Preface

This handbook is unique in many respects. First of all, the title and the scope of subject matter is unique and is not to be found in a single volume in the existing literature. It is about a subject that is becoming very relevant and important in the 21st century. Secondly, the theme is unique and comprises a well-knitted theme of diverse yet related areas like quality, reliability, maintainability, safety, risk, environmental impacts, and sustainability. Thirdly, this handbook is about bringing together contributors of very diverse expertise, interests, and hail from different parts of the world to a common platform in executing a unifying and meaningful project. This initiative is expected to facilitate intense interaction between the experts from the diverse areas of performability engineering and break open the watertight compartments that exist today in an effort to present a holistic approach to performace assessment and design. It is also heartening to see that some of the contributors are founders of the areas that they represent. Therefore, the editor considers it a rewarding experience and a very encouraging step towards the realization of the objective for which this handbook is intended.

There are hundreds of books available on the subject of dependability and constituent areas such as quality, reliability, maintainability, safety, *etc.,* related to the performance of a product, system or a service. Dependability is primarily considered an aggregate of one or more of the attributes of survivability, like quality, reliability, maintainability, *etc*., and safety. However, these attributes are interrelated and reflect the level or grade of the product so designed and utilized, which is expressed through dependability. Nevertheless these attributes are very much influenced by the raw material, fabrication, technology, techniques, and manufacturing processes and their control, and also by the nature and the manner of usage. Currently, dependability and cost effectiveness are primarily seen as instruments for conducting international trade in the free market regime, thereby deciding the economic prosperity of a nation. This makes one realize that optimal design of a product, system, or service is one where one optimizes dependability with respect to costs incurred and sometimes with respect to other techno-economic constraints. This can at best be called partial optimization of the design of a product, system, or service. The material and energy requirements, waste generated, processes employed, and disposability are rarely considered for arriving at an optimal design or configuration of a product or a system.

With world resources declining, the cost of raw materials is likely to escalate spirally in the near future as mining becomes more and more costly and energy intensive due to grades of ore becoming poorer than before. To keep pace with the rising population, the increased volume of production is bound to affect the world environmental health further unless pollution prevention measures are vigorously pursued. At every stage of the life-cycle of a product, be it extraction of material, manufacturing, use, or disposal, energy and materials are required as inputs, and emissions (gaseous, solid effluents, or residues) are always associated with this, which influences the environmental health of our habitat. Therefore, the importance

of minimization of material and energy requirements along with the importance of control of effluents and waste management can hardly be emphasized enough while designing products and systems with acceptable levels of performance. Unless we consider all these factors together, we cannot call the design of products, systems, and services truly optimal from the engineering point of view.

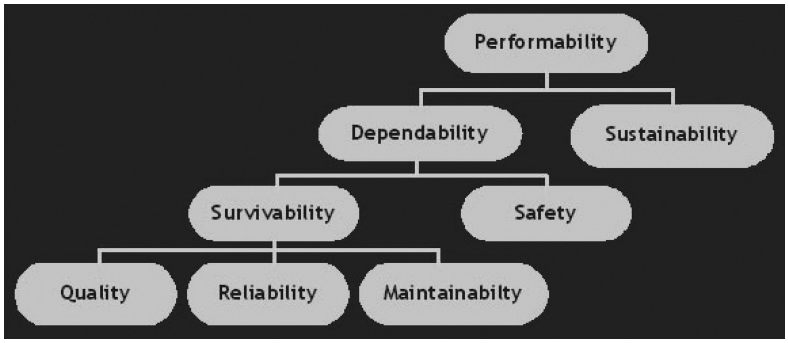
Certainly, these factors cannot be considered in isolation of each other. Therefore, emphasis has to be placed on a holistic view of the entire life cycle of activities of a product or system along with the associated cost of environmental preservation at each stage while maximizing the product performance. It must be emphasized here that to preserve our environment for our future generations, the internalization of the hidden costs of environment preservation will have to be accounted for, sooner or later, in order to be able to produce sustainable products in the long run. Open access resources can no longer be treated as freely available, unless we account for their restoration costs as well. In short, we can no longer rely solely on the criteria of dependability for optimizing the performance of a product, system, or service. We need to introduce and define a new performance criterion that will take a holistic view of the performance enhancement along with the associated environmental aspects.

