

# Chapter 6 Predictive Maintenance Technologies

## 6.1 Introduction

Predictive maintenance attempts to detect the onset of a degradation mechanism with the goal of correcting that degradation prior to significant deterioration in the component or equipment. The diagnostic capabilities of predictive maintenance technologies have increased in recent years with advances made in sensor technologies. These advances, breakthroughs in component sensitivities, size reductions, and most importantly, cost, have opened up an entirely new area of diagnostics to the O&M practitioner.

As with the introduction of any new technology, proper application and **TRAINING** is of critical importance. This need is particularly true in the field of predictive maintenance technology that has become increasingly sophisticated and technology-driven. Most industry experts would agree (as well as most reputable equipment vendors) that this equipment should not be purchased for in-house use if there is not a serious commitment to proper implementation, operator training, and equipment monitoring and repair. If such a commitment cannot be made, a site is well advised to seek other methods of program implementation—a preferable option may be to contract for these services with an outside vendor and rely on their equipment and expertise.

Table 6.1.1 below highlights typical applications for some of the more common predictive maintenance technologies. Of course, proper application begins with system knowledge and predictive technology capability – before any of these technologies are applied to live systems.

**Table 6.1.1. Common predictive technology applications (NASA 2000)**

Technologies	Application	Pumps	Electric Motors	Boiler Generation	Condensers	Heavy Equipment/Cranes	Circuit Breakers	Valves	Heat Exchangers	Electrical Systems	Transformers	Tanks, Piping
Vibration Monitoring/Analysis		X	X	X		X						
Lubricant, Fuel Analysis		X	X	X		X					X	
Wear Particle Analysis		X	X	X		X						
Bearing, Temperature/Analysis		X	X	X		X						
Performance Monitoring		X	X	X	X				X		X	
Ultrasonic Noise Detection		X	X	X	X			X	X		X	
Ultrasonic Flow		X			X			X	X			
Infrared Thermography		X	X	X	X	X	X	X	X	X	X	
Non-destructive Testing (Thickness)					X				X			X
Visual Inspection		X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance			X	X			X			X	X	
Motor Current Signature Analysis			X									
Motor Circuit Analysis			X				X			X		
Polarization Index			X	X						X		
Electrical Monitoring										X	X	

# Chapter 6 Predictive Maintenance Technologies

**Marcel A. Müller**



## **Chapter 6 Predictive Maintenance Technologies:**

Emerging Technologies in Digital Manufacturing and Smart Factories Hassan, Ahdi, Dutta, Pushan Kumar, Gupta, Subir, Mattar, Ebrahim, Singh, Satya, 2023-12-29 Rapid digital transformation is forcing the manufacturing industry to drastically alter its current trajectory for future success. The remarkable convergence of digitalization and manufacturing is reshaping industries ushering in an era known as Industry 5.0. This revolutionary transition has given birth to digital manufacturing and smart factories heralding a new dawn in the way we produce goods. The amalgamation of artificial intelligence, AI, robotics, the internet of things, IoT, augmented reality, AR, virtual reality, VR, big data analytics, cloud computing, and additive manufacturing stands poised to unlock unprecedented avenues in the realm of production. Practitioners, researchers, dreamers, and pioneers all are beckoned to explore the uncharted territories of digital innovation in manufacturing. Emerging Technologies in Digital Manufacturing and Smart Factories spans domains from mechanical and electrical engineering to computer science from industrial economics to business strategy and this book addresses this diverse audience. The book embarks on a comprehensive voyage unveiling the latest evolutions and nascent trends within digital manufacturing and smart factories. From inception to execution from design optimization to predictive maintenance every phase of the manufacturing lifecycle is scrutinized through the lens of cutting edge technologies. Rather than relying exclusively on the theoretical realm this book also ventures into the crucible of real world application offering practical insights drawn from varied industries including automotive, aerospace, and pharmaceuticals.

