Supporting Implementation of Condition Based Maintenance: Highlighting the Interplay between Technical Constituents and Human and Organizational Factors

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ABSTRACT

This article presents two case studies and theory on the topic of implementing a condition based maintenance approach. It visualizes that condition based maintenance, within the Swedish industry, is utilized to a lesser degree than corrective and predetermined maintenance, and argues that one reason for this is the difficulty in implementation. It also argues that additional factors, beyond technical aspects within the condition based maintenance approach, are necessary to take into consideration if successful implementation is to be achieved. The purpose of the two case studies was to investigate the process of implementing a condition based maintenance approach. The result of the investigation was compiled into a checklist with important factors to take into consideration when attempting to implement condition based maintenance within an industrial setting.

Keywords: condition based maintenance; condition monitoring; implementation; maintenance

INTRODUCTION

Increased productivity is a key issue for manufacturing companies to stay competitive in a continuously growing global market. Increased productivity can be achieved through increased availability, for example. In achieving high availability, efficient maintenance is a prerequisite in order to prevent breakdowns, waiting time for spare parts, lengthy trouble-shooting, bad planning, and so forth. During the past decades, maintenance costs have been debated and many times have been accused of being too high rather than justified. McKone and Weiss (1998) state that a company can spend the equivalent of its net income on maintenance alone. Maggard and Rhyne (1992) state that maintenance expenses on a yearly basis usually range in between 15-40% of the total production cost. Wireman (1990) states that as much as one-third of the total maintenance cost is spent unnecessarily due to circumstances such as bad planning, overtime costs, poor use of work order systems, and bad use of preventive maintenance.

Good maintenance has been defined as the condition when very few corrective main-
tenance actions are undertaken, and when as little preventive maintenance as possible is performed (Cooke & Paulsen, 1997). This put a great deal of stress on planning proper preventive maintenance intervals and preventive maintenance tasks, that is, scheduling. The preventive maintenance should, for the most effective execution, be planned for when an item’s pre-set normal condition is exceeded. In some cases a machine can actually be run until just before failure (Al-Najjar, 1997).

The need for condition based maintenance with the use of proper condition monitoring tools was revealed as early as in the 1960's through a study performed during the development of the preventive maintenance program for the Boeing 747. The study’s purpose was to determine the failure characteristics of aircraft components (Overman, 2002). The study was, at the request of the Department of Defense (USA), documented and published by Nowlan and Heap in 1978. It was found that a relatively small part of all components (11%) had clear ageing characteristics which would enable a scheduled overhaul, that is, predetermined preventive maintenance. The rest of the components (89%) did not show such ageing characteristics which leads to the conclusion that they were random failures which are, thus, not applicable to scheduled overhauls (Nowlan & Heap, 1978). Page (2002) presents similar conditional-probability curves within the manufacturing industry, stating that only 30% of all components have clear ageing characteristics, and that this percentage decreases as complexity and technology increases. Evidently, when planning appropriate maintenance schedules, the ageing feature of a component is not the best approach, and in some applications not even possible, thereby introducing condition based maintenance and condition monitoring as one solution to the issue.

This article is divided into eight sections. The first section introduces the area of condition based maintenance, presents the problem discussion and formulates the purpose of the article. The second section contains a theoretical overview of the issue. Section three describes the research methods used. Section four, which contains the case findings, is divided into two sub-sections, covering two case studies. Section five contains a discussion on the findings in a theoretical context; this section is divided into three sub-sections, covering the two case studies and a summary. Section six covers the results and section seven covers the conclusions. Section eight lists the references used.

**Problem Discussion**

Independent investigations reveal that condition based maintenance is not utilized to the extent one might expect. An investigation performed by Jonsson (1997), surveying 284 relevant respondent answers in the manufacturing industry of Sweden, revealed that only two-fifths of the maintenance time is spent on preventive or condition based maintenance. In maintenance techniques, the use of objective condition monitoring is valued very low in comparison to human senses, corrective maintenance, and other preventive techniques. Alsyouf (2004) presents another investigation within the Swedish industry placing condition based maintenance at second place, tied to corrective maintenance, as the most frequently used maintenance approach, only loosing to predetermined maintenance. The condition monitoring tools that were reported to be used in the same investigation were of quite low-tech art though. A third investigation performed by Bengtsson (2004a) reports that condition based maintenance, as a maintenance approach, is only utilized in 10% of all maintenance activities; the investigation came to the same conclusions as Alsyouf’s concerning the use of condition monitoring tools.

Condition monitoring tools have been used and developed for many decades. Still, according to the investigations above, the majority of the Swedish industry has not started to utilize the technical advantage of these tools. When surveying published research within condition based maintenance and condition monitoring most papers and books deal with the technical aspects, and less of the organizational. Pengxiang et al. (2005) state that most research within condition
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