

Preface

Manufacturers of complex engineering systems are increasingly offering through-life engineering services (TES) in addition to their product provision. The industrial trend toward servitization has encouraged new research in novel and applied technologies and engineering solutions to support TES. This book provides a foundation on different aspects of TES. It illustrates example case studies to aid understanding of the challenges in implementing TES solutions. There are 25 chapters in the book that are categorized into seven parts. The chapters also demonstrate the latest thinking in the area of TES. The task of editing this book was considered as a part of the EPSRC Centre in Through-life Engineering Services activities in order to support the academic and industrial community. The book structure is grounded by the views from practitioners and researchers in TES from a think tank meeting. The authors are from different countries around the world and also represent multiple manufacturing sectors: aerospace, railway, and automotive. The TES Book is the first book in this area. The book also helps in defining a boundary for the TES.

TES involves the application of “service knowledge” across the life cycle of a product in order to mitigate degradation and reduce maintenance through design and manufacturing. The services are necessary to support recently developed “performance-based contracts”. The initial taxonomy for TES has highlighted the key technical applications involved. The definition and the taxonomy are the bases to scope the TES activities against the traditional maintenance initiatives. TES provides a technology-enabled service delivery system. The NedTrain example presented in the book outlines major challenges in implementing TES across a large enterprise and has highlighted the need to better understand the technical states of all relevant systems in real-time to improve the maintenance planning and execution. The emphasis on data, diagnostics, and prognostics is continued in the next part of the book with technical and people issues discussed relative to dealing with no-fault found faults and the monitoring of mechanical and control systems. The study of component and system degradation in use and over time is a major theme for TES. The book presents an overview of non-destructive testing techniques application to assess the degradation and automate the process. The latest developments in

maintenance-repair-overhaul (MRO) are presented with emphasis on cleaning technologies, repair and overhaul approaches and planning, and digital assistance. The impact of these technologies on sustainable enterprises is outlined. These parts of the book also present how the degradation information could be used for maintenance planning and scheduling. Changing design of legacy systems based on service feedback is not trivial; the book proposes a “use of functional blueprints” to manage the design change. Providing TES over the entire operational life of a product involves significant additional uncertainty and risks. One such risk is in the area of obsolescence management and in our ability to design for obsolescence. The book highlights several types of risks across the supply chain, these uncertainties and associated risks also have major impact on the whole life cost of the product. New and effective standards to support the obsolescence management are essential to reduce the cost. Autonomous maintenance is setting the agenda for future developments in TES. Two main directions are highlighted, one to develop self-healing technologies to reduce the maintenance activities and therefore reduce the cost and the other to apply robots for maintenance to bring automation and thus reduce human effort in maintenance. The book concludes with a discussion relative to the future challenges and opportunities in TES. The research and business trends are determined through a number of structured interactions with industry and academic studies. Although the interactions are not comprehensive in terms of the industry sectors included, the conclusions provide direction for researchers and practitioners alike. This book will help to support the TES community with better views on the foundation and technology trends with real-life examples.

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Through-life Engineering Services

Motivation, Theory, and Practice

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2015, XVI, 457 p. 162 illus., Hardcover

ISBN: 978-3-319-12110-9