

SUBIR CHOWDHURY

AUTHOR OF MANAGEMENT 21C

DESIGN FOR SIX SIGMA

The revolutionary process
for achieving extraordinary profits

FT Prentice Hall
FINANCIAL TIMES

Design for Six Sigma



Advance praise

'In his latest book, *Design for Six Sigma*, Chowdhury effectively communicates how to turn Six Sigma strategy into a breakthrough performance. Chowdhury's excellent contribution shows how to make Six Sigma part of the way we work – the unifying framework to align and energize an entire company.'

Dave B. Burritt, *Six Sigma Deployment Champion, Caterpillar Inc.*

'Subir Chowdhury has written the quintessential book on Design for Six Sigma that fills a critical need for published material on the subject. This innovative book provides a clear road map for all executives, business managers, and Six Sigma leaders who are engaged in the competitive race to build cost-effective, defect-free processes and products that will win customers and guarantee their loyalty.'

Cynthia Callas,

Vice President of Six Sigma Deployment/Black Belt, Merrill Lynch

'Why design a process that isn't optimal and will only need Six Sigma improvements later? Subir Chowdhury's most important and timely book lays the groundwork using DFSS tools to design the process correctly the first time, thus saving time, effort, money, and most of all customer frustration.'

Richard (Dick) Cunningham, *Executive Six Sigma Champion and Director of Operational & Business Excellence, Johns Manville Corporation – a Berkshire Hathaway Company*

'Written in an easy-to-read story format, Chowdhury's previous book, *The Power of Six Sigma*, provides a clear understanding of how Six Sigma can benefit any business activity. I award all Project Champions a copy as they complete their training workshop and recommend all others read it as well. Chowdhury's *Design for Six Sigma* promises to be just as powerful and helpful.'

Douglas R. Pratt,

P.E., Director, Six Sigma Process Excellence, Dow Corning Corporation

'In order to truly attain Six Sigma status, following the process outlined in Chowdhury's book, *Design for Six Sigma* (DFSS), is crucial. DFSS will help your company greatly increase its competitive strength.'

Rob Lindner, *Vice President, Corporate Quality, Sunbeam Corporation*

'Whether your product is the result of a complex technical manufacturing process or group-driven ideation, *Design for Six Sigma* offers a framework to get it right the first time. With this important and outstanding new book, Subir Chowdhury drives home the need for today's businesses to understand their customers before trying to service them.'

Roxanne O'Brasky,

President, International Society of Six Sigma Professionals (ISSSP)

PEARSON EDUCATION LIMITED

Head Office:

Edinburgh Gate

Harlow CM20 2JE

Tel: +44 (0)1279 623623

Fax: +44 (0)1279 431059

London Office:

128 Long Acre

London WC2E 9AN

Tel: +44 (0)20 7447 2000

Fax: +44 (0)20 7447 2170

Website: www.business-minds.com

First published in 2002 in the United States by Dearborn Trade Publishing

This edition published in Great Britain in 2003

© Subir Chowdhury Limited 2003

The right of Subir Chowdhury to be identified as author
of this work has been asserted by him in accordance
with the Copyright, Designs and Patents Act 1988

ISBN 0 273 66269 4

British Library Cataloguing in Publication Data

A CIP catalogue record for this book can be obtained from the British Library

All rights reserved; no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without either the prior written permission of the publishers or a licence permitting restricted copying in the United Kingdom issued by the Copyright Licensing Agency Ltd, 90 Tottenham Court Road, London W1P 0LP. This book may not be lent, resold, hired out or otherwise disposed of by way of trade in any form of binding or cover other than that in which it is published, without the prior consent of the publishers.

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold with the understanding that neither the authors nor the publisher is engaged in rendering legal, investing, or any other professional service. If legal advice or other expert assistance is required, the service of a competent professional person should be sought.

The publisher and contributors make no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any responsibility or liability for any errors or omissions that it may contain.

10 9 8 7 6 5 4 3 2 1

Typeset by Northern Phototypesetting Co. Ltd, Bolton

Printed and bound in Great Britain by Biddles Ltd, Guildford & King's Lynn

The publishers' policy is to use paper manufactured from sustainable forests.

