

PRODUCT DEVELOPMENT AND DESIGN FOR MANUFACTURING

A Collaborative Approach to
Producibility and Reliability

Second Edition, Revised and Expanded

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ABOUT THE SERIES

The genesis of modern methods of quality and reliability will be found in a sample memo dated May 16, 1924, in which Walter A. Shewhart proposed the control chart for the analysis of inspection data. This led to a broadening of the concept of inspection from emphasis on detection and correction of defective material to control of quality through analysis and prevention of quality problems. Subsequent concern for product performance in the hands of the user stimulated development of the systems and techniques of reliability. Emphasis on the consumer as the ultimate judge of quality serves as the catalyst to bring about the integration of the methodology of quality with that of reliability. Thus, the innovations that came out of the control chart spawned a philosophy of control of quality and reliability that has come to include not only the methodology of the statistical sciences and engineering, but also the use of appropriate management methods together with various motivational procedures in a concerted effort dedicated to quality improvement.

This series is intended to provide a vehicle to foster interaction of the elements of the modern approach to quality, including statistical applications, quality and reliability engineering, management, and motivational aspects. It is a forum in which the subject matter of these various areas can be brought together to allow for effective integration of appropriate techniques. This will promote the true benefit of each, which can be achieved only through their interaction. In this sense, the whole of quality and reliability is greater than the sum of its parts, as each element augments the others.

The contributors to this series have been encouraged to discuss fundamental concepts as well as methodology, technology, and procedures at the leading edge of the discipline. Thus, new concepts are placed in proper perspective in these evolving disciplines. The series is intended for those in manufacturing, engineering, and marketing and management, as well as the consuming public, all of whom have an interest and stake in the products and services that are the lifeblood of the economic system.

The modern approach to quality and reliability concerns excellence: excellence when the product is designed, excellence when the product is made, excellence as the product is used, and excellence throughout its lifetime. But excellence does not result without effort, and products and services of superior quality and reliability require an appropriate combination of statistical, engineering, management, and motivational effort. This effort can be directed for maximum benefit only in light of timely knowledge of approaches and methods

that have been developed and are available in these areas of expertise. Within the volumes of this series, the reader will find the means to create, control, correct, and improve quality and reliability in ways that are cost effective, that enhance productivity, and that create a motivational atmosphere that is harmonious and constructive. It is dedicated to that end and to the readers whose study of quality and reliability will lead to greater understanding of their products, their processes, their workplaces, and themselves.

Edward G. Schilling

PREFACE

The objective of this book is to illustrate the strategies and “best practices” for ensuring a competitive advantage. Successful product development has become a necessary but difficult collaborative task that requires effective and timely communication between various disciplines. Everyone involved in product development should have a basic knowledge of product development processes and the design fundamentals of producibility and reliability. A key benefit of this book is that it serves as a single informational source for the relationships between the many disciplines and methodologies. It is intended for college students and professionals involved with the design, development, manufacturing and support processes.

Technological change, global markets and the importance of knowledge are fundamentally changing product development. One unique aspect of this text is the large number and wide variety of topics presented. We believe that successful product development requires a systematic application of many methods and techniques that are tailored to the particular product and market environment. No single method is emphasized. Some of the many methods discussed include collaborative development, technical risk management, producibility measurement, mistake proofing, Boothroyd and Dewhurst DFMA, Taguchi methods, Six Sigma quality, rapid prototyping, testability, self-diagnostics, self-maintenance, environmental design, Isakawa, thermal analysis, and others. The relationships between these methods and the topics of the Internet, electronic commerce and supply chain are discussed.

Another unique aspect is the inclusion of the software design process. This is especially important in today’s market, as many products are either software themselves or contain software. Software development requires different strategies and processes than hardware development. Today’s design team needs to recognize these important differences.

Major industry studies of product development that the authors participated in provided the foundation for this book. These major studies include:

- Producibility Systems Guidelines for Successful Companies (1999 BMP Producibility Task Force Report)
- Transitioning from Development to Production DOD 4245.7M (i.e., often called the Willoughby templates)

- Best Practices for Transitioning from Development to Production (NAVSO P-6071)
- Producibility Measurement Guidelines (NAVSO P-3679)

This applied industry approach is helpful to both university students and practicing professionals. Much of this text was developed as a joint industry, government, and university project. Years with Texas Instruments, General Motors, and the U.S. Navy were also major influences when writing this text. Special thanks are given to Willis Willoughby, Jr., Ernie Renner, Douglas Patterson, Bernie List, Ed Turner, Gail Haddock and Lisa Burnell.

The book describes both what needs to be done (the best practices) and how to do them (product development steps or tasks). Brief examples start each chapter to give the reader a feel for the material that will be covered. Many of the examples are brief summaries of published articles used to highlight key design aspects, and expose the reader to current issues in design. Readers are encouraged to read the entire reference for greater understanding. Each chapter includes important definitions, best practices, an explanation of why the topic is important, and the steps for applying the methodology. These discussions will provide the reader with a working knowledge of critical techniques and terminology that will help in communicating with other engineering disciplines.

This book is divided into three major parts:

Part I introduces the reader to how change is affecting product development, the value of knowledge, and an overview of the design process.

Part II reviews the major stages in the design and development process. These chapters examine the processes of requirement definition, conceptual design, trade-off analysis, detailed design, simulation, life cycle costing, test and evaluation, manufacturing, operational use, repairability, product safety, liability, supply chain, logistics, and the environment.

Part III reviews producibility and the specialized techniques that have been proven in industry for designing a highly producible and reliable product. These include simplification, standardization, producibility methods, testability, and reliability design methods.

As mentioned earlier, this text is the result of joint industry, government and university projects involving many contributors. Some of the many contributors were:

BMP Producibility Measurement Task Forces both 1991 and 1999

All task force members but especially Robert Hawiszczak, Raytheon; Erich Hausner, TRW; Michael Barbieri, Lockheed Martin Tactical Aircraft; Scott McLeod, Dr. Mikel Harry, Motorola, and finally Amy Scanlon and Roy Witt, BMP.

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This project includes the research work, write-ups and suggestions of many students. The purpose was to insure that the information was effective for college students and recent college graduates. Special thanks are given to those who provided major materials including Richard McKenna (7 steps for assembly), Tracey Lackey (software testability rules), Marcelo Sabino (software translation), Heather Stubbings (software interfaces), Eloisa Acha (artwork), and the many other students who helped. Additional thanks are given to the many authors cited in the book.

Without the technical expertise of those listed above, this book would not have been possible. We especially appreciate the support of our families: Pat, Audrey, and Russell; Mary, Paul, Carlos, and Christy. Finally, we would like to acknowledge the editorial assistance and the technical support of Ann von der Heide and Ginny Belyeu, who lived through the book's many revisions.

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