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Shewhart control charts

Cartes de contrôle de Shewhart

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8258 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*.

Annex A of this International Standard is for information only.

Introduction

The traditional approach to manufacturing is to depend on production to make the product and on quality control to inspect the final product and screen out items not meeting specifications. This strategy of detection is often wasteful and uneconomical because it involves after-the-event inspection when the wasteful production has already occurred. Instead, it is much more effective to institute a strategy of prevention to avoid waste by not producing unusable output in the first place. This can be accomplished by gathering process information and analysing it so that action can be taken on the process itself.

The control chart as a graphical means of applying the statistical principles of significance to the control of a production process was first proposed by Dr. Walter Shewhart in 1924[1]. Control chart theory recognizes two kinds of variability. The first kind is random variability due to "chance causes" (also known as "common causes"). This is due to the wide variety of causes that are consistently present and not readily identifiable, each of which constitutes a very small component of the total variability but none of which contributes any significant amount. Nevertheless, the sum of the contributions of all of these unidentifiable random causes is measurable and is assumed to be inherent to the process. The elimination or correction of common causes requires a management decision to allocate resources to improve the process and system.

The second kind of variability represents a real change in the process. Such a change can be attributed to some identifiable causes that are not an inherent part of the process and which can, at least theoretically, be eliminated. These identifiable causes are referred to as "assignable causes" or "special causes" of variation. They may be attributable to the lack of uniformity in material, a broken tool, workmanship or procedures or to the irregular performance of manufacturing or testing equipment.

Control charts aid in the detection of unnatural patterns of variation in data resulting from repetitive processes and provide criteria for detecting a lack of statistical control. A process is in statistical control when the variability results only from random causes. Once this acceptable level of variation is determined, any deviation from that level is assumed to be the result of assignable causes which should be identified and eliminated or reduced.

The object of statistical process control is to serve to establish and maintain a process at an acceptable and stable level so as to ensure conformity of products and services to specified requirements. The major statistical tool used to do this is the control chart, which is a graphical method of presenting and comparing information based on a sequence of samples representing the current state of a process against limits established after consideration of inherent process variability. The control chart method helps first to evaluate whether or not a process has attained, or continues in, a state of statistical control at the proper specified level and then to obtain and maintain control and a high degree of uniformity in important product or service characteristics by keeping a continuous record of quality of the product while production is in progress. The use of a control chart and its careful analysis leads to a better understanding and improvement of the process.

Shewhart control charts

1 Scope

This International Standard establishes a guide to the use and understanding of the Shewhart control chart approach to the methods for statistical control of a process.

This International Standard is limited to the treatment of statistical process control methods using only the Shewhart system of charts. Some supplementary material that is consistent with the Shewhart approach, such as the use of warning limits, analysis of trend patterns and process capability is briefly introduced. There are, however, several other types of control chart procedures, a general description of which can be found in ISO 7870.

2 Symbols

n Subgroup size; the number of sample observations per subgroup

k Number of subgroups

X Value of measured quality characteristic (individual values are expressed as ($X_1, X_2, X_3, ...$). Sometimes the symbol Y is used instead of X.

$\overline{X}$ (X bar) Subgroup average value:

$$\overline{X} = \frac{\sum X_i}{n}$$

$\overline{\overline{X}}$ (X double bar) Average value of the subgroup averages

μ True process mean value

Me Median value of a subgroup. For a set of n numbers $X_1, X_2, ...X_n$ arranged in ascending or descending order of magnitude, the median is the middle number of the set if n is odd and the mean of the two middle numbers if n is even

$\overline{Me}$ Average value of the subgroup medians

R Subgroup range: difference between the largest and smallest observations of a subgroup.

NOTE 1 In the case of charts for individuals, R represents the moving range, which is the absolute value of the difference between two successive values $|X_1 - X_2|$, $|X_2 - X_3|$, etc.

$\overline{R}$ Average value of the R values for all subgroups

s Sample standard deviation:

$$s = \sqrt{\frac{\sum (X_i - \overline{X})^2}{n-1}}$$

$\overline{s}$ Average value of the subgroup sample standard deviations

σ True within-subgroup process standard deviation value

$\hat{\sigma}$ Estimated within-subgroup process standard deviation value

p Proportion or fraction of nonconforming units in a subgroup:

p = number of nonconforming units in a subgroup/subgroup size

$\overline{p}$ Average value of the proportion or fraction nonconforming:

$\overline{p}$ = number of nonconforming units in all subgroups/total number of inspected units

np Number of nonconforming units in a subgroup

c Number of nonconformities in a subgroup

$\overline{c}$ Average value of the c values for all subgroups