Quality Control
by
Statistical Methods

by

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Informal talk before Graduating Class in Princeton ESMWT Course in Quality Control by Statistical Methods, Newark College of Engineering, May 7, 1945.

INTRODUCTION

Up to March 3, 1945

4,451 students

had taken ESMWT courses in Quality Control by Statistical Methods.

Tonight I shall try to give you a glimpse of the potential scope of quality control by statistical methods.

Quality control by statistical methods is a management function.

Definition of management

"Management is the art and science of preparing, organizing, and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man." - Transactions ASME, 1913, page 1272.

Quotation from recent address of Mr. E. Herbert Eisenhart, president of Bausch and Lomb Optical Company (Industrial Quality Control, March 1945)

"It seems to me then that quality control, standing definitely in line with the other primary tools of management, offers the ways and means for another safeguard for the Private Enterprise system in our American economy. As we look into the future, when our individual enterprises

will have lost the biggest customer they have ever had, the Federal Government, the obstacles in the way of self-preservation will be increasingly complex. We will have not only more keen and effective competition from many new concerns in our own country, but foreign manufacturers will be eager to sell more of their products in this country. Top management of successful enterprise in this country will be faced with tremendous competitive conditions, and yet I am sure that with top management viewing its obligations comprehensively, effectively and thoroughly, our American System of Free Enterprise can continue in a world concerned with the new concept of internationalism. This can be done, however, only through effective utilization of the available tools of management and among these the contributions of quality control must be received with enthusiastic approval."

Charts 1 and 2

1. First chart of typical manufacturing organization shows statistics only in business end of organization.
2. Second chart shows statistics in many branches in organization.

Quality Control as a Profession

that touches every phase of applied science.

Slide 1 #13713

Human wants.
Research
Development
Design
Production ... control chart
Inspection ... sampling plans
Operational research

1 Quality

Slide 2 #13710

Three types of quality.

Slide 3 #25437

Operational meaning of a quality characteristic in terms of measurements.

Quality in this sense applies to measurements of both

1. Animate objects, including persons.
2. Physical objects.

Slide 4 #25438

Previously Observed	Practically Verifiable	Only Theoretically Verifiable

$X_1, X_2, \ldots, X_i, \ldots, X_n, \quad X_{n+1}, \ldots, X_{n+j}, \quad X_{n+j+1}, \ldots$

Past Future

The meaning of quality always involves prediction.

Slide 5 #17836

The specification of quality in terms of measurements.

Slide 6 #25376

Operationally verifiable meaning of a physical constant such as wave length requires meaning of <u>random.</u>

Operationally, concept of <u>randomness</u> is basic in the field of specification.

2 CONTROL

Quality control practiced long before introduction of statistical techniques, but in different sense.

The engineer's job (and that of the applied scientist in general) is to devise and develop the operations that if carried out, will produce things that people want.

Two fundamental concepts:

1. Control in the sense of what we do.

2. Control in terms of the results.

When everything possible is done to control an operation, we sometimes call this maximum control.

Examples of what we do

1. Control within tolerance limits by gauges.

2. Gunner on battleship firing at target he cannot see.

3. The operation of statistical control.

Slide 7 #21879

5 steps

Slide 8 #21614

144 observations of thickness of inlay.

Chart 3

Control chart criteria points to assignable causes.

Chart 4

Run chart, serial correlation, etc., points to kinds of causes.

Difference between:

1. This operation is statistically controlled.

2. The results of this operation is in a state of statistical control (or random).

STATISTICAL CONTROL

1. Statistical hypothesis

1.1 Example Randomness.

Involves predictions. Throw of a perfect die or flip of a perfect coin. 0011100011.....

Slide 9 #16921 Confidence interval prediction.

Slide 10 #16920 Tolerance interval prediction.

2. Experiment

Throw real die or coin.

Repetitive observation.

Slide 11 #22370

Herewwe must test for randomness first.

Also take H and C into account.

3. Test hypothesis.

Set criteria. Theory tells how many times criteria will be exceeded if hypothesis is true.

THE ACT OF CONTROL

Slide 12 #23040

SOME QUESTIONS AND ANSWERS

Question 1 Does statistics tell you how many observations to take before deciding that an operation is in state of statistical control? Why the statement that we should take at least 25 samples of 4?

Slide 13	#25408	Repetitive measurements on Type A contacts.

Question 2 Does statistics per se tell us when to look for trouble or an assignable cause?

Slide 14	#25405	Seven of possible 144 arrangements
Slide 15	#25407	

Question 3 What does statistics do in looking for trouble? It enables you to compute how often you will look if operation is random. We must depend on experience to tell us what kind of runs are important.

Slide 16	#22504	Panel contacts.
" 17	#25406	
" 18	#25375	

Small probability of occurrence is not the criterion for looking for trouble, but rather experience.

The Future Problem

An adequate science of control for management should take into account the fact that measurements of phenomena in both social and natural science for the most part obey neither deterministic nor statistical laws, until assignable causes of variability have been found and removed. Statistical control provides practical control-chart and run-char techniques for discovering such causes so tha they can be removed, or taken into account, and it provides statistical hypotheses, experiments, and tests of hypotheses for discov ing and using statistical laws resulting afte the assignable causes have been removed.

The steps involved in attaining and making the most efficient use of a given degree of control often involve the co-ordinate effort of literally thousands of employees, including physicists, chemists, engineers, sales agents, purchasing agents, lawyers, and economists. Very few of these people have ever had training even in classical statistics and probability and yet many of them must be sold on the use of statistical control techniques if the control statistician is to have an opportunity of making his full contribution to management in the solution of its problems. This situation constitutes a problem, not only for those now in industry, but also for those responsible for training the industrial leaders of tomorrow so that they will have sufficient knowledge to help them recognize the potential contributions of statistical control theory and technique.