Fortunately, we have the concept of sustainability that provides us with the framework to consider subjects like dematerialization, energy auditing, waste minimization, reuse and recycling, and other environmental considerations that can be of immense use in exploring means of clean production. The concepts of industrial ecology can be of great help in reducing the overall impact on the environment and to sustain development. Therefore, we have to explore ways of including dependability and sustainability in our criteria for the design of all future products, systems, and services, and to start with we need a term to represent all these activities.

In 1980, John Meyer introduced the term *performability* in the context of the performance evaluation of aircraft control computers for use by NASA. At the time this term was mainly used to reflect a composite attribute implying reliability and other associated attributes like availability, maintainability, *etc*., although dependability had been used at times to include a greater number of the attributes related to performance. Therefore, it was considered appropriate and logical to extend the meaning of this term to include attributes such as dependability and sustainability, rather than inventing a new term. Performability now would not only mean to include reliability, maintainability, or availability as was originally proposed, but also to include the whole gamut of attributes, like quality, reliability, maintainability, safety, and sustainability.

This handbook has been conceived to stimulate further thinking in this direction and to spur research and developmental effort in making sustainable products, systems, and services, which is the foremost need of the 21st century if humans are to survive and future generations are to have the same or better quality of life to prosper on this planet. The objective of this handbook is to introduce engineers, designers, producers, users, and researchers to visualize the interrelationships of all the performance attributes, to bring a synergetic interaction between various players of constituent areas of performability, and to exhort them to launch their activities in the direction of furthering performability engineering.

Today, there is hardly any book available on the market that deals with this subject in its entirety and provides a holistic perspective of the problem. Neither do the existing books on the subject of survivability and safety or dependability ever deliberate the issues related to sustainability. Nor do the books on the subject of sustainability and related areas touch upon problems of survivability and safety or dependability. For instance, while designing for survivability or dependability, internalization of environmental costs is not even mentioned, let alone considered. A truly optimal product design must balance out all the conflicting conditions imposed upon product development by the manufacturing processes. Obviously, the basic platform for addressing the inherently complex problems of this nature should emerge from the perspectives of performance, environment, and economics, as these products have to be produced in a competitive world market.



This handbook is primarily aimed at facilitating interactions and linkages between these diverse areas and helps promote the objective of designing, producing, operating, and using sustainable and dependable products, systems, and services.

Also with this handbook, a person intending to have introduction to performability engineering will not have to search extensively for relevant information to start his work. It is hoped that this handbook will offer a reader the necessary background in the subject just at one place. This is, therefore, the first book of its kind. It is also true that if we have to take to performability engineering as a profession, we need to create manpower in this discipline and introduce this subject for serious studies in the present day engineering curriculum. This handbook offers that opportunity to start with.

The handbook is organized in ten distinct sections as follows:

1. System design (7 chapters)
2. Engineering management (3 chapters)
3. Quality engineering and management (7 chapters)
4. Reliability engineering (18 chapters)
5. Reliability and risk methodology (4 chapters)
6. Risk management and safety (5 chapters)
7. Maintenance engineering and maintainability (5 chapters)
8. Sustainability and future technologies (9 chapters)
9. Performability applications (12 chapters)
10. Software engineering and applications (4 chapters)
11. Epilogue

The subject matter contained in the chapters has been selected to provide a balanced coverage of the entire spectrum of performability engineering. The chapters have been designed to provide up-to-date information on the subject being discussed. It is expected that this coverage will help achieve the objective for which this handbook is intended.

In spite of best efforts to make a cohesive presentation, there are bound to be lapses here and there in such a voluminous work; the editor takes the blame for all these shortcomings. However, if the handbook is able to create interest among the readers in performability engineering, it should be a matter of great achievement and pleasure to the editor. Eventually, it would prove to be a good idea that all engineers, irrespective of their areas of activity or discipline, are exposed to the subject of performability engineering to offer them with a wider vision of the requirement of sustainable and dependable products, systems, and services in the 21st century.

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