Glossary

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Acceptance control chart   A cross between a sampling inspection plan and a control chart. Control limits are based on product specification and are intended to detect assignable causes that would lead to the production of an unacceptable fraction of non-conforming product.

Acceptable quality level (AQL)   Maximum per cent defective considered satisfactory for a process average.

Acceptance sampling   Acceptance or rejection of a product or process on the basis of sampling inspection.

Autoregressive-integrated moving average (ARIMA) process   A flexible class of parametric statistical models (systematically developed by G. E. P. Box and G. M. Jenkins) for time series that includes autoregressive and moving average processes and also allows for a certain type of non-stationary behaviour.

Autocorrelation plot   Shows how the correlation between neighbouring values of a time series varies with time distance apart.

Blocking   A grouping of units into sets in a statistically designed experiment, the units in each set being expected to respond similarly if treated alike. Each such homogeneous set is called a 'block'. Blocking is used to remove the effects of extraneous variation from experimental error.

Box & Jenkins model   See autoregressive-integrated moving average (ARIMA) process.

Box-and-whisker plot   A graphical display (proposed by J. W. Tukey) which depicts location, dispersion and outliers for a single data set.

BSI   British Standards Institution.

BS600: 1935   The first of a continuing series of reports published by the British Standards Institution concerned with application of statistical methods in standardization and the specification of quality.

BS600R   A widely used, brief, updated version of BS600 first issued in 1940.

c-chart   See control chart.

CAD/CAM   Computer aided design and manufacture: see CAD and CAM.

Cause–effect diagram   One of K. Ishikawa's seven elementary statistical aids for quality improvement.

Check sheet   One of K. Ishikawa's seven elementary statistical aids for quality improvement; for example, a record of details of current rejected items.

CAD   Computer aided design.

CAM   Computer aided manufacture.

Control chart   A graphical display for monitoring a measurable characteristic of a production process for the purpose of showing whether the process is operating within its limits of expected variation. Examples are p-chart (for proportions found defective in subgroup samples); c-chart (for numbers of defects in items); R-chart (for ranges of subgroup samples); $\bar{x}$-chart (for means of subgroup samples); etc.

Crosby, P.   American quality management expert, associated particularly with an educational programme.

CUSUM chart   The cumulative sum control chart is a graphical procedure for series data based on sums of a plotted variable rather than individual variable values as in the classical control chart proposed by Shewhart; it provides a rapid means of detecting small but important changes in the level of a process.

Degrees of freedom   As a statistical term it usually corresponds to the excess of the number of observations over the number of parameters in a model in which the mean of the observations is linear in the parameters; and is the effective number of available independent observations for estimating dispersion terms in the model.

Deming, W. E.   A leading figure in the field of statistical quality control. His ideas were followed closely in Japan after 1945 and have had a profound and lasting influence in the success of Japanese industry.

Design of experiments   Statistically designed experiments are appropriate when the effects under investigation can be masked by large uncontrolled variability outside the investigator's control. In a well-planned experiment, the experimental arrangement should be as simple as possible, comparisons will be made precisely and will be largely free from systematic error and conclusions should have wide validity and their uncertainty should be assessable.

Digidot plot   A time series plot incorporating a stem-and-leaf plot along the vertical axis for the plotted variable.

Dispersion measure   A quantity derived from a set of data which provides a measure of the variability of the data. Examples are the range, the interquartile range and the standard deviation.

Engineering design   See system design.

Evolutionary operation (EVOP)   The basic philosophy of evolutionary operation (proposed by G. E. P. Box) is that an efficient industrial process should be

run to produce not only a product, but also information on how to improve that product. This is achieved by making small deliberate changes to process variables according to a factorial design about current best values. Information from continual averaging and comparison of results at the slightly different conditions can point to a direction of improved output.

Experimental design See design of experiments.

Experimental unit The smallest division of experimental material such that any two units may receive different treatments in the actual experiment.

Exponentially weighted moving average (EWMA) This is the averaging procedure used in exponential smoothing of time series data whereby the current value of the smoothed data is taken as a weighted average of the current value of the unsmoothed data and the most recent value of the smoothed data.

External noise See outer noise.

