

# CONTENTS

## CHAPTER ONE

### PERSPECTIVE ON PACKAGING

1

What Is Packaging?

3

Primitive Packaging

4

From Rome to the Renaissance

6

The Industrial Revolution

7

The Evolution of New Packaging Roles

8

Packaging in the Late 20th Century

10

Modern Packaging

12

Environmental and Sustainability Issues

21

The Modern Packaging Industry

31

## CHAPTER TWO

### PACKAGING FUNCTIONS

37

Introduction

39

The Contain Function

40

The Protect/Preserve Function

41

The Food Preservation Function

42

The Transport Function

56

The Inform/Purchase Decision Function

57

The End-of-Life or Cradle-to-Cradle Function

58

**CHAPTER THREE**

**BRAND IDENTITY STRATEGY AND PACKAGE DESIGN 61**

|  |    |
|--|----|
| Introduction                                       | 63 |
| Demographics, Psychographics and Ethnography       | 65 |
| The Retail Environment                             | 68 |
| Fundamental Messages                               | 69 |
| Equity and Brand Names                             | 71 |
| Color  | 73 |
| Graphic Design Elements                            | 74 |
| Balance and Unity                                  | 76 |
| Direction and Dominance                            | 76 |
| Typography   | 78 |
| Package and Marketing Studies                      | 80 |
| Market and Package Evaluation Methodology Examples | 81 |

**CHAPTER FOUR**

**PACKAGE PRINTING AND DECORATING 89**

|  |     |
|--|-----|
| Introduction   | 91  |
| Color  | 91  |
| Artwork  | 100 |
| Preparation for Printing                                 | 107 |
| Proofing   | 109 |
| Printing Methods   | 111 |
| Relief Printing: Flexography and Letterpress             | 113 |
| Lithography  | 116 |
| Gravure Printing   | 119 |
| Digital Printing   | 121 |
| Comparing Flexography, Lithography, Gravure, and Digital | 122 |
| Other Package Decoration Techniques                      | 124 |
| Printing Dimensional Packages                            | 127 |
| Labeling   | 131 |

**CHAPTER FIVE**

**ENVIRONMENTAL AND SUSTAINABILITY ISSUES 137**

|                              |     |
|------------------------------|-----|
| Consumer Perceptions         | 139 |
| Sustainability and Packaging | 139 |

|  |     |
|--|-----|
| Defining and Producing Sustainable Packaging | 142 |
| Environmental Labeling and Declaration       | 150 |
| Environmental Packaging Procedure Template   | 154 |

## CHAPTER SIX

### **PAPER AND PAPERBOARD** **165**

|  |     |
|--|-----|
| Sources and Preparation of Fiber           | 167 |
| Representative Paper-Making Machines       | 171 |
| Paper Characterization                     | 176 |
| Paper Types                                | 179 |
| Paperboard Grades                          | 181 |
| Selected Methods of Paper Characterization | 183 |

## CHAPTER SEVEN

### **PAPERBOARD CARTONS** **187**

|                                    |     |
|------------------------------------|-----|
| Paperboard Package Classifications | 189 |
| Folding Carton Design              | 190 |
| Selecting the Correct Paperboard   | 193 |
| The Carton Production Process      | 194 |
| Basic Tube-Style Folding Cartons   | 197 |
| Basic Tray-Style Cartons           | 205 |
| Beverage Baskets and Setup Boxes   | 208 |

## CHAPTER EIGHT

### **METAL CANS AND CONTAINERS** **213**

|                              |     |
|------------------------------|-----|
| Background                   | 215 |
| Can-Making Steels            | 217 |
| Three-Piece Steel Cans       | 219 |
| Two-Piece Drawn Cans         | 221 |
| Impact Extrusion             | 225 |
| Aerosol Cans                 | 228 |
| Can Dimensioning             | 228 |
| Protective Coatings for Cans | 228 |
| Decoration                   | 230 |
| Aerosols                     | 230 |

**CHAPTER NINE**

**GLASS CONTAINERS 239**

|                                    |     |
|------------------------------------|-----|
| Glass Types and General Properties | 241 |
| Commercial Glass Manufacturing     | 243 |
| Bottle Manufacturing               | 245 |
| Bottle Design Features             | 251 |