Leased Thrust: The Subscription Economics of Commercial Jet Engines Larry Jennings, When you board a massive commercial airliner it is highly likely that the airline does not actually own the engines bolted to the wings. Over the last few decades manufacturing giants like Rolls Royce and GE quietly stopped selling their multi million dollar turbines outright pivoting to a radical highly lucrative subscription model known as Power by the Hour. In this B2B arrangement airlines lease the engines and pay a flat fee solely for the hours the turbines are physically generating thrust in the air. This book dissects the staggering financial engineering behind modern aviation leasing. We explore how this model forces manufacturers to obsessively monitor their engines via live telemetry turning them from simple hardware companies into proactive data driven maintenance monopolies. The narrative exposes the hidden cash flows of international aviation demonstrating how standardizing maintenance completely eradicated the aftermarket parts industry and locked airlines into unbreakable lifelong corporate contracts. Look beneath the wings of global travel. Understand the brilliant recurring revenue subscription model that completely dominates the modern aerospace economy. Business Economics Industries Transportation Business Economics Corporate Finance General amazon keywords power by the hour aviation jet engine leasing economics b2b subscription business models short excerpt Airlines do not buy engines anymore. They simply rent the thrust locking themselves into a multi billion dollar subscription model that quietly controls the skies. Larry Jennings Leased Thrust: The Subscription

Economics of Commercial Jet Engines Telemetry Maintenance and the Power by the Hour Monopoly in Modern Global Aviation Logistics **Transforming the Service Sector With New Technology** Rana, Varinder Singh, Bathla, Gaurav, Raina, Ashish, Chhabra, Divoy, 2025-05-07 Technology can impact the service sector in a variety of ways It can be used to transform a number of service related businesses including hospitality tourism banking healthcare and others Businesses navigating the rapidly changing landscape of services and technology can benefit from it by using emerging technology to create new services or improve existing ones With the rapid rise in technology the regulatory landscape is changing requiring additional changes to ensure responsible innovation and protect consumers interests Transforming the Service Sector with New Technology strives to stimulate innovation aid in strategic decision making and benefit service industries as a whole It provides valuable information about how technology is impacting and transforming the services sector and insights in responsibly regulating it Covering topics such as customer engagement recovery strategies and technology driven product placement this book is an excellent resource for industry decision makers Industrialists hospitality professionals entrepreneurs policymakers scholars academicians professionals and more *Real-World Applications and Implementations of IoT* Aritra Acharyya, Prasenjit Dey, Sujit Biswas, 2025-02-11 This book explores state of the art internet of things IoT solutions for energy conservation security agricultural advancements mining security healthcare and environmental protection This book delves deep into the technology offering a comprehensive analysis detailed descriptions and in depth discussions of recently developed IoT applications With a strong focus on the cutting edge research at a global scale the book combines IoT with artificial intelligence AI shedding light on emerging possibilities and advancements Designed to cater to a broad audience from those with a foundational understanding of science to seasoned engineering and technology experts this book can serve as an essential resource for engineering students and science master s programs Researchers seeking to stay at the forefront of IoT and AI will also find it invaluable Facility Manager's Maintenance Handbook 2E (PB) Bernard T. Lewis, Richard Payant, 2007-06-01 An Updated Guide to Establishing Cutting Edge Operations and Maintenance Procedures for Today s Complex Facilities An essential on the job resource Facility Manager s Maintenance Handbook presents step by step coverage of the planning design and execution of operations and maintenance procedures for structures equipment and systems in any type of facility This career building reference provides the tools needed to streamline facility management processes reduce operational costs and ensure the effective utilization maintenance repair and renovation of existing physical assets Now with 40% new information this Second Edition includes brand new chapters on emergency response procedures maintenance operations benchmarking capital and operational budgets management boiler and steam plant operations and other vital topics The only book of its kind to cover both operations and maintenance the updated Facility Manager s Maintenance Handbook features Updated information on mechanical equipment and systems maintenance The latest fire protection procedures A comprehensive account of building codes Guidance on hazardous

