

# INDEX

- Abbreviations, 981–984
- Abrasive technique, surface treatment, 867–868
- Absorbent paper, described, 716
- Acceleration, vibration, 955–956
- Acceptable quality limit (AQL), 849
- Accordion-fold tags, 878
- Acetate, plastic films, 163
- Acronyms, 981–984
- Acrylate coatings, evaporated, surface treatment, 872
- Acrylic adhesives, acrylic plastic polymers, 1
- Acrylic-based inks, acrylic plastic polymers, 1
- Acrylic multipolymers, nitrile polymers, 670
- Acrylic plastic polymers, 1–2
  - acrylic adhesives, 1
  - acrylic-based inks, 1
  - PVC modifiers, 2
- Acrylonitrile (AN), hot-fill technology, 495
- Acrylonitrile-butadiene-styrene (ABS), nitrile polymers, 670
- Active packaging, 2–8
  - defined, 2
  - film composites, 5–7
  - forms of, 3–5
  - goals of, 3
  - modified atmosphere packaging, 652–653
  - problems addressed by, 2–3
  - research and development, 7
- Additives (plastic), 8–13
  - antiblocking agents, 8–9
  - antifogging agents, 9
  - antimicrobial agents, 9
  - antioxidant agents, 9
  - antiozonant agents, 9
  - antislip agents, 9
  - antistatic agents, 9
  - barrier polymers, permeability variations, 74
  - biodegradable-biocide environment, 9–10
  - blowing and foam agents, 10
  - catalyst agents, 10
  - colorant agents, 10
  - coupling agents, 10
  - electrically conductive agents, 10–11
  - flame retardant agents, 11
  - fragrance enhancer agents, 11
  - heat stabilizer agents, 11
  - impact modifier agents, 11
  - lubricant agents, 11
  - mold release agents, 11–12
  - nucleating agents, 12
  - overview, 8
  - plasticizer agents, 12
  - processing aid agents, 12
  - reinforced plastic low-profile agents, 12
  - slip agents, 12
  - stabilizing agents, 12–13
  - ultraviolet stabilizing agents, 13
- Adhesive applicators, 13–23
  - cold-glue systems, 14
  - equipment classification, 14
  - hot-melt systems, 15–20
  - maximum instantaneous delivery rate calculation, 20–22
  - packaging adhesives, 13–14
- Adhesive bond strength, polymer properties, 763
- Adhesives, 23–25
  - corrugated boxes, 101
  - extrudable, 25–28
    - applications of, 27
    - commercial forms, 26–27
    - overview, 25–26
    - types of, 26
  - fiber drums, 311
  - hot-melt adhesives, 24–25
  - medical packaging, 612–613
  - overview, 23
  - radiation effects, 798
  - solvent-borne adhesives, 25
  - surface and hydrocarbon-barrier modification, 864–865
  - waterborne systems, 23–24
- Advance disposal fees, environmental regulation, 353
- Advertising, law and regulation (U.S.), 557
- Aerosol containers, 27–31. *See also* Pressure containers
  - current technology, 28–29
  - future trends, 30–31
  - history, 27–28
  - tinplate options, 29–30
- Aerosol propellants, 787–791
  - chemistry, 788–791
  - overview, 787–788
- Aesthetics
  - bottle and jar closures, 208, 214
  - consumer packages, 889
- Air conveying, 31–35
  - benefits of, 34–35
  - characteristics of, 33–34
  - function of, 31–33
  - system design and installation, 274–276
- Air-removal system, vacuum packaging, 949–951
- Air shipment, export packaging, 370
- Alcoholic beverages. *See also* Beer; Beverage casks, 71
  - food packaging, 703–704
- Aliphatic polyesters/thermoplastic starch, biodegradable materials, 79
- Aluminum
  - dual-ovenable packaging, 645
  - radiation effects, 796
  - recycling, 345, 801, 804
- Aluminum cans, 132–134. *See also* Metal cans; Steel cans
  - aerosol propellants, 789–790
  - carbonated beverages, 159
  - hot-fill technology, 493–494
  - pressure containers, 781
- Aluminum closures, bottle and jar closures, 216
- Aluminum drums, testing, 894
- Aluminum foil, 458–463
  - applications, 460–461
  - aseptic packaging, 462–463
  - flexible foil packages, 461–462
  - foil lidding, 462
  - history, 459
  - ionomers, 529
  - lidding, 563
  - material, 458–459
  - microwave ovens, 463
  - properties, 459–460
  - regulated packages, 462
  - rigid packaging, 463
  - semirigid packaging, 463
- Aluminum pressure containers, 781
- American Association of Railroads
  - packaging forms, 573
  - plastic pails, 706
- American Cancer Society, nutrition labeling, 675
- American Heart Association, nutrition labeling, 675
- American National Standards Institute (ANSI)
  - bulk bags (flexible intermediate bulk containers), 53
  - filling machinery, still liquid, 396

- American National Standards Institute (ANSI) (*Continued*)  
 ISO standards, 524  
 steel drums and pails, 321
- American Society for Testing and Materials (ASTM)  
 biodegradable materials, 77  
 bulk packaging, 53, 122  
 career development, 167  
 child-resistant packaging, 203  
 cushioning design, 289  
 distribution hazard measurement, 305  
 distribution packaging, 309  
 edge-crush concept, 332  
 electrostatic discharge protective packaging, 342  
 forensic packaging, 464  
 heat sealing, 827  
 permeation testing, 896  
 plastic drums, 316  
 polymer properties, 760-764  
 pressure-sensitive tape, 883-884, 885, 886  
 product fragility testing, 903, 904  
 retortable packages, 808  
 shipping containers, 906-909  
 slipsheets, 844  
 solid-fiber boxes, 113  
 testing, 894  
 vibration, 957, 958
- American Trucking Association  
 packaging forms, 573  
 transportation codes, 930
- Amorphous-poly- $\alpha$ -olefin (APAO) polymers,  
 hot-melt adhesives, 25
- Ampuls and vials, glass, 35-38
- Animal glue, waterborne adhesives, 23
- ANSI. *See* American National Standards Institute (ANSI)
- Antiblocking agents, additives, plastic, 8-9
- Antifogging agents, additives, plastic, 9
- Antimicrobial agents, additives, plastic, 9
- Antimicrobial films, active packaging, 6-7
- Antioxidant agents, additives, plastic, 9
- Antiozonant agents, additives, plastic, 9
- Antislip agents, additives, plastic, 9
- Antistatic agents, additives, plastic, 9
- Applicators, bottle and jar closures, 211
- Apron conveyor, 271
- Argon, modified atmosphere packaging, 651
- Arm conveyor, 271
- Aroma barrier testing, 38-41  
 apparatus for, 40-41  
 overview, 38-39  
 permeation testing, 898  
 temperature effects, 40  
 test vapor generation, 41  
 theory, 39-40
- Aromas, permeability (of aromas and solvents), 724-733. *See also* Permeability (of aromas and solvents)
- Artificial intelligence (AI), integrated packaging design and development, 514. *See also* Computer applications
- Aseptic packaging, 41-45. *See also* Medical packaging; Sterile disposable healthcare products  
 aluminum foil, 462-463  
 fiber drums, 312-313  
 filling systems, 43, 44  
 food packaging, 702  
 history, 42  
 materials, 43-45  
 multilayer flexible packaging, 661  
 overview, 41-42  
 package characteristics, 42  
 process systems, 42-43  
 sterile disposable healthcare products, 693-699  
 thermal process, 42
- Aseptic process, blow molding, 91-92
- Asia, environmental regulation, 350-351
- ASTM. *See* American Society for Testing and Materials (ASTM)
- Augers, dry-product filling machinery, 385
- Australia, environmental regulation, 350-351
- Austria, environmental law and regulation, 550
- Automatic wraparound case loading, 193
- Backpressure force  
 air conveying, 31-32  
 conveying speed, 282
- Bag closures, 220
- Bag-in-box packaging, 46-51  
 cartoning machinery (end-load), 584  
 dry product, 46-48  
 form/fill/seal pouch, horizontal, 467-468  
 liquid product, 48-51  
 oriented polyester film, 412-413
- Bagmaking machinery, 54-60  
 electronic controls, 59-60  
 multiwall-bag machinery, 54-56  
 overview, 54  
 plastic bag machinery, 56-59
- Bags  
 bulk, flexible intermediate bulk containers. *See* Bulk bags (flexible intermediate bulk containers)  
 bulk packaging, 121  
 heavy duty, plastic, 60-61  
 multiwall. *See* Multiwall bag(s)  
 plastic, 66-69. *See also* Plastic bag(s)  
 testing, 890-891
- Bakery products  
 bag closures, 220  
 modified atmosphere packaging, 654
- Balanced-pressure fillers, filling machinery,  
 still liquid, 390-391
- Bandpass filters, vibration, 957
- Bands, shrink, 69-70
- Band sealing, heat sealing, 824
- Bar chain conveying. *See* Lug or bar chain conveying
- Bar code, 225-228  
 applications, 227  
 benefits of, 225  
 computer applications, 228-231  
 data content, 227  
 defined, 225  
 labeling, 537  
 printing of, 228  
 reading of, 228  
 symbology, 225-227
- Barges, export packaging, 368
- Barrels, 70-71
- Barrier films  
 bag-in-box packaging, liquid product, 49  
 defined, 177  
 multilayer flexible packaging, 660-661
- Barrier-foam trays, 931-933
- Barrier polymers, 71-77  
 availability, 76-77  
 modified atmosphere packaging, 652-653  
 nitrile polymers, 670  
 overview, 71-72  
 permeability data, 73  
 permeability units, 73  
 permeability variations, 73-76  
 permeation process, 72-73  
 polymer composition, 76  
 polymer properties, 763
- Bar sealing, heat sealing, 823-824
- "Basic resin doctrine" exemption, law and regulation (U.S.), food packaging, 554
- Basis weight  
 defined, 177  
 paperboard, 718
- Beer. *See also* Alcoholic beverages; Beverage carbonated beverages compared, 160-161  
 food packaging, 703-704  
 glass bottles, 159  
 metal cans, 159
- Belgium, 350, 550
- Belt conveying, 266-268
- Belt feeders, dry-product filling machinery, 386
- Bending moment, defined, marine environment, 592-595
- Beverage carriers, 168-170
- Beverage industry. *See also* Alcoholic beverages; Beer  
 air conveying, 31-35  
 carbonated beverage packaging, 158-161  
 food packaging, 703-704
- Biaxially oriented polypropylene (BOPP), cellophane, 195
- Biodegradable-biocide environment, additives, plastic, 9-10
- Biodegradable materials, 77-83  
 cellulose, 79  
 chitin and chitosan, 79-80  
 polyamides, 81  
 polyesters, 80-81  
 poly(ethylene-co-vinyl alcohol), 82  
 polyethylene oxide, 82  
 polyurethanes, 81  
 poly(vinyl alcohol), 81-82  
 proteins, 80  
 pullulan, 80  
 standards, 77  
 starch-based materials, 78-79  
 traditional plastics, 77-78
- Biological deterioration, active packaging, 2-3
- Biplex (duplex), paperboard, 718
- Blade coating, coating equipment, 223
- Bleached board, defined, 177
- Bleached papers, described, 714
- Blister packaging. *See also* Carded packaging  
 components and assembly, 161-162  
 heat-seal coatings, 163  
 machinery, 164-165



