Multivariate Methods to Monitor Product-Process Parameters

Luan Jaupi
Conservatoire National des Arts et Métiers
Statistique Appliquée
292, rue Saint-Martin
75003 Paris, FRANCE
jaupi@ cnam.fr

Keywords

Quality characteristic, principal components, influence function, non-conformities, process parameter, regression, control chart.

Abstract

Multivariate quality control problems involve the evaluation of a process based on the simultaneous behavior of quality characteristics and process parameters. Multivariate methods for monitoring processes with multivariate measurements in both product quality characteristics space and process parameters space are considered.

With complex products we usually find many different types of quality characteristics. Generally, not all of these quality characteristics are equally important. Some of them may be very critical to describe each item quality (leading quality characteristics), and some of them may be moderate ones (less important quality characteristics). Moreover, when the number of quality characteristics is high the use of multivariate control charts based on T-squared or Chi-squared statistics may be very inappropriate, because the upper control limit of these control charts raises steeply with the number of variables. Therefore it is convenient to employ control procedures that are based on leading quality characteristics but enables to identify special causes that may affect the overall process. Our approach to build up such control charts consists to monitor the stable level of variability of the process according to the directions settled by a generalized PCA, which is based on the leading variables.

Usually, with complex products we find also that many different types of non-conformities or defects can occur. We will present too, some multivariate methods that we have used to find out the process parameters that are responsible for the observed product non-conformities. The proposed methods are illustrate with real applications from the field of automobiles and chemical processes.

References

ALT F. B. & SMITH, N. D. (1988) *Multivariate Process Control*. Handbook of Statistics Vol. 7, 333-351, North-Holland.

JACKSON, J. E. (1959). *Quality Control Methods for Several Related Variables*, Technometrics 1(4): 359-377.

JAUPI L. (1999): *Comparison of Multivariate Control Charts for Complex Processes*, First International Symposium on Industrial Statistics, Linköping, Sweden, 19 - 21 August 1999.

JAUPI L. SAPORTA G. (1997): *Control Charts for Multivariate Process Based on Influence Functions*, Proceedings of the Conference on Statistical Science, Monte Verità, Zwitzerland, Birkhäuser Verlag Basel, 1997, p. 193-201.

JAUPI L. SAPORTA G. (1995): *A Simple Approach to Design Cusum Quality Control Schemes for Noconformities*, International Conference on Statistical Methods and Statistical Computing for Quality and Productivity Improvement, Seoul, Korea, 1995, p.565-569.

JAUPI L. SAPORTA G. (1994) *Multivariate Process Control Through the Means of Influence Functions;* Proceedings in Computaional Statistics, COMPSTAT'94, p. 195-200, Physica-Verlag.

JAUPI L. SAPORTA G. (1993): *Using the Influence Function in Robust Principal Components Analysis;* In S. Morgenthaler, E. Ronchetti and W.A. Stahel, eds., New Directions in Statistical Data Analysis and Robustness, p. 147-156 , Birkhäuser Verlag, Basel.

RAO,C.R.(1964). *The Use and Interpretation of Principal Components in Applied Research* : Sankhya, A, 26, 329-358.

TANAKA, J. & MORI, Y. (1995). *Principal Component Analysis Based on a Subset of Variables and its Application*: Proceedings of International Conference on Statistical Methods and Statistical Computing for Quality and Productivity Improvement, Seoul, Korea, 1995, 308-317.