Preface

Billions of dollars are currently spent producing high-technology products and services in a variety of production systems operating in different manufacturing and service sectors (e. g., aviation, automotive industry, software development, banks and financial companies, health care). Most of these products are very complex and sophisticated owing to the number of functions and components. As a result, the production process that realizes these products can be very complicated.

A significant example is the largest passenger airliner in the world, the Airbus A380, also known as the "Superjumbo," with an operating range of approximately 15,200 km, sufficient to fly directly from New York City to Hong Kong. The failure and repair behaviors of the generic part of this system can be directly or indirectly associated with thousands of different safety implications and/or quality expectations and performance measurements, which simultaneously deal with passengers, buildings, the environment, safety, and communities of people.

What is the role of maintenance in the design and management of such a product, process, or system? Proper maintenance definitely helps to minimize problems, reduce risk, increase productivity, improve quality, and minimize production costs. This is true both for industrial and for infrastructure assets, from private to government industries producing and supplying products as well as services.

We do not need to think about complex production systems, e. g., nuclear power plants, aerospace applications, aircraft, and hospital monitoring control systems, to understand the strategic role of maintenance for the continuous functioning of production systems and equipment.

Concepts such as safety, risk, and reliability are universally widespread and maybe abused, because daily we make our choices on the basis of them, willingly or not. That is why we prefer a safer or a more reliable car, or why we travel with a safer airline instead of saving money with an ill-famed company. The acquisition of a safer, or high-quality, article is a great comfort to us even if we pay more.

The strategic role of maintenance grows in importance as society grows in complexity, global competition increases, and technological research finds new applications. Consequently the necessity for maintenance actions will continue to increase in the future as will the necessity to further reduce production costs, i. e., increase efficiency, and improve the safety and quality of products and processes. In particular, during the last few decades the so-called reliability and maintenance engineering

discipline has grown considerably in both universities and industry as well as in government.

The activities of planning, design, management, control, and optimization of maintenance issues are very critical topics of reliability and maintenance engineering. These are the focus of this book, whose aim is to introduce practitioners and researchers to the main problems and issues in reliability engineering and maintenance planning and optimization.

Several supporting decision models and methods are introduced and applied: the book is full of numerical examples, case studies, figures, and tables in order to quickly introduce the reader to very complicated engineering problems. Basic theory and fundamentals are continuously combined with practical experience and exercises useful to practitioners but also to students of undergraduate and graduate schools of engineering, science, and management.

The most important keywords used in this book are as follows: product, process, production system, productivity, reliability, availability, maintainability, risk, safety, failure modes and criticality analyses (failure modes and effects analysis and failure mode, effects, and criticality analysis), prediction and evaluation, assessment, preventive maintenance, inspection maintenance, optimization, cost minimization, spare parts fulfillment and management, computerized maintenance management system, total productive maintenance, overall equipment effectiveness, fault tree analysis, Markov chains, Monte Carlo simulation, numerical example, and case study.

The book consists of 12 chapters organized as introduced briefly below.

Chapter 1 identifies and illustrates the most critical issues concerning the planning activity, the design, the management, and the control of modern production systems, both producing goods (manufacturing systems in industrial sectors) and/or supplying services (e. g., hospital, university, bank). This chapter identifies the role of maintenance in a production system and the capability of guaranteeing a high level of safety, quality, and productivity in a proper way.

Chapter 2 introduces quality assessment, presents statistical quality control models and methods, and finally Six Sigma theory and applications. A brief illustration and discussion of European standards and specifications for quality assessment is also presented.

Chapter 3 introduces the reader to the actual methodology for the implementation of a risk evaluation capable of reducing risk exposure and guaranteeing the desired level of safety.

Chapter 4 examines the fundamental definitions concerning maintenance, and discusses the maintenance question in product manufacturing companies and service suppliers. The most important maintenance engineering frameworks, e. g., reliability-centered maintenance and total productive maintenance, are presented.

Chapter 5 introduces the reader to the definition, measurement, management, and control of the main reliability parameters that form the basis for modeling and evaluating activities in complex production systems. In particular, the basic maintenance terminology and nomenclature related to a generic item as a part, component, device, subsystem, functional unit, piece of equipment, or system that can be considered individually are introduced.

Chapter 6 deals with reliability evaluation and prediction. It also discusses the elementary reliability configurations of a system in order to introduce the reader to the basic tools used to evaluate complex production systems.

Chapter 7 discusses about the strategic role of the maintenance information system and computerized maintenance management systems in reliability engineering. Failure rate prediction models are also illustrated and applied.

Chapter 8 introduces models and methods supporting the production system designer and the safety and/or maintenance manager to identify how subsystems and components could fail and what the corresponding effects on the whole system are, and to quantify the reliability parameters for complex systems. In particular models, methods, and tools (failure modes and effects analysis and failure mode, effects, and criticality analysis, fault tree analysis, Markov chains, Monte Carlo dynamic simulation) for the evaluation of reliability in complex production systems are illustrated and applied to numerical examples and case studies.

Chapter 9 presents basic and effective models and methods to plan and conduct maintenance actions in accordance with corrective, preventive, and inspection strategies and rules. Several numerical examples and applications are illustrated.

Chapter 10 discusses advanced models and methods, including the block replacements, age replacements, and inspection policies for maintenance management.

Chapter 11 presents and applies models and tools for supporting the activities of fulfillment and management of spare parts.

Chapter 12 presents two significant case studies on reliability and maintenance engineering. In particular, several models and methods introduced and exemplified in previous chapters are applied and compared.

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