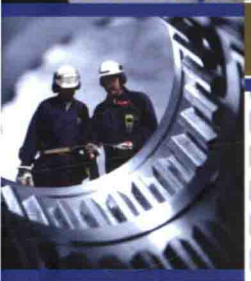
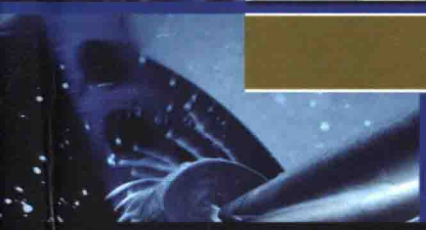
D. R. Kiran

Maintenance Engineering and Management

Precepts and Practices





Second Edition

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Maintenance Engineering and Management : *Precepts and Practices*

Second Edition

The book "Maintenance Engineering and Management" deals with the management principles and practices that govern the maintenance function apart from the engineering techniques. It gives the maintenance engineer, the latest developments in maintenance engineering techniques like wear debris analysis, preventive maintenance and condition monitoring as well as management concepts like reliability based maintenance, logical fault location and lean maintenance.

Salient Features:

- Syllabi from around 20 Universities and Institutions of India as well as those of Boston University and University of Dar Es salaam are collected to draw the outline for this book.
- Topics like non-destructive testing, environmental impact, tramp oils etc., Which are covered in detail in this book.
- Maintenance of the production facilities including the expanding scope of the modern maintenance.
- Several case studies are given from the practical experience.

In the new second edition, some suggestions from the reviewers have been adapted and incorporated. New and improved figures and diagrams together with case studies have been added.

The book **"Maintenance Engineering and Management: *Precepts and Practices*"** is fully devoted to the aspects of maintenance, which forms a vital part of TQM approach.

The author has not only given in-depth, knowledge of the different aspects of maintenance, but also given a new dimension to it by clearly defining Maintenance Strategy Implementation in Maintenance work. He has also clearly brought out the interlinking areas of materials management and maintenance engineering.

The value addition is by the topics covered like NDT, detailed impact of the environmental issues which is very relevant in the present context. The industrial safety and job hazards analysis is an eye opener.

The book is a good reference material for the managers in manufacturing industries and will also benefit the student community to make their career as maintenance Engineers.

Major Chandrasekharan, V. V. (Retd.)
Chartered Engineer & Management Consultant

" I read Professor Kiran's book with interest. It provides rich practical knowledge and insights. I recommend it to anyone preparing to operate or work in a manufacturing plant."

Dr. Sanjay Emani Sharma,
Vice President for Open Learning
Massachusetts Institute of Technology, Boston. M. A.

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Maintenance Engineering and Management

Precepts and Practices

Second Edition

This Book is Dedicated to

All the persons who were associated with me during my 45 years long industrial and academic career and who helped me in bringing this book to this shape.

Preface to Second Edition

At the outset the author wishes to thank the publishers and the readers for necessitating the release of a second edition of this book in conformance to the syllabi from around 20 Universities and Institutions of India as well as those of Boston University and University of Dar Es salaam. Several eminent academicians and industry leaders have given positive review about this book, and the author wishes to adapt the suggestions made by some of them. Topics like wear debris analysis, non-destructive testing, environmental impact, instruments for condition monitoring, logical fault location, tramp oils etc. which are specified by Universities but hardly covered in many other maintenance books, found special appreciation from the reviewers.

In view of the technical advancement in the recent times, the maintenance practices have widened their tentacles into the computerized systems, mobile applications and web-based applications needing specific mention. This books provides the preliminary understanding of this aspect.

While the basic text and treatment of the theme is maintained as in the first edition, some suggestions from the reviewers have been adapted and incorporated in the new edition. New and improved figures and diagrams together with case studies have been added. The chapter on Scientific Inventory Control has preceded that on the Spare Part Inventory Control to conform to the logical precepts of the inventory principles.

Consequently this book continues to be of immensive help to the busy maintenance engineer who needs instant answers to a wide variety of on-the-job problems at the same time providing a comprehensive knowledge to the engineering/management student who wants to build up a career in industry.

Several case studies are given from the practical experience of the author, both in India and abroad, presenting an authoritative treatment of maintenance engineering and management that can be found only in international reference books.

As stated in the first edition preface, though a separate book on Industrial Safety by this author is expected to follow soon, in deference to syllabi of some universities that specify basics of industrial safety in the maintenance management syllabus, two chapters on industrial safety that illustrate the basic principles are included.

D. R. Kiran

Preface to First Edition

The economic liberalization of late twentieth century saw enormous industrial growth in India. As a result today's maintenance engineer faces new challenges in minimizing downtime for trouble free operation of the machinery and other equipment that are under his charge. He finds that he has to manage more than he can engineer the maintenance function. In other word she is as much responsible for efficiently managing his day-to-day performance of his functions, as for the sound physical knowledge and skill in maintenance of the production facilities including the expanding scope of modern maintenance that includes dimensions beyond the factory walls. As the modern management techniques change, the maintenance management techniques too change, and needless to say that for the best possible functioning, the maintenance engineer must be up-to-date in the latest management precepts and practices.

Under this background this book deals with the management principles and practices that govern the maintenance function apart from the engineering techniques for the effective and optimal systems for the maintenance of equipment. It gives the maintenance engineer, the latest developments in maintenance engineering techniques like wear debris analysis, preventive maintenance and condition monitoring as well as management concepts like reliability based maintenance, logical fault location and lean maintenance. Consequently this book is expected to be of immensive help to the busy maintenance engineer who needs instant answers to a wide variety of on-the-job problems at the same time providing a comprehensive knowledge to the engineering/management student who wants to build up a career in industry.