- pharmaceutical packaging, 734
- plastic film, 423
- plastic films, 163
- skin packaging compared, 165
- Blocking, polymer properties, 763
- Blow and blow (B&B) process, glass container manufacturing, 479–480
- Blow and cast film, extrusion, 373, 375–376
- Blowing and foam agents, additives, plastic, 10
- Blow molding, 83–93
  - aseptic process, 91–92
  - defined, 83
  - extrusion-injection-molded neck process, 87
  - extrusion process, 83–87
  - heat-resistant polyester bottles, 90–91
  - history, 83
  - injection process, 87
  - labeling, 297
  - low-density polyethylene (LDPE), 757–758
  - multilayer and coextrusion process, 89–90
  - nylon, 684
  - plastic bottle design, 93, 94
  - polypropylene (PP), 767
  - process basics, 83
  - product design guidelines, 92
  - rigid plastic containers, 110
  - secondary processes, 92
  - stretch process, 87–89
- Blown-film coextrusion, 238. *See also* Coextrusion machinery
- Board thickness, defined, 177
- Boil-in-bag, oriented polyester film, 412
- Booklet tags, 877
- Bottle design, plastic. *See* Plastic bottle design
- Bottle and jar closures, 206–220
  - functions, 207–208
  - future trends, 217–218
  - history, 206–207
  - materials, 215–216
  - methods, 208–210
  - sealing systems, 214–215
  - selection of, 216–217
  - specification, 217
  - types, 210–214
- Bottles, testing, 891
- Bottom-discharge bucket conveyor, 271
- Bottom seal, plastic bags, 67
- Botulism
  - food canning, 123, 124, 701
  - oxygen scavengers, 691
- Box compression test (BCT), edge-crush concept, 332
- Boxes. *See also* Corrugated boxes; Rigid-paperboard boxes; Rigid plastic containers; Wood boxes
  - solid-fiber, 112–113
  - testing, 891–893
  - wirebound, 113–115
  - wood, 115–117
- Box-sealing tape, pressure-sensitive tape, 884–885
- Brazil, 117–120
- Bread bag closures, 220
- Breakage, export packaging, 366
- Breakaway caps, bottle and jar closures, 212–213
- Bridge impact test, shipping container testing, 907
- British Imperial System, 638
- British Standards Institute (BSI), 53
- Bruce box, 114
- Bucket elevator conveyor, 271
- Buckling resistance, cushioning design, 289
- Budgets, management, 588
- Bulk bags (flexible intermediate bulk containers), 51–54, 448–449. *See also* Intermediate bulk containers
  - disposal and reuse, 53
  - filling and dispensing, 52
  - handling, transportation and storage, 52–53
  - materials, 52
  - overview, 51
  - testing, 893
  - testing and standards, 53
  - uses for, 51–52
- Bulk packaging, 120–122
  - considerations in, 120–121
  - materials, 121–122
  - testing, 122
- Bulk palletizer, 709
- Bulk-product feed, dry-product filling machinery, 388
- Bundle-wrapping machines, wrapping machinery, 972
- Burst/seal strength, leakage testing, 900
- Butyrate, plastic films, 163
- Cable conveying, 273–274
- Calcium oxide (lime), active packaging, 3–4
- Calender coaters, coating equipment, 223
- Calendering, rigid polyvinyl chloride (PVC) film, 428–429
- California, 352–353, 354, 556
- Caliper (thickness), paperboard, 718
- Canada, 344
- Candy, food packaging, 703
- Can multipacks, beverage carriers, 168
- Canning, 123–128, 701–702
  - defined, 123
  - future trends, 128
  - hot-fill technology, 492–496
  - operations, 124–127
  - overview, 123
  - process description, 123–124
  - regulation, 127–128
- Cans
  - aluminum, 132–134
  - composite, 134–139
    - construction, 134–136
    - defined, 134
    - future trends, 137
    - manufacture, 134
    - self-manufactured, 137–139
  - corrosion, 139–143. *See also* Corrosion
  - fabrication of. *See* Metal can fabrication
  - plastic, 144
  - steel, 144–155. *See also* Steel cans
  - testing, 893
- Can seamers, 128–132
  - described, 128–129
  - features and attachments, 130–131
- history, 145
- machine types, 129–130
- methods, 129
- overlap measurement, 131
- seam profiles, 131
- seam tightness evaluation, 131
- setup, 130
- steel cans, 151
- Capping machinery, 155–158
  - continuous-thread closures, 155–157
  - presson closures, 157–158
  - rollon closures, 157
  - vacuum closures, 157
- Caps. *See* Closures
- Carbonated beverage packaging, 158–161
  - beer market compared, 160–161
  - deposit laws, 160
  - food packaging, 703
  - overview, 158
  - package types, 158–160
- Carbonated liquid filling machinery, 389–390
- Carbon dioxide
  - modified atmosphere packaging, 651
  - oxygen scavengers, 689
- Carbon dioxide absorbers, modified atmosphere packaging, 652
- Carbon dioxide tracer gas, leakage testing, 900
- Carbon dioxide transmission rate (CO<sub>2</sub>TR), permeation testing, 897–898
- Carbon monoxide, modified atmosphere packaging, 651
- Cardboard boxes. *See* Corrugated boxes
- Carded packaging, 161–166
  - blister packaging, 161–162
  - heat-seal coatings, 163–164
  - ionomers, 528
  - machinery, 164–166
  - paperboard, 164
  - plastic films, 163
  - skin packaging, 162–163
- Career development, 166–168
- Carrier rules, transportation codes, 929–930
- Carriers, beverage, 168–170
- Carton finish, defined, 177
- Cartoning machinery (end-load), 580–588
  - carton closing, 587
  - carton loading, 583
  - detectors, 587
  - fully automatic horizontal, 580–582
  - leaflet feeds, 585–586
  - microprocessors, 587–588
  - multipackers, 584–585
  - overloads, 587
  - overview, 580
  - product infeeds, 583–584
  - semiautomatic horizontal, 580
  - semiautomatic vertical, 580
  - side seam gluing, 582–583
- Cartoning machinery (top-load), 170–176
  - carton closing, 174–176
    - adhesive closure, 175–176
    - dust-flap-style closure, 174–175
    - heat-seal closure, 176
    - lock closure, 175
    - triple-seal style closure, 175
  - carton forming, 170–172



- Cartoning machinery (top-load) (*Continued*)  
 conveying, 173  
 forming capabilities, 173  
 glue forming, 172–173  
 heat-seal forming, 173  
 lock forming, 172  
 options, 176  
 product loading  
   automatic, 174  
   manual, 173
- Cartons. *See also* Folding cartons  
 folding, 181–187  
 gabletop, 187–189  
 testing, 893
- Carton terminology, 176–181  
 carton development, 180, 181  
 generally, 176–177  
 guidelines and standards, 178–181  
 packing, 177
- Car-type conveyor, 272
- Cascade-filling systems, dry-product filling  
 machinery, 386
- Casein, waterborne adhesives, 23–24
- Case loading, 189–194  
 automatic wraparound, 193  
 fully automated, 190–191  
 horizontal automatic caser/erector/loader/  
   sealer, 191  
 horizontal semiautomatic, 190  
 manual, 189–190  
 overview, 189  
 tray former/loader, 193  
 variations, 193–194  
 vertical, 191–193
- Cask. *See* Barrels
- Cast-film process  
 coextrusion, flexible packaging, 238  
 stretch film, 437
- Catalyst agents, additives, plastic, 10
- Cellophane, 194–195  
 features, 194  
 history, 194  
 physical properties, 195  
 production, 195  
 types, 194–195  
 vinylidene chloride copolymer (VDC), 961
- Cellular plastic, defined, 451. *See also*  
 Foamed plastics
- Cellulose  
 biodegradable materials, 79  
 cellophane, 194–195  
 corrugated boxes, 100  
 foamed plastics, 451  
 plastic films, 163  
 radiation effects, 797
- Center winder (duplex winder), slitting and  
 rewinding machinery, 844–845
- Certified Packaging Professional (CPP), 589
- Checkweighers, 195–199  
 process control, 196–198  
 production reporting, 198  
 regulatory compliance, 195–196
- Cheeses, vacuum packaging, 953
- Chemical degradation, polymers, 761–763
- Chemical deterioration, active packaging, 3
- Chemical etching, surface treatment, 869
- Chemical priming, surface treatment, 869
- Child-resistant packaging, 199–204
- bottle and jar closures, 213–214, 216  
 classification, 203  
 effectiveness, 203  
 enforcement, 203  
 history, 199  
 law and regulation (Europe), 549  
 plastic bottle design, 99  
 regulatory effects, 199–200  
 testing procedures, 200–202
- China, 350
- Chitin, biodegradable materials, 79–80
- Chitosan, biodegradable materials, 79–80
- Chlorinated organics, environment, 344
- Chlorine, environment, 344
- Chlorofluorocarbons (CFC), aerosol propel-  
 lants, 788–789, 790
- Chub packaging, 204–205
- Circulating systems, packaging adhesives,  
 14
- Clay-coated board  
 defined, 177  
 skin packaging, 842
- Clean Air Act, 458, 556
- Clean Water Act, 556
- Cloeren system, coextrusion machinery, flat,  
 234
- Clostridium botulinum*  
 food canning, 123, 124, 701  
 oxygen scavengers, 691
- Closure liners, 205–206, 214–215
- Closures. *See also* Stretch film  
 aluminum foil, foil lidding, 462  
 bottle and jar, 206–220. *See also* Bottle  
   and jar closures  
 bread bag, 220  
 continuous-thread, capping machinery,  
   155–157  
 presson, capping machinery, 157–158  
 rollon, capping machinery, 157  
 vacuum, capping machinery, 157
- Coated papers, described, 717
- Coated recycled paperboard, folding cartons,  
 182
- Coated solid bleached sulfate (SBS) paper-  
 board, folding cartons, 181
- Coated solid unbleached sulfate (SUS) paper-  
 board, folding cartons, 181
- Coating equipment, 221–225  
 coating heads, 221–224  
 drying, 224–225  
 metal can fabrication, 627–629  
 overview, 221  
 saturators, 224  
 web handling, 225
- Coatings  
 coextrusion, flexible packaging, 238  
 evaporated acrylate coatings, surface treat-  
   ment, 872  
 extrusion coating, 378–381. *See also* Ex-  
   trusion coating  
 metal can fabrication, 626–627  
 oriented polypropylene film, 422  
 radiation effects, 798  
 steel cans, 153–154  
 surface and hydrocarbon-barrier modifica-  
   tion, 866  
 transparent glass on plastic food-packag-  
   ing materials, 445–448
- vinylidene chloride copolymer (VDC), 961
- Cobb test, corrugated box testing, 892
- Code, bar, 225–228. *See also* Bar code
- Code marking  
 computer applications, 228–231  
 labeling, 537
- Code of Federal Regulations (CFR)  
 food additives, FDA, 552–553  
 steel drums and pails, 322  
 transportation codes, 930
- Coefficient of friction (COF)  
 coextrusion machinery, tubular, 235  
 oriented polypropylene film, 418
- Coextrusion  
 blow molding, 89–90  
 bottles. *See* Blow molding  
 ethylene-vinyl alcohol (EVOH) copoly-  
   mers, 359  
 extrudable adhesives, 27  
 flexible packaging, 237–240  
   advantages, 237  
   manufacturing process, 237–239  
   raw materials, 239  
   structures, 239  
   technology, 237  
 medical packaging, 612  
 multilayer flexible packaging, 663–664  
 nylon, 683–684  
 oriented polyester film, 411  
 plastic bags, heavy duty, 61  
 plastic film, 425  
 semirigid packaging, 240–242  
   applications, 241  
   barrier materials, 240–241  
   economic factors, 241–242  
   structural materials, 241  
   technology, 240  
 stretch film, 437  
 surface and hydrocarbon-barrier modifica-  
   tion, 866
- Coextrusion machinery, 231–237  
 flat, 231–234  
   encapsulation and lateral adjustment,  
   234  
   equipment, 231–233, 234  
   methods, 233–234  
 tubular, 234–237  
   economic factors, 236  
   equipment, 235  
   process design, 235  
   quality control, 235–236
- Coffee  
 oriented polyester film, 412  
 vacuum-bag packaging, 948–949
- Cohesive bond strength, polymer properties,  
 763
- Cold adhesives, adhesive applicators, 13
- Cold-gas-plasma treatment, surface treat-  
 ment, 870–872
- Cold-glue systems, packaging adhesives, 14
- Cold-vinyl adhesives, cartoning machinery  
 (top-load), 175
- Collagen, biodegradable materials, 80
- Collapsible tubes, 941–945  
 future trends, 945  
 history, 941–942  
 laminated, 944–945  
 metal, 942



