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# 1 Motivation of Talk

- The intensive use of an automatic data acquisition systems and the use of on-line computers for process monitoring have led to an increased occurrence of industrial processes with two or more correlated quality characteristics, in which the statistical process control and the capability analysis should be performed using multivariate methodologies. (book)

- Unfortunately, despite the availability of increased computing capabilities, in the Multivariate Statistical Quality Control (MSQC) framework the software solutions are limited or restricted in their level of success and ease of use for dealing with the problems of industry or promoting academic instruction.

## 2  Multivariate Control Charts

- With the enhancements in data acquisition systems it is usual to deal with processes with more than one correlated quality characteristic to be monitored.

- A common practice is to control the stability of the process using univariate control charts.

- This practice increases the probability of false alarm of special cause of variation.

- The control ellipsoid or $\chi^2$ control chart

- The $T^2$ or Hotelling chart

- The Multivariate Exponentially Weighted Moving Average (MEWMA) chart

- The Multivariate Cumulative Sum (MCUSUM) chart

- The chart based on Principal Components Analysis (PCA)

# 3 Hotelling $T^2$ Control Chart (Phase I)

- The origin of the $T^2$ control chart dates back to the pioneer works of Harold Hotelling who applied this method to the bombsight problem in Second World War.

- The Hotelling (1947) procedure has become without doubt the most applied in multivariate process control and it is the multivariate analogous of the Shewhart control chart.

- For that reason, it is also known as multivariate Shewhart control chart.

- Often in practice the parameters $\mu$ and $\Sigma$ are unknown and consequently must be estimated across the unbiased estimators $\bar{x}$ and S.

# 4 Graphical Methods

- The first section of this chapter will examine two graphical techniques: histogram and Q-Q plot that facilitate the assumption of normality.

- Histogram is a graphical technique that allows a visual summary of the data. It provides information about the center, the spread, the skewness, and the existence of outliers. (NIST / SEMATECH e-Handbook of Statistical Methods).

- A visual inspection of a histogram permits to establish an initial hypothesis of the distribution; in this case a bell-shaped is desired.

- Although histograms are basically used in univariate scenarios, univariate normality per se does not imply multivariate normality; if a departure from normality is founded in individual variables, this has a negative effect in the multinormality.