Syllabi from around 20 Universities and Institutions of India as well as those of Boston University and University of Dar Es salaam are collected to draw the outline for this book. Topics like wear debris analysis, non-destructive testing, environmental impact, instruments for condition monitoring, logical fault location, tramp oils etc. which are specified by these Universities but hardly covered in any other Indian book, are covered in detail in this book. Several case studies are given from the practical experience of the author, both in India and abroad, presenting an authoritative treatment of maintenance engineering and management that can be found only in international reference books.

The title of the book is hence aptly chosen as *Maintenance Engineering and Management - Precepts and Practices.*

Though a separate book on Industrial Safety by this author is expected to follow soon, in deference to syllabi of some universities that specify basics of industrial safety in the maintenance management syllabus, two chapters on industrial safety that illustrate the basic principles are added.

D. R. Kiran

About the Author

Prof. D. R. Kiran, B.Sc., B.E., M.Sc. (Eng.), (Ph.D.), FIE(I), FIIIE, FIIProdE, FIIPlantE, FITTE, FISNT, has a rich practical experience of forty years both in industry and academy. Starting his career in 1968 with Larsen & Toubro, he held top positions like Planning Manager of Rallifan (CF division), World Bank Adviser/Instructor for Transport Managers in Tanzania and the Principal of PMR Institute of Technology, Chennai.

At industries in India and abroad, he did projects at L&T, National Bicycle Company etc., besides several Tanzanian industries, both as an internal and external consultant that included logical fault location, condition monitoring systems, WDA etc., besides ABC analysis, codification and other industrial engineering applications. He started his academic career in 1979, teaching Maintenance Engineering at B.E. level at the University of Dar Es Salaam. This rich experience in maintenance and planning helped him in introducing topics of special interest and specific use to the maintenance engineer.

In recognition of his services in the field of engineering education, he was presented with the coveted Bharat Excellence Award and Gold Medal for Excellence in Education in New Delhi in 2006. He is listed as an International Expert in Industrial Engineering and Management in the International Directory of Experts and Expertise. He is nominated for the post of Honorary Deputy Director General in India for International Biographical Center.

Earlier during the eighties, he was introduced to Dr. Julius Nyerere, the then President of Tanzania as a Pioneer of Work Study in that country. He was one among few non-political foreigners to be interviewed by the government newspaper of Tanzania.

He has authored three text books on Professional Ethics and Human Values (2nd edition), Maintenance Engineering and Management (2nd Edition) and Total Quality Management. He also published 23 papers in professional journals and seminar proceedings and was the Chief Guest in several Technical Meets. He is the Vice Chairman of Indian Institute of Plant Engineers, Tamilnadu Chapter.

He is widely travelled having visited over 30 countries and is a philanthropist.

Abbreviations

ABC control	A, B and C category control
ABCD PEN F2 PVC LOSS	Acronym for the 16 characteristics of lubricants
ADP	Automated Data Processing
AIIE	American Institute of Industrial Engineers
AKS	Asset Knowledge Science
ALARP	As Low as Reasonably Practicable
AMMS	Asset Maintenance Management System
AN	Alkylated naphthalene
ARR	Average Rate of Returns
ASTM	American Society of Tool and Manufacturing Engineers, now called Society of Manufacturing Engineers
BLS	Bureau of Labor Statistics
BSI	British Standards Institute's
BIS	Bureau of Indian Standards
CAM	Challenger's Adverse minimum
CASPA	Computer Aided systematic Particle Analysis
CAVE	Computer Aided Visual Engineering
CBM	Condition based maintenance
CCI	Construction Cost Index
CFC	Chlorofluorocarbon
CFMEA	Concept FMEA
CMMS	Computerized Maintenance Management System
CPFR	Collaborative Planning, Forecasting and Replenishment
CT	Computer Tomography
CVTWDA	Computer vision techniques for wear debris analysis
DAM	Defender's Adverse minimum,
DERA	Defense Evaluation and Research Agency
DFMEA	Design FMEA
DOD/UAL	US Department of Defense and United Airlines
DOE	Design for Environment
DOM	Design out maintenance

DRBFM	Design Review Based on Failure Mode
EAM	Enterprise asset management
EAMS	Enterprise Asset Management Systems
EBME	Electro Biomechanical Engineering
ECM	Environmentally conscious manufacture
EDM'	Electric discharge machine
EFDC	Early Fatigue Detection Centre
EIA	Environment Impact Assessment
EMS	Environmental Management Systems
EOQ	Economic order quantity
EOT Cranes	Electric Overhead Traveling Cranes
ERP	Enterprise resource planning
ERR	Economic rate of return
ERV	Estimated Replacement Value
ET	Eddy current test
FAR	Fixed Asset Register
FMEA	Failure mode and effects analysis
FMECA	Failure mode, effects and criticality analysis
FSN	Fast moving, Slow moving or Non-moving
FTI	Fixed time inspection
FTM	Fixed time maintenance
GDP	Gross Domestice Produce
GHGs	Green house gases
GOK	God only knows
GOLF	Government, Local or Foreign
HML	Hyundai Motors Limited
HML	High cost, medium cost and low cost
HPS	High Pressure stabilizers
HRMS	Human resource management systems
HVAC	Heating, Ventilation and Air Conditioning
ILO	International Labor Organization
Imax system	Fixed Maximum Stock Ordering system
Imin system	Fixed Safety Stock Ordering system
IMMS	Integrated Maintenance Management System
IRR	Internal Rate of Returns