THE BURN-IN PROBLEM - A DISCUSSION OF SEQUENTIAL STOP AND GO STRATEGIES

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Abstract The problems related to burn-in are decision problems. They are specified by assigning both the structure of relevant costs/rewards and the stochastic model for lifetimes of involved components. In this paper we specifically confine attention to the problem of optimal duration of burn-in by presenting a discussion about some aspects of general type, and reviewing some related results.

Keywords: Decision analysis, optimal stopping, open-loop feedback, exchangeability.

1. **Introduction**

As is well-known, the term burn-in describes the procedure of testing units or components before taking them to operation. There is a quite rich and still growing literature about this topic, probably because it revealed to be related to some of the most intriguing problems in reliability theory. Indeed it is a subject where not only mathematical, statistical, and industrial aspects are combined but also somehow superimposed by different paradoxical and foundational facets.
In this respect, it is to be noticed in particular that, from an intuitive point of view, burn-in procedures are justified in cases when the lifetimes of involved components manifest some aspects of infant mortality, that is when the possibility of early failures exists. However, in order to achieve clear results and to develop convincing methods, it is necessary to understand what infant mortality really is, how it can arise in problems from the field and how situations of infant mortality really justify the implementation of burn-in procedures. Conditions of infant mortality often are created by situations of heterogeneity, and heterogeneity among components typically implies that the one-dimensional distribution of any single component’s lifetime is of mixture type. For this reason the theme of burn-in is also strictly related to the literature concerning the definitions of early failures, infant mortality and to the identification of models of mixtures which create infant mortality.

Within the topic of burn-in, furthermore, the analysis of different problems is in order. The first question to be asked is: In a specified situation, is it convenient to burn-in components? If the response to this question is “Yes”, other problems arise, concerning the type of burn-in to be implemented. In fact we can perform different types of burn-in: if industrial units of interest are components to be assembled in the same system, one natural problem concerns the choice between making burn-in at “system level” or at “component level”.

A further question concerns the level of stress during burn-in. In fact, in some models, one is allowed to test the units during burn-in under the same environmental conditions existing during operation of the components in the field. More often, however, strictly related to burn-in there is the idea of “compressing time” by testing components at a higher stress level in order to precipitate early failures. Then the problem arises to determine optimally the level of stress during burn-in.

Once one established that burn-in is to be performed and the type of implementation has been fixed, the main problem, in any case, is the one of choosing how long the burn-in experiment should last or, in other words, one should fix a procedure to optimally stopping burn-in: Considering $m$ produced items, and given some cost structure such as costs for failures during and after the test and gains per unit time for released items, the problem then is to determine the optimal burn-in duration. This optimal burn-in time may either be fixed in advance and therefore be deterministic, or one may consider the random information given by the lifetimes of the items failing during the test and obtain a random burn-in time as described below.

We point out that generally the problems related to burn-in mentioned so far, essentially are decision problems or can be reduced to decision problems, more or less directly; as such, they are specified by assigning both the structure of relevant costs/rewards and the stochastic model for lifetimes of involved components.