Design for Six Sigma



Subir Chowdhury

FT Prentice Hall
FINANCIAL TIMES

An imprint of **Pearson Education**

London ■ New York ■ Toronto ■ Sydney ■ Tokyo ■ Singapore ■ Hong Kong

Cape Town ■ New Delhi ■ Madrid ■ Paris ■ Amsterdam ■ Munich ■ Milan ■ Stockholm

Dedication

To my friend, co-author and mentor Dr Genichi Taguchi.

This book would never have materialized without the continuous help of the following colleagues and friends:

Alan Wu ■ Barry Bebb ■ Shin Taguchi ■ Brad Walker

ASI – American Suppliers Institute

Contents



Acknowledgments xi

About the author xiii

Preface xv

1 DFSS: the only way to achieve Six Sigma 1

Part I People Power of DFSS

2 DFSS implementation strategy 29

3 People roles in DFSS 54

Part II Process Power of DFSS: IDDOV

4 Identify and define opportunity 75

5 Develop concepts 105

6 Optimize the design 131

7 Verify the design 153

Glossary 172

Bibliography 176

Index 179

Acknowledgments



I would like to extend enormous gratitude to the man who taught all of us the power of Robust Engineering – Dr Genichi Taguchi. I am very fortunate to work closely with this genius. His teaching inspires me every day.

Dr Armand V. Feigenbaum, Philip B. Crosby and J. D. Power III have also been a great inspiration to me. Their continuous support of my work is extremely valuable. I honour and respect all of them.

A great talent who helped me to refine the manuscript with integrity and a sense of quality is my friend John Bacon. I feel a deep sense of gratitude to John for his enormous support and hard work, and for helping me.

My two dear friends and colleagues in business, Shin Taguchi and Alan Wu, have been instrumental in making this book happen. They worked in the hotel room at 1 am when required, to challenge my thoughts. Thank you both for your continuous support.

My colleague and friend, Dr Barry Bebb, is a phenomenal researcher. Barry, thank you for your hard work on the manuscript and continuous challenge.

My colleague Brad Walker helped me on the book during the holiday seasons. A young consultant, Brad is always striving for the best. Thank you, Brad.

Thanks to my colleagues Jim Wilkins, John Terninko, Dave Kesselring and Bill Eureka for their continuous hard work on Six Sigma and DFSS deployment at different organizations.

Thanks to my Dearborn Trade editor, Jean Iversen, for her project leadership and continuous challenge.

Thanks also to my very special friend in the publishing business, Cynthia Zigmund, publisher at Dearborn Trade, for her belief in every one of my writing ventures from the first day I met her, and for her continuous encouragement.

I extend my gratitude to everyone at Dearborn Trade for their hard work: Sandy Thomas, Leslie Banks, Robin Bermel, Mindi Rowland, Paul Mallon and Jack Kiburz.

Special thanks to my very special friend, Richard Stagg, publisher at Financial Times Prentice Hall, for his continuous encouragement and support. Richard is a true Black Belt Publisher. Also, thanks to everyone at Financial Times Prentice hall for their excellent work; Amanda Thompson, Stephen Partridge, Liz Wilson and Jason Bennett.

Thanks to all of my dear friends and colleagues in the business, especially everyone at ASI – American Supplier Institute – for their assistance and help.

All my friends in the Six Sigma business, including AIT Group, BMG and George Group, have given me continuous support. Thank you.

I am also grateful to my parents, Sushil and Krishna Chowdhury, and to my in-laws, Ashim and Krishna Guha, for their constant demonstration of love.

This book would never have become a reality without the support of my lovely wife Malini. Of course, the real joy in my daily life comes from my little daughter Anandi.

About the author



Subir Chowdhury is Executive Vice President at ASI – American Supplier Institute – the world’s premier consulting and training firm on Design for Six Sigma and Robust Engineering. Prior to ASI, he served as a quality management consultant at General Motors Corporation. Hailed by the *New York Times* as a ‘leading quality expert’, Chowdhury was also recognised by *Quality Progress* of the American Society for Quality as one of the ‘voices of quality in the 21st century’.