Factor A condition which is specifically changed for parts of a designed experiment. The values of the condition used in the experiment are called factor levels.

Factorial experiment A single experiment in which more than one factor is investigated simultaneously.

Failure modes and effects analysis (FMEA) In such an analysis of a complex system of components all potential failure modes of each component are identified and their effects on the system's performance is investigated.

Fault tree analysis (FTA) Fault trees are logical descriptions of a complex system which enable determination of the possible causes of a specific (possibly catastrophic) event.

Fishbone diagram See cause–effect diagram.

Fractional factorial experiment Factorial experiments in which not all of the combinations of factor levels occur. Such arrangements can be used to investigate the main effects and some low-order interactions of a large number of potentially important factors under the assumption that the remaining interactions are comparatively negligible.

Hazard rate function Sometimes known as the age-specific failure rate of a component or system. Roughly speaking, the hazard rate at time t gives the probability of almost immediate failure of a component or system which is known to be functioning at time t.

Histogram A graphical representation of a frequency distribution, typically using bars to exhibit the relative frequency of values in a data-set.

Inner noise A term used by G. Taguchi to describe noise variables such as component wear and material variability which cannot be controlled.

Inner design array A term used by G. Taguchi to describe that part of a statistical experiment to investigate the response characteristics of a product to different combinations of product design variables (or parameters). See parameter design.

ISO International Standards Organization.

Internal noise See inner noise.

Ishikawa, K. Japanese quality control expert whose text, *Guide to quality control*, has a profound influence in statistical education in Japan.

Ishikawa's seven tools Simple statistical tools to aid the process of informed observation in the pursuit of quality: check sheets, Pareto charts, cause–effect diagrams, histograms, graphs, stratification and scatter plots.

JUSE Japanese Union of Scientists and Engineers.

Juran, J. M. American quality control expert whose work, with that of W. E. Deming, had a profound influence in Japan.

JIT Just-in-time.

Location measure A quantity derived from a set of data which is a measure of the 'centre' of the data. Examples are the mean, median and mode.

Mean The average of a set of data values.

Median The 'middle' value of a set of data values.

Military standard (MIL STD) A widely used set of sampling acceptance plans.

Moving average Used to smooth away the high-frequency or noise components of time series data; an unsmoothed value is replaced by a smoothed value which is a weighted average of the unsmoothed value and neighbouring (in time) unsmoothed values.

Multivariate control chart When it is required to control the levels of two or more variables simultaneously, a common procedure is to combine averages, standard deviations and correlation coefficients into a single measure of deviation and monitor a plot of the statistic.

Noise Uncontrollable variability in the output of a process or performance of a product.

Non-stationary time series A process whose probabilistic behaviour evolves or varies with time.

Off-line quality control A term used by G. Taguchi to refer to testing (using statistically designed experiments) at the design stage of a product in order to make it robust against manufacturing and use environments.

One-factor-at-a-time experimentation A usually inefficient method of experimentation where each factor under study is varied separately and not in planned combination with the other factors, as in factorial experiments. Unlike factorial experiments, information on interactions between factors is usually not available from such experiments.

On-line quality control Quality control methods employed during production, such as statistical process control and sampling inspection.

Operating characteristic curve (OC-curve) The operating characteristic curve for a given sampling inspection plan is the probability a batch will be accepted as a function of product quality.

Outer design array A term used by G. Taguchi for that part of an experiment in which otherwise uncontrollable noise variables are varied systematically to investigate the sensitivity of different product designs to manufacturing and use environments.

Outer noise A term used by G. Taguchi to describe

environmental noise variables to which a product may be subjected while in use.

Outlier   Part of a data-set which does not accord with the general pattern of the data.

p-chart   See control chart.

Parameter design   The second of a three-stage design procedure for off-line quality control proposed by G. Taguchi. In this stage, levels of product design variables (parameters or factors) are selected so that the effects of noise factors on the functional characteristics of the product are minimized.

Pareto chart   One of K. Ishikawa's seven tools. A simple graphical procedure to display classification of defects (say) by type.

Power   The power or sensitivity of a statistical test is the probability that the test results in rejection of an hypothesis when, in fact, some alternative hypothesis is valid. Also used in a quite different sense in statisitical spectral analysis of time series.

