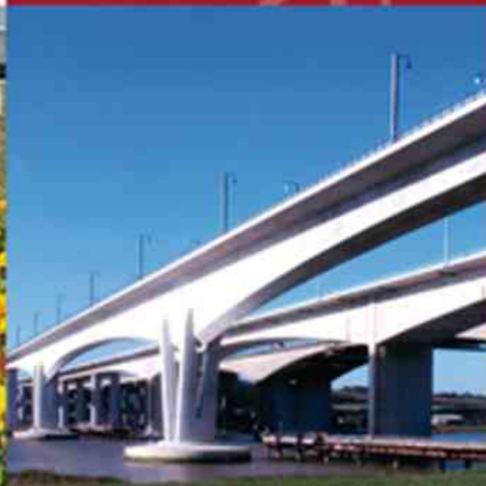
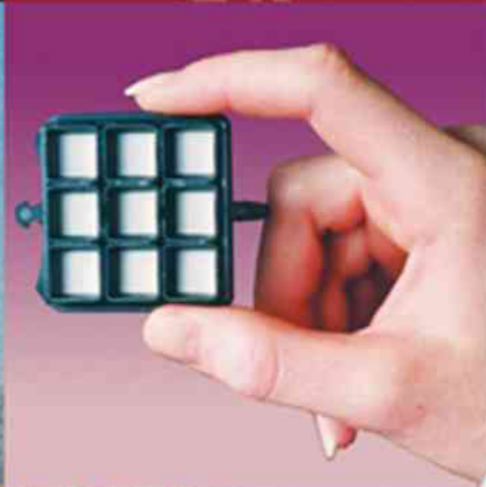
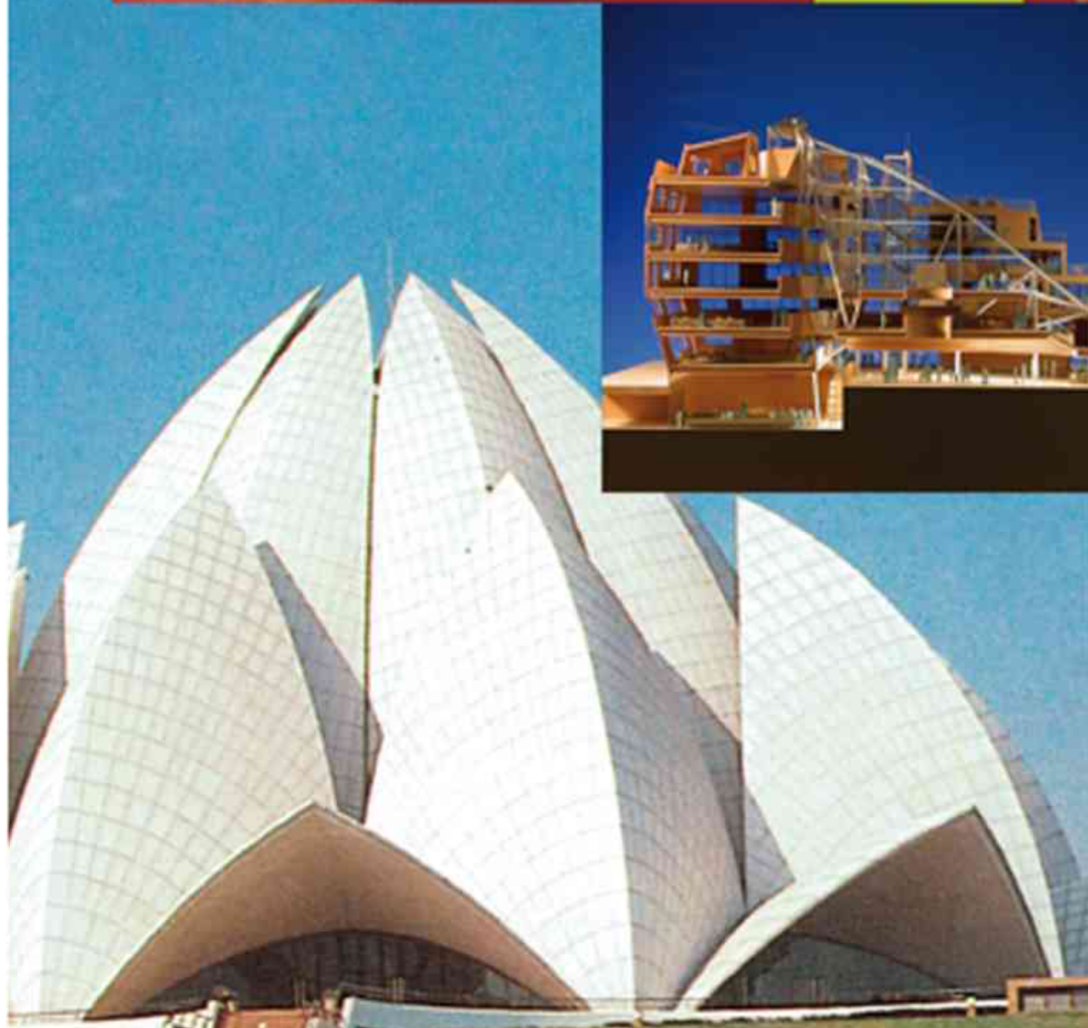