Author of seven books, Chowdhury’s most recent international bestselling books include *The Power of Six Sigma* and *Management 21C: Someday We’ll All Manage This Way*. His books have been translated into more than twelve languages. He is frequently cited in the national and international media.

Chowdhury has received numerous international awards for his leadership in quality management and major contributions to the automotive industry. He was honoured by the Automotive Hall of Fame, and the Society of Automotive Engineers awarded him its most prestigious recognition, the Henry Ford II Distinguished Award for Excellence in automotive engineering. He also received the honourable US Congressional Recognition. From 1999 to 2000, he served as Chairman of the American Society for Quality’s Automotive Division. In 2002, the Society of Manufacturing Engineers honoured Chowdhury with its most prestigious international honour, ‘SME Gold Medal’.

Chowdhury lives with his wife, Malini, and daughter, Anandi, in Novi, Michigan.

Preface



Virtually every American over the age of 25 recalls the day in early 1986 when the Space Shuttle Challenger exploded just 73 seconds after lift-off from Cape Canaveral's launchpad. All aboard died, including America's darling, Christa McAuliffe, who was chosen from 11,000 other American teachers to become the first teacher in space. Like so many tragedies, part of the horror of the Challenger disaster is how easily it could have been avoided. As the *Guardian* reported:

Roger Boisjoly, a senior engineer at Morton-Thiokol – the contractors that built the solid rocket boosters for the space shuttle – had been airing doubts about the Challenger's O-rings for at least six months before the disaster. A year earlier he'd gone to Florida to inspect the spent rockets from a previous mission. He had been amazed at the condition of the joints. The primary seal had failed and allowed hot gas to surge by.

In addition to the terrible loss of life, the Challenger disaster also cost the United States billions of dollars and set back NASA's cause several years – all because of a cheap, simple part that NASA had already been warned was faulty. Likewise, the Concorde crash of July 2000 not only killed all 113 people on board; it prompted an investigation that grounded all Concorde flights for months, costing more than \$30 million to ensure that the remaining fleet was safe.

And in the United States, Bridgestone/Firestone will pay up to \$51.5 million to settle claims over allegedly faulty tyres that

have been linked to 271 deaths and more than 800 injuries. The reputation of the Ford Explorer has suffered in the process too. Ford, the world's number-two car manufacturer, and Firestone ended their nearly 100-year-old relationship in a dispute over who is to blame.

Such tragedies make us rethink the way we live and work. On the one hand, we're reminded of how fragile life is and of how easily things can go wrong at any moment. But on the other hand, smart business people are reminded of the importance of quality in everything they do, and how such events can be avoided if they keep focused on doing their best work at every turn.

When I meet with CEOs or senior executives across the globe, I find that very few truly practise prevention as a strategy. I think the reason is simple: putting out fires is glamorous, preventing them is not. In most companies, those who quell potential disasters get all the glory, but the quiet workers who ensure that those disasters never occur in the first place don't get half the attention or rewards. In the 21st century, customers have come to demand perfection in their products and services, and if you can't deliver, they'll go elsewhere.

The irony is that most senior executives understand the importance of quality – it's been beaten into them for decades – and truly believe that they know the secrets of how to achieve perfection in their line of work. It's the same Ford Motor Company, after all, that embraced Dr W. Edwards Deming's legendary philosophy of quality in the 1980s. Two decades later, in 2001, Ford's chief operating officer Nick Scheele said, 'When I say we need to get back to basics, what I mean is we emphasize our products and our quality.'

It's been my experience that most executives harbour misconceptions about the many quality initiatives that have

bombarded US companies over the past two decades. This book will clarify these misconceptions. The first, and most important, misconception to dispel is that Design for Six Sigma (DFSS) only applies to engineering designs. Given the name Design for Six Sigma, this confusion is understandable but costly if not corrected, because DFSS can be applied with equal effectiveness to such varied tasks as billing, marketing, customer service, and everything in between. DFSS will also teach you how to determine what your customers truly want and optimize your operations at every turn to give it to them.

I wrote this book with the belief that designing products and processes right the first time must be every company's first concern. The most visionary CEOs lead their teams with this focus in mind. This book is not just for CEOs, but also for those engineering managers who believe they know what Robust Design® is all about and end up fighting fire after fire when a product is actually launched. And it's for those operations managers who call in consulting firms to fix their own processes. Finally, this book is for anyone who wants to serve customers effectively and efficiently by understanding the true customer's voice.

When I asked my very good friend, the late Philip B. Crosby, to give me his take on Six Sigma a few years ago, he answered with a question, 'Which is better – 3.4 defects per million opportunities or zero?' That's the difference between Six Sigma – an incredibly high rate of perfection – and perfection itself. That was Phil's attitude.

The same year, when I put the same question to another close colleague of mine, Dr Genichi Taguchi, his response was 'Why not Seven Sigma?' Both Crosby and Taguchi stressed thinking about quality 'upstream' instead of 'downstream' – in other words, where the process begins, not where it ends.

That's what Design for Six Sigma is all about – focusing on preventions instead of cures.

As I mention in my previous book, *The Power of Six Sigma*, although Six Sigma and Design for Six Sigma are fundamentally different quality initiatives, they both rely on combining People Power with Process Power. At a recent Harvard Business School gathering, former GE Chairman and CEO (and Six Sigma devotee) Jack Welch said: 'You have to be sure every day that you're turning people on.' Focusing on the people doing the work – and not just abstract theories – is the key ingredient to make any change last in your company. *Design for Six Sigma* is uniquely qualified to inspire, guide, and motivate your employees and colleagues to do their best work for the team.

I openly confess that it really does not matter who is preaching the virtues of Six Sigma or Design for Six Sigma, because the tools used in both of these powerful management strategies are nothing new. They have been around for decades. But how successful your organization is depends entirely on how effectively those tools are applied. Several organizations have already deployed Design for Six Sigma after their initial Six Sigma success but will likely fail on their DFSS initiatives, because they are misapplying the DFSS methodology and tools.

Six Sigma's trademark methodology of DMAIC (define, measure, analyze, improve, and control) has become a standard operating procedure in companies around the globe. Unfortunately, in DFSS there is little consistency among practitioners about the terms that define the process. As a result, the acronyms range from DMADV (define, measure, analyze, design, verify) to DMEDI (define, measure, explore, develop, implement) to IDDOV (identify, define, develop,

optimize, and verify). The good news is that it really does not matter what you call it. The DFSS methodology is still a straightforward, five-step process, just as is Six Sigma's DMAIC.

Most consulting firms require fewer training days to teach Black Belts (the programme's movers and shakers) about DFSS than they do for Six Sigma (about five to ten days compared with sixteen to twenty days). However, everyone involved rightly stresses that DFSS is more rigorous to implement than Six Sigma, in part because the practitioners must master more quality concepts such as Quality Function Deployment and Robust Design. This book will clear out all the cobwebs and let you and your people get right to work on exciting projects that bring results.

At the time of writing, *Design for Six Sigma* is the first book on DFSS. With so many business writers and consultants out there these days, I'm a little surprised that I am the first. Not only have countless business people been clamouring for a book on DFSS, but in my discussions with business executives and managers, they have repeatedly asked for a quick read that is not overly technical and is reader friendly. I have done my best to honour this request with this book. The book in your hands is not a technical how-to book but an easy-to-understand explanation of Design for Six Sigma that will help you and your company in dramatic fashion.

The book opens with an introductory chapter on Design for Six Sigma and also reviews the basics of its predecessor, Six Sigma, and explains the differences between the two. Chapters 2 and 3 explain the roles employees fulfil in DFSS Projects and how they're implemented, while chapters 4 through 7 take the reader on a detailed tour of each phase of the five-step process (IDDOV) of the DFSS management strategy. My goal is to

answer virtually all the questions anyone new to DFSS may have.

I will consider this book a success if I can help business people and organizations deploy DFSS effectively. It would bring me a deep sense of satisfaction if, because of such companies' renewed emphasis on quality through DFSS, we all see fewer innocent victims of corporate carelessness, such as those that resulted in the tragedies mentioned above. Some day, we'll all lead our organizations the DFSS way!

Subir Chowdhury

Executive Vice President, ASI–American Supplier Institute

E-mail: subir.chowdhury@asiusa.com

Website: <http://www.asiusa.com>