ABC'S OF THE QUALITY CONTROL CHART IN USE

by

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1941

Lecture to be given May 20, before a class of sixty engineers in the course on Inspection given at the Newark Engineering School, Newark, by the Engineering Department of Princeton University.

I

First Hour

HOW IT WORKS

Control Chart. Action graph.

Introduction

1. Object in Use.

   1.1 Reduce number of rejects.

   1.2 Reduce cost of inspection

   1.3 Reduce tolerances (to make most efficient use of materials)

2. How it works on percent defective.

   Slide 1 - 8833 - 3E

   Slide 2 - 7959 - Table 1E

   Slide 3 - 8834 - 4E

3. Evidence - reduction of rejects.

   Slide 4 - 1st wholesale experiment - 6E

4. Reduction in tolerances.

   Slide 5 - 7809 - Table 2E

   Slide 6 - 8837 - 7E

   Slide 7 - 18845 - Dodge Fuses

a. Chart + common sense

b. Chart = rules.

c. Chart – action limits.

d. Chart – sample areas.

5. Reduce cost of inspection.

Slide 8 - Control chart for fuses 16047

6. Old and New View of Inspection. 9M

Old	New
Screening process	Detect assignable cause.
Eye on product	Eye on Process
Throw away sample data	Continuing quality report
Routine job	Important step in scientific method

Slide 9 - 20472 - M10

Inspects in accord with standard	Helps shape standard in same way that judge helps shape the law.

7. War Emergency Inspection vs. company inspection.

8. Conclusion.

8.1 Can reduce cost of inspection

8.2 " " " " inspection

8.3 " " tolerance limits

II

Second Hour

WHY IT WORKS

1. Historical

Interchangeability 1787

Go-no-go tolerance limits.

Slide 10 - 16062 - M1

Slide 11 - 17802 - M2 - Steps in control.

2. Fundamental Problem

2.1 Valid prediction within tolerance range.

2.2 Minimize tolerance range

Slide 12 (Tolerance limits) 21624

3. Concept of repetitive operation.

3.1 Measurements under the same essential condition.

Slide 13 - 17798 - vel. light 18M

29	26	38	30.5	61	33	35	37
28	32	40	32	40	42	36	38
27	16	36	30	31	39	36	38
30	31	32.5	63	33	43	37	39
27	19	36	62	30.5	34	36	38

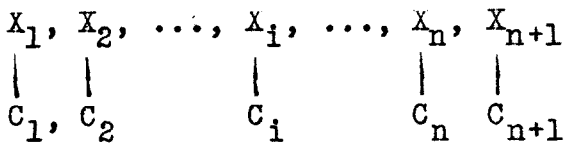
Forty Measurements of Resistance of Relay Contact

3.2 Mass Production.

3.3 Drawings from a bowl.

Slide 14 - 8942 - 112E

4. Concept of Sequence of Repetitive Operations



5. Concept of Random Operation.

6. Concept of State of Maximum Control.

7. Statistical Terms.

7.1 Frequency distribution

16, 19, 26, 27,27, 28, 29, 30,30,
30.5,30.5, 31,31, 32,32, 32.5,
33,33, 34, 35, 36,36,36,36,36,
37, 37, 38,38,38,38, 39,39, 40,40,
42, 43, 61, 62, 63.

7.2 Median 35.5

7.3 Average:

$$\begin{array}{r} 29 \\ 28 \\ 27 \\ 30 \\ \hline 4\,|\,114 \\ 28.5 \end{array}$$

7.4 Standard Deviation

	deviation v	v^2
29	29 - 28.5 = .5	.25
28	28 - 28.5 = .5	.25
27	27 - 28.5 = 1.5	2.25
30	30 - 28.5 = 1.5	2.25
		4|5.00
		1.25

$\sigma = \sqrt{1.25} = 1.1180$

7.5 Variance = σ^2

7.6 Range 30 - 27 = 3

8. Two Clues to State of Control (Taking account order

8.1 Displacement from average

Slide 15 - As time goes on 11040

8.2 Runs up and down - Runs above and below

Slide 16 - Runs - resistance 22020

9. Two Kinds of Errors.

9.1 Look for trouble when not present.

9.2 Not look for trouble when present.

10. Should indicate trouble when and where it comes in.

11. Self-correcting, continuing operation.

12. In limit $\bar{x}$ = expected value
3σ = tolerance range

Sl. 11.

3rd Hour

HOW TO MAKE AND USE CONTROL CHART

1. To be considered not as test of significant difference but as

OPERATION OF STATISTICAL CONTROL

Slide 17 - 5 steps in operation of s.c. 21879

2. STEP 1

2.1 Order not frequency distribution.

Slide 18 - 15438 204 random

Slide 19 144 meas. thickness 21613

Slide 20 Control chart P. paper 21616

2.2 Deviation from an average as illustrated by last slide.

2,3 Runs

Slide 21 Runs, inlay thickness 21617

~~Slide 22 Values of " " 21618~~

3. STEP 2

3.1 Break up into groups where

C ⌒ C

Then take in order:

4. STEP 3 (in relation to Criterion I)

4.1 Choice of sample size.

4.1.1 Small enough to catch trouble when it occurs.
4.1.2 Small enough that dispersion will not be too large if assignable causes are present.

Chart prepared by Miss Angell.

$\sigma_{144} = 17.3$

$\bar{\sigma}$ for 4's = 12.58

$\bar{\sigma}$ " 12's = 15.10

$\bar{\sigma}$ " 36's = 16.49

$\bar{\sigma}$ " 72's = 17.33

4.2 Choice of statistics Theta and σ_{Theta}

4.2.1 Average σ normally distributed for most unimodal distributions.
4.2.2 Range and σ.

4.3 Chart shall be continuing and self corrective. Statistics Theta and $\bar{\sigma}$ shall be unbiassed in the limit so error of first kind can be fixed. Chart shall not indicate trouble too often when not present.

4.4 Choose statistic that will catch trouble best.

5. STEP 4

5.1 Look for trouble on red signal

5.2 Correct chart if trouble is removed.

6. STEP 5

6.1 Everyone agreed that observations are being made under the same essential conditions.

6.2 At least 100 observations under presumably the same conditions

Slide 22 22 Samples of 4 catch trouble, 367
" of 10 do not,

6.3 Nearly one thousand observations under controlled conditions before we can rely much upon accuracy of error of first kind.

Slide 23 Milestones on The Road to Control 1960