

# A framework for maintenance concept development

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## Abstract

Today, world-class competitiveness is a must for companies. The undeniable global competition, characterised by both a technology push and a market pull, and the rapidly evolving technology and increased customer requirements put forward a lot of challenges for management. One of these challenges concerns the production equipment. High-speed technological innovation combined with severe competition shortens the equipment life cycle and puts equipment under higher stress. In order to deal with this problem, a company's strategic investments in production equipment should not only consider cost and capacity, but also technology trends, flexibility, etc. Another important aspect is maintenance. Proper maintenance helps to keep the life cycle cost down and ensures proper operations and smooth internal logistics. The decision on the required maintenance concept and a thorough and easily accessible technical knowledge are crucial here. More and more companies are searching for a customised maintenance concept. The framework described in this paper offers some guidelines to develop such a concept, and borrows some ideas from maintenance concepts described in literature. An important feature of the framework is that it allows to incorporate all information available in the company, ranging from experience of maintenance workers to data captured by modern Information and Communication Technology (ICT) means. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

A company contains a large number of technical systems which all interact to achieve the pursued business objectives. Maintenance contributes more than ever to the achievement of these objectives. Indeed, proper maintenance does not only help to keep the life cycle cost down; it also contributes positively to the overall performance of the company. However, maintenance also contributes

significantly to the total cost, and this often forms the basis of performance improvement demands to the maintenance department.

A maintenance concept can be defined as the set of various maintenance interventions (corrective, preventive, condition based, etc.) and the general structure in which these interventions are foreseen [1]. The maintenance concept forms the framework from which installation-specific maintenance policies are developed and is the embodiment of the way a company thinks about the role of maintenance as an operations function. As a consequence, it influences every part of the maintenance activities in the company. To develop an appropriate maintenance concept, maintenance must be

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considered holistically. Factors that technically describe each system to maintain, as well as factors that describe the interrelations between the different systems and factors that describe the general organisational structure should be addressed. If some of the necessary aspects are not considered (e.g. due to uncaredful analysis or lost data or knowledge), the maintenance concept will never reach its full potential.

The latter makes the importance of an appropriate maintenance concept very clear. Because of the high direct and indirect cost involved (for in-house as well as for outsourcing maintenance) and because of the operational impact maintenance may have on the equipment's performance, maintenance concept development should be done in structured way. Moreover, the maintenance concept should be customised; i.e. it should consider all relevant factors of the situation on-hand. As such, it will be really tailored to the needs of the company in question. This means that the maintenance concept will be unique for each company. The underlying structure for developing such a concept may however be very comparable. Another important remark is that since industrial systems evolve rapidly (think, e.g. about the high-speed technological innovation), the maintenance concept will also have to be reviewed periodically in order to take into account the changing systems and the changing environment. This calls not only for a structured, but also for a flexible maintenance concept, allowing feedback and improvement.

The goal of this paper is to describe a framework for maintenance concept development, which leaves enough room for customisation. The framework takes into account both computerised information and 'knowledge' (worker experience, know-how), and can help to manage this knowledge. This is an important feature, because before the introduction of Maintenance Management Information Systems (MMIS), information was on paper or in the head of people. Gathering the latter information (knowledge) is very time consuming and difficult and there is a high risk that useful information will get lost. Nevertheless, all knowledge is very important and valuable because it is already placed in a certain context, namely experience [2].

## 2. The need for a customised maintenance concept

In many industries maintenance amounts for a substantial sum and the maintenance personnel sometimes comprises a significant number of the total work force, e.g. up to 30% or more in the chemical process industry. The potential impact of maintenance at the level of operations and logistics (flexibility, throughput time, quality, etc.) is considerable, and therefore the financial implications of maintenance can be substantial. The recognition of maintenance as a potential profit-generator, however, is a fairly recent development. Another recent development is the realisation that interrelationships with other operating functions cannot be denied. Maintenance becomes more and more part of the integrated business concept. Regarding the future, there is a growing trend towards outsourcing (external partnerships). There is also a shift from failure-based to use-based maintenance and increasingly towards condition-based maintenance. Greater emphasis is put on the availability, reliability and safety of the production facilities. As regards human resources, highly qualified personnel are being demanded and continuous training efforts are needed. Appropriate computer support has become indispensable for stock tracking, personnel management, job order tracking, processing of historical data, efficient document control and the like. Maintenance has become more and more integrated, as shown by the renewed interest in Life Cycle Costing (LCC). Table 1 places this evolution of maintenance in a time perspective.

In the past, the Centre for Industrial Management conducted quite some action research and case studies in the domain of maintenance. One of these research projects was carried out at an automobile manufacturer [3,1]. Focus was on 'difficult' cases: (fully) automated, thus complex and expensive, equipment, which moreover was relatively new, thus not much data on failure and maintenance behaviour was available yet. The technical system considered in the project was a paint-spraying robot, used in a truck cabin paint shop. The goal was not only to develop an efficient and effective maintenance concept for this new, unique and complex technical system, but also to

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