

## SECTION IX GLOSSARY

1. **Accuracy** – The closeness or agreement between a measured value and a standard or true value; uncertainty as used herein, is the maximum inaccuracy or error that may reasonably be expected (see measurement error).
2. **Average Value** – The arithmetic mean of N readings. The average value is calculated as:

$$\bar{X} = \text{average value} = \frac{\sum_{i=1}^N X_i}{N}$$

3. **Bias (B)** – The difference between the average of all possible measured values and the true value. The systematic error or fixed error which characterizes every member of a set of measurements (Fig. IX-1).

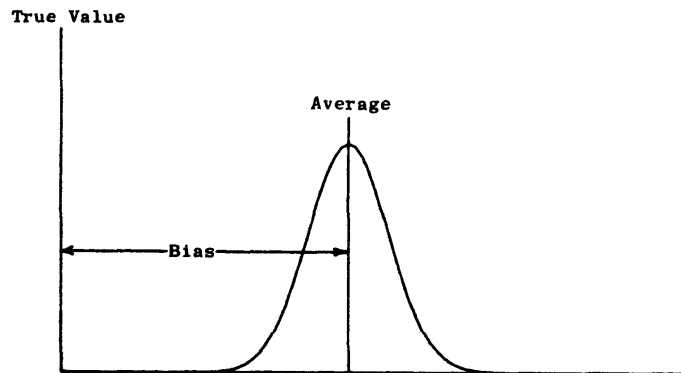


Fig. IX-1 Bias in a Random Process

4. **Calibration** – The process of comparing and correcting the response of an instrument to agree with a standard instrument over the measurement range.
5. **Calibration Hierarchy** – The chain of calibrations which link or trace a measuring instrument to the National Bureau of Standards.
6. **Correlation Coefficient** – A measure of the linear interdependence between two variables. It varies between -1 and +1 with the intermediate value of zero indicating the absence of correlation. The limiting values indicate perfect negative (inverse) or positive correlation (Fig. IX-2).

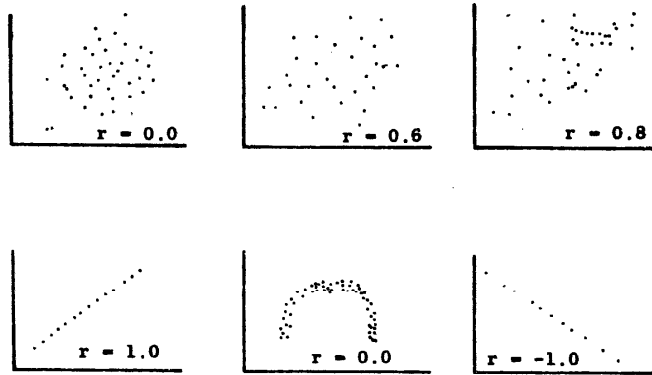


Fig. IX-2 Correlation Coefficients

7. **Coverage** - A property of confidence intervals with the connotation of including or containing within the interval with a specified relative frequency. Ninety-five-percent confidence intervals provide 95-percent coverage of the true value. That is, in repeated sampling when a 95-percent confidence interval is constructed for each sample, over the long run the intervals will contain the true value 95 percent of the time.
8. **Degrees of Freedom (df)** - A sample of  $N$  values is said to have  $N$  degrees of freedom, and a statistic calculated from it is also said to have  $N$  degrees of freedom. But if  $k$  functions of the sample values are held constant, the number of degrees of freedom is reduced by  $k$ . For example, the statistic  $\sum_{i=1}^N (X_i - \bar{X})^2$ , where  $\bar{X}$  is the sample mean, is said to have  $N - 1$  degrees of freedom. The justification for this is that (a) the sample mean is regarded as fixed or (b) in normal variation the  $N$  quantities  $(X_i - \bar{X})$  are distributed independently of  $\bar{X}$  and hence may be regarded as  $N - 1$  independent variates or  $N$  variates connected by the linear relation  $\sum(X_i - \bar{X}) = 0$ .
9. **Elemental Error** - The bias and/or precision error associated with a single component or process in a chain of components or processes.
10. **Estimate** - A value calculated from a sample of data as a substitute for an unknown population constant. For example, the sample standard deviation ( $S$ ) is the estimate which describes the population standard deviation ( $\sigma$ ).
11. **Joint Distribution Function** - A function describing the simultaneous distribution of two variables. The cumulative probability distribution for 2 variables.
12. **Laboratory Standard** - An instrument which is calibrated periodically at the NBS. The laboratory standard may also be called an interlab standard.

