Quality Engineering

Dr. John W. Sutherland

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Course Topics

- Introduction
- History Perspective on Quality
- Deming's 14 Points
- Taguchi's View of Quality
- Statistical Fundamentals
- Conceptual Framework for Statistical Process Control
- Statistical Basis for Shewhart Control Charts
- Construction and Interpretation of Shewhart Control Charts
- Computer Workshops
- Rational Sampling
- Process Capability
- Variation of Assemblies
- Control Charts for Individuals
- Control Charts for Attribute Data
- Case Studies
- Other topics for graduate credit

Text

Statistical Quality Design and Control, Contemporary Concepts and Methods, Macmillan (Prentice-Hall), Richard E. DeVor, T. H. “Phil” Chang, John W. Sutherland

Grade Determination (grad. credit % in parentheses)

25% Homework (20%)
15% Computer Workshops (10%)
25% Midterm Exam (25%)
35% Final (35%)
Extra Assignments (10%)

Grade Breakdown

Class GPA: approx. 3.0 - grad. students graded separately

Web-based Materials

- **the course web site can be accessed from: http://www.me.mtu.edu/~jwsuther**

- **At the web-site, the following materials may be retrieved:**
  - **Course notes**
  - **Homeworks**
  - **listing of assignment results for both on- and off-campus students**
  - **other**

- **For listing of assignment results we need a 3 digit codeword**

Is Quality Important?

- **Met with corporate executives from over 100 companies**

- **Identified issues of concern:**
  - Quality
  - Efficient use of resources (people, inventory, etc.)
  - Faster time to market
  - Costs

- **Quality???**
  6 sigma, ISO 9000, warranty costs, customer voice, etc.

Assignment

- Read Chapters 1 and 2
- Problems:
- Graduate Credit:

A “Quality” Case Study

BigTop Balloon’s **yearly production is 100M (about 80,000 balloons/day)**

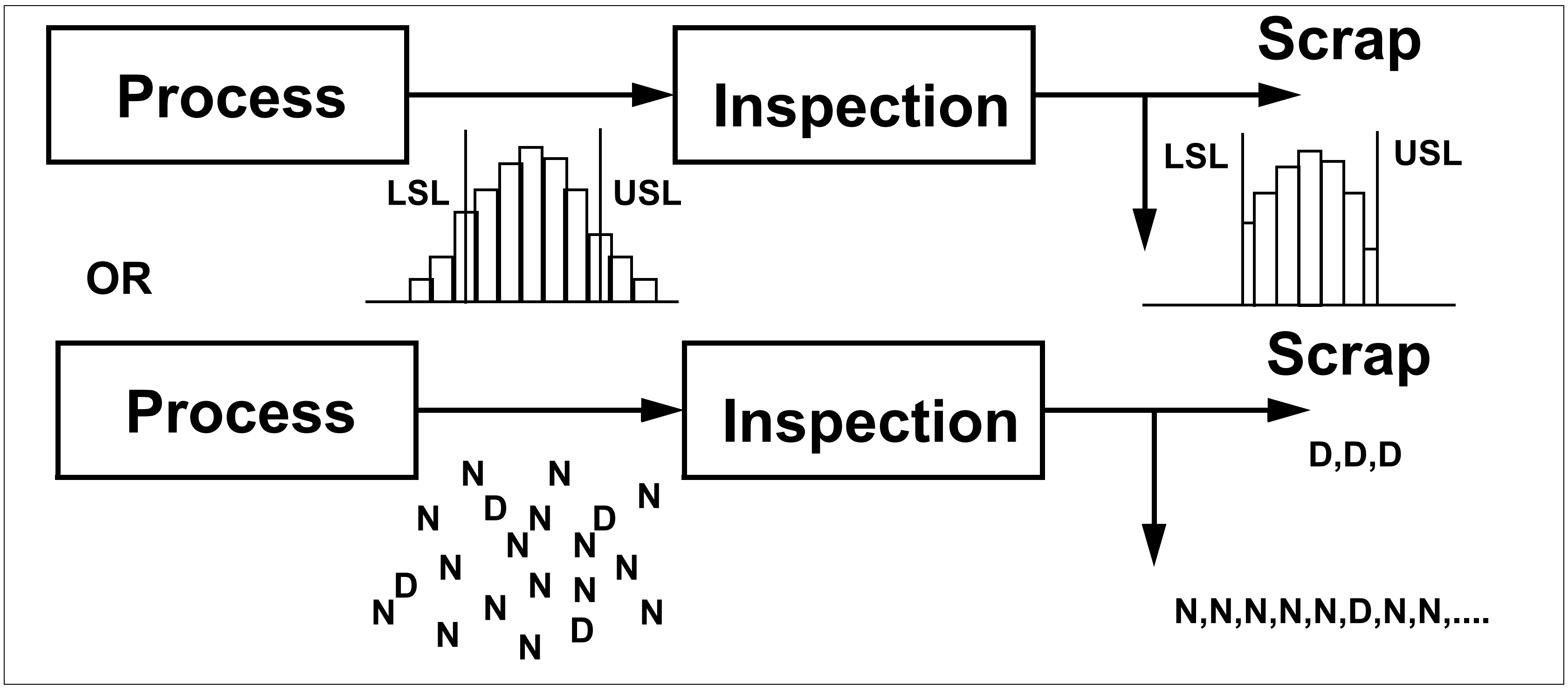
They sell their product in packets of 100 balloons

