



Contents

<i>Preface: Why and How</i>	ix
1. What Gets Included	1
2. How We Got Here	7
2.1 Materials Used by Organisms	8
2.2 Materials in Prehistory	11
2.3 Ancient and Medieval Materials	15
2.4 Materials in the Early Modern Era	22
2.5 Creating Modern Material Civilization	27
2.6 Materials in the Twentieth Century	34
3. What Matters Most	45
3.1 Biomaterials	46
3.2 Construction Materials	52
3.3 Metals	57
3.4 Plastics	62
3.5 Industrial Gases	65
3.6 Fertilizers	70
3.7 Materials in Electronics	72
4. How the Materials Flow	77
4.1 Material Flow Accounts	79
4.2 America's Material Flows	83
4.3 European Balances	87
4.4 Materials in China's Modernization	90
4.5 Energy Cost of Materials	94
4.6 Life-Cycle Assessments	103
4.7 Recycling	111
5. Are We Dematerializing?	119
5.1 Apparent Dematerializations	120
5.2 Relative Dematerializations: Specific Weight Reductions	122
5.3 Consequences of Dematerialization	129

5.4	Relative Dematerialization in Modern Economies	137
5.5	Declining Energy Intensities	143
5.6	Decarbonization and Desulfurization	151
6.	Material Outlook	157
6.1	Natural Resources	158
6.2	Wasting Less	165
6.3	New Materials and Dematerialization	168
6.4	Chances of Fundamental Departures	173
Appendix A Units and Unit Multiples		181
Appendix B US Material Production, GDP and Population, 1900–2005		183
Appendix C Global Population, Economic Product, and Production of Food, Major Materials, and Fuels 1900–2010		185
Appendix D Global Energy Cost of Major Materials in 2010		187
Appendix E		189
<i>References</i>		191
<i>Index</i>		223