

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

Risk Communication

People today must make decisions about many health, safety, and environmental risks. Nuclear power, HIV/AIDS, radon, vaccines, climate change, and emerging infectious diseases are just some of the issues that may face them in the news media, ballot box, or doctor's office. In order to make sound choices they need to get good information. Because their time is limited, that information has to be carefully selected and clearly presented. This book provides a systematic approach for risk communicators and technical experts hoping to serve the public by providing information about risks. The procedure uses approaches from risk and decision analysis to identify the most relevant information; it also uses approaches from psychology and communication theory to ensure that its message is understood. This book is written in nontechnical terms, designed to make the approach feasible for anyone willing to try it. It is illustrated with successful communications, on a variety of topics.

M. Granger Morgan is Lord Chair Professor of Engineering and Head of the Department of Engineering and Public Policy at Carnegie Mellon University, where he also holds academic appointments in Electrical and Computer Engineering and in the H. John Heinz III School of Public Policy and Management.

Baruch Fischhoff is University Professor in the Department of Social and Decision Sciences and the Department of Engineering and Public Policy at Carnegie Mellon University. He serves on the editorial boards of several journals and is a member of the Institute of Medicine of the National Academy of Sciences.

Ann Bostrom is Associate Professor in the School of Public Policy at the Georgia Institute of Technology.

Cynthia J. Atman is Director of the Center for Engineering Learning and Teaching in the College of Engineering at the University of Washington, where she also holds an academic appointment as Associate Professor of Industrial Engineering.

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

RISK COMMUNICATION

A Mental Models Approach

M. Granger Morgan

Carnegie Mellon University

Baruch Fischhoff

Carnegie Mellon University

Ann Bostrom

Georgia Institute of Technology

Cynthia J. Atman

University of Washington



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

CAMBRIDGE UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9780521802239

© Cambridge University Press 2002

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2002

Reprinted 2011

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data

Risk communication : a mental models approach / M. Granger Morgan ... [et al].
p. cm.

Includes bibliographical references and index.

ISBN 0-521-80223-7 - ISBN 0-521-00256-7 (pbk.)

1. Risk communication. I. Morgan, M. Granger (Millett Granger), 1941-

T10.68 R58 2001

658.4'08 - dc21 00-067448

ISBN 978-0-521-80223-9 Hardback

ISBN 978-0-521-00256-1 Paperback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

CONTENTS

| | |
|--|-----------|
| <i>Preface</i> | ix |
| 1 INTRODUCTION | 1 |
| 1.1 The context of risk communication | 1 |
| 1.2 The goals of risk communication | 3 |
| 1.3 The goals of communication recipients | 5 |
| 1.4 Criticisms of risk communication | 7 |
| 1.5 How people think about risk and uncertainty | 10 |
| 1.6 What kinds of communications are we considering? | 14 |
| 2 OUR MENTAL MODELS APPROACH | 19 |
| 2.1 The need for a systematic approach | 19 |
| 2.2 The mental models metaphor | 21 |
| 2.3 Constructing the influence diagram | 22 |
| 2.4 Eliciting mental models | 23 |
| 2.5 The value of open-ended interviews | 25 |
| 2.6 The cost of open-ended interviews | 26 |
| 2.7 Confirmatory questionnaires | 27 |
| 2.8 Creating communications | 28 |
| 2.9 More testing | 29 |
| 2.10 Is it worth it? | 30 |
| 3 CREATING AN EXPERT MODEL OF THE RISK | 34 |
| 3.1 Influence diagrams | 35 |