**CHAPTER TEN**

**POLYMER CHEMISTRY FOR THE NONCHEMIST 261**

|                                      |     |
|--------------------------------------|-----|
| Introduction to Plastics             | 263 |
| Polarity and Material Properties     | 266 |
| Hydrocarbons and Polyethylene        | 267 |
| Other Packaging Polymers             | 273 |
| Molecular Structure and Properties   | 274 |
| Thermal Behavior                     | 277 |
| Density and Yield                    | 280 |
| Thermoplastic and Thermoset Polymers | 281 |

**CHAPTER ELEVEN**

**SHAPING PLASTICS 285**

|  |     |
|--|-----|
| Selecting the Material and the Process | 287 |
| Plasticating Extruders                 | 289 |
| Profile Extrusion                      | 290 |
| Injection Molding                      | 295 |
| Extrusion Blow Molding                 | 301 |
| Injection Blow Molding                 | 306 |
| Bottle Design                          | 310 |
| Thermoforming                          | 314 |
| Other Forming Methods and Variations   | 318 |
| Recognizing Molding Methods            | 321 |

**CHAPTER TWELVE**

**PLASTIC APPLICATIONS 325**

|   |     |
|---|-----|
| Polyethylene (PE)   | 327 |
| High-Density Polyethylene (HDPE)  | 328 |
| Low-Density Polyethylene (LDPE) and Linear Low-Density Polyethylene (LLDPE) | 330 |

|  |            |
|--|------------|
| Polystyrene (PS)   | 332        |
| Polypropylene (PP)   | 333        |
| Polyethylene Terephthalate (PET)                           | 335        |
| Polyvinyl Chloride (PVC)                                   | 337        |
| Polyvinylidene Chloride (PVDC)                             | 338        |
| Polyvinyl Acetate (PVAC) and Ethylene-Vinyl Acetate (EVA)  | 339        |
| Polyamide (PA or Nylon)                                    | 339        |
| Polyvinyl Alcohol (PVAL) and Ethylene-Vinyl Alcohol (EVOH) | 341        |
| Ethylene Acid Copolymers and Ionomers                      | 341        |
| Other Packaging Polymers                                   | 342        |
| Additives  | 345        |
| Characterizing Plastic Materials                           | 346        |
| Chemical Properties  | 355        |
| <b>CHAPTER THIRTEEN</b>                                    |            |
| <b>CLOSURES</b>  | <b>361</b> |
| Selection Considerations                                   | 363        |
| Container and Closure Dimensioning                         | 364        |
| Metal Closures   | 367        |
| Closure Seals  | 370        |
| Plastic Closures   | 373        |
| Injection Molds and Closure Design                         | 374        |
| Closure Application  | 376        |
| Tamper Evidence  | 378        |
| Tamper-Evident Closure Systems                             | 379        |
| Child-Resistant (CR) Closures                              | 380        |
| Special Closures and Functions                             | 380        |
| <b>CHAPTER FOURTEEN</b>                                    |            |
| <b>ADHESIVES</b>   | <b>389</b> |
| Introduction to Adhesives                                  | 391        |
| Theories of Adhesion                                       | 392        |
| Surface Treatment  | 394        |
| Solidification   | 397        |
| Common Classes of Packaging Adhesive                       | 399        |
| Flexible Laminating Adhesives                              | 405        |

|                                       |     |
|---------------------------------------|-----|
| Adhesive Application                  | 406 |
| Viscosity                             | 407 |
| Adhesive Selection and Considerations | 410 |
| Inspecting Bond Failures              | 415 |

**CHAPTER FIFTEEN**

**FLEXIBLE PACKAGING LAMINATES 419**

|   |     |
|---|-----|
| Laminates   | 421 |
| Aluminum Foil                                     | 422 |
| Vacuum Metallizing                                | 427 |
| Other Non-Organic Coatings and Barrier Treatments | 430 |
| Laminate Structural and Physical Properties       | 432 |
| Flexible Bags, Pouches and Sachets                | 434 |
| Vertical and Horizontal Form/Fill/Seal Machines   | 434 |
| Sealability                                       | 436 |
| Barrier Properties                                | 439 |
| Aesthetics and Other Properties                   | 441 |
| Laminating Processes                              | 442 |
| Specifying Laminates                              | 446 |
| Examples of Laminates                             | 448 |