Cost of production of each packet is $2 -- thus yearly cost of production $2M

The *BigTop Balloon* company has been receiving many complaints lately about the quality of their products.

First Approach

- **Management's initial reaction: hire inspectors for 100% testing**

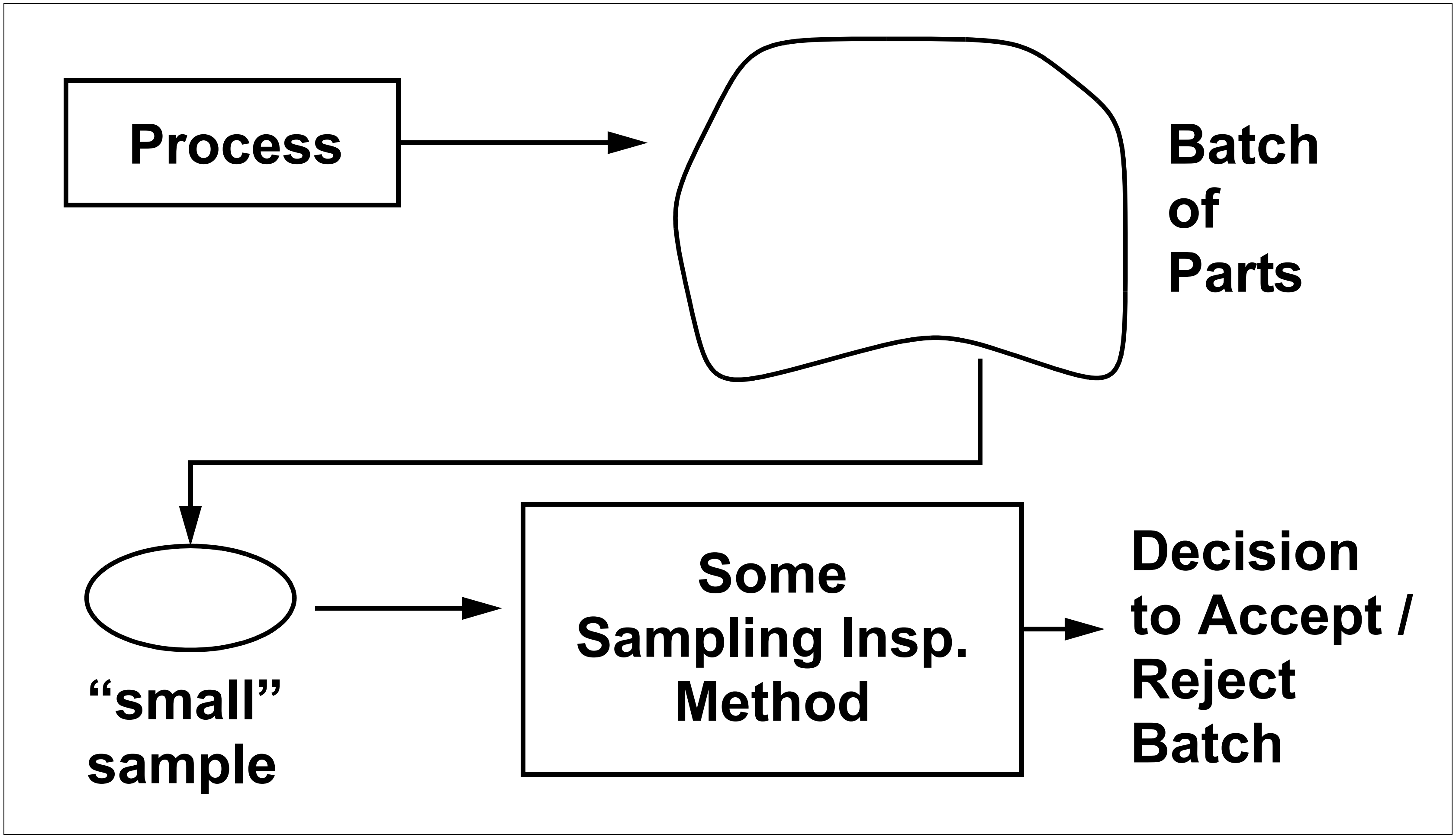


Examining the Proposed Approach

- **Upon doing the math -- the expense of 100% testing comes out to be $20M**
  Assuming:
  - Each inspector will look at 2000 balloons a week
  - 2000 balloons/wk * 50 wks = 100,000 balloons/year
  - Total inspectors required -- 1000
  - Pay inspectors $20,000/year
  - Total cost of inspection $20m

- **Thus, 100% testing -- to ensure that only quality balloons reach the customer, is too expensive**

Acceptance Sampling



Second Approach

- **Decide to test 100 balloons per day (out of 80,000) using a moderately priced testing machine**

- **Testing Criteria -- for a day's sample of 100 balloons**
  # bad balloons $\leq$ 1 --- Accept day's production
  # bad balloons $\geq$ 2 --- Reject day's production

- **How effective is this sampling plan?**
- **What can we conclude about the Quality Level of the production?**
- **Cost?**

OC Curve

- We want to draw a graph called an Operating Characteristic (OC) Curve