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

vi

CONTENTS

| | | |
|----------|--|-----------|
| 3.2 | Strategies for creating influence diagrams | 42 |
| 3.3 | Examples of influence diagrams | 48 |
| 3.4 | Summary | 58 |
| 4 | MENTAL MODELS INTERVIEWS | 63 |
| 4.1 | Designing and testing the interview protocol | 63 |
| 4.1.1 | Strategy | 63 |
| 4.1.2 | Design details: A radon example | 65 |
| 4.2 | Conducting the interview | 70 |
| 4.2.1 | Strategy | 70 |
| 4.2.2 | Quality control | 74 |
| 4.2.3 | Sample participants | 74 |
| 4.2.4 | Sample size | 76 |
| 4.3 | Picture sorting | 78 |
| 4.4 | Summarizing, analyzing, and interpreting the results | 79 |
| 5 | CONFIRMATORY QUESTIONNAIRES | 84 |
| 5.1 | Objectives of questionnaire studies | 84 |
| 5.2 | Designing and testing confirmatory questionnaires | 86 |
| 5.3 | Conducting and analyzing the study | 92 |
| 5.4 | Special questionnaires to explore key points | 95 |
| 6 | DEVELOPMENT AND EVALUATION OF COMMUNICATIONS | 97 |
| 6.1 | Principles | 97 |
| 6.1.2 | Choosing message content: A radon example | 98 |
| 6.2 | Building messages from users' decision needs and mental models results | 100 |
| 6.3 | Evaluation | 103 |
| 6.4 | Technical review | 104 |
| 6.4.1 | Choosing experts | 104 |
| 6.5 | Text-based evaluation methods | 106 |
| 6.5.1 | A radon example of text-based evaluation | 106 |
| 6.6 | Reader-based evaluation methods | 111 |
| 6.6.1 | Open-ended methods | 112 |
| 6.6.2 | Structured evaluations/surveys | 116 |
| 6.7 | Conclusion | 120 |

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

CONTENTS

vii

| | | |
|-----|--|-----|
| 7 | CASE STUDIES: APPLICATIONS TO ENVIRONMENTAL RISKS | 125 |
| 7.1 | Climate change | 125 |
| 7.2 | Power-frequency fields | 141 |
| 7.3 | Radon in homes | 151 |
| 7.4 | Nuclear energy sources for space missions | 154 |
| 8 | A MENTAL MODELS APPROACH TO HIV/AIDS | 160 |
| 8.1 | An expert model of HIV/AIDS | 161 |
| 8.2 | Mental models interviews | 164 |
| 8.3 | A structured survey | 167 |
| 8.4 | A mental models communication and its evaluation | 171 |
| 8.5 | Discussion | 173 |
| 9 | SOME CONCLUDING THOUGHTS | 179 |
| 9.1 | The cost of risk communication | 179 |
| 9.2 | Quality assurance | 180 |
| 9.3 | Mental models methods in context | 182 |
| 9.4 | The bottom line | 182 |
| | <i>Appendix A: Brochure on global warming and climate change</i> | 185 |
| | <i>Appendix B: Brochure on fields from electric power</i> | 239 |
| | <i>Appendix C: Risk communication materials on HIV/AIDS</i> | 303 |
| | <i>Appendix D: Sample transcripts of mental model interviews</i> | 329 |
| | <i>Index</i> | 341 |

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

PREFACE

Do-it-yourself books typically help readers to perform physical tasks, such as installing energy-efficient windows or growing aphid-free roses. This do-it-yourself book offers help on an intellectual task: developing risk communications using a mental models approach. Such communications are designed to contain, in readily usable form, the information that people need to make informed decisions about risks to health, safety, and the environment. Some of these decisions involve risks that individuals face in their everyday lives. Others involve risks that they must address as citizens in a modern society.

The public health and safety communities have long attempted to tell people about risks such as home fires, infectious disease, and auto accidents. The design of most of their communications relies primarily on intuition and conventional wisdom. Some of these communications have worked well, especially those with inherently simple messages, such as “don’t smoke in bed.” Although people may not have followed this advice, that is not because they did not understand *what* they were supposed to do, although not understanding *why* may have reduced compliance. Other communications have been less successful, even with ostensibly clear-cut messages (e.g., “Just Say No”). These messages have much simpler content than attempts to explain such complex, novel risks as those posed by modern technical systems or environmental pollution.