- plastic, 942-944
- Color
  - bottle and jar closures, 208
  - folding cartons, 181
- Color Additives Amendment of 1960, 255
- Colorants, 242-256
  - additives, plastic, 10
  - decorating, 294
  - dyes, 243
  - glass container design, 472
  - overview, 242
  - paper and paperboard, 255
  - pigments, 242-243, 244-254
  - plastic bottle design, 97
  - plastics, 243, 255
  - regulatory requirements, 255-256
  - stretch film, 438
  - supply options, 255
- Communication measurement, marketing effectiveness, of consumer packages, 889
- Compatibility
  - food-package compatibility, law and regulation (Europe), 543
  - product compatibility, steel cans, 149
- Component-specific specification, specification and quality assurance, 849-850
- Composite cans, 134-139
  - construction, 134-136
  - future trends, 137
  - self-manufactured, 137-139
- Composting, environmental concerns, 346
- Compounding, extrusion, 372-373
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, "Superfund"), 556
- Compression molding, 256, 922, 924-925
- Compression resistance, cushioning design, 289
- Compression strength, edge-crush concept, 332
- Compression tests, shipping container testing, 908
- Computer applications
  - cartoning machinery (end-load), 587-588
  - checkweighers, 198
  - code marking, 228-231
  - glass container design, 475
  - integrated packaging design and development, 514-519
  - labeling, 296
  - materials handling, 606-607
  - pallet patterns, 256-258
  - plastic bottle design, 97
  - shelf life, 833-834
  - thermoforming, 921
- Concentrated load, defined, marine environment, 592
- Conservation, environment, 343
- Constant carton line (CCL), defined, 176
- Constant-opening line (COL), defined, 176
- Consulting, 260-263
  - hiring guidelines, 262-263
  - qualifications, 261-262
  - rationale for, 260-261
- Consumer demand, economics, 328-329
- Consumer goods specification, specification and quality assurance, 852
- Consumer packages, testing of, for marketing effectiveness, 887-890
- Consumer research, 258-260
- Contact sealing, heat sealing, 825
- Containerized loads, export packaging, 368, 370
- Containment closure, bottle and jar closures, 210
- Contamination
  - air conveying, 35
  - export packaging, 366
- Content labeling, 547-548. *See also* Labeling
- Content mandates, environmental regulation, 352-353
- Continuous-flow heating process, aseptic packaging, 42
- Continuous tags, 876-879
- Continuous-thread closures
  - bottle and jar closures, 208-209
  - capping machinery, 155-157
- Contract packaging, 263-264
- Convenience closure, bottle and jar closures, 210-212
- Conversion factors, 979-981
- Conveying, 264-283
  - air conveying, 31-35
  - defined, 264-265
  - guides and control components, 281
  - interconnecting machinery, 281
  - lightweight containers, 282
  - power transmission, 276-277
  - single filing, 282-283
  - stages, 282
  - stretch-film wrapping machinery, 975-976
  - system design and installation, 265-276, 281-282, 283
  - air design, 274-276
  - belt design, 266-268
  - cable design, 273-274
  - lug or bar chain design, 270, 271-276
  - mesh-top or open-top design, 268-269
  - met-top or flat-top chain design, 269-270
  - roller design, 270, 273, 277, 278, 279
  - screw design, 273, 280
  - tabletop chain design, 265-266
  - vibratory design, 276
  - technology, 282
  - transfers, 277-278, 281
- Cook/chill food production, 283-285
- Copermeant, permeability (of aromas and solvents), 726-728
- Copolyester, plastic films, 163
- Copolymers
  - biodegradable materials, 77-83
  - polyethylene terephthalate (PET), 744
- Cork, bottle and jar closures, 206
- Corona treatment, 410, 865, 870
- Corrosion, 139-143
  - electrostatic discharge protective packaging, 339
  - export packaging, 366
  - hydrogen specificity, 141-142
  - mechanism, 140-141
  - overview, 139-140
  - problems, 142-143
  - steel cans, 149
- vapor-corrosion inhibitor (VCI), marine environment, 590
- Corrugated board
  - edge-crush concept, 331-334
  - recycling, 345-346
  - skin packaging, 842
- Corrugated boxes, 100-108
  - board construction, 101-102
  - bulk packaging, 121
  - dimensioning, 106
  - economics, 106-107
  - equipment, 103-105
  - future trends, 108
  - industry organization, 103
  - joints, 105-106
  - materials, 100-101
  - Mullen test versus edge-crush test, 102-103
  - overview, 100
  - recycling, 107-108
  - styles, 107
  - testing, 891-892
- Corrugated pallets, expendable, 710
- Corrugated plastic, 285-287
- Coupling agents, additives, plastic, 10
- Crates
  - bulk packaging, 122
  - marine environment, 591-592, 596-597
  - testing, 892
  - wood boxes, 117
- Creep resistance, cushioning design, 288-289
- Crossbar conveyor, 272
- Crown bottle and jar closures, 210
- Crystallized polyethylene terephthalate (CPET), dual-ovenable packaging, 644
- Curing
  - offset container printing, 300
  - screen printing, 303
  - thermosetting plastics, 925
- Currently Good Manufacturing Practices (CGMP), 735
- Curtain coater, coating equipment, 224
- Cushioning
  - foamed plastics, 455
  - product fragility testing, 904
  - shock, 835-836, 837
- Cushioning design, 287-293
  - constraints on, 289-290
  - cushion characteristics, 288-289
  - future trends, 293
  - overview, 287
  - procedures, 290-293
- Customer-supplier relations, total quality management (TQM), 929
- Cut-sheet thermoforming, 920
- Dairy products, 187-189, 701
- Darkening of foods, 143, 149, 153
- Databases. *See* Computer applications
- Dating. *See also* Shelf life
  - law, 548
  - printing, computer applications, 229
  - shelf life, 832
- Dating equipment. *See* Bar code; Code marking
- Death rates. *See* Mortality rates
- Decals. *See* Decorating; Labeling



- Decorating, 294–303. *See also* Labeling  
 glass container design, 472–473  
 glass container manufacturing, 484  
 heat-transfer labeling, 294–296  
 hot stamping, 296–297  
 in-mold labeling, 297–298  
 Japanese packaging, 668–669  
 labeling, 537  
 marketing effectiveness, of consumer packages, 888–889  
 multilayer flexible packaging, 660, 663  
 offset container printing, 298–300  
 pad printing, 300–302  
 PETG copolyester, 830  
 screen printing, 302–303  
 surface and hydrocarbon-barrier modification, 864–865
- Delaney Clause, Federal Food, Drug and Cosmetic Act, 553
- Denmark, 550
- Density, polymer properties, 759–760
- Depalletizing, 709–710
- Deposit laws, 160, 354, 556
- Deregulation, logistical/distribution packaging, 573
- Design, plastic bottles, 93–100
- Design for assembly (DFA), integrated packaging design and development, 514–519
- Design for manufacturability (DFM), integrated packaging design and development, 514–519
- Dessicants, defined, marine environment, 590
- Die-cut tags, 876
- Dielectric constant, polymers, 764
- Dielectric sealing, heat sealing, 826
- Dimension standards, carton terminology, 176
- Dioxins, paper, law and regulation (Europe), 546
- Direct roll coaters, coating equipment, 221–222
- Direct stamping method, hot stamping, 296
- Displacement-ram volumetric fillers, filling machinery, still liquid, 393
- Distribution hazard measurement, 303–307  
 data analysis, 305–306  
 overview, 303–304  
 process of, 304–305
- Distribution packaging, 307–310. *See also* Logistical/distribution packaging  
 checklist for, 310  
 components of, 310  
 design, 309–310  
 economics, 330  
 functions of, 307  
 objective of, 307  
 protective-package concept, 308–309  
 system approach, 308
- Double-package maker (DPM), bag-in-box packaging, dry products, 46
- Dow system, coextrusion machinery, flat, 233
- Drag chain conveyor, 272
- Drawing and ironing (D&I), metal can fabrication, 615–616, 621, 622–625
- Draw and redraw (DRD), metal can fabrication, 615–616, 625–626
- Drop test, shipping container testing, 906–907
- Drums. *See* Fiber drums; Plastic drums; Plastic pails; Steel drums and pails
- Dry bag-in-box packaging, 46–48
- Dry foods, food packaging, 702
- Dry-product filling machinery, 384–389. *See also* Filling machinery
- Dual-ovenable packaging. *See* Microwavable and dual-ovenable packaging
- Duplex (biplex), paperboard, 718
- Duplex winder (center winder), slitting and rewinding machinery, 844–845
- Dust, static control, 858
- Dust flap, defined, 177
- Dust-flap-style closure, cartoning machinery (top-load), 174–175
- Dye-leak test, leakage testing, 899–900
- Dyes, colorants, 242, 243. *See also* Colorants
- East Asia, 350–351
- Eastern Europe. *See also* Europe  
 environmental regulation, 350  
 packaging, 360–361, 362
- Ecolabeling  
 environmental regulation, 351, 354  
 Europe, 549  
 U.S., 557
- Economics, 325–330  
 consumer demand, 328–329  
 losses, marine environment, 601–602  
 macroeconomics, 325  
 management, budgets, 588  
 microeconomics, 329–330  
 recycling, 800, 803–804  
 standup flexible pouches, 856  
 supply industries, 325–328  
 tamper-evident packaging, 880–881  
 total quality management (TQM), 928
- Edge-crush concept, 331–334  
 background, 331  
 compression strength, 332  
 corrugated board, 331–332  
 models, 332–333  
 testing, 891
- Edge-crush test  
 corrugated boxes, 102–103, 105  
 transportation codes, 930
- Edible film, 397–401  
 composition, 397–398  
 food and drug coating, 398–399  
 future trends, 400  
 manufacture, 398  
 overview, 397  
 physical properties, 399–400
- Education, 334–335  
 career development, 167  
 management, 588–589
- Electrically conductive agents, additives, plastic, 10–11
- Electrical properties, polymers, 764
- Electrochemical potential, corrosion, 140–141
- Electron-beam sterilization, sterile disposable healthcare products, 697–699
- Electronic data processing (EDP), labels, 536, 537
- Electronic Industries Association (EIA), 342
- Electrostatic charge. *See also* Static control  
 antistatic agents, additives, plastic, 9  
 extrusion coating, 380  
 static control, 857–860  
 surface treatment, 873
- Electrostatic discharge protective packaging, 335–343. *See also* Static control  
 classification, 336  
 history, 336  
 overview, 335–336  
 standards, 339, 342  
 technological solutions, 339–342  
 terms and test methods, 336–339
- Embossing, aluminum foil, 461
- Employee involvement, total quality management (TQM), 929
- Enamel peeling, corrosion, 142
- End-load cartoning machinery. *See* Cartoning machinery (end-load)
- Environment, 343–348  
 additives, plastic, 9–10  
 aerosols, 31, 788–791  
 biodegradable materials, 77  
 bulk bags (flexible intermediate bulk containers), 53  
 colorants, 255  
 corrugated boxes, 107–108  
 cushioning design, 289  
 deposit laws, carbonated beverage packaging, 160  
 economics, 330  
 edible film, 397  
 Europe, 362  
 foamed plastics, 458  
 foam trays, 937  
 green marketing, 347  
 integrated packaging design and development, 515–516  
 ISO 14001 environmental management system, 533–535  
 life-cycle assessment, 347  
 medical packaging, 614  
 oriented polyester film, 414  
 overview, 343  
 plastic bottle design, 99–100  
 pollution, 343–344  
 poly(vinyl chloride) (PVC), 774  
 pressure-sensitive tape, 886–887  
 recycling, 799–808  
 regulation, 347  
 resource depletion, conservation, and sustainable use, 343  
 rigid plastic containers, 111  
 shelf life, 831–832  
 shipping container testing, 906  
 solid-waste issues, 344–347  
 stretch film, 442–443
- Environmental Protection Agency (EPA). *See* U.S. Environmental Protection Agency (EPA)
- Environmental regulation, 348–355. *See also* Regulation  
 international, 348–351  
 ecolabeling, 351, 549  
 Europe, 348–350, 549–551, 805–808  
 Pacific Rim and East Asia, 350–351  
 standards, 351  
 North America, 351–355, 556–557



- advance disposal fees, 353
- content mandates, 352–353
- deposit laws, 354
- green labeling, 354, 557
- heavy metals, 354
- history, 351–352
- landfill bans, 353–354
- resin coding, 354–355
- EPA. *See* U.S. Environmental Protection Agency (EPA)
- Equilibration, permeation testing, 895–896
- Ethanol, modified atmosphere packaging, 651
- Ethanol emitting sachets, active packaging, 4–5
- Ethylene absorbing sachets, active packaging, 4–5
- Ethylene-acrylic acid (EAA), coextrusion, flexible packaging, 239
- Ethylene-butyl acrylate, hot-melt adhesives, 24
- Ethylene-methacrylic acid (EMA), coextrusion
  - flexible packaging, 239
  - semirigid packaging, 241
- Ethylene oxide sterilization, sterile disposable healthcare products, 696–697
- Ethylene-vinyl acetate (EVA)
  - bag-in-box packaging, liquid product, 48–49
  - carded packaging, 164
  - coextruded flexible packaging, 237, 239
  - heat sealing, 826
  - hot-melt adhesives, 24–25
  - hot-melt wax carton, 963
  - labeling, 298
  - rotational molding, 819
  - skin packaging, 840, 841
- Ethylene-vinyl alcohol (EVOH) copolymers, 355–360
  - applications, 360
  - coextrusion
    - flexible packaging, 239
    - semirigid packaging, 240
  - collapsible tubes, 942, 945
  - edible film, 399
  - films, 359–360
  - hot-fill technology, 495
  - microwavable packaging, 645
  - overview, 355–356
  - packaging structures, 358–359
  - properties, 356–358
  - regulation, 358
  - surface and hydrocarbon-barrier modification, 866
- Europe, 360–362. *See also* Law and regulation (Europe)
  - Eastern Europe, 362
  - glass, 361
  - metals, 361
  - modified atmosphere packaging, 656–659
  - overview, 360–361
  - paper, 361
  - plastic, 361
  - reduction strategies, 362
  - regulation, 348–350, 541–552
  - shelf life, 832
  - standup flexible pouches, 855–856
  - technology, 362
- European Court of Justice (ECJ), law and regulation, 542
- European Standardisation Committee (CEN), biodegradable materials, 77
- European Union. *See also* Law and regulation (Europe)
  - beverage carriers, 170
  - bulk bags (flexible intermediate bulk containers), 53
  - child-resistant packaging, 201–202, 203
  - environmental regulation, 347, 348–350
  - fiber drums, 315
  - function and organization of, law and regulation, 541–543
  - ISO standards, 524–525, 529
  - plastic drums, 318
  - recycling, 805–808
  - steel drums and pails, 322
- Evaporated acrylate coatings, surface treatment, 872
- Exhibitions, 362–365
- Expendable corrugated pallets, 710
- Expert witnesses, consulting, 261
- Export packaging, 365–370. *See also* Marine environment; Shipping
  - conditions, 366
  - guidelines, 370
  - hazards, 365–366
  - marine environment, 589–603
  - marks and symbols, 367, 369
  - product analysis, 366–367
  - techniques, 367–368, 370
- Extrudable adhesives, 25–28
  - applications of, 27
  - commercial forms, 26–27
  - overview, 25–26
  - types of, 26
- Extruded polystyrene foam, 449–450
- Extrusion, 370–378
  - blow and cast film, 373, 375–376
  - blow molding, 83–87
  - compounding, 372–373
  - foam sheet extrusion, 377
  - multilayer flexible packaging, 663
  - nylon, 682–683, 684
  - oriented polypropylene film, 417
  - overview, 370
  - PETG copolyester, 828
  - plastic film, 425–427
  - rigid sheet extrusion, 376–377
  - single-screw extruders, 370–372
  - stretch film, 437
- Extrusion coating, 378–381
  - applications, 378, 380
  - folding carton manufacture, 184–185
  - low-density polyethylene (LDPE), 757
  - machinery, 379, 380–381
  - nylon, 684
  - overview, 378
- Extrusion-injection-molded neck process, blow molding, 87
- Eye-tracking research, consumer research, 259–260
- Fair Packaging and Labeling Act, 676
- Fats and oils, food packaging, 702–703
- FDA. *See* U.S. Food and Drug Administration (FDA)
- Federal Food, Drug and Cosmetic Act of 1938, 255, 553, 676, 758, 961
- Federal Hazardous Substances Act, 255
- Ferrous metals, recycling, 800–801
- Fiber, molded, 382–383
- Fiberboard boxes, testing, 891–892
- Fiber drums, 310–316. *See also* Plastic drums
  - applications, 311
  - construction, 311
  - defined, 310–311
  - regulation, 314–315
  - styles, 312–314
  - testing, 894
- Filament tapes, pressure-sensitive tape, 885–886
- Filling machinery
  - aseptic packaging, 43, 44
  - bulk bags (flexible intermediate bulk containers), 52
  - carbonated liquid, 389–390
  - count measurement, 383–384
  - dry-product, 384–389
    - bulk-product feed, 388
    - equipment, 388–389
    - overview, 384
    - product-feed systems, 385–387
    - weighing systems, 387–388
  - plastic bottle design, 95
  - still liquid, 390–397
    - container positioning, 394–396
    - design and selection, 396–397
    - methods, 390–394
    - overview, 390
    - tube filling, 939–941
- Film(s). *See also* Plastic film; Stretch film
  - blow and cast film, extrusion, 373, 375–376
  - edible, 397–401. *See also* Edible film
  - electrostatic discharge protective packaging, 339–342
  - ethylene-vinyl alcohol (EVOH) copolymers, 359–360
  - flexible PVC, 401–403. *See also* Flexible polyvinyl chloride (PVC) film
  - fluoropolymer, 403–405. *See also* Fluoropolymer film
  - high-density polyethylene, 405–407. *See also* High-density polyethylene
  - medical packaging, 612
  - modified atmosphere packaging, 652–653
  - multilayer flexible packaging, 660–661
  - nonoriented polypropylene, 407–408. *See also* Nonoriented polypropylene film
  - nylon, 683
  - oriented polyester, 408–415. *See also* Oriented polyester film
  - oriented polypropylene, 415–422. *See also* Oriented polypropylene film
  - plastic, 423–427. *See also* Plastic film
  - polypropylene (PP), 767–768
  - recycling, 346
  - rigid polyvinyl chloride (PVC), 427–431. *See also* Rigid polyvinyl chloride (PVC) film
  - shrink, 431–434