- It plots Probability of Acceptance vs. Fraction Defective.

- Take a single part at random.
  Probability that it is defective: p - fraction defective
  Probability that it is non-defective: 1-p

- Such a probability situation (only two outcomes -- binomial distribution)

Binomial Distribution

- **What if we have two parts? What is probability of**
  (D, D)?
  (D, N)?
  (N, D)?
  (N, N)?

- **Summarizing**
  - **For a Sample Size of n**
  - **Fraction defective of p**

Probability of d defectives in a group of n parts:

$$Prob(d) = \binom{n}{d}(p)^d(1 - p)^{n - d}$$

Back to our OC Curve

- For our example: the sample size n = 100, and the cutoff value for defectives is c=1 (if we get 1 or less defectives, we accept the batch).

- So, we are concerned about the probability of getting either d=0 or d=1 defectives in the sample.

- What value to use for p?
  We do not know the actual quality (p value - fraction defective) of the parts we are producing, so we need to check what happens for a few different p values.

More on our OC Curve

- What if p=0? (There are no defectives in the batch). The probability of getting either d=0 or d=1

  Prob(d=0) = $\binom{100}{0}(0.00)^0(1.00)^{100}$ = 1.00

  So, when the fractive defective is 0, the probability of us accepting the batch is 1.00.