James Armstrong

Design Matters

The Organisation
and Principles
of Engineering Design



Springer

Design Matters

James Armstrong

Design Matters

**The Organisation and Principles
of Engineering Design**

James Armstrong, OBE, FREng, FICE, FIStructE
32 Langford Green
London
SE5 8BX
UK

ISBN 978-1-84628-391-8

e-ISBN 978-1-84628-722-0

DOI 10.1007/978-1-84628-722-0

British Library Cataloguing in Publication Data

Armstrong, James

Design matters : the organisation and principles
of engineering design

1. Engineering design

I. Title

620'.0042

ISBN-13: 9781846283918

Library of Congress Control Number: 2007930217

© 2008 Springer-Verlag London Limited

Apart from any fair dealing for the purposes of research or private study, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988, this publication may only be reproduced, stored or transmitted, in any form or by any means, with the prior permission in writing of the publishers, or in the case of reprographic reproduction in accordance with the terms of licences issued by the Copyright Licensing Agency. Enquiries concerning reproduction outside those terms should be sent to the publishers.

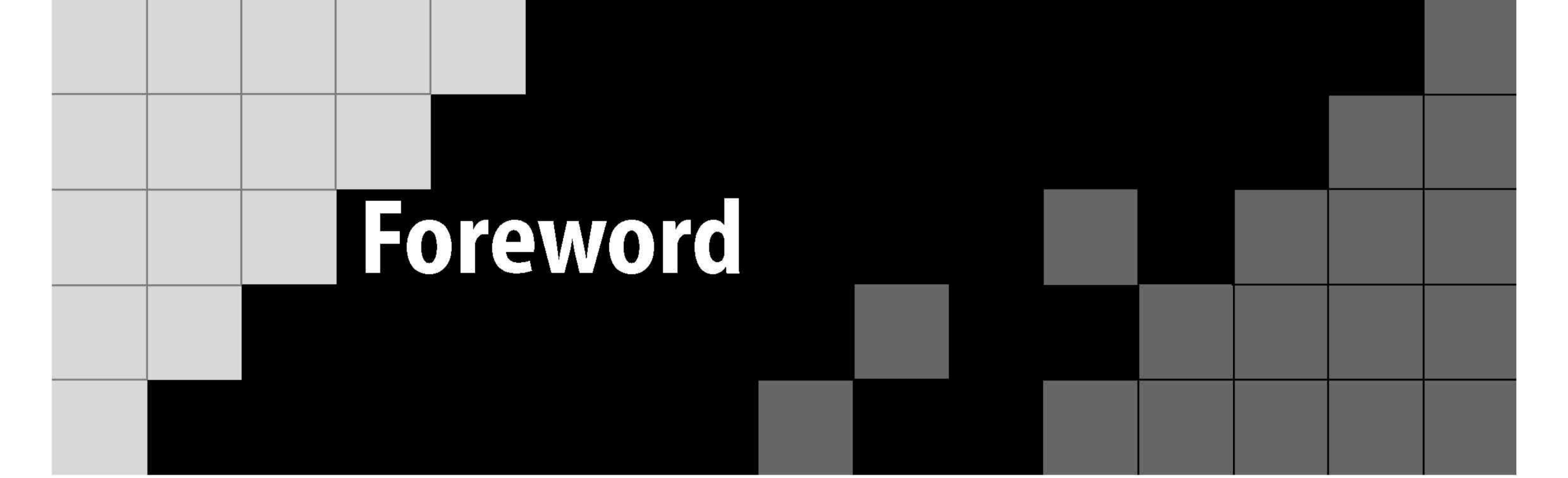
The use of registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant laws and regulations and therefore free for general use.

The publisher makes no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility or liability for any errors or omissions that may be made.

Printed on acid-free paper

9 8 7 6 5 4 3 2 1

springer.com



Foreword

Following several years as chairman of the Design Matters Group at the UK Royal Academy of Engineering, James Armstrong prepared at the request of the Academy a booklet outlining the basic strategic principles of engineering design, illustrated by four case studies.

James Armstrong has a wide range of experience relating to many different projects and requiring the integrating of many different disciplines. This experience has been used to demonstrate the basic design process and to show how the same general principles can be used to demonstrate the process on such diverse projects. It also suggests how these principles can be used to set out the strategic process for all engineering projects and incorporate the understanding in undergraduate engineering courses at university.

The principles identified cover fundamental strategic issues. They arise from experience of handling projects, involving planning, financing, and political/social issues as well as basic architectural and engineering matters.