- Film(s). *See also* Plastic film; Stretch film  
(Continued)  
stretch, 434-445. *See also* Stretch film  
thermotropic liquid-crystalline polymers  
(TLCP), 570-572  
transparent glass on plastic food-packag-  
ing materials, 445-448
- Film composites  
active packaging, 5-7  
composite can construction, 135
- Findability testing, consumer research, 259
- Finished-goods specification, specification  
and quality assurance, 852
- Finland, 550
- Fire  
flame retardant agents, additives, plastic,  
11  
foamed plastics, 458
- First-in-first-out (FIFO), time-temperature  
indicators, 927
- Fish  
food packaging, 700  
modified atmosphere packaging, 654  
vacuum packaging, 953-954
- Fitment closure, bottle and jar closures,  
211-212
- Fixed-spout closure, bottle and jar closures,  
210-211
- Flame retardant agents, additives, plastic,  
11
- Flame technique, 865, 869-870
- Flammability, polymers, 762
- Flat coextrusion machinery. *See* Coextrusion  
machinery
- Flat-top conveying, 33-34, 269-270
- Flavor protection  
ethylene-vinyl alcohol (EVOH) copoly-  
mers, 356-357  
oriented polyester film, 409, 410  
permeation testing, 896, 989
- Flexible films, ethylene-vinyl alcohol  
(EVOH) copolymers, 359
- Flexible intermediate bulk containers. *See*  
Bulk bags (flexible intermediate bulk  
containers)
- Flexible packaging  
coextrusion, 237-240  
extrusion coating, 378  
lidding, 561-563  
medical packaging, 611-612  
multilayer flexible packaging, 659-665.  
*See also* Multilayer flexible packaging  
retortable packages, 809  
standup flexible pouches, 852-856. *See  
also* Standup flexible pouches
- Flexible polyvinyl chloride (PVC) film, 401-  
403. *See also* Rigid polyvinyl chloride  
(PVC) film  
composition, 401  
heat stabilizers, 401  
lubricants, 402  
manufacture, 402  
markets, 402-403  
plasticizer, 401  
resin, 401
- Flexographic ink, 511-512
- Flexography  
described, 785-787  
labeling, 537, 538
- Flight conveyor, 272
- Florida, 353
- Fluorination  
blow molding, 92  
surface treatment, 865-866, 872-873
- Fluoropolymer film, 403-405  
applications, 404  
composition, 403  
manufacture, 403-404  
properties, 404  
safe handling, 404
- Flutes, corrugated boxes, 101-102
- Foam, extruded polystyrene, 449-450
- Foamed crystallized polyethylene terephthal-  
ate (CPET), dual-ovenable packaging,  
644
- Foamed plastics, 451-458  
applications, 455-458  
definitions, 451  
environmental concerns, 458  
expansion process, 451  
health and safety factors, 458  
history, 451  
manufacture, 455  
properties, 451-455
- Foaming agents, additives, plastic, 10
- Foam sheet extrusion, described, 377
- Foam trays, 933-937  
applications, 935-937  
environmental concerns, 937  
history, 933  
manufacture, 933-935  
producers, 935
- Focus groups  
consumer research, 259  
marketing effectiveness, of consumer pack-  
ages, 887
- Foil, aluminum, 458-463. *See also* Alumi-  
num foil
- Foil printing, computer applications, 230
- Foils. *See* Film(s)
- Foil transfer, holographic packaging, 490
- Folding cartons, 181-187  
bag-in-box packaging, dry products, 46  
history, 181  
hot-melt application, 186-187  
manufacture, 184-186  
paperboard selection, 181-182  
styles, 182-184
- Food additives, 255, 552-555
- Food Additives Amendment of 1958, 255,  
552
- Food and Drug Administration (FDA). *See*  
U.S. Food and Drug Administration  
(FDA)
- Food canning. *See* Canning
- Food packaging, 699-704. *See also* entries  
under specific processes and foods  
canned foods, 701-702  
classification, 700  
cook/chill methods, 283-285  
foam trays, 935-937  
fresh foods, 700  
overview, 699-700  
partially processed foods, 700-701  
polycarbonate (PC), 741-742  
steam-table trays, 937-938  
thermoform/fill/seal, 910
- Forced vibration, free vibration versus, 955
- Forensic packaging, 463-465
- Form/fill/seal pouch  
aluminum foil, 462  
horizontal, 465-468  
ionomers, 528  
standup flexible pouches, 855  
vertical, 468-470
- Fourdrinier machine, paperboard manufac-  
ture, 719
- Fragility. *See also* Product fragility testing  
cushioning design, 289  
defined, marine environment, 592
- Fragrance enhancer agents, additives, plas-  
tic, 11
- Fragrance protection, ethylene-vinyl alcohol  
(EVOH) copolymers, 356-357
- France, 550-551
- Free vibration, forced vibration versus, 955
- Freeze and thaw indicators, described,  
501-502
- Freight containers, standards, ISO, 525
- Frequency, vibration, 955-956
- Friction, polymer properties, 763
- Friction-fit bottle and jar closures, 209-210
- Friction sealing, heat sealing, 825
- Frozen foods, food packaging, 702
- Fruits and vegetables  
food packaging, 700, 701  
modified atmosphere packaging, 655  
vacuum packaging, 954
- FTC. *See* U.S. Federal Trade Commission  
(FTC)
- Furnish, paperboard, 718
- F value, food canning, 124
- Gabletop cartons, 187-189
- Galvanic corrosion, 140-141
- Gamma sterilization, sterile disposable  
healthcare products, 697
- Gas-barrier protection  
ethylene-vinyl alcohol (EVOH) copoly-  
mers, 356  
modified atmosphere packaging, 652-653
- Gas packaging. *See* Modified atmosphere  
packaging
- Gas-plasma technique, surface and hydrocar-  
bon-barrier modification, 865
- Gas sealing, heat sealing, 825
- Gatefold tags, 877
- Gauge randomization, blow and cast film, ex-  
trusion, 375-376
- Gauging, coextrusion machinery, flat, 234
- Gelatin, biodegradable materials, 80
- Gel lacquers, carded packaging, 164
- Generally recognized as safe (GRAS), food  
additives, 552, 553
- General packaging specification, specifica-  
tion and quality assurance, 849
- German Institute for Standardisation (DIN),  
77
- Germany, 349-350, 551
- Glass bottles  
beverage carriers, 169-170  
bottle and jar closures, 207  
carbonated beverages, 159  
testing, 891



- Glass closures, bottle and jar closures, 216
- Glass container(s)
  - ampuls and vials, 35–38. *See also* Ampuls and vials
  - economics, 328
  - European packaging, 361, 362
  - hot-fill technology, 494
  - law and regulation (Europe), 546
  - microwavable packaging, 646
  - pressure containers, 781
  - radiation effects, 796
  - recycling, 345, 804
  - standards, ISO, 524
- Glass container design, 471–475
  - computer applications, 475
  - manufacturing conditions, 471–472
  - market factors, 472–473
  - shape and dimensions, 471
  - strength factors, 473–475
- Glass container manufacturing, 475–484
  - chemical phase, 476–477
  - mechanical/forming phase, 477–478
  - overview, 475–476
  - process, 478–484
  - terminology, 484
- Glassine, described, 715
- Glass on plastic food-packaging materials, 445–448
- Glass-transition temperature, polymer properties, 759
- Global warming, 344, 788–791. *See also* Environment
- Glue flap, defined, 177
- Glue-style carton, defined, 177
- Grain direction, defined, 177
- Grain products, food packaging, 703
- Grammage, defined, 177
- Graphics, multiwall bags, 65–66
- Gravitational-force indicators, described, 502–503
- Gravity-discharge bucket conveyor, 272
- Gravity-flow systems, dry-product filling machinery, 385
- Gravure coaters, coating equipment, 222–223
- Gravure ink, 512–513
- Gravure printing
  - described, 784–785
  - labeling, 538
- Greaseproof paper, described, 715
- Grease-resistant paper, paper, 715
- Greece, 551
- Greenhouse gases, environment, 344
- Green labeling. *See* Ecolabeling
- Green marketing, environment, 347
- Gross Domestic Product (GDP), packaging economics, 325
- Guidelines, carton terminology, 178–181
- Gummed-paper labels, 536
- Gummed tape, 883
- HACCP system, 485–489
  - concept, 485
  - origin of, 485
  - principles, 485–488
- Hand loading. *See* Manual loading
- Hazard analysis critical control point (HACCP) system. *See* HACCP system
- Hazardous materials
  - bulk bags, 449
  - export packaging, 366–367
  - fiber drums, 310–311, 314–315
  - intermediate bulk containers, 519, 521
  - law and regulation (Europe), 549
  - law and regulation (U.S.), 556
  - plastic drum regulation, 317–318
  - plastic pails, 705–707
  - steel drums and pails, 319, 322
  - transportation codes, 930
- Hazardous Materials Regulations (HMR), fiber drums, 310–311, 314–315
- Headers, defined, marine environment, 592
- Health and safety issues
  - foamed plastics, 458
  - law and regulation (Europe), food packaging, 543–547
  - law and regulation (U.S.), food packaging, 552–555
  - leak testing, 558–561
  - linear and very low-density polyethylene (LLDPE and VLDPE), 752
  - logistical/distribution packaging, 575
  - low-density polyethylene (LDPE), 758
  - nutrition labeling, 674–681
  - oxygen scavengers, 690–691
  - polypropylene (PP), 768
  - static control, 858–859
- Healthcare packaging. *See* Aseptic packaging; Medical packaging; Pharmaceuticals; Sterile disposable healthcare products
- Heat-resistant polyester bottles, blow molding, 90–91
- Heat-seal coatings
  - blister packaging, 162, 163
  - multilayer flexible packaging, 662–663
  - skin packaging, 162, 163–164
- Heat-seal forming, cartoning machinery (top-load), 173
- Heat sealing, 823–827
  - band sealing, 824
  - bar sealing, 823–824
  - contact sealing, 825
  - dielectric sealing, 826
  - friction sealing, 825
  - gas sealing, 825
  - hot-melt sealing, 825–826
  - hot-wire or knife sealing, 825
  - impulse sealing, 824–825
  - induction sealing, 826
  - ionomers, 527–529
  - magnetic sealing, 826
  - method selection, 826–827
  - overview, 823
  - pneumatic sealing, 826
  - polymer properties, 763
  - radiant sealing, 826
  - secondary conversion, 684
  - solvent sealing, 826
  - testing, 827
  - ultrasonic sealing, 825
- Heat-seal labeling machinery, 540
- Heat-sensitive labels, 537
- Heat-shrink packaging, electrostatic discharge protective packaging, 341
- Heat stabilizer agents, additives, plastic, 11
- Heat-transfer labeling, described, 294–296
- Heavy duty plastic bags, 60–61
- Heavy metals, 354, 556
- High-density polyethylene (HDPE), 405–407, 745–748
  - applications, 405
  - blow molding, 83, 86
  - bottle and jar closures, 215
  - coextruded flexible packaging, 237, 239
  - coextruded semirigid packaging, 241
  - collapsible tubes, 942
  - composite can construction, 136
  - defined, 745
  - folding cartons, 184
  - labeling, 297, 298
  - manufacture, 406–407, 745–746
  - microwavable packaging, 646
  - molecular structure, 746–747
  - pallets, 711
  - plastic bottle design, 96, 97
  - plastic netting, 666
  - plastic pails, 705
  - properties, 405–406, 747–748
  - recycling, 346, 800, 803, 804
  - regulation, 748
  - rotational molding, 819–820
- High-impact polystyrene (HIPS), thermoforming, 914
- High-level palletizer, 708
- High-nitrile resins, nitrile polymers, 670
- High temperature short time (HTST) process, aseptic packaging, 42, 43
- Holograms, 414, 489–492
- Holt-melt systems, packaging adhesives, 15–20
- Homopolymers, polyethylene terephthalate (PET), 744
- Hong Kong, 350
- Horizontal automatic case/erector/loader/sealer, 191
- Horizontal form/fill/seal pouch, 465–468
- Horizontal impact test, shipping container testing, 907
- Horizontal semiautomatic case loading, 190
- Hot-fill technology, 492–496
  - aluminum cans, 493–494
  - glass containers, 494
  - overview, 492
  - plastic packages, 494–495
  - processing, 492
  - tinplate cans, 493
- Hot-melt adhesives
  - acrylic plastic polymers, 1
  - adhesive applicators, 13–14
  - cartoning machinery (top-load), 172–173, 175
  - described, 24–25
  - folding cartons, 186–187
- Hot-melt sealing, heat sealing, 825–826
- Hot-melt wax carton, 962–964
- Hot-stamping
  - computer applications, 230
  - described, 296–297
  - holographic packaging, 490
  - labeling, 538
  - oriented polyester film, 414
- Hot-wire sealing, heat sealing, 825
- Housewares exemption, 554–555