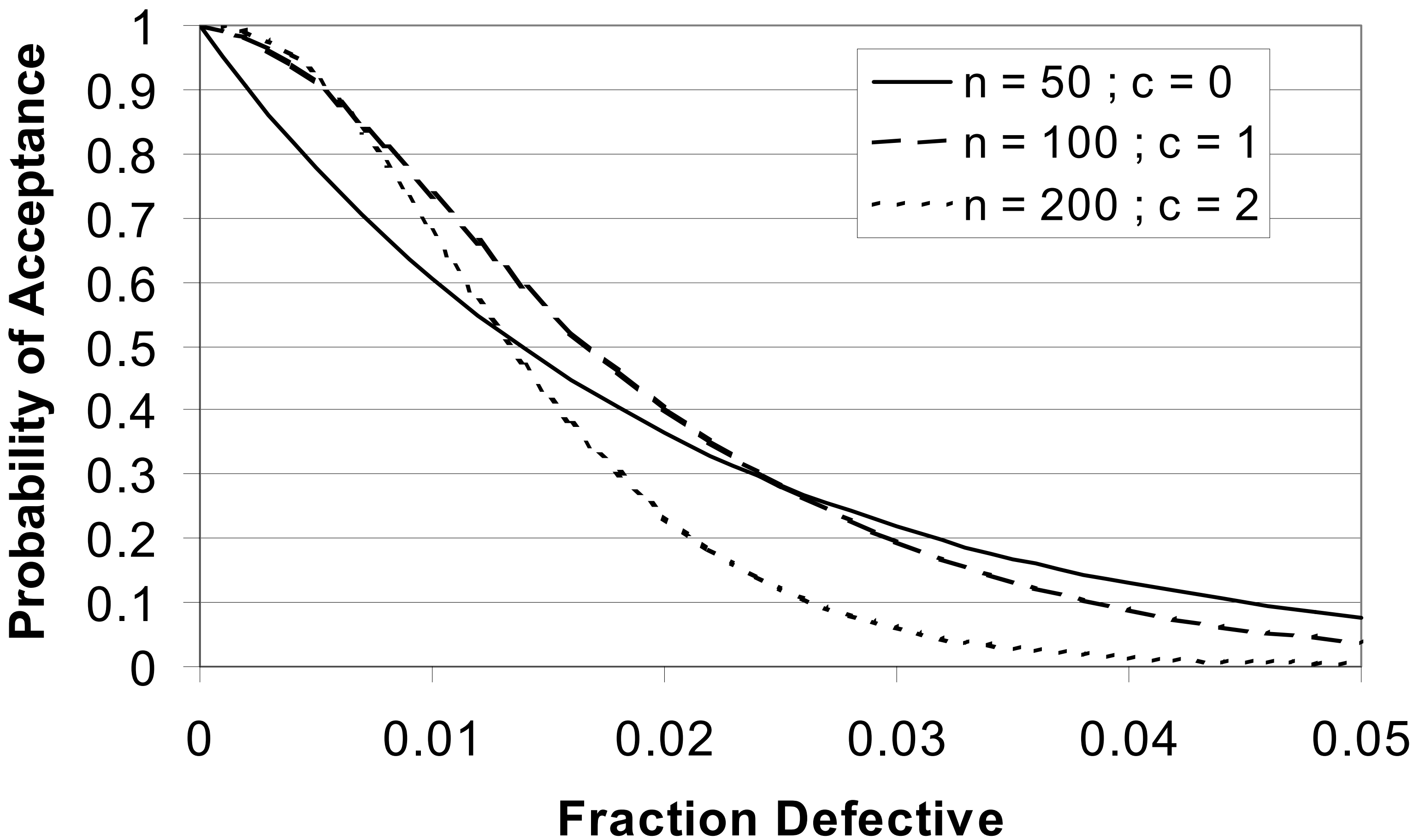
- When p = 0.01, check for d=0 and d=1

  Prob(d=0) = $\binom{100}{0}(0.01)^0(0.99)^{100}$ =

  Prob(d=1) = $\binom{100}{1}(0.01)^1(0.99)^{99}$ =

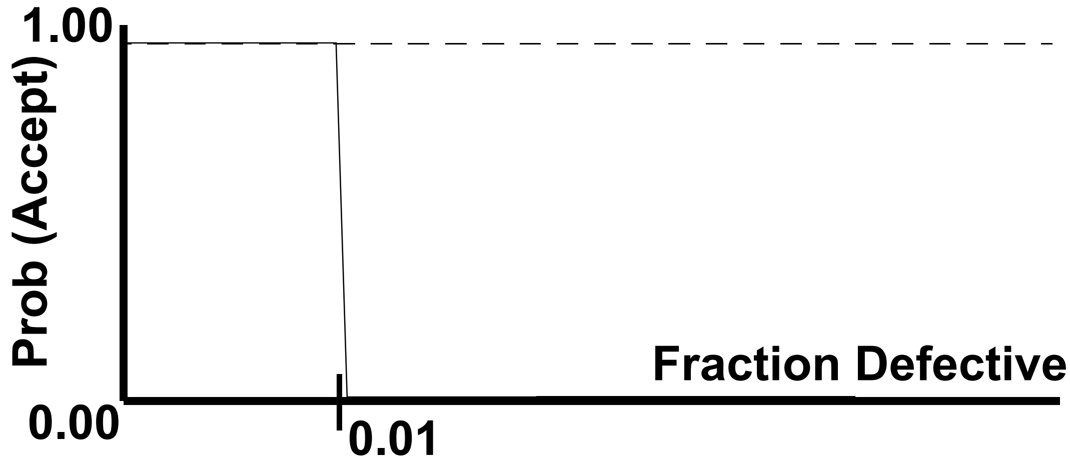
Probability of acceptance = X + X = X.

