Materials and the designer

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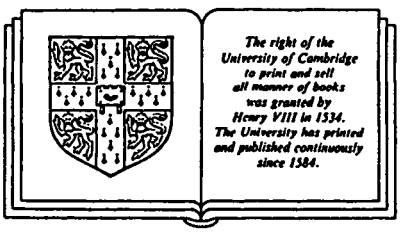

CAMBRIDGE UNIVERSITY PRESS
Cambridge
New York Port Chester
Melbourne Sydney

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
40 West 20th Street, New York, NY 10011, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

First published 1987
First paperback edition 1990

British Library cataloguing in publication data

Cornish, Eric H.
Materials and the designer.
1. Materials 2. Design, Industrial
I. Title
620.1'1 TA403.6

Library of Congress cataloguing in publication data

Cornish, E. H.
Materials and the designer.
Bibliography.
Includes index.
1. Materials. 2. Engineering design. I. Title.
TA403.C644 1986 620.1'1 86-6087

ISBN 0 521 30734 1 hardback
ISBN 0 521 38580 6 paperback

Transferred to digital printing 1999

UB

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Preface

This book does not aspire to discuss pure materials science topics, nor to offer comprehensive numerical design data for each material, although reference is made to underlying materials science concepts wherever opportune. It does, however, seek to identify those parameters which must be considered when selecting materials for use in engineering applications. Emphasis is put on the needs of manufacturing industry, which is defined for present purposes as involved in production of prefabricated parts and components intended for civil, domestic, marine, military, aerospace and chemical processing applications. The decision has been taken to omit all aspects of the building and construction industry, so no reference is made to concrete, timber, bitumens, soil and masonry.

The chapter on the impact of design on manufacturing industry is intended to demonstrate how correct selection of materials in terms of their performance, availability and cost, together with exploitation of available production capability, will enhance the profitability of a commercial operation.

Having embarked upon a design study, it is necessary for the expertise and judgement of the design engineer to be coordinated with those of other experts to produce the most effective result. The chapter on the design process draws attention to the variety of knowledge and advice which the designer needs to draw upon to make materials choices with a high level of confidence.

A large number of metallic and non-metallic materials, each with a wide spectrum of properties, is available to the designer. The salient features of the main materials families, and their typical properties and performance limitations in service are outlined as a guide to further, in-depth, study. Surface coatings and finishes, as systems for protection in adverse service environments, are also considered.

Guidelines by which degradation and failure mechanisms, induced by chemical and mechanical agencies, can be identified and assessed to provide

economic safety margins in use, are briefly presented, and existing world standards for quality assurance and product control are reviewed.

Factors controlling the selection of alternative materials in an existing product design receive attention, being perhaps necessitated by new market forces as a result of changes in service requirements or in production processes. Some economic and strategic factors related to the supply of raw materials are discussed, and a concept of an 'envelope of properties' is elaborated to delineate areas of acceptability for materials alternatives. This concept seeks to assist in making changes to the choice of materials for modifying an existing product.

The chapter on the impact of available production processes on design possibilities draws together some of the more important processes applied to materials, to remind the designer how an in-depth knowledge of these can affect his concept of a properly engineered and cost-effective product.

Summarising, it may be claimed that the product designer ideally needs a broad knowledge of the materials technology world, with its ramifications of materials sources, materials products supply, the behaviour of materials under different processing conditions, the factors involved in substituting one material for another, the question of preferred production methods for different product configurations, and many other aspects of the subject. These topics are addressed in the various chapters of this book to ensure that the person responsible for materials selection has an adequate understanding of the nature of specialist advice which he may and should seek, and that he has sufficient knowledge of materials to frame relevant questions and, most importantly, to understand the experts' answers, be he building a safety-pin or a road bridge.

Apologies and acknowledgements

For simplicity the term 'he, the designer' has been used throughout the book, being intended to apply to any individuals of either sex who, although not necessarily trained in materials-related disciplines, have responsibility for selecting materials used in a manufactured article.

After a lifetime of work with materials, this author, as would any other, finds it impossible specifically to acknowledge all the sources of detailed information which have been drawn upon. Much use has been made of data drawn from day-to-day reading, as shown in the list of References, and peer discussion, coupled with that built-in mental awareness of the main truths about materials which is the residuum of student days. Most of the references cited are to specific papers, and as such are recorded in the References list. Occasionally however, a text listed in the Bibliography is known to contain specific data under discussion: the author and year are cited as for references. So an author 'missing' from the References will be found listed in the Bibliography.

A special mention should be made of my colleague from the British National

Committee on Materials, the late Nigel C.W. Judd. It was he who provided the motivation for this book and I am indebted to his memory for the many fruitful discussions and interchanges of information which we had before his untimely death.

Thanks are also due to STL Ltd for providing considerable assistance, to Mrs J.R. Newcomb for her untiring work with the word processor, and to Mrs J.M. Trentham for producing the illustrations. Mr M.V. Coleman, Dr M.J. Folkes, Mr P. Green, Mr A.C. Harman, Mr F. Kerry, Mr P.J. Lesley, Dr K. Paul, Mr J.Pemberton, Mr S. Tattersall, Mr K. Taylor, and Mr V. White deserve the author's thanks for making valuable comments on various chapters.

Some of the concepts in the book, notably views of material flammability and of materials 'envelopes of properties', are considered to be novel, but doubtless, like almost everything else, they have been developed before, forgotten and then reinvented. While acknowledging, in Figures, Tables and References, at least some published authorities, the author begs the reader's indulgence by admitting that countless scientists have shaped his thoughts, and so he thanks the world at large. Specifically, however, acknowledgements are due to E.I. DuPont de Nemours for permission to reproduce Figure 3.6, to the Institution of Production Engineers for permission to reproduce Figures 11.1, 11.2 and 11.3, and to Mr K Thomas of the Institution of Structural Engineers Materials and Components Study Group for the concept and much of the content of Table 3.4.

However, the author can claim something specifically for himself; that is, full responsibility for the absence of that information which should be included in an ideal book reflecting an ideal world. Such omissions are entirely his own responsibility and reflect that sad lack of omniscience and of available pages which so many authors share.

In parts of this book, mention is made of trade names, specific materials and proprietary processes. Their inclusion does not imply that the publishers or the author have tested them, and they thus cannot endorse what may well be worthy additions to the designer's armoury.

E.H. Cornish 1986.