**CHAPTER SIXTEEN**

**CORRUGATED FIBERBOARD 453**

|  |     |
|--|-----|
| Introduction   | 455 |
| Papermaking  | 455 |
| The Corrugated Structure                               | 459 |
| Corrugated Box Manufacturing                           | 461 |
| The Corrugator   | 464 |
| Finishing/Converting                                   | 465 |
| Regulations and Standards                              | 468 |
| Specifying Box Requirements and Design with Box Styles | 473 |
| Testing (Shop Floor and Referee)                       | 477 |
| Special Treatments                                     | 486 |
| References   | 488 |
| Reference Organizations                                | 489 |

**CHAPTER SEVENTEEN**

|  |            |
|--|------------|
| <b>DISTRIBUTION PACKAGING</b>              | <b>491</b> |
| Distribution Packaging: A Systems Approach | 493        |
| Tracking Distribution Losses               | 499        |
| The Warehouse                              | 503        |
| Unit Loads                                 | 504        |
| Good Distribution Practice                 | 509        |
| Evaluating Distribution Packaging          | 511        |

**CHAPTER EIGHTEEN**

|  |            |
|--|------------|
| <b>SHOCK, VIBRATION AND COMPRESSION</b>  | <b>525</b> |
| Shock                                    | 527        |
| Quantifying Shock Fragility              | 530        |
| Cushioning Against Shock                 | 534        |
| Vibration                                | 536        |
| Compression                              | 540        |
| Estimating Required Compression Strength | 546        |

**CHAPTER NINETEEN**

|                                   |            |
|-----------------------------------|------------|
| <b>PACKAGING LAW</b>              | <b>551</b> |
| Complying with Legal Requirements | 553        |
| Subject Matter of Packaging Law   | 554        |
| Concepts of Packaging Law         | 560        |

**CHAPTER TWENTY**

|                                  |            |
|----------------------------------|------------|
| <b>PACKAGING MACHINERY</b>       | <b>567</b> |
| Automated Production             | 569        |
| The New Production Line          | 570        |
| Speed                            | 573        |
| Buffers                          | 577        |
| Straight-Line and Rotary Systems | 579        |
| Changeovers                      | 581        |
| Machine Control                  | 583        |
| Upgrading Existing Equipment     | 584        |
| Filling Systems                  | 584        |

|   |     |
|---|-----|
| Liquid Filling                                    | 586 |
| Dry-Product Filling                               | 591 |
| Introduction to Statistical Process Control (SPC) | 596 |
| Sources of Information                            | 604 |

**CHAPTER TWENTY-ONE**

**APPLIED PACKAGING 609**

|   |     |
|---|-----|
| Carded Display Packaging                            | 611 |
| Blister Packaging                                   | 612 |
| Carded Skin Packaging                               | 614 |
| Chub Packages                                       | 615 |
| Fiber Cans  | 615 |
| Collapsible Tubes                                   | 617 |
| Plastic and Paper Bags                              | 618 |
| Bar Codes   | 622 |
| Security Labeling                                   | 626 |
| Durable Goods Packaging                             | 627 |
| Wood Packaging                                      | 628 |
| Pharmaceutical Packaging: Human Drugs and Biologics | 630 |
| Creative Designs                                    | 644 |
| Molded Pulp Containers and Forms                    | 648 |

**CHAPTER TWENTY-TWO**

**THE PACKAGE DEVELOPMENT PROCESS 653**

|   |     |
|---|-----|
| Managing the Packaging Function                           | 655 |
| Project Scope   | 657 |
| Package Development Process                               | 659 |
| Specifications  | 665 |
| Writing a Specification                                   | 668 |
| Case Study: Redesign of an Oil Bottle and Shipping System | 673 |
| An Example of Graphic Design Development                  | 678 |
| Package Designer's Checklist                              | 680 |

**ANSWERS TO CHAPTER REVIEW QUESTIONS 689**

**INDEX 725**