- Humidity  
  electrostatic discharge protective packaging, 338  
  permeability (of aromas and solvents), 728–729
- Humidity indicators, described, 502
- Hydrocarbon-barrier modification. *See* Surface and hydrocarbon-barrier modification
- Hydrocarbon resistance, ethylene-vinyl alcohol (EVOH) copolymers, 356
- Hydrocarbons, aerosol propellants, 789
- Hydrogen peroxide, aseptic packaging, 42
- Hydrogen specificity, corrosion, 141–142
- Hydrogen swell, corrosion, 142–143
- Hydroxypropylmethyl cellulose (HPMC), edible film, 397, 398, 399
- Impact modifier agents  
  additives, plastic, 11  
  poly(vinyl chloride) (PVC), 773
- Impact shock measurement, 836
- Imprinting, computer applications, 228–231
- Impulse sealing, heat sealing, 824–825
- Incineration, environmental concerns, 346–347
- Incline impact test, shipping container testing, 907
- India, 497–498, 856
- Indicating devices, 498–503  
  freeze and thaw indicators, 501–502  
  gravitational-force indicators, 502–503  
  humidity indicators, 502  
  temperature indicators, 500–501  
  time and temperature indicators, 499–500
- Individual-rewind-arm (IRA) winders, slitting and rewinding machinery, 845–846
- Induction sealing, heat sealing, 826
- Industrial products, extrusion coating, 380
- Industrial wraps, extrusion coating, 380
- Injection molding, 503–511  
  blow molding, 87  
  low-density polyethylene (LDPE), 757  
  machinery, 505–511  
  mold design, 503–505  
  overview, 503  
  polypropylene (PP), 768  
  rigid plastic containers, 110  
  thermosetting plastics, processing systems, 922–923
- Ink-jet printing, computer applications, 229–230
- Inks, 511–514  
  acrylic-based, acrylic plastic polymers, 1  
  blister packaging, 162  
  colorants, 243, 255–256. *See also* Colorants  
  corrugated boxes, 101  
  liquid, 511–513  
  overview, 511  
  pad printing, 301–302  
  paste, 513–514  
  radiation effects, 798  
  screen printing, 303  
  skin packaging, 162, 841  
  surface and hydrocarbon-barrier modification, 864–865
- In-mold labeling, described, 297–298
- Innerseals  
  bottle and jar closures, 214–215  
  closure liners, 206
- Inorganic pigments, colorants, 242. *See also* Colorants
- Instantaneous pump delivery rate (IPDR). *See* Maximum instantaneous delivery rate (MIDR) calculation
- Institute for Standards Research (ISR), biodegradable materials, 77
- Institute of Packaging Professionals (IoPP), 167, 260, 589
- Insulation, thermal, foamed plastics, 455–456
- Insurance, marine environment, 601–602
- Integrated packaging design and development, 514–519  
  model for, 518  
  overview, 514–515  
  rationale for, 515  
  tools, technologies, and methodologies, 515–517
- Intermediate bulk containers, 519–521. *See also* Bulk bags (flexible intermediate bulk containers)  
  applications, 521  
  defined, 519  
  overview, 519  
  UN code, 519–521
- International Air Transport Association (IATA)  
  fiber drums, 314–315  
  international standards, 527
- International Civil Aviation Organization (ICAO)  
  fiber drums, 314–315  
  international standards, 527  
  steel drums and pails, 322
- International environmental regulation. *See* Environmental regulation; International standards
- International Maritime Organization (IMO)  
  fiber drums, 314–315  
  intermediate bulk containers, 519  
  international standards, 526  
  plastic drums, 317  
  steel drums and pails, 322
- International standards, 521–527  
  defined, 521  
  International Standards Organization (ISO)  
  described, 521–523  
  ISO 9000, 524–526, 529–533  
  packaging standards, 523–524  
  organizations, 526–527
- International Standards Organization (ISO)  
  aerosol containers, 30  
  biodegradable materials, 77  
  bulk bags (flexible intermediate bulk containers), 53  
  child-resistant packaging, 199, 201, 202  
  described, 521–523  
  ISO 9000, 524–526, 529–533  
  described, 529–530  
  European Union, 529  
  function, 530–532  
  rationale, 530  
  registration to, 532–533
- ISO 14001 environmental management system, 533–535
- membership in, 522
- packaging standards of, 523–524
- paperboard, 718
- shipping containers, 906
- steel cans, 145
- International System, 638, 639, 642. *See also* Metrication
- Interviews, consumer research, 259, 887
- Inventory  
  life-cycle assessment, 565–566  
  time-temperature indicators, 927
- Ionomers, 527–529  
  applications, 529  
  development, 527  
  properties, 527–528  
  structure, 527
- Ireland, 551
- Iron, recycling, 800–801
- Irradiation, 49. *See also* Radiation effects
- ISO 9000. *See* International Standards Organization (ISO)
- Isostatic high pressure system, aseptic packaging, 43
- Italian Standardization Agency (UNI), biodegradable materials, 77
- Italy, 77, 551
- Japan, 350, 667–669, 856
- Jar closures, 206–220. *See also* Bottle and jar closures
- Jones side-seam gluer (SSG), carton terminology, 179
- Just-in-time inventory, plastic pallets, 710
- Kiss roll coaters, coating equipment, 221–222
- Knife and bar coaters, coating equipment, 223
- Knife sealing, heat sealing, 825
- Korea, 350
- Kraft paper  
  corrugated boxes, 100  
  described, 714  
  medical packaging, 611  
  multiwall bags, 64
- Labeling, 536–541. *See also* Decorating; Nutrition labeling; Printing  
  aluminum foil, 461  
  application machinery, 538–541  
  heat-seal labeling, 540  
  overprinting, 540–541  
  pressure-sensitive labeling, 539–540  
  wet-glue labeling, 539
- blow molding, 92
- bottle and jar closures, 208, 216–217
- carbonated beverages, 159
- colorants, 255
- composite can construction, 136
- computer applications, 228–231
- corrugated boxes, 101
- ecolabeling, environmental regulation, 351, 354
- export packaging, marks and symbols, 367, 369
- folding cartons, 181, 185



- glass containers, 472, 484
- hazardous materials, bulk bags, 449
- heat-transfer labeling, described, 294–296
- holographic packaging, 490
- hot stamping, 296–297
- in-mold labeling, 297–298
- label printing, 537–538
- label types, 536–537
- law and regulation (Europe), 547–549
- law and regulation (U.S.), 556–557
- multilayer flexible packaging, 660
- nutrition labeling, 674–681
- offset container printing, 298–300
- oriented polyester film, 414
- pad printing, 300–302
- printing, computer applications, 228–231
- screen printing, 302–303
- shrink bands, 69–70
- thermoform/fill/seal, 912
- Label overprinting machinery, 540–541
- Label readership, consumer research, 260
- Laminated collapsible tubes, 944–945
- Lamination
  - aluminum foil, 461
  - coextrusion, flexible packaging, 238
  - folding carton manufacture, 185
  - holographic packaging, 490–492
  - medical packaging, 612
  - multilayer flexible packaging, 663
  - secondary conversion, 684–685
- Landfill, 347, 353–354
- Laser printers, computer applications, 230
- Laser scanner, bar codes, 228
- Latin America, 856
- Law and regulation (Europe), 541–552. *See also* Regulation
  - child-resistant packaging, 549
  - environmental, 549–551
  - European Union, 541–543
  - food-contact legislation, 543–547
  - food-package compatibility, 543
  - labeling, 547–549
  - overview, 541
  - trademarks, 549
- Law and regulation (U.S.), 552–558. *See also* Regulation
  - environmental, 556–557
  - Food and Drug Administration (FDA), 552–555
    - food additive definition, 552
    - food packaging, 552–555
    - generally, 552
- Lead, steel cans, 150, 154
- Lead pigments, 256
- Leaflet feeds, cartoning machinery (end-load), 585–586
- Leakage testing, 558–561, 898–901. *See also* Permeation testing
  - burst/seal strength, 900
  - CO<sub>2</sub> tracer gas, 900
  - overview, 898–899
  - pressure/pressure-decay method, 900
  - waterbath or dye-leak test, 899–900
- Left-hand machine, defined, 176
- Legal issues
  - expert witnesses, consulting, 261
  - liability, printing, computer applications, 229
- Letterpress, labeling, 538
- Letterpress ink, 514
- Letterset ink, 513–514
- Level-sensing fillers, filling machinery, 392–393
- Liability, printing, computer applications, 229
- Lidding, 561–563
- Life-cycle assessment, 563–569
  - components of, 564–566
  - defined, 563
  - environment, 347
  - impact assessment, 566–568
  - improvement assessment, 568
  - limitations, 568
  - overview, 563
  - packaging choices, 563–564
  - uses of, 564
- Lighters, export packaging, 368
- Linear and very low-density polyethylene (LLDPE and VLDPE), 748–752. *See also* Low-density polyethylene (LDPE)
  - applications, 750–751, 756–758
  - defined, 748
  - history, 748–749
  - manufacture, 749, 754
  - markets, 755
  - pressure-sensitive tape, 886
  - properties, 751–752
  - rotational molding, 819–820
  - safety and health, 752
  - second-generation, 752
  - standup flexible pouches, 854, 855
  - structure and properties, 749–750
- Linear low-density resins, plastic bags, heavy duty, 60–61
- Liners
  - closure liners, 205–206, 214–215
  - paperboard, 718
- Liquid
  - carbonated, filling machinery, 389–390
  - still, filling machinery, 390–397. *See also* Filling machinery
- Liquid bag-in-box packaging, 48–51
- Liquid cleaning technique, surface treatment, 868–869
- Liquid-crystalline polymers. *See* Thermotropic liquid-crystalline polymers (TLCP)
- Liquid-crystal polymers (LCP), dual-ovenable packaging, 645
- Liquid inks, 511–513
- Liquid packaging, extrusion coating, 378
- Lithography. *See* Decorating; Labeling; Printing
- Load-bearing floorboards, defined, marine environment, 592
- Lock closure, cartoning machinery (top-load), 175
- Logistical/distribution packaging, 572–579. *See also* Distribution packaging
  - innovations, 577
  - overview, 572–573
  - packaging forms, 573
  - packaging performance, 573–576
  - problems, 576–577
- Losses, marine environment, 601–602
- Low-density polyethylene (LDPE), 752–758. *See also* Linear and very low-density polyethylene (LLDPE and VLDPE)
  - applications, 756–758
  - blow molding, 83
  - bottle and jar closures, 215
  - carded packaging, 162, 163, 164
  - characteristics, 753
  - coextruded flexible packaging, 237, 239
  - coextruded semirigid packaging, 241
  - collapsible tubes, 942, 943
  - composite can construction, 136
  - dual-ovenable packaging, 643
  - edible film, 399
  - folding cartons, 184
  - health and safety factors, 758
  - ionomers, 527, 528
  - manufacture, 753–754
  - markets, 755
  - overview, 752–753
  - plastic bottle design, 97
  - properties, 754–755
  - rotational molding, 819
  - skin packaging, 840
  - standup flexible pouches, 854
- Low-level palletizer, 708–709
- Lubricants
  - additives, plastic, 11–12
  - poly(vinyl chloride) (PVC), 773
- Lug or bar chain conveying, system design and installation, 270, 271–276
- Lug cap bottle and jar closures, 209
- Lug closures, capping machinery, 157
- Luxembourg, 551
- Macroeconomics, packaging, 325
- Magnetic sealing, heat sealing, 826
- Mall interview, consumer research, 259
- Management, 588–589
  - budgets, 588
  - career development, 167
  - future trends, 589
  - organizational factors, 588
  - packaging specifications, 589
  - professional growth, 589
  - project control, 589
  - responsibilities, 588
  - staffing, 588
  - training, 588
- Management information system (MIS), 514
- Manual loading
  - cartoning machinery (top-load), 173
  - case loading, 189–190
- Manufacturer's seam or side seam, defined, 177–178
- Manufacturing specifications, specification and quality assurance, 850, 852
- Marine environment, 589–603. *See also* Export packaging; Shipping
  - container problems, 600–601
  - damage and claims, 602
  - definitions, 590–595
  - design considerations, 597–600
  - insurance and losses, 601–602
  - marks and numbers, 595
  - preservation, 595–597
  - shipping containers, testing of, 906–909
  - unitization and palletization, 600–601