Power spectrum analysis   Frequency domain analysis of time series data.

QA   Quality assurance.

QC   Quality control.

QI   Quality improvement.

Quality measurement plan (QMP)   A quality measurement plan (developed by B. Hoadley) is a bayesian procedure for measuring the distribution of outgoing quality of a product or service.

R-chart   See control chart.

Randomization   Refers to a random assignment of treatments to experimental units in an experimental design. Its purpose is to guarantee inferential validity in the face of unspecified disturbances.

Range   A measure of variability; the difference between the largest and smallest value in a data-set.

Reliability function   The reliability function or survival function of a system at time t is the probability that the system will be functioning at t.

Replication   Independent observations taken under identical conditions during the course of an experiment.

Response surface   The relation between a response and a number of predictor variables.

Response surface design   Special designs to explore the empirical relation between a response and predictors.

Robustness   Insensitivity to assumptions.

Robustness (to environment)   A product design is robust if the product operates according to specification under a wide variety of uses and environmental conditions.

Run   A single performance of an experiment with all the input variables under consideration held fixed at prechosen levels.

Running average   See moving average.

Sampling inspection   The process of evaluating the quality of material by inspecting some but not all of it.

Sampling plan   Specifies the sample size and associated acceptance criterion to be used when the acceptability of a lot or process is decided by means of sampling inspection.

Scatter plot   A graphical display of the joint distribution of two variables in a data-set.

Screening design   In quality control, highly fractionated factorial designs are used as screening designs to investigate simultaneously the main effects of several factors on the performance of a product or process.

Sequential t-test   An example of a sequential probability ratio test where in the sampling inspection context items are inspected one by one and a decision (accept, reject, or continue) is made about the lot at every step.

Shewhart, W. A.   American pioneer of statistical quality control. He recognized that measured quality characteristics are subject to stable patterns of variation under normal production conditions, and reasons for excessive variation may be discovered and corrected.

Shewhart control chart   Provides information on both short-term variability estimated from a measure of dispersion (usually the range or standard deviation) of a small sample of observations (usually four or five) taken within a relatively short time, and on long-term variation estimated from sample-to-sample changes in some measure of location (usually the mean).

Signal-to-noise ratio   An index used by G. Taguchi to facilitate simultaneous analysis of variation in response (noise) and mean response (signal) as a function of product design factors (parameters). The index used in any particular situation is related to the loss function used. An example is the logarithm of the coefficient variation. Also used more broadly to compare systematic and random features.

Skewness   Asymmetry of a distribution.

Standard deviation   A measure of dispersion.

Statistical process control (SPC)   Statistical process control uses control charts for monitoring the characteristics of processes to detect deviations from target values and from statistical control.

Stem-and-leaf plot   A graphical display (popularized by J. W. Tukey) which provides distributional information similar to that from a histogram, but in addition retains the numerical information in the data.

Stratification   One of K. Ishikawa's seven tools, whereby test items are divided into groups such that the items in each group have some property or set of properties in common, relevant to the investigation in hand, which are not shared by items in the other groups.

Student's t-test   Significance test for population means by using small samples.

System design   The first of a three-stage design procedure for off-line quality control proposed by G. Taguchi. In this stage, a system (product) is designed to fulfil a specific function.

Taguchi, G.   Japanese quality engineer who has developed a systematic approach to off-line quality control in which he emphasizes the use of designed experiments not only to set a product's char-

acteristics at their target values, but also to reduce variation around these targets.

Tolerance design The third of a three-stage design procedure for off-line quality control proposed by G. Taguchi. In this stage, it may be necessary to specify narrower tolerances for some of the factors (parameters) if the reduction in variation achieved at the parameter design stage is insufficient.

Treatment A term used in statistical experimental design. It refers to aspects under the investigator's control (materials, processes, etc.) which are to be compared.

Two-level factorial experiment A factorial experiment in which each factor has only two levels.

V-mask A symbol, $>$, used in conjunction with cumulative sum control charts. The vertex of the V is placed forward of the last plotted point. A shift in the process mean is indicated if the arms of the V-mask obscure any previously plotted points.

$\bar{x}$-chart See control chart.

x–y plot See scatter plot.