materials handling Excellent preparation for the IFMA Certified Facility Manager CFM qualification Inside This State of the Art Facility Management Resource Part 1 Organizing for Maintenance Operations Part 2 Facility Operations and Maintenance Operations Plans Maintenance Plans Part 3 Equipment and Systems Operations Maintenance o Part 4 Facilities Emergency Preparedness o Part 5 Capital Investment **Technology and Safety of Marine Systems** J. Wang,2003-07-22 Traditionally society has regulated hazardous industries by detailed references to engineering codes standards and hardware requirements These days a risk based approach is adopted Risk analysis involves identifying hazards categorizing the risks and providing the necessary decision support to determine the necessary arrangements and measures to reach a safe yet economical operating level When adopting such an approach the abundance of techniques available to express risk levels can often prove confusing and inadequate This highly practical guide to safety and risk analysis in Marine Systems not only adds to the current techniques available but more importantly identifies instances where traditional techniques fall short Uncertainties that manifest within risk analysis are highlighted and alternative solutions presented In addition to risk analysis techniques this book addresses influencing elements including reliability Maintenance Decision making and Human error The highly practical approach of this title ensures it is accessible to the widest possible audience Maintenance, Replacement, and Reliability Andrew K. S. Jardine,Albert H. C. Tsang,2021-09-15 Since the publication of the second edition in 2013 there has been an increasing interest in asset management globally as evidenced by a series of international standards on asset management systems to achieve excellence in asset management This cannot be achieved without high quality data and the tools for data interpretation The importance of such requirements is widely recognized by industry The third edition of this textbook focuses on tools for physical asset management decisions that are data driven It also uses a theoretical foundation to the tools mathematical models that can be used to optimize a variety of key maintenance replacement reliability decisions Problem sets with answers are provided at the end of each chapter Also available is an extensive set of PowerPoint slides and a solutions manual upon request with qualified textbook adoptions This new edition can be used in undergraduate or post graduate courses on physical asset management **Beyond the Hype: Realizing the True Potential of AI** Anup Bolshetty,2023-04-19 Discover the true potential of AI beyond the hype with this insightful and thought provoking book From healthcare to finance transportation to manufacturing explore the many ways in which AI is transforming industries and society as well as the ethical challenges that must be addressed Written in an accessible and engaging style this book is essential reading for anyone interested in the future of technology and its impact on our world *Engineering Innovation: How Technology Is Transforming Traditional Design* Charles Nehme,2025-11-06 The world of engineering is at a critical inflection point For decades our foundational principles from mechanics and thermodynamics to material science have remained constant but the tools we use to apply them are undergoing a dramatic and accelerating transformation We are moving beyond simple Computer Aided Design CAD into an era defined by intelligent data driven

systems This book Engineering Innovation How Technology Is Transforming Traditional Design is your essential guide to navigating this new landscape It is born from the conviction that innovation is not an optional add on but a core competency for the modern professional We explore how emerging technologies like the Internet of Things IoT drone based reality capture Artificial Intelligence AI and additive manufacturing 3D printing are not just enhancing workflows but fundamentally redefining what is possible in design construction and asset management From mastering the digital twin to implementing generative design this text provides a practical roadmap for integrating cutting edge technology into traditional engineering disciplines Our focus is on the digital transformation of engineering workflows a necessary shift that promises greater efficiency enhanced sustainability and safer higher performing built environments The future is being engineered now and this book ensures you are leading the way

Tool and Manufacturing Engineers Handbook: Material and Part Handling in Manufacturing Philip Mitchel,1983 Get the expert advise you need to shrink handling costs reduce downtime and improve efficiency in plant operations You ll use this comprehensive handbook during post design process selection and planning for establishing quality controls tests and measurements to streamline production and for managerial decision making on capital investments and new automated systems

**Handbook of Research on Digital Transformation, Industry Use Cases, and the Impact of Disruptive Technologies** Wynn, Martin George,2021-10-15 Companies from various sectors of the economy are confronted with the new phenomenon of digital transformation and are faced with the challenge of formulating and implementing a company wide strategy to incorporate what are often viewed as disruptive technologies These technologies are sometimes associated with significant and extremely rapid change in some cases with even the replacement of established business models Many of these technologies have been deployed in unison by leading edge companies acting as the catalyst for significant process change and people skills enhancement The Handbook of Research on Digital Transformation Industry Use Cases and the Impact of Disruptive Technologies examines the phenomenon of digital transformation and the impact of disruptive technologies through the lens of industry case studies where different combinations of these new technologies have been deployed and incorporated into enterprise IT and business strategies Covering topics including chatbot implementation multinational companies cloud computing internet of things artificial intelligence big data and analytics immersive technologies and social media this book is essential for senior management IT managers technologists computer scientists cybersecurity analysts academicians researchers IT consultancies professors and students

Crist Power Plant Case Study Chetan S. Sankar,P. K. Raju,2000 Reliability Centered Maintenance (RCM) Neil B. Bloom,2005-12-22 A properly implemented and managed RCM program can save millions in unscheduled maintenance and breakdowns However many have found the process daunting Written by an expert with over 30 years of experience this book introduces innovative approaches to simplify the RCM process such as single vs multiple failure analysis hidden failures analysis potentially critical components analysis run to failure and the difference between redundant standby

and backup functions Included are real life examples of flawed preventive maintenance programs and how they led to disasters that could have easily been avoided Also illustrated in detail with real life examples is the step by step process for developing implementing and maintaining a premier classical RCM program Senior management middle management supervisors and craftsmen technicians responsible for plant safety and reliability will find this book to be invaluable as a means for establishing a first class preventive maintenance program Della Steam Plant Case Study P. K. Raju, Chetan S. Sankar, 2000 **Technology for the '90s** M. K. Au-Yang, 1993 *E Source Technology Atlas Series: Drivpower*, 1996