- Marketing effectiveness, of consumer packages, testing for, 887–890
- Marks, numbers, and symbols, 367, 369, 590, 595
- Massachusetts, 353
- Materials handling, 603–610  
analytic methods, 604–606  
definitions, 603  
equipment, 607  
objectives, 603–604  
overview, 603  
packaging and, 607–609  
plant layout, 606–607  
principles, 604
- Maximum instantaneous delivery rate (MIDR) calculation, packaging adhesives, 20–22
- McKee formula, edge-crush concept, 332–333
- Meat industry  
chub packaging, 204–205  
edible film, 398  
food packaging, 700, 701  
modified atmosphere packaging, 653–654  
vacuum packaging, 952–953
- Meat Inspection Act, 255
- Mechanical breakaway caps, bottle and jar closures, 212–213
- Medical packaging, 610–615. *See also* Sterile disposable healthcare products  
adhesives, 612–613  
aluminum foil, foil lidding, 462  
environmental concerns, 614  
lidding, 562–563  
materials selection, 611–614  
overview, 610  
package function definition, 610–611  
polycarbonate (PC), 741  
sterile disposable healthcare products, 693–699  
sterilization methods, 614
- Medications. *See* Pharmaceuticals
- Mesh-top conveying, 268–269
- Metal can fabrication, 615–629  
can types, 615–616  
coating equipment, 627–629  
coatings, 626–627  
overview, 615  
three-piece manufacture, 617–621  
two-piece manufacture, 621–626
- Metal cans. *See also* Aluminum cans; Steel cans  
carbonated beverages, 159–160  
oriented polyester film, 414
- Metal closures, bottle and jar closures, 216
- Metal collapsible tubes, 942
- Metal containers  
bulk packaging, 121–122  
standards, ISO, 524
- Metallizing. *See* Vacuum metallizing
- Metals  
economics, 327–328  
Europe, 361, 546–547  
radiation effects, 796  
recycling, 800–801, 804
- Methyl cellulose, edible film, 398
- Metrication, 638–642  
benefits of system, 639  
conversion tables, 640–642  
history, 638–639  
International System, 639, 642  
overview, 638  
rounding, 642  
terms and symbols, 642
- Metric Conversion Act of 1975, 639
- Met-top conveying, 269–270
- Microeconomics, packaging, 329–330
- Microprocessors. *See* Computer applications
- Microwavable and dual-ovenable packaging, 642–646  
active packaging, 7  
materials, 643–646  
dual-ovenable, 643–645  
microwave-only, 645–646  
oriented polyester film, 413  
overview, 642–643
- Microwave ovens, aluminum foil, 463
- Microwave pasteurization and sterilization, 646–648
- Mildew, export packaging, 366
- Military packaging, 648–650  
retortable packages, 810  
steam-table trays, 938
- Modified atmosphere packaging, 650–659  
active packaging, 652–653  
bakery products, 654  
European market, 656–659  
fish, 654  
fruits and vegetables, 655  
gases used in, 651, 657  
materials, 652  
overview, 650–651  
oxygen scavengers, 688, 689  
poultry, 654  
prepared foods, 654–655  
red meat, 653–654  
shelf life, 835
- Moisture barrier, edible film, 397, 398
- Moisture control, active packaging, film composites, 5–6
- Moisture vapor transmission rate (MVTR), fiber drums, 311. *See also* Water-vapor transmission rate (WVTR)
- Molded fiber, 382–383
- Molded pulp  
described, 791–794  
dual-ovenable packaging, 643–644
- Molding  
compression molding, 256  
injection molding, 503–511. *See also* Injection molding  
rigid plastic containers, 110–111  
rotational molding, 819–822  
thermosetting plastics, processing systems, 921–923, 924–925
- Mold release agents, additives, plastic, 11–12
- Monsanto v Kennedy*, law and regulation (U.S.), food packaging, 554
- Mortality rates, child-resistant packaging, 201
- Movable-spout closure, bottle and jar closures, 211
- Mullen test, corrugated boxes, 102–103, 105
- Multilayer films, plastic film, 425
- Multilayer flexible packaging, 659–665  
appearance, 660  
barrier protection, 660–661  
future trends, 664  
manufacture, 663–664  
overview, 659–660  
product containment, 661–663
- Multilayer plastic bottles. *See* Barrier polymers; Blow molding; Coextrusion
- Multilayer process, blow molding, 89–90
- Multipackers  
cartoning machinery (end-load), 584–585  
wrapping machinery, 972
- Multiplex, paperboard, 718
- Multiwall bag(s), 61–66  
constructions, 64  
equipment, 65  
extrusion coating, 380  
graphics, 65–66  
history, 61–62  
sizing of, 64  
specifications, 64–65  
testing, 890  
transportation, 66  
types of, 62–64
- Multiwall-bag machinery, 54–56
- Municipal solid waste (MSW), 330, 344–347
- National Academy of Sciences, nutrition labeling, 675
- National Aeronautics and Space Administration (NASA)  
electrostatic discharge protective packaging, 336  
HACCP system, 485
- National Bureau of Standards (NBS), checkweighers, 195
- National Classification Committee (NCC), steel drums and pails, 321
- National Institute of Standard and Technology (NIST), metrication, 639
- National Motor Freight Classification (NMFC)  
fiber drums, 314  
plastic pails, 706  
steel drums and pails, 321  
transportation codes, 930
- Natural rubber latex, waterborne adhesives, 24
- Netherlands, 350, 551
- Netting, plastic, 666–667
- Nippon packaging. *See* Japan
- Nitrile polymers, 669–672  
applications, 671–672  
copolymers, 670  
overview, 669–670  
properties, 670–671
- Nitrocellulose (NC), 164, 194
- Nitrogen, modified atmosphere packaging, 651
- Noncirculating systems, packaging adhesives, 14
- Nonferrous metals, recycling, 801
- Nonoptical systems, filling machinery, count measurement, 383–384
- Nonoriented polypropylene film, 407–408  
manufacture, 408  
properties, 408
- Nonreturnable glass bottles, 159, 170



- Nonwovens, 672–674  
 bonding methods, 673–674  
 defined, 672  
 fibers, 672  
 manufacture, 672–673  
 paper, described, 717
- North Carolina, 354
- Nucleating agents, additives, plastic, 12
- Nutrition labeling, 674–681. *See also* Labeling  
 claims, 679–680  
 computer applications, 228  
 Europe, 548–549  
 history, 674–675  
 Nutrition Facts panel, 677–679  
 overview, 674  
 regulatory agencies, 675–677
- Nutrition Labeling and Education Act of 1990, 674, 675
- Nylon, 681–686  
 applications, 685  
 coextrusion, flexible packaging, 239  
 dual-ovenable packaging, 644–645  
 overview, 681  
 processing methods, 682–684  
 properties, 682  
 secondary conversion, 684–685  
 strapping materials, 862
- Occupational injury, logistical/distribution packaging, 575
- Occupational Safety and Health Administration (OSHA). *See* U.S. Occupational Safety and Health Administration (OSHA)
- Odor protection  
 absorbent films, active packaging, 7  
 ethylene-vinyl alcohol (EVOH) copolymers, 356–357  
 oriented polyester film, 409, 410
- Offset container printing, described, 298–300
- Offset lithographic ink, 513
- Offset printing. *See* Decorating; Printing
- Ohmic (electrical) resistance system, aseptic packaging, 43
- Oil-resistant paper, 715
- Oils. *See* Fats and oils
- Open-top conveying, 268–269
- Opposed-shelf type vertical chain conveyor, 276
- Optical systems, filling machinery, count measurement, 383
- Oregon, 352, 556
- Organic permeation, aroma barrier testing, 39–40
- Organic pigments, colorants, 242. *See also* Colorants
- Organic Reclamation and Composting Association (ORCA), 77
- Oriented polyester film, 408–415  
 applications, 411–414  
 environmental concerns, 414  
 future trends, 414–415  
 manufacture, 409, 411  
 overview, 408–409  
 properties, 409–410  
 surface modifications, 410–411
- Oriented polypropylene film, 415–422  
 history, 415  
 manufacture, 416  
 morphology, 416–417  
 orientation process, 417–418  
 properties, 418–422  
 resins, 415
- Oriented polystyrene (OPS), plastic films, 163
- Outer flat, defined, 178
- Overprinting machinery, 540–541
- Over-the-counter drugs, pharmaceutical packaging, 735
- Overwrap packaging, plastic film, 423
- Oxidation, corrosion, 140–141
- Oxygen, modified atmosphere packaging, 651
- Oxygen scavengers, 687–692  
 active packaging, 2, 4, 5–6  
 applications, 689  
 chemistry, 688–689  
 food-safety and regulation, 690–691  
 history, 687  
 modified atmosphere packaging, 652  
 overview, 687  
 sizing and selection, 689–690  
 spoilage, 687–688  
 testing, 690  
 troubleshooting, 691
- Oxygen transmission rate (OTR)  
 permeation testing, 896–897  
 shelf life, 831, 833  
 surface and hydrocarbon-barrier modification, 866
- Ozone, antiozonant agents, additives, plastic, 9
- Ozone depletion, 344, 788–791
- Pacific Rim, 350–351
- Package handling systems. *See* Conveying
- Package-integrity issues for sterile disposable healthcare products. *See* Sterile disposable healthcare products
- Packaging adhesives. *See* Adhesives
- Packaging of food. *See* Food packaging
- Pad printing. *See also* Decorating; Printing  
 computer applications, 230  
 described, 300–302
- Pails. *See* Plastic pails; Steel drums and pails
- Pallet  
 defined, 708  
 expendable corrugated, 710  
 plastic, 710–714
- Palletizing  
 described, 708–710  
 marine environment, 591, 600–601  
 patterns, computer applications, 256–258
- Pallet packing  
 carton terminology, 179  
 standards, ISO, 523
- Pallet-type conveyor, 273
- Pan conveyor, 273
- Paper, 714–717  
 absorbent paper, 716  
 bleached papers, 714  
 coated papers, 717  
 colorants, 255
- European packaging, 361  
 greaseproof and glassine, 715  
 kraft papers, 714  
 law and regulation (Europe), 546  
 medical packaging, 611  
 nonwovens, 717  
 overview, 714  
 radiation effects, 796  
 recycling, 801–802, 803–804  
 specialty-treated paper, 716  
 synthetic, 724  
 tissue papers, 716–717  
 vegetable parchment, 715  
 water-, grease-, and oil-resistant paper, 715  
 waxed papers, 715–716  
 wet-strength paper, 716
- Paper bags. *See* Multiwall bag(s)
- Paperboard, 717–723  
 beverage carriers, 168–169  
 carded packaging, 162, 164  
 colorants, 255  
 composite can construction, 134–136, 137–139  
 corrugated plastic compared, 286  
 dual-ovenable packaging, 643  
 economics, 327  
 ethylene-vinyl alcohol (EVOH) copolymers, 359  
 folding cartons, 181–182  
 law and regulation (Europe), 546  
 manufacture, 719–721  
 overview, 717–718  
 physical characteristics, 719  
 radiation effects, 796  
 recycling, 345–346  
 skin packaging, 841–842  
 structure and properties, 718–719  
 terminology, 718  
 types, 721–723
- Paperboard boxes, rigid. *See* Rigid-paperboard boxes
- Parenteral drugs, pharmaceutical packaging, 733–734
- Parison programming, blow molding, 86–87
- Pasta products, modified atmosphere packaging, 654
- Pasted open mouth (POM) multiwall bag, 62, 63, 64
- Pasted valve stepped end (PVSE) multiwall bag, 63, 64
- Paste inks, 1, 513–514
- Pasteurization, microwave, 646–648
- Performance testing, shipping container testing, 908–909
- Peristaltic-pump volumetric fillers, filling machinery, 393
- Permeability (of aromas and solvents), 724–733  
 aroma barrier testing, 39–40  
 barrier polymers, 72–76  
 chemical composition, 725–726  
 copermeant presence, 726–728  
 numerical consistency of data, 730–732  
 overview, 724–725  
 polymer morphology, 726  
 relative humidity effects, 728–729