Our method was created to meet this challenge, with an approach that reflects both the natural science of how risks are created and con-

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

trolled and the social science of how people comprehend and respond to such risks. In the original project, Greg Fischer, Baruch Fischhoff, and Emilie Roth represented the theories and methods of psychology. Lester Lave brought the perspective and analytical methods of economics. Granger Morgan and Indira Nair offered the skills and substantive knowledge of natural science and engineering. All contributed their experiences with policy analysis and contacts with the communities in which these results might be used. Several doctoral students and postdoctoral fellows provided backgrounds in engineering, management, law, policy analysis, and applied social science; they include Cynthia Atman, Ann Bostrom, Keith Florig, Gordon Hester, Urbano Lopez, Michael Maharik, Jon Merz, and Marilyn Jacobs Quadrel.

Together, we developed the approach presented here. At its heart are commitments to the scientific facts of risk, the empirical understanding of human behavior, and the need for openness in communication about risk. We sought an approach that would treat diverse problems with a common set of methods and theories, as well as one that would be readily usable by the professionals entrusted with communicating about risks. The method presented here has been applied to such diverse topics as the potential risks from radon in homes, nuclear energy sources in space, electromagnetic fields, climate change, and sexually transmitted diseases. Some of the resulting communications have been professionally published and widely distributed to the public. We have also benefited from the experiences of Sarah Thorne and Gordon Butte, of Decision Partners, with whom we have tested and adapted these methods in a variety of applications.

This book is designed to share what we have learned. In our work, we have found that each communication task creates new challenges, reflecting either the nature of the risk or people's intuitive beliefs about it. As a result, while this is a do-it-yourself book, use it as a field guide rather than a cookbook! Don't hesitate to innovate when our standard methods do not fully address the particular situation you face – and, please, share your experiences with us.

In addition to the people just listed, a number of others have helped to make our work possible. Patti Steranchak provided extensive administrative support and assisted in the development of many of the materials, the production of most of the communication brochures, and the prepara-

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

PREFACE

xi

tion of this manuscript. Connie Cortés conducted many of the mental models interviews in the early years of the project. Claire Palmgren picked up where she left off. Other significant contributions have come from Jack Adams, Tony Bradshaw, Wändi Bruine de Bruin, Irene Brychcin, Stephanie Byram, Caron Chess, Wendy Davis, Julie Downs, George Duncan, Dan Geisler, Dan Kovacs, David Lincoln, Donald MacGregor, Kevin Marsh, Denise Murrin-Macey, Karen Pavlosky, Richard Puerzer, Daniel Reed, Donna Riley, Karen Schriver, Paul Slovic, Tom Smuts, Ola Svenson, and Rosa Stipanovic, as well as from dozens of experts who reviewed our draft communications, and hundreds of individuals who participated in a wide variety of experimental studies.

Finally, we thank our spouses, Betty Morgan, Andi Fischhoff, Doug Bostrom, and Mike Meyer, for the patience and support that have made this work possible.

Creating such a broad-based and interdisciplinary method would not have been feasible without core support from the National Science Foundation (under grants SBR-9521914, SES-8715564, SES-9309428, SES-9022738, SES-9209940, SES-9209553 and SES-9975200) and supplementary support from the Electric Power Research Institute (under contracts RP 2955-3, RP 2955-10, and RP 2955-11), the Carnegie Corporation of New York, the Environmental Protection Agency (under grant CR 824706-01-2 and R8279200-1-0), the National Institute for Alcohol Abuse and Alcoholism (under grant IU19AI 38513), the National Institute of Allergies and Infectious Disease (under grant IU19 AI 38513), and the Scaife Family Foundation.

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

Cambridge University Press

978-0-521-80223-9 - Risk Communication: A Mental Models Approach

M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia J. Atman

Frontmatter

[More information](#)

Risk Communication