13. Mathematical Model – A mathematical description of a system. It may be a formula, a computer program, or a statistical model.
14. Measurement Error – The collective term meaning the difference between the true value and the measured value. Includes both bias and precision error; see accuracy and uncertainty. Accuracy implies small measurement error and small uncertainty.
15. Multiple Measurement – More than a single concurrent measurement of the same parameter.
16. NBS – National Bureau of Standards. The reference or source of the true value for all measurements in the United States of America.
17. Parameter – An unknown quantity which may vary over a certain set of values. In statistics, it occurs in expressions defining frequency distributions (population parameters). Examples: the mean of a normal distribution, the expected value of a Poisson variable.
18. Precision Error – The random error observed in a set of repeated measurements. This error is the result of a large number of small effects, each of which is negligible alone.
19. Precision Index – The precision index is defined herein as the computed standard deviation of the measurements.

$$s = \sqrt{\frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N-1}} \quad \text{usually, but sometimes } S = \sqrt{\sum_i s^2}$$

20. Proving Ring – Laboratory standard for force measurements.
21. Sample Size (N) – The number of sampling units which are to be included in the sample.
22. Standard Deviation ( $\sigma$ ) – The most widely used measure of dispersion of a frequency distribution. It is the precision index and is the square root of the variance: S is an estimate of  $\sigma$  calculated from a sample of data.
23. Standard Error of Estimate – The measure of dispersion of the dependent variable (output) about the least-squares line in curve fitting or regression analysis. It is the precision index of the output for any fixed level of the independent variable input. The formula for calculating this is

$$S_{EE} = \sqrt{\frac{\sum_{i=1}^N (Y_{OBS} - Y_{CAL})^2}{N-K}}$$

for a curve fit for N data points in which K constants are estimated for the curve.

24. Standard Error of the Mean – An estimate of the scatter in a set of sample means based on a given sample of size N. The sample standard deviation (S) is estimated as

$$S = \sqrt{(X_i - \bar{X})^2 / (N-1)}$$

Then the standard error of the mean is  $S/\sqrt{N}$ . In the limit, as N becomes large, the estimated standard error of the mean converges to zero, while the standard deviation converges to a fixed non-zero value.

25. Statistic – A parameter value based on data.  $\bar{X}$  and S are statistics. The bias limit, a judgment, is not a statistic.
26. Statistical Confidence Interval – An interval estimate of a population parameter based on data. The confidence level establishes the coverage of the interval. That is, a 95-percent confidence interval would cover or include the true value of the parameter 95 percent of the time in repeated sampling.
27. Statistical Quality Control Charts – A plot of the results of repeated sampling versus time. The central tendency and upper and lower limits are marked. Points outside the limits and trends and sequences in the points indicate non-random conditions.
28. Student's "t" Distribution (t) – The ratio of the difference between the population mean and the sample mean to a sample standard deviation (multiplied by a constant) in samples from a normal population. It is used to set confidence limits for the population mean.
29. Taylor's Series – A power series to calculate the value of a function at a point in the neighborhood of some reference point. The series expresses the difference or differential between the new point and the reference point in terms of the successive derivatives of the function.

Its form is 
$$f(X) - f(a) = \sum_{r=1}^{r=n-1} \frac{(X-a)^r}{r!} f^{(r)}(a) + R_n$$

where  $f^{(r)}(a)$  denotes the value of the rth derivative of  $f(x)$  at the reference point  $X = a$ . Commonly, if the series converges, the remainder  $R_n$  is made infinitesimal by selecting an arbitrary number of terms.

30. Traceability – The ability to trace the calibration of a measuring device through a chain of calibrations to the National Bureau of Standards.
31. Transducer – A device for converting mechanical stimulation into an electrical signal. It is used to measure quantities like pressure, temperature, and force.
32. Transfer Standard – A laboratory instrument which is used to calibrate working standards and which is periodically calibrated against the laboratory standard.

33. True Value – The reference value defined by the National Bureau of Standards which is assumed to be the true value of any measured quantity.
34. Uncertainty (U) – The maximum error reasonably expected for the defined measurement process:  $U = \pm(B + t_{95} S)$ .
35. Variance ( $\sigma^2$ ) – A measure of scatter or spread of a distribution. It is estimated by  $S^2 = \frac{\sum(X_i - \bar{X})^2}{N-1}$  from a sample of data. The variance is the square of the standard deviation.
36. Working Standard – An instrument which is calibrated in a laboratory against an interlab or transfer standard and is used as a standard in calibrating measuring instruments.