

Planning and Control of Maintenance Systems

Modelling and Analysis

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Preface

Maintenance systems play a key role in achieving organizations' missions and abilities to attain their profit targets and survive in globally competitive marketplace and changing economies. The purpose of this book is to present maintenance as an integrated system with objectives, strategies, and processes that need to be planned, designed, engineered, and controlled using statistical and optimization techniques. The theme of the book is the strategic holistic system approach for maintenance. This approach enables maintenance decision makers to view maintenance as a provider of a competitive edge not a necessary evil. The book has fourteen chapters including maintenance systems, maintenance strategic and capacity planning, planned and preventive maintenance, work measurements and standards, material (spares) control, maintenance operations and control, planning and scheduling, maintenance quality, training, reliability-centered maintenance (RCM), total productive maintenance (TPM), intelligent maintenance systems, maintenance performance, productivity, and continuous improvement.

Chapter 1 provides an over view of the book. It outlines the philosophy and approach the book adopts in addressing maintenance systems. This chapter presents maintenance as a system with inputs, outputs, processes, and activities that need to be planned, designed, engineered, executed, and controlled. In addition, it highlights maintenance activities and strategies and concludes with maintenance terms and their definitions.

Chapter 2 focuses on maintenance strategic and capacity planning. Forecasting techniques that are useful for maintenance planning are presented. The need to align maintenance strategic plan with organizational goals is emphasized. Heuristic and mathematical models for capacity planning are discussed and demonstrated by examples from maintenance.

Chapter 3 addresses preventive maintenance and breakdown repairs. Various useful diagnostic techniques for monitoring equipment health and condition are presented. These techniques play a key role in designing condition-based maintenance. The steps for designing an effective planned maintenance are discussed. Mathematical models for determining optimal preventive maintenance and inspection frequencies are presented. The concept of imperfect maintenance is

explained, and approaches for modeling its effect are provided. Finally, a brief description of delay time modeling for determining preventive maintenance is provided.

Chapter 4 discusses the need for maintenance job time standards and covers techniques for developing such standards. The techniques covered include work measurement, work sampling, standard data, and comparative estimation.

Chapter 5 focuses on spare parts provisioning for maintenance. Effective ordering policies for repairs and ordering strategies are discussed. A methodology for estimating material and spare parts costs is outlined.

Chapter 6 discusses maintenance operation and control systems. The role of the work order system is presented in detail. Guidelines for designing effective work order systems are provided. The components of the maintenance control system and their underlying structures are outlined. Work order coordination, maintenance unit control and reports for feedback and improvement are presented as well.

Chapter 7 presents maintenance planning and scheduling. The elements of medium- and short-term planning are discussed. Effective planning models for scheduling including networks and critical path analysis are presented with examples. This chapter concludes with planning turnaround maintenance.

Chapter 8 describes maintenance quality control. The responsibility, organization, and tools for controlling and improving quality of maintenance work are presented with examples.

Chapter 9 deals with maintenance training and discusses skills required for maintenance. In addition, this chapter presents a framework for designing a training program for maintenance personnel and outlines means for evaluating and improving the effectiveness of such programs.

Chapter 10 addresses computerized maintenance systems and presents the requirements for a typical maintenance management information system (MMIS). It also provides a methodology for evaluating MMISs.

Chapter 11 discusses reliability centred maintenance (RCM) and presents a step-by-step approach for developing a RCM program. In addition, this chapter outlines the steps for implementing RCM.

Chapter 12 presents total productive maintenance (TPM) as a successful approach for managing maintenance. This chapter provides the main elements of TPM and a road map for implementing it.

Chapter 13 addresses the concepts and techniques of e-maintenance. The development of information and communication technology made it possible to go beyond predictive maintenance to e-maintenance. This chapter presents the elements of e-maintenance and the requirement for its implementation together with few case studies.

Chapter 14 focuses on maintenance performance measures, productivity, and continuous improvement. It presents maintenance performance measures, indices, quality improvement tools, root cause analysis, benchmarking, and process re-engineering. The applicability of these techniques in maintenance is demonstrated using case studies.

Each chapter includes a number of exercises, which are of two types. Answers to the first type of exercises can be found within the text. Answers to the second type require some research. The authors have tried as much as possible to make this book self-contained. Techniques and models used in the text are explained within the text; however, for readers who did not have a basic course in probability and statistics, an appendix is provided to alleviate this deficiency. The book has a modest mathematical level. Engineering or management students, practicing engineers, and managers who have completed an introductory course in statistics should have no difficulty understanding almost all of the text. It is our intent to give readers an understanding of the relevant methodology and how to apply it, rather than to provide a complete treatment of the mathematical theory.

This is the second edition of the book. Four new chapters are added to the second edition and three chapters are revised substantially to reflect developments in maintenance since the publication of the first edition. The new chapters cover reliability-centered maintenance, total productive maintenance, e-maintenance and maintenance performance, productivity, and continuous improvement. The revised chapters include Chap. 1 the introduction, Chap. 2 *Maintenance Strategic and Capacity Planning*, and Chap. 14 *Maintenance Performance, Productivity, and Continuous Improvement*. The write-up of the other chapters has been improved to enhance presentation and readership.

This book is suitable as a textbook or a reference for professionals and practitioners. It can be used as a text for undergraduate- or first-year graduate-level courses in maintenance. It will be of interest to industrial engineering, mechanical engineering, electrical engineering, and industrial management students. It can also be used as a textbook for short courses on maintenance in industry.

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