Displaying the OC Curve



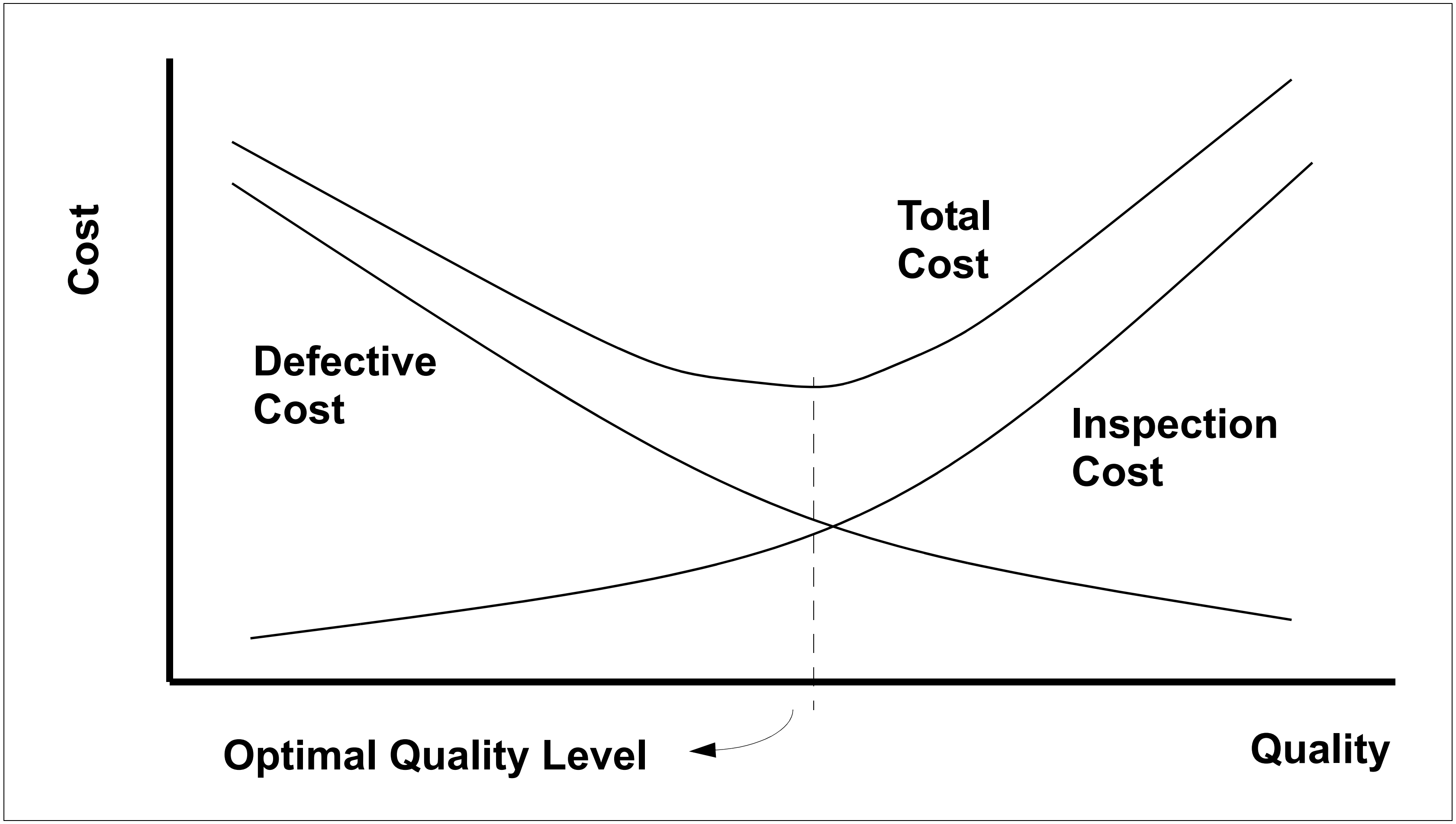
More on OC Curves

Seemingly, we are willing to accept 1% of the production as defective (initial plan was n=100, c=1). A *perfect* OC curve for this would appear as follows:



To approach perfection, need larger and larger values for n. With increasing n, the sampling cost increases.

Let’s Look at the Cost



Fundamental Flaws with this Philosophy

- Focus is on product control (not process control)
  - Emphasis: find and remove defective parts so that the customer never gets them.
  - The process remains unchanged -- the faults producing the defective products still exist
- We are willing to tolerate some level of defective parts.

This course will focus on the modern quality philosophy

- Emphasis: improving the process by removing faults. As faults are removed, quality improves & production rate increases & costs reduce.