*Maintenance Planning and Scheduling Handbook, 4th Edition* (Doc) D. D. D. Palmer, 2019-09-13 The industry standard resource for maintenance planning and scheduling thoroughly revised for the latest advances Written by a Certified Maintenance and Reliability Professional CMRP with more than three decades of experience this resource provides proven planning and scheduling strategies that will take any maintenance organization to the next level of performance The book resolves common industry frustration with planning and reduces the complexity of scheduling in addition to dealing with reactive maintenance You will find coverage of estimating labor hours setting the level of plan detail creating practical weekly and daily schedules kitting parts and more all designed to increase your workforce without hiring Much of the text applies the timeless management principles of Dr W Edwards Deming and Dr Peter F Drucker You will learn how you can do more proactive work when your hands are full of reactive work Maintenance Planning and Scheduling Handbook Fourth Edition features more new case studies showing real world successes a new chapter on getting better storeroom support major revisions that describe the best KPIs for planning major additions to the issue of selling planning to gain support revisions to make work order codes more useful a new appendix on numerically auditing planning success and a new appendix devoted entirely to selecting a great maintenance planner Maintenance Planning and Scheduling Handbook Fourth Edition covers The business case for the benefit of planning Planning principles Scheduling principles Handling reactive maintenance Planning a work order Creating a weekly schedule Daily scheduling and supervision Parts and planners The computer CMMS in maintenance How planning works with PM PdM and projects Controlling planning the best KPIs KPIs for planning and overall maintenance Shutdown turnaround overhaul and outage management Selling organizing analyzing and auditing planning **Bottom-line Automation** Peter Martin, 2006 This newly revised edition helps today's manufacturing companies face the challenges of a global marketplace where every part of the operation must become more efficient to enhance the bottom line Based on the results and conclusions of an applied research project of process manufacturing operations directed by the author Bottom Line Automation presents an overview of more than 30 years of industry trends pointing out the strengths and pitfalls of each The book also explains how manufacturers selected automation technology suppliers for state of the art technological features in their systems rather than for the improvements the technology could offer the manufacturing operation New topics in the book discuss the economic optimization of industrial assets Key findings

include the fact that returns on automation investments were rarely if ever calculated In fact accounting systems were not even capable of measuring the performance offered by process automation systems The author explains a strategy for measuring and improving automation system performance for the ultimate goal the bottom line and provides case studies of how such a strategy was implemented in three process manufacturing organizations The author brings more than 30 years of industry experience education and research together in this unprecedented work **Maintenance Engineering**

**Handbook, Eighth Edition** Keith Mobley,2014-01-03 Updated modernized digitized and streamlined edition of this classic handbook which has been educating plant and facility professionals in every aspect of maintenance engineering for more than half a century **Maintenance Engineering Handbook** Lindley R. Higgins,R. Keith Mobley,Ricky Smith,2002

MAINTENANCE ENGINEERING HANDBOOK Sixth Edition The latest science technology and management solutions for facility maintenance issues The one reference you can bank on for current answers to virtually any maintenance question Lindley R Higgins and R Keith Mobley s Maintenance Engineering Handbook provides the best of today s strategies and technologies from the world s leading experts One stop source of answers on all maintenance engineering functions from managing planning and budgeting to solving environmental problems New coverage of the latest computer applications maintenance technologies and tools Strategies equipment techniques and tips for facilities from industrial plants to residential complexes institutions schools hospitals and office buildings NEW IN THIS EDITION Technology updates Improvements in prevention and prediction Equipment testing and monitoring tools The latest computer programs Advances in maintenance economics Guidance on insurance administration New maintenance techniques for centrifugal air compressors centrifugal pumps and other equipment Maintenance Engineering s Most Current Comprehensive and Complete Reference A McGraw Hill Classic 55 SPECIALISTS Buildings and grounds Computer applications Corrosion and cleaning Costs and controls Electrical equipment Estimates and budgets Instrumentation and monitoring tools Inventory Lubrication Measuring servicing testing Mechanical equipment Organization and management Parts and components Personnel and policies Practices and prevention Sanitation and housekeeping Specialized equipment Welding

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