- Permeability (of aromas and solvents) (*Continued*)  
 temperature effects, 729–730  
 transport process, concentration dependence of, 726
- Permeation testing, 895–898. *See also* Leakage testing  
 carbon dioxide transmission rate (CO<sub>2</sub>TR), 897–898  
 history, 896  
 overview, 895  
 oxygen transmission rate (OTR), 896–897  
 permeation, 895–896  
 water-vapor transmission rate (WVTR), 897
- PETG copolyester  
 extrusion, 828  
 forming, 828  
 overview, 827–828  
 properties, 829–830  
 secondary fabrication, 828  
 sheet assembly, 828, 830
- pH  
 corrosion, 141, 142–143  
 food canning, 123  
 steel cans, 149
- Pharmaceuticals, 733–736  
 aluminum foil, foil lidding, 462  
 ampuls and vials, glass, 35–38  
 bottle and jar closures, 212  
 child-resistant packaging, 199, 200  
 edible film, 398–399  
 ethical, 733–735  
 lidding, 562  
 manufacture, 735–736  
 oriented polyester film, 414  
 over-the-counter, 735  
 plastic bottle design, 99
- Phenolics, bottle and jar closures, 215–216
- Photodegradation, polymers, 762
- Pigments. *See also* Colorants  
 colorants, 242–243  
 listing of, table, 244–254  
 poly(vinyl chloride) (PVC), 773  
 selection of, table, 243
- Pilferage, export packaging, 366
- Pinch-bottom open-mouth (PBOM) multiwall bag, 63, 64
- Pinhole flex test, polymer properties, 761
- Pitting corrosion, 142
- Pivoted-bucket conveyor, 273
- Plain-paper labels, 536
- Plastic  
 additives, plastic, 8–13  
 biodegradable materials, 77–78  
 bottle and jar closures, 215–216  
 carded packaging, 161–166  
 colorants, 243, 255  
 corrugated, 285–287  
 decorating, 294. *See also* Decorating  
 economics, 328  
 environmental concerns, 352  
 European packaging, 361  
 foamed plastics, 451–458. *See also* Foamed plastics  
 hot-fill technology, 494–495  
 law and regulation (Europe), 543–546  
 radiation effects, 796–798  
 recycling, 346, 802–803, 804  
 thermosetting plastics, processing systems, 921–923
- Plastic additives. *See* Additives (plastic)
- Plastic bag(s), 66–69  
 applications, 68–69  
 bulk packaging, 121  
 heavy duty, 60–61  
 manufacturing methods, 66–68  
 testing, 890–891
- Plastic bag machinery, 56–59
- Plastic bottle(s)  
 beverage carriers, 170  
 carbonated beverage packaging, 158–159  
 testing, 891
- Plastic bottle design, 93–100  
 environmental concerns, 99–100  
 overview, 93  
 prototyping and testing, 97–98  
 requirements, 93–95  
 specialty bottles, 98–99  
 specifications, 95–97  
 steps in, 93
- Plastic boxes, testing, 892–893
- Plastic cans, 144
- Plastic-clip closure, bag closures, 220
- Plastic collapsible tubes, 942–944
- Plastic containers. *See* Rigid plastic containers
- Plastic drums, 315–318. *See also* Fiber drums  
 design, 316–317  
 overview, 315  
 regulation, 317–318  
 resins, 315–316  
 testing, 894
- Plastic film, 423–427. *See also* Film(s)  
 applications, 423–424  
 blister packaging, 163  
 manufacture, 426–427  
 modified atmosphere packaging, 652–653  
 multilayer films, 425  
 multilayer flexible packaging, 660–661  
 overview, 423  
 resins, 424–425  
 skin packaging, 162, 163, 840–841  
 vinylidene chloride copolymer (VDC), 961
- Plasticizers  
 additives, plastic, 12  
 edible film, 397–398  
 flexible polyvinyl chloride (PVC) film, 401  
 poly(vinyl chloride) (PVC), 773
- Plastic netting, 666–667
- Plastic pails, 704–708  
 design, 707  
 manufacture, 707–708  
 materials, 705  
 overview, 704–705  
 performance requirements, 705–706  
 specifications, 706–707  
 testing, 894
- Plastic pallets, 710–714
- Plastic ring beverage carriers, 168
- Plastic-sheet packages, testing, 893
- Platen printers, computer applications, 230
- Plug-orifice closure, bottle and jar closures, 211
- Ply, paperboard, 718
- Ply separation test, corrugated box testing, 892
- Pneumatic sealing, heat sealing, 826
- Pocket conveyor, 273
- Point, defined, 178
- Point-of-purchase packaging, 736–740  
 future trends, 740  
 high visibility versus, 736  
 materials, 736  
 permanent, 738–740  
 temporary, 736–738
- Poison-prevention packaging, child-resistant packaging, 199–204. *See also* Tamper-evident packaging
- Poison Prevention Packaging Act (PPPA) of 1970, 199, 255, 462
- Poisson's ratio, polymer properties, 761
- Polarization, corrosion, 141
- Politics, environmental regulation, 352
- Pollution, environment, 343–344
- Polyamides, biodegradable materials, 81
- Polycaprolactone, biodegradable materials, 81
- Polycarbonate (PC)  
 described, 740–742  
 dual-ovenable packaging, 645  
 electrostatic discharge protective packaging, 339, 340–341
- Polyester(s). *See also* Polyethylene terephthalate (PET)  
 biodegradable materials, 80–81  
 bottles, heat-resistant, blow molding, 90–91  
 electrostatic discharge protective packaging, 341  
 hot stamping, 296  
 medical packaging, 612  
 strapping materials, 862
- Polyester film. *See* Oriented polyester film
- Polyetherimide (PEI), dual-ovenable packaging, 645
- Polyethylene naphthalate (PEN), oriented polyester film, 414–415
- Polyethylene oxide, biodegradable materials, 82
- Polyethylene (PE)  
 bag closures, 220  
 high-density, 745–748. *See also* High-density polyethylene (HDPE)  
 labeling, 295  
 linear and very low-density (LLDPE and VLDPE), 748–752. *See also* Linear and very low-density polyethylene (LLDPE and VLDPE)  
 low-density, 752–758. *See also* Low-density polyethylene (LDPE)  
 microwavable packaging, 646  
 modified atmosphere packaging, 652  
 plastic bags, heavy duty, 60–61  
 plastic drums, 315–316  
 plastic pails, 705, 708  
 skin packaging, 840  
 surface and hydrocarbon-barrier modification, 866
- Polyethylene terephthalate glycol (PETG). *See* PETG copolyester
- Polyethylene terephthalate (PET), 742–745  
 applications, 744–745



- beverage carriers, 168
- blow molding, 83, 87, 88, 89, 90, 91
- carbonated beverages, 158, 160
- dual-ovenable packaging, 643–644
- folding cartons, 184
- history, 742
- homopolymers and copolymers, 744
- hot-fill technology, 494
- labeling, 298
- manufacture, 742–744
- oriented polyester film, 408–415
- plastic bottle design, 97
- recycling, 346, 800, 802–803, 804
- Polyethylene vinyl alcohol (EVOH)
  - biodegradable materials, 82
  - blow molding, 89–90
  - coextrusion machinery, flat, 231
- Polyhydroxyalkanoates, biodegradable materials, 80
- Poly(lactic acid)/poly(glycolic acid), biodegradable materials, 80–81
- Polymer(s)
  - acrylic plastic polymers, 1–2
  - barrier polymers, 71–77. *See also* Barrier polymers
  - biodegradable materials, 77–83
  - electrostatic discharge protective packaging, 341–342
  - permeability (of aromas and solvents), 724–733. *See also* Permeability (of aromas and solvents)
  - radiation effects, 796–798
- Polymer properties, 758–765
  - barrier properties, 763
  - density and thermophysical properties, 759–760
  - electrical properties, 764
  - mechanical properties, 760–761
  - optical appearance, 764
  - overview, 758–759
  - solubility and chemical degradation, 761–763
  - surface and adhesion, 763–764
- Polyolefins
  - blow molding, 86
  - coextruded semirigid packaging, 241
  - coextrusion, flexible packaging, 239
- Polyphenylene oxide/polystyrene (PPO), microwavable packaging, 645–646
- Polypropylene, strapping materials, 862
- Polypropylene film. *See* Nonoriented polypropylene film; Oriented polypropylene film
- Polypropylene (PP), 765–768
  - applications, 766–768
  - biaxially oriented, cellophane, 195
  - blow molding, 83, 87, 88, 89
  - bottle and jar closures, 215
  - composite can construction, 136
  - corrugated plastic, 286
  - dual-ovenable packaging, 643
  - folding cartons, 184
  - health and safety issues, 768
  - hot-fill technology, 495
  - labeling, 298
  - manufacture, 766
  - microwavable packaging, 645
  - modified atmosphere packaging, 652
  - plastic bottle design, 96, 97
  - properties, 765–766
  - recycling, 803
- Polysaccharide-lipid bilayer film, edible film, 398
- Polystyrene foam
  - extruded, 449–450
  - foamed plastics, 456–457
- Polystyrene (PS), 768–771
  - applications, 769–770
  - bag closures, 220
  - blow molding, 83
  - bottle and jar closures, 215
  - coextrusion, semirigid packaging, 241
  - high-impact polystyrene (HIPS), thermoforming, 914
  - manufacture, 770–771
  - overview, 768–769
  - plastic bottle design, 97
  - recycling, 346, 351–352, 803
- Polysulfone (PSO), dual-ovenable packaging, 645
- Polyurethanes, biodegradable materials, 81
- Poly(vinyl alcohol), biodegradable materials, 81–82
- Poly(vinyl chloride) (PVC), 771–775
  - additives, plastic, 11, 12
  - applications, 773–774
  - beer market, 160
  - blow molding, 83, 84, 88
  - carded packaging, 162, 163, 164
  - compounding, 773
  - environmental concerns, 344
  - folding cartons, 182
  - food packaging, 700
  - law and regulation (Europe), 544, 547
  - lidding, 562
  - manufacture, 772
  - markets, 772
  - overview, 771
  - pharmaceutical packaging, 734
  - plastic bottle design, 97
  - polymer properties, 760
  - recycling, 346, 774, 803
  - regulation, 774
  - shrink bands, 69–70
  - shrink films, 434
  - structure and properties, 772–773
- Poly(vinyl chloride) (PVC) modifiers, acrylic plastic polymers, 2
- Polyvinylidene chloride (PVDC) copolymer. *See also* Vinylidene chloride (VDC) copolymer
  - beer market, 160
  - cellophane, 194, 195
  - coextrusion
    - flexible packaging, 239
    - semirigid packaging, 240
  - coextrusion machinery, flat, 231–234
  - extrusion coating, 380, 381
  - lidding, 563
  - oriented polyester film, 410
  - oriented polypropylene film, 420
  - plastic films, 424
  - surface and hydrocarbon-barrier modification, 866
- Portable conveyor, 270
- Portugal, 551
- Positive-displacement volumetric fillers, filling machinery, 393
- Pouch packaging. *See also* Standup flexible pouches
  - cook/chill food production, 285
  - form/fill/seal pouch, horizontal, 465–468
  - retortable packages, 809–810
  - standup flexible pouches, 852–856
- Poultry
  - food packaging, 700
  - modified atmosphere packaging, 654
  - vacuum packaging, 951
- Poultry Inspection Act, 255
- Power-and-free conveyor, 274
- Power density, vibration, 957
- Power transmission, conveying, 276–277
- Prebreak, defined, 178
- Preservation, marine environment, 590, 595–597
- Press and blow (P&B) process, glass container manufacturing, 479–480
- Press-on closures, capping machinery, 157–158
- Press-on twist-off closures, capping machinery, 157
- Press-on vacuum cap bottle and jar closures, 210
- Press-twist bottle and jar closures, 209
- Pressure containers, 775–783. *See also* Aerosol containers
  - aluminum, 781
  - construction, 779–780
  - dimensions, 778–779
  - glass and plastic, 781
  - history, 775–776
  - overview, 775
  - pressure resistance, 780–781
  - steel, 776–778
  - tinplate linings, 780
  - valves, 781–783
- Pressure/pressure-decay method, leakage testing, 900
- Pressure-sensitive adhesives, acrylic plastic polymers, 1
- Pressure-sensitive labeling machinery, 539–540
- Pressure-sensitive tape, 883–887
  - box-sealing tape, 884–885
  - environmental concerns, 886–887
  - filament tapes, 885–886
  - overview, 883
  - specialty tapes, 886
  - testing, 883–884
- Printing, 783–787. *See also* Colorants; Decorating; Inks; Labeling
  - aluminum foil, 461
  - bar codes, 228
  - colorants, 243, 255–256
  - computer applications, 228–231
  - corrugated plastic, 287
  - flexography, 785–787
  - gravure, 784–785
  - holographic packaging, 489–492
  - inks, 511–514
  - labeling, 537–538
  - multilayer flexible packaging, 660, 663
  - offset container printing, 298–300
  - oriented polyester film, 414



