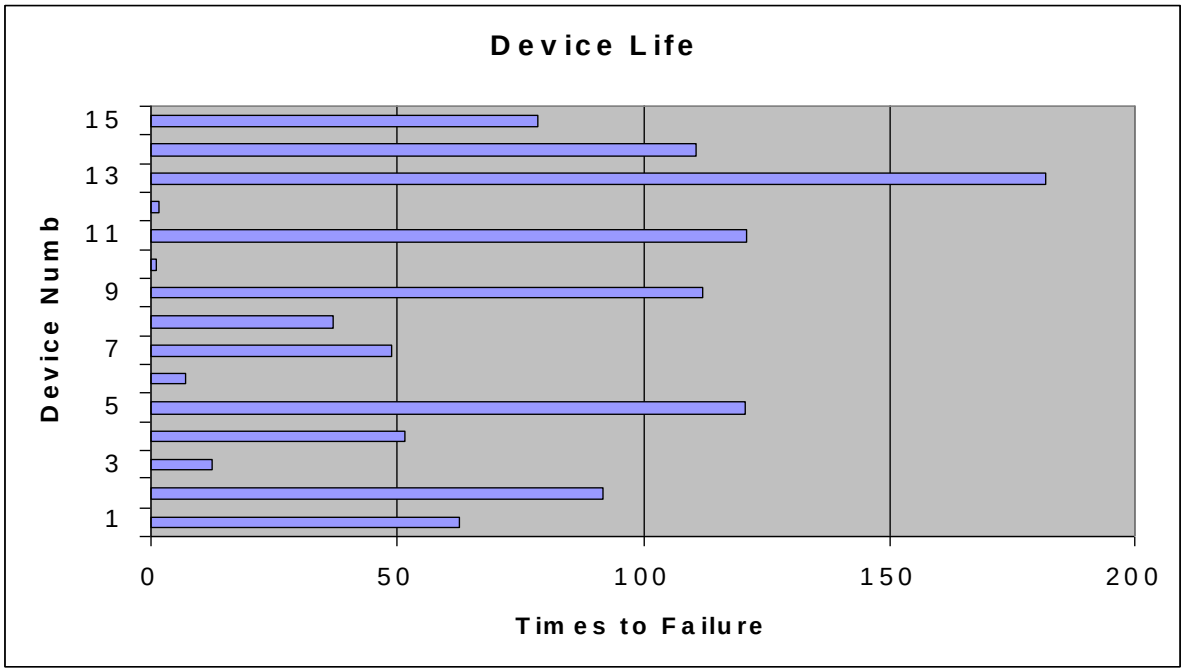
Operations research analyses

- System performance/optimization
  - Linear/Non Linear/Goal programming
  - Stochastic Models (Queuing/Inventory)
- Simulation modeling/analysis
  - Discrete event simulation models
  - System performance/optimization

Reliability is Quality in Time

- Types of Reliability Analyses
  - Data collection Needs
  - Reliability Assessment
  - Reliability Testing
  - Reliability Estimation
  - Reliability Growth

Example of Life Testing



Reliability Issues/Methods

- Some Relevant Issues
  - Availability
  - Maintainability
  - Survivability
- And Reliability Methodology
  - FMEAs and FMECAs
  - Fault Tree Analysis (FTA)

A Roadmap for Change (Juran)

- Phase I: Decide (assess the status of the organization)
- Phase II: Prepare (goals and objectives; launch pilot plan)
- Phase III: Launching (train, deploy and measure)

A Roadmap for Change

- Phase IV: Expand (modify and review identified problem areas)
- Phase V: Sustain (inspect, audit)
- Result: Successful Integration of Big “Q” into the Organization with higher revenues and productivity.

Summarizing

- The Quality Function Evolution:
  - Check, Inspection, SPC, Data Anal.
  - Root Cause Anal., Re-engineering
  - Lean manufacturing, Benchmarking
  - Process Flow Revision, Simulation
  - Supply Chain Management, Design
  - Continuous Improvement, Six Sigma

Conclusions

- Quality affects everyone
- Quality affects every process
- Quality affects profits/market share
- Quality issues are often unnoticed
- Quality assessments uncover them
- Quality methodology solves them
- Quality improvement pays for itself