

Materials and Design

The Art and Science of Material
Selection in Product Design

Mike Ashby and Kara Johnson



Third Edition





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Preface

This third edition represents the culmination of many years teaching and researching the fundamentals and application of material science and material selection (Mike) and a few more years exploring ideas related to materials, materiality, and making—both with designers and in the context of the design industry (KJ). We have explored these ideas both in general and with specific reference to one material or one manufacturing process or one particular product design challenge. We hope that you enjoy this edition and that it provides a valuable reference both now and in the future.

With the success of the first two editions of this book and based on additional input from students, teachers, designers, and our own experiences, we have been encouraged to evolve the storytelling and the details of this textbook one more time in a third edition. With help from Willy and Patrick at Swayspace, we re-designed the cover to capture a more authentic merger of the words “materials” and “design.” We have included more IDEO perspective based on industry experience that one of us (KJ) has accumulated over the last 10+ years in order to illustrate not just a point-of-view about materials and design but also to introduce and define the role of materiality and making. Based on Mike’s recent work, there is a new chapter about sustainability and issues related to eco- and “green” design. The material and process profiles, too, have expanded once again to include more biopolymers and fibers and we have added some new photography in order to make them each more accessible and inspirational.

Books on material selection—and there are many—focus on finding a match between material properties, the technical requirements of a design, and the science of materials. There are now well-developed methods for doing this, supported by sophisticated software tools (Granta Design, CES). Together they form the basis for the teaching of material selection in engineering programs around the world. But these programs frequently ignore or at best devote little attention to what might be called the art of materials—the role they play in industrial design. This may be because the more technical aspects of engineering form a structured, analytical field that can be recorded and taught as a set of formal procedures. Design cannot so easily be formulated as a method; it relies instead on

Mike Ashby's Top Five

1. *The Material of Invention*—Intriguing descriptions of the role of material in “invention.” Manzini, E. (1989), ISBN: 0-85072-247-0.
2. *Experiences in Visual Thinking*—A very readable introduction to creative thinking and design. McKim, R.H. (1980), ISBN: 0-8185-0411-0.
3. *The Visual Display of Quantitative Information*—The bible of graphical methods for representing—and misrepresenting—information. Tufte, E.R. (1983), ISBN: 0-9613921-0-X.
4. *Designing Pleasurable Products*—A discussion of the design requirements of function, usability and pleasure. Jordan, P.S. (2000), ISBN: 0-748-40844-4.
5. *Design of Everyday Things*—A book that provides insight into the design of familiar products. Norman, D.A. (1998), ISBN: 0-385-26774-6.

Kara Johnson's Top Five

1. *Manufacturing Processes for Design Professionals*—The best reference available to get inside the factory. Thompson, R. (2007), ISBN: 978-0-500-51375-0.
2. *Ronan and Erwan Bouroullec (Works)*—An inspiring documentary of the Bouroullec brothers' design process and experimentation. Bouroullec, R&E and Koivu, A. (2012), ISBN: 978-0714862477.
3. *Haptic*—A collection of objects inspired by and made from paper. Takeo Paper Show (2004), ISBN: 978-4022579317.
4. *Suke Suke, Fuwa Fuwa, Zawa Zawa*—A collection of extreme manipulations of beautiful fabrics. Nuno Corporation, www.nuno.com.
5. *I Miss My Pencil*—A series of experiments in the senses, modern craft, love and fetish. Johnson, K. and Bone, M. (2009), ISBN 978-0-8118-6075-8.

"visual" thinking, sketching and modeling, an exploration of aesthetics and perception, behaviors and storytelling.

This book is about the role of materials and processes in product design. It complements an earlier text (by Mike) that develops methods for choosing materials and processes to match the technical requirements of a product: "Materials Selection in Mechanical Design." Here, by contrast, the emphasis is on a wider range of the information about materials that designers need, the way they use it, and the reasons they do so. This book preceded but also complements a set of design experiments published a few years ago by Kara: "I Miss My Pencil." These experiments were intended to inspire designers to think about objects and materiality as a form of storytelling within the context of the following categories: the senses, craft, love, and fetish.

The book has two audiences: students and working designers. For students, the purpose is to introduce the role of materials and manufacturing in design, using language and concepts with which they are already familiar. For working designers, the purpose is to present a concise reference source for materials and manufacturing, profiling their characteristics. To this end, the book is divided into two parts. The first presents ideas about mixing materiality and design, methods of material selection, and relevant case studies; the second is devoted to the profiles. Whether studying or working...this book is written for material scientists who want to know more about design, and for designers who want to know more about materials.

Many colleagues have been generous with their time and ideas. In particular, we are grateful for discussions, criticisms, contributions, and constructive suggestions from Professor Yves Brechet of the University of Grenoble; Dr. David Cebon, Dr. John Clarkson, Dr. Hugh Shercliff, Dr. Luc Salvo, Dr. Didier Landru, Dr. Amal Esawi, Dr. Ulrike Wegst, Ms. Veronique Lemerrier, Mr. Christophe LeBacq, and Mr. Alan Heaver of Cambridge University; Dr. Pieter-Jan Stappers of the Technical University of Delft; Dr. Torben Lenau of the Technical University of Denmark; Jihoon Kim from IDTC and Nicolas Zurcher from IDEO for their photography; and Julie Christensen of Surface Design, San Francisco for her mentorship. We have included case studies from IDEO and we both deeply appreciate the opportunity to continue to work with IDEO to define and explore the role of materials and materiality in design and to unlock the culture of making stuff and making ideas real that is an inherently endless and amazing part of the design process. We also particularly

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