- Printing (*Continued*)  
 overview, 783-784  
 pad printing, 301-302  
 PETG copolyester, 830  
 screen printing, 302-303  
 skin packaging, 839, 841  
 thermoform/fill/seal, 912
- Processing aid agents, additives, plastic, 12
- Produce, food packaging. *See* Fruits and vegetables
- Product fragility testing, 901-906  
 environment definition, 901  
 fragility definition, 901-904  
 overview, 901
- Product liability. *See* Liability
- Propellants, aerosol. *See* Aerosol propellants
- Propionate, plastic films, 163
- Protective materials, defined, marine environment, 591
- Protective-package concept, distribution packaging, 308-309
- Protein  
 biodegradable materials, 80  
 waterborne adhesives, 23
- Pullulan, biodegradable materials, 80
- Pulp. *See* Molded pulp
- Pulsed electric field (PEF) system, aseptic packaging, 43
- Pump dispenser, bottle and jar closures, 212
- Pure Food and Drug Act of 1906, 674
- Push bar conveyor, 274
- QLF transparent barrier coating, transparent glass on plastic food-packaging materials, 445-448
- Qualitative research, marketing effectiveness, of consumer packages, 887-888
- Quality assurance. *See* Specification and quality assurance
- Quality function deployment (QFD), integrated packaging design and development, 516-517
- Quantitative research, marketing effectiveness, of consumer packages, 888
- Quenching, blow and cast film, extrusion, 375
- Radiant sealing, heat sealing, 826
- Radiation effects, 796-799  
 composites, 798  
 glass, 796  
 metals, 796  
 overview, 796  
 paper, 796  
 paperboard, 796  
 plastics, 796-798  
 rubber, 798  
 testing, 798
- Radiation sterilization, sterile disposable healthcare products, 697-699
- R. A. Jones (RAJ) carton, carton terminology, 176-177
- Ramsey proposal, law and regulation (U.S.), food packaging, 553-554
- Random vibration, sinusoidal vibration versus, 956
- Recall questioning, consumer research, 259
- Reciprocating-flight conveyor, 274
- Reciprocating printers, computer applications, 230
- Recycled materials  
 board, defined, 178  
 law and regulation (U.S.), food packaging, 555  
 paperboard, carded packaging, 164  
 skin packaging, 842
- Recycling, 799-808  
 corrugated boxes, 107-108  
 economics, 330, 803-804  
 edible film, 397  
 environmental concerns, 343, 345-346, 352-353  
 Europe, 361, 805-808  
 history, 351-352  
 increase in, 799-800  
 metals, 800-801  
 paper, 801-802  
 plastics, 802-803  
 poly(vinyl chloride) (PVC), 774  
 separation, 800
- Refillable containers  
 environmental regulation, 350, 354  
 polycarbonate (PC), 741
- Refillable glass bottles  
 beverage carriers, 169-170  
 carbonated beverages, 159
- Refrigeration, shelf life, 831-832
- Regenerated cellulose. *See* Cellophane
- Regulation. *See also* Environmental regulation  
 aerosol propellants, 788-791  
 aluminum foil, 462  
 bottle and jar closures, 216  
 checkweighers, 195-196  
 child-resistant packaging, 199-203  
 colorants, 255-256  
 corrugated boxes, 103, 105  
 environmental, 347, 348-355  
   international, 348-351  
   North America, 351-355  
 ethylene-vinyl alcohol (EVOH) copolymers, 358  
 fiber drums, 314-315  
 food canning, 127-128  
 high-density polyethylene (HDPE), 748  
 linear and very low-density polyethylene (LLDPE and VLDPE), 752  
 low-density polyethylene (LDPE), 758  
 nutrition labeling, 674-681  
 oxygen scavengers, 690-691  
 plastic drums, 317-318  
 plastic pails, 705-707  
 polypropylene (PP), 768  
 poly(vinyl chloride) (PVC), 774  
 pressure containers, 775, 780, 781  
 recycling, 800, 805-808  
 shipping container testing, 909  
 solid-fiber boxes, 113  
 steel drums and pails, 321-322  
 transportation codes, 930  
 vinylidene chloride copolymer (VDC), 961
- Reinforced plastic low-profile agents, additives, plastic, 12
- Reinforcing straps, defined, marine environment, 592
- Relative humidity. *See* Humidity
- Research and development, active packaging, 7
- Resin coding, environmental regulation, 354-355
- Resin emulsions, waterborne adhesives, 24
- Resource Conservation and Recovery Act (RCRA), 556
- Resource depletion, environment, 343
- Retortable packages, 808-811  
 flexible, 809  
 overview, 808-809  
 pouches, 809-810  
 trays, 810-811
- Retorting  
 food canning, 124-127  
 oriented polyester film, 413
- Returnable glass bottles. *See* Refillable glass bottles
- Reuse, environmental concerns, 345
- Reverse roll coaters, coating equipment, 222
- Rewind, slitting and rewinding machinery, 847
- Rewinding machinery. *See* Slitting and rewinding machinery
- Right-hand machine, defined, 176
- Rigidity, defined, marine environment, 592
- Rigid packaging, aluminum foil, 463
- Rigid-paperboard boxes, 108-110  
 applications, 110  
 history, 108  
 manufacture, 108-109  
 materials, 109-110  
 testing, 893
- Rigid plastic containers, 110-112  
 bulk packaging, 121  
 ethylene-vinyl alcohol (EVOH) copolymers, 359  
 manufacture, 110-111  
 overview, 110  
 types of, 111-112
- Rigid polyvinyl chloride (PVC) film, 427-431. *See also* Flexible polyvinyl chloride (PVC) film  
 film and sheet production, 428-429  
 markets, 431  
 polymer properties, 760  
 properties, 428  
 resins, 427-428  
 thermoforming, 429-431
- Rigid sheet extrusion, described, 376-377
- Robotic palletizer, 709
- Robots, 811-817  
 automation, 813  
 roll handling, 819  
 task definition, 811-813  
 vision technology, 816  
 worker integration, 813-816
- Roll coaters, coating equipment, 221-223
- Roller coders, computer applications, 230
- Roller conveying, 270, 273, 277, 278, 279
- Roll handling, 817-819
- Rolling chain conveyor, 274
- Rolling-diaphragm volumetric fillers, filling machinery, 393
- Roll-on, rolloff (Ro-Ro), export packaging, 368
- Roll-on bottle and jar closures, 209
- Roll-on closures, capping machinery, 157



- Roll-on stamping method, hot stamping, 296–297
- Rotational molding, 110, 819–822
- Rubber, radiation effects, 798
- Rubber latex, natural, waterborne adhesives, 24
- Rub strips, defined, marine environment, 591–592
- Sachets, active packaging, 3–5
- Sack industry. *See* Multiwall bag(s)
- Sacks, extrusion coating, 380
- Safety and health issues. *See* Health and safety issues
- Saturators, coating equipment, 224
- Scoring, defined, 177, 178
- Scraped-surface heat-exchange (SSHE) systems, aseptic packaging, 43
- Screen ink, 513
- Screen printing, described, 302–303. *See also* Silk screen printing
- Screw conveying, 273, 280
- Screw feeders, dry-product filling machinery, 386
- Sealants. *See* Adhesives
- Sealed-container filling system, filling machinery, 390–392
- Sealing, bottle and jar closures, 207. *See also* Heat sealing
- Self-adhesive labels, 536–537
- Self-heating/cooling packages, active packaging, 7
- Semirigid packaging
  - aluminum foil, 463
  - coextrusion, 240–242
  - medical packaging, 612–613
  - plastic containers, ethylene-vinyl alcohol (EVOH) copolymers, 359
  - vinylidene chloride copolymer (VDC), 961
- Sewn open mouth (SOM) multiwall bag, 62, 63
- Sewn valve (SV) multiwall bag, 63, 64
- Shear-cut tags, 876
- Sheet polyethylene terephthalate glycol (PETG). *See* PETG copolyester
- Shelf impact measurement, consumer research, 259–260
- Shelf life, 830–835
  - cook/chill food production, 284
  - defined, 830–831
  - factors influencing, 831–832
  - multilayer flexible packaging, 660–661
  - testing, 832–835
  - time-temperature indicators, 926, 927
- Shipping. *See also* Export packaging; Marine environment
  - bag-in-box packaging, liquid product, 50–51
  - distribution hazard measurement, 303–307
  - distribution packaging, 307–310
  - export packaging, 365–370
- Shipping container testing, 906–909
  - compression tests, 908
  - conditions, 908
  - methods, 906–907
  - performance testing, 908–909
  - regulation, 909
- sources, 906
- vibration, 907–908
- water-resistance test, 908
- water-vapor transmission test, 908
- Shock, 835–839
  - cushioning, 288, 837
  - damaging effects, 837–839
  - impact shock measurement, 836
  - overview, 835–836
  - product fragility testing, 901–904
  - shock waveform analysis, 836–837
- Shrinkable oriented polyester film, 414
- Shrink bands, 69–70
- Shrink films, 431–434
- Shrink packaging, plastic film, 423
- Sideweld seal, plastic bags, 66–67
- Silica gel sachets, active packaging, 3–4
- Silk screen printing. *See also* Decorating; Printing
  - described, 302–303
  - labeling, 538
- Singapore, 350
- Single-screw extruders, described, 370–372
- Sinusoidal vibration, random vibration versus, 956
- Skids, defined, marine environment, 591
- Skin packaging, 839–843. *See also* Carded packaging
  - applications, 843
  - blister packaging compared, 165
  - components and assembly, 162–163
  - equipment, 842–843
  - heat-seal coatings, 163–164
  - ionomers, 528
  - machinery, 165–166
  - materials, 839–842
  - overview, 839
  - plastic films, 163, 423
  - sterile disposable healthcare products, 693
- Slat conveyor, 274
- Sliding-chain conveyor, 275
- Slip agents, additives, plastic, 12
- Slip depressants, additives, plastic, 9
- Slip promoters, additives, plastic, 11
- Slipsheets, 843–844
- Slit seal, plastic bags, 67–68
- Slitting and rewinding machinery, 844–849
  - center winders, 844–846
  - overview, 844
  - slitting, 847
  - surface winders, 846–847
  - tension control, 847
  - terminology, 848
  - unwinding, 847
- Slot-orifice coater, coating equipment, 224
- Snap-fit cap bottle and jar closures, 210
- Society for Environmental Toxicology and Chemistry (SETAC), 347
- Solid bleached sulfate (SBS) paperboard
  - carded packaging, 164
  - skin packaging, 841–842
- Solid-fiber boxes, 112–113
- Solid-phase thermoforming, 915–916
- Solid waste, 344–347, 556
- Solubility, polymers, 761–763
- Solvent-borne adhesives, adhesives, 25
- Solvent inks, acrylic-based, acrylic plastic polymers, 1
- Solvent resistance, ethylene-vinyl alcohol (EVOH) copolymers, 356
- Solvents, permeability (of aromas and solvents), 724–733. *See also* Permeability (of aromas and solvents)
- Solvent sealing, heat sealing, 826
- Spain, 551
- Special construction folding cartons, 184
- Specialty labeling, law and regulation (Europe), 549
- Specialty tapes, pressure-sensitive tape, 886
- Specialty-treated paper, described, 716
- Specification and quality assurance, 849–852
  - component-specific specification, 849–850
  - consumer or finished-goods specification, 852
  - general packaging specification, 849
  - manufacturing specifications, 850, 852
  - overview, 849
  - total quality management (TQM), 927–929
- Spinwelding, 964–966
- Splicing, defined, marine environment, 592
- Spray dispenser, bottle and jar closures, 212
- Spreads, food packaging, 703
- Stabilizing agents
  - additives, plastic, 12–13
  - poly(vinyl chloride) (PVC), 773
- Standards
  - biodegradable materials, 77
  - bulk bags, 449
  - bulk bags (flexible intermediate bulk containers), 53
  - carton terminology, 178–181
  - child-resistant packaging, 199–203
  - corrugated boxes, 102–103, 104, 105
  - defined, 521
  - electrostatic discharge protective packaging, 339, 342
  - environmental regulation, international, 351
  - filling machinery, still liquid, 396–397
  - international standards, 521–527. *See also* International standards
  - military packaging, 649–650
  - plastic bottle design, 96–97
  - solid-fiber boxes, 113
  - steel cans, 145
  - steel drums and pails, 321
  - styrene-butadiene (SB) copolymers, 864
- Standup flexible pouches, 852–856
  - applications, 855–856
  - economics, 856
  - history, 853–854
  - machinery, 855
  - oriented polyester film, 413–414
  - overview, 852–853
  - technology, 854–855
- Staples, 856–857
- Starch, waterborne adhesives, 23
- Starch-based materials, biodegradable materials, 78–79
- State governments, law and regulation (U.S.), 556, 557
- Static. *See* Electrostatic charge
- Static control, 857–860. *See also* Electrostatic charge



- Static control (*Continