RELIABILITY FOR ENGINEERS

Other Macmillan titles of related interest

Mechanical Reliability, 2nd edition, A. D. S. Carter

Reliability and Maintainability in Perspective, 2nd edition, D. J. Smith

Reliability for Engineers

An Introduction

Eur Ing Michael Beasley
BSc (Hons), CEng, MIEE, FSaRS

M
MACMILLAN

© M. Beasley 1991

All rights reserved. No reproduction, copy or transmission of this publication may be made without written permission.

No paragraph of this publication may be reproduced, copied or transmitted save with written permission or in accordance with the provisions of the Copyright, Designs and Patents Act 1988, or under the terms of any licence permitting limited copying issued by the Copyright Licensing Agency, 33-4 Alfred Place, London WC1E 7DP.

Any person who does any unauthorised act in relation to this publication may be liable to criminal prosecution and civil claims for damages.

First published 1991

Published by
MACMILLAN EDUCATION LTD
Houndmills, Basingstoke, Hampshire RG21 2XS
and London
Companies and representatives
throughout the world

British Library Cataloguing in Publication Data
Beasley, M.

Reliability for engineers.

1. Reliability engineering

I. Title

620.00452

ISBN 978-0-333-54238-5 ISBN 978-1-349-21369-6 (eBook)

DOI 10.1007/978-1-349-21369-6

To my wife Frances and our children Ian and Susan

Contents

<i>Preface</i>	viii
1 Introduction	1
2 Product Development	7
3 The Statistics of Failure – I	16
4 The Statistics of Failure – II	37
5 Component Reliability	61
6 System Reliability	75
7 Methods of Increasing System Reliability	91
8 Fault-tolerant Systems – I	95
9 Fault-tolerant Systems – II	102
10 The Behaviour of Maintained Systems	110
11 Elements of Markov Analysis	118
12 Spare Parts Provisioning	135
13 Software Reliability	143
14 Maintainability	153
15 System Reliability Prediction	161
16 Reliable Systems: Specification, Design, Manufacture and Installation	169
17 Reliability Growth	183
18 Reliability Demonstration	185
19 Some Analytical Methods and Computer Software	197
20 The Final Product	202
21 References	204
22 Bibliography	207
23 Answers to Exercises	209
<i>Appendix 1: χ^2 Distribution Tables for Even-numbered Degrees of Freedom</i>	224
<i>Appendix 2: 5%, 95%, and Median (50%) Rank Tables</i>	230
<i>Appendix 3: The Elements of Probability Theory</i>	242
<i>Appendix 4: Glossary of Terms</i>	253
<i>Index</i>	256

Preface

This book is the outcome of lectures on reliability which I have given, firstly in-house in STC plc and later at Hatfield Polytechnic. It is intended to help both students who are new to the subject and practising engineers who are looking for help in reliability engineering.

Until my retirement I spent my working life in the telecommunications industry, and thus I had electrical engineers mostly in mind when writing this text. However, the theory and principles of reliability engineering are of wide applicability so that I hope this book will also be useful to workers in other engineering disciplines.

It is difficult, if not impossible, to learn reliability engineering in complete isolation. So my warm thanks go to all my former colleagues in STC plc who by discussions and instruction helped my understanding of the subject; in particular I should like to mention Dr G. G. Pullum, Mr G. H. P. Breuer and Mr I. Campbell.

I have also been greatly helped as a part-time lecturer at Hatfield Polytechnic by my colleagues Mr E. A. De Maria, Mr P. J. Bunn and Mr P. F. Jackson, to all of whom I owe a debt of gratitude.

There are already a number of good textbooks on reliability; my excuse for writing yet another is that I believe mine to be of practical help - to the student as well as to the qualified engineer.

I am grateful to Mrs D. J. Ross and Mrs S. M. Pilkington who typed early versions of the lecture notes from which this book has been developed; and also to my wife Frances who had the arduous task of typing most of the final manuscript.

Finally, it is a pleasure to express my thanks to Mr Malcolm Stewart and his colleagues of Macmillan Education Ltd for their help in bringing this book to press.