Following the publication of the booklet, James Armstrong was invited by the international publishers Springer to expand the presentation of the three principles of need, vision and delivery into a more comprehensive book, of value to the practising engineer and to engineering educators.

In this book the fundamental principles are defined, with suggestions as to the need for and the process of relating the humanities to the sciences of natural law, and demonstrates this with 12 case studies of a variety of design projects from different engineering disciplines. General advice on the establishment of the three principles is given, together with a detailed analysis of one project, and a suggested format for auditing the design process.

Hugh Norie
Chairman Design Matters Group
Royal Academy of Engineering

Contents

Contributors	xiii
1 Introduction.....	1
Purpose and Structure of the Book	1
Design Context.....	4
The Needs of Society	5
The Creative Designer	6
Basic Education	8
2 The Design Process.....	11
Introduction	11
The Nature of Design Principles	12
Practice of Design	14
Formulation of Need.....	14
Creative Response – the Vision	16
Delivery	18
Performance in Practice	20
Example of Case Study	21
Formulation of Need.....	21
Creative Response – the Vision	22
Delivery	23
Performance in Practice	24
Summary of Design Procedure	24
3 Case Studies – Introduction	25
Statements of Principle	25
Case Study Format.....	26
Need – All Design Begins with a Clearly Defined Need....	26
Vision – All Designs Arise from a Creative Response to a Need	26

Delivery – All Designs Result in a System or Product That Meets the Need	27
Performance	28
Summary of Design Procedure	28
Key Features of Specific Case Studies	28
4 Case Studies	31
Case Study 1: Automated Blood Analyser	31
Formulation of Need	32
The Creative Response – the Vision	35
Contextual Constraints.....	35
Effective Creativity.....	36
Delivery.....	40
Performance in Practice.....	42
Case Study 2: Intelligent Prosthesis.....	45
Formulation of Need	45
The Creative Response – the Vision	46
Contextual Constraints.....	46
Effective Creativity.....	48
Delivery.....	50
Performance in Practice.....	51
Case Study 3: Channel Tunnel UK Terminal.....	55
Formulation of Need	55
The Creative Response – the Vision	56
Contextual Constraints.....	56
Effective Creativity.....	58
Delivery.....	60
Management and Control	62
Contract Procedures	62
Performance in Practice.....	63
Assessment of Design Brief.....	63
Economic Performance	63
Case Study 4: Channel Tunnel Rail Link (CTRL).....	65
Formulation of Need	65
The Creative Response – the Vision	67
Contextual Constraints.....	67
Effective Creativity.....	68

Delivery.....	69
Performance in Practice.....	72
Case Study 5: London Eye	75
Formulation of Need	75
The Creative Response – the Vision	77
Contextual Constraints.....	77
Effective Creativity.....	79
Delivery.....	81
Performance in Practice.....	83
Case Study 6: Lesotho Hydro-electric Project.....	85
Formulation of Need	85
Project Background.....	85
The Creative Response – the Vision	86
Contextual Constraints.....	86
Effective Creativity.....	88
Delivery.....	88
Performance in Practice.....	90
Case Study 7: Maribyrnong Footbridge.....	93
Formulation of Need	93
The Creative Response – the Vision	94
Contextual Constraints.....	94
Effective Creativity.....	95
Delivery.....	96
Performance in Practice.....	98
Case Study 8: Bahá’í Temple – Delhi.....	101
Formulation of Need	101
The Creative Response – the Vision	103
Contextual Constraints.....	103
Effective Creativity.....	104
Delivery.....	107
Performance in Practice.....	109
Case Study 9: Hampden Gurney Junior School.....	111
Formulation of Need	111
The Creative Response – the Vision	112
Contextual Constraints.....	112
Effective Creativity.....	113

Delivery.....	116
Performance in Practice.....	117
Case Study 10: Bridge Academy	119
Formulation of Need	119
The Creative Response – the Vision	120
Contextual Constraints.....	120
Effective Creativity.....	122
Delivery.....	123
Case Study 11: Harris Manchester College, Oxford.....	127
Formulation of Need	127
The Creative Response – the Vision	129
Contextual Constraints.....	129
Effective Creativity.....	131
Delivery.....	134
Performance in Practice.....	136
Case Study 12: Angel of the North.....	137
Formulation of Need	137
The Creative Response – the Vision	138
Contextual Constraints.....	138
Effective Creativity.....	138
Delivery.....	140
Performance in Practice.....	142
5 Project Design Audit.....	145
Values	145
Professions	146
A Detailed Case Study	146
Formulation of Need.....	147
The Creative Response – the Vision.....	150
Delivery	153
Appendix – The Case Study Format.....	157
Formulation of Need	157
The Creative Response – the Vision	157
Contextual Constraints.....	157
Effective Creativity.....	158

Contents

Delivery.....	158
Performance in Practice.....	159
Index.....	161