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Utilising statistical residual life estimates of bearings to quantify the influence of preventive maintenance actions

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Abstract

In this paper it is illustrated how statistical residual life estimates of bearings can be used to justify maintenance practices. Residual life estimates are based on Proportional Intensity Models for non-repairable systems utilising historic failure data and corresponding diagnostic measurements. A case study is presented where failure and diagnostic data obtained from roller bearings operating in the dryer section of a paper machine are used to predict future failure times of bearings. If these predictions are compared to the diagnostic measurements, i.e. vibration and lubrication levels, it becomes evident how changes in these diagnostic measurements influence the residual life of the bearings. From this it is possible to justify maintenance practices.

Keywords: Lifetime estimate; Bearing; Maintenance quality

1. Introduction

Preventive maintenance is often initiated on industrial equipment based on observed diagnostic measurements such as vibration levels, temperatures, pressures, etc., that are outside of certain acceptable levels. After performing the preventive maintenance the success of this action is judged on a binary basis. If the said diagnostic measurements have decreased or increased sufficiently to be within specification, the preventive maintenance action is considered to be successful. If not, additional actions are often instigated to get all diagnostic measurements within specification.

In this paper we describe a methodology to quantify the success of preventive maintenance more accurately than a simple binary number. The residual life estimation methodology of Vlok [1] is applied but not with the sole purpose to predict future failures. It is shown how these estimates can be used to quantify the success and efficiency of preventive maintenance actions.

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The paper starts off with an introduction to the residual life estimation concept and describes the data required to perform the calculations. It further discusses how this concept can be used to quantify the success of preventive maintenance actions. The validity of the theory is illustrated with a case study in the last section.

2. Residual life estimation of equipment based on failure intensity proportions

In recent research a methodology suitable to estimate the residual life of industrial equipment was developed based on actuarial statistics (see [1,2]). Life insurance companies need to make an estimate on a client's residual life at his/her current age to be able to set appropriate insurance premiums. These companies compile data of the ages of people (with certain similarities) at death and their associated life styles, e.g. the number of cigarettes smoked per day, number of beers per week, stress levels, etc. This data is represented by a Proportional Intensity Model (PIM) and it is hence possible to estimate the residual life of a living client at a certain age with a certain life style.

The methodology for machines makes use of the ages of machines at failure and associated diagnostic information that was collected during the machine's lifetime. The concept is shown in Fig. 1. Data of similar failed machines is compiled and a PIM specially developed for reliability data is fitted to observations. From here it is possible to estimate the residual life of a machine currently in operation, at a certain age and with certain diagnostic measurements. The methodology, its terminology, data requirements and outputs are described in the remainder of this paper.

2.1. Terminology and notation

The terminology and notation of Ascher and Feingold [3] is used in this paper for clarity. First, proper terminology for different types of machines and their components is required:

(i) *Part.* An item that is never disassembled and is discarded after its first failure, i.e. the first time it ceases to perform satisfactory.

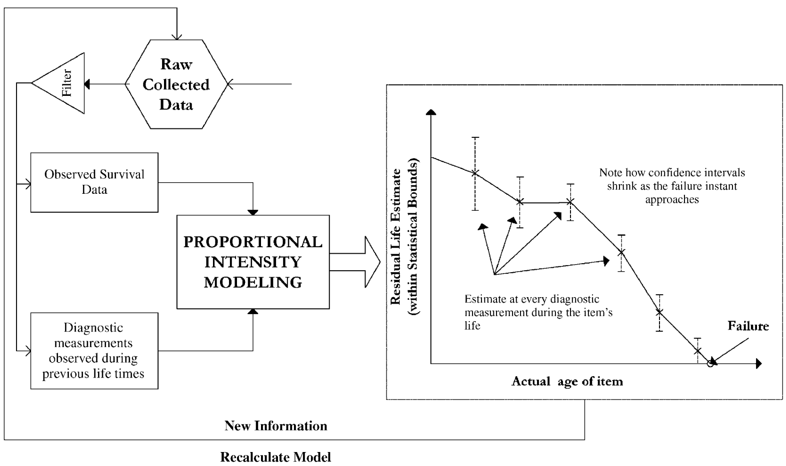

Fig. 1. Global overview of the RLE concept.