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## Preface

To be able to compete successfully both at national and international levels, production systems and equipment must perform at levels not even thinkable a decade ago. Requirements for increased product quality, reduced throughput time and enhanced operating effectiveness within a rapidly changing customer demand environment continue to demand a high maintenance performance.

In some cases, maintenance is required to increase operational effectiveness and revenues and customer satisfaction while reducing capital, operating and support costs. This may be the largest challenge facing production enterprises these days. For this, maintenance strategy is required to be aligned with the production logistics and also to keep updated with the current best practices.

Maintenance has become a multidisciplinary activity and one may come across situations in which maintenance is the responsibility of people whose training is not engineering. This handbook aims to assist at different levels of understanding whether the manager is an engineer, a production manager, an experienced maintenance practitioner or a beginner. Topics selected to be included in this handbook cover a wide range of issues in the area of maintenance management and engineering to cater for all those interested in maintenance whether practitioners or researchers.

This handbook is divided into 6 parts and contains 26 chapters covering a wide range of topics related to maintenance management and engineering.

Part I deals with maintenance organization and performance measurement and contains two chapters. Chapter 1 by Haroun and Duffuaa describes the maintenance organization objectives, the responsibilities of maintenance, and the determinants of a sound maintenance organization. In Chapter 2, Parida and Kumar address the issues of maintenance productivity and performance measurement. Topics covered include important performance measures and maintenance performance indicators (MPI), measurement of maintenance productivity performance and various factors and issues like MPI and MPM systems, MPI standard and MPIs use in different industries.

Part II contains an overview and introduction to various tools used in reliability and maintenance studies and projects. In Chapter 3, Ben-Daya presents basic statistical concepts including an introduction to probability and probability distributions, reliability and failure rate functions, and failure statistics. In Chapter

4, Ben-Daya provides an overview of several tools including failure mode and effect analysis, root cause analysis, the Pareto chart, and cause and effect diagram.

Part III contains three chapters related to maintenance control systems. Chapter 5 by Duffuaa and Haroun presents the essential elements and structure of maintenance control. Topics included cover required functions for effective control, the design of a sound work order system, the necessary tools for feedback and effective maintenance control, and the steps of implementing effective maintenance control systems. Cost control and budgeting is the topic of Chapter 6 by Mirghani. This chapter provides guidelines for budgeting and costing planned maintenance services. Topics covered include overview of budgeting and standard costing systems, budgeting framework for planned maintenance, a methodology for developing standard costs and capturing actual costs for planned maintenance jobs, and how detailed cost variances could be generated to assess the cost efficiency of planned maintenance jobs. The final chapter in this part is Chapter 7 by Riane, Roux, Basile, and Dehombreux. The authors discuss an integrated framework called OPTIMAIN that allows maintenance decision makers to design their production system, to model its functioning and to optimize the appropriate maintenance strategies.

Part IV focuses on maintenance planning and scheduling and contains five chapters. Forecasting and capacity planning issues are addressed in Chapter 8 by Al-Fares and Duffuaa. Topics covered include forecasting techniques, forecasting maintenance workload, and maintenance capacity planning. Necessary tools for these topics are presented as well and illustrated with examples. Chapter 9 by Diallo, Ait-Kadi and Chelbi deals with spare parts management. This chapter addresses the problem of spare parts identification and provisioning for multi-component systems. A framework considering available technical, economical and strategic information is presented along with appropriate mathematical models. Turnaround maintenance (TAM) is the object of Chapter 10 by Duffuaa and Ben-Daya. This chapter outlines a structured process for managing TAM projects. The chapter covers all the phases of TAM from its initiation several months before the event till the termination and writing of the final report. Chapter 11 by Al-Turki gives hands on knowledge on maintenance planning and scheduling for planners and schedulers at all levels. Topics covered include strategic planning in maintenance, maintenance scheduling techniques, and information system support available for maintenance planning and scheduling. Chapter 12 by Boukas deals with the control of production systems and presents models for production and maintenance planning. The production systems are supposed to be subject to random abrupt changes in their structures that may result from breakdowns or repairs.

Part V addresses maintenance strategies and contains eight chapters. Chapter 13 by Ait-Kadi and Chelbi presents inspection models. Topics covered include models for single and multi-component systems, and conditional maintenance models. Chapter 14 by Kothamasu, Huang and VerDuin offers a comprehensive review of System Health Monitoring and Prognostics. Topics surveyed include health monitoring paradigms, health monitoring tools and techniques, case studies, and organizations and standards. Ito and Nakagawa present applied maintenance models in Chapter 15. In this chapter, the authors consider optimal maintenance

models for four different systems: missiles, phased array radar, Full Authority Digital Electronic Control and co-generation systems based on their research. In Chapter 16, Siddiqui and Ben-Daya provide an introduction to reliability centered maintenance (RCM) including RCM philosophy, RCM methodology, and RCM implementation issues. Total productive maintenance (TPM) is the subject of Chapter 17 by Ahuja. Topics include basic elements of TPM, TPM methodology and implementation issues. Maintenance is an important concept in the context of warranties. Chapter 18 by Murthy and Jack highlights the link between the two subjects and discusses the important issues involved. Topics covered include link between warranty and maintenance, maintenance logistics for warranty servicing, and outsourcing of maintenance for warranty servicing. Delay Time (DT) Modeling for Optimized Inspection Intervals of Production Plant is the title of Chapter 19 by Wang. Topics covered include DT models for complex plant, DT model parameters estimation, and related developments and future research on DT modeling. Intelligent maintenance solutions and e-maintenance applications have drawn much attention lately both in academia and industry. The last chapter in Part V, Chapter 20 by Liyanage, Lee, Emmanouilidis and Ni deals with Integrated E-maintenance and Intelligent Maintenance Systems. Issues discussed include integrated e-maintenance solutions and current status, technical framework for e-maintenance, technology integration for advanced e-maintenance solutions, some industrial applications, and challenges of e-Maintenance application solutions.

Part VI deals with maintainability and system effectiveness and contains one chapter by Knezevic. It covers topics related to maintainability analysis and engineering and maintainability management.

Part VII contains five chapters presenting important issues related to safety, environment and human error in maintenance. Safety and maintenance issues are discussed in Chapter 22 by Pintelon and Muchiri. This chapter establishes a link between safety and maintenance, studies the effect of various maintenance policies and concepts on plant safety, looks at how safety performance can be measured or quantified, and discusses accident prevention in light of the safety legislation put in place by governments and some safety organizations. In Chapter 23, Raouf proposes an integrated approach for monitoring maintenance quality and environmental performance. Chapter 24 by Liyanage, Badurdeen and Ratnayake gives an overview of emerging sustainability issues and shows how the asset maintenance process plays an important role in sustainability compliance. It also elaborates on issues of quality and discusses best practices for guiding decisions. The last two chapters deal with human error in maintenance. Chapter 25 by Dhillon presents various important aspects of human reliability and error in maintenance. Finally Chapter 26 by Nicholas deals with human error in maintenance – a design perspective.

Maintenance professionals, students, practitioners, those aspiring to be maintenance managers, and persons concerned with quality, production and related areas will find this handbook very useful as it is relatively comprehensive when compared with those existing in the market.

The Editors

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