Change-point Problems
IMS Lecture Notes – Monograph Series (Volume 23, 1994)

LIKELIHOOD RATIO METHODS FOR MONITORING PARAMETERS OF A NESTED RANDOM EFFECT MODEL

BY EMMANUEL YASHCHIN
IBM Research Division

In many practical situations the variance of a set of measurements can be attributed to several known sources of variability. For example, if several measurements of each item of a lot are taken, one may need to deal not only with the within-item variability, but also with item-to-item-within-lot and lot-to-lot components of variability. In such cases conventional control charts tend to produce an unacceptably high rate of false alarms and, in general, represent a rather weak diagnostic tool. This paper shows how to build a control system, based on Likelihood Ratio Tests, capable of controlling the mean and variance components of a nested random effect model. The strong points and weaknesses of this approach are compared to those of competing methods.

1. Introduction. One of the major aims of Statistical Process Control (SPC) is to achieve the condition where all the parameters related to a given manufacturing, business, ecological or similar process, conform to some prescribed on-target behavior. The means by which this aim is achieved include not only direct process adjustments, but also identification and neutralization of so called *special* causes of unfavorable changes in parameters of interest. Success in this form of control depends, to a large extent, on identification of a suitable model for the observed process. Once this is done and a systematic corrective action is taken to reduce variability due to predictable effects of feed-forward and feed-back variables, process control activity concentrates on monitoring the adequacy of the model and the levels of its parameters.

In many practical situations, the relevant model involves the mean and various measures of variability for a given type of measurement. For example, in situations where production is on a lot-by-lot basis and several measurements are taken at random from each lot, one will usually need to monitor not only the measure of total variance, but also its individual components. This is important because of the following reasons. First, knowing which component

---

AMS 1991 Subject Classification: Primary 62L10; Secondary 62N10

Key words and phrases: Change-point control charts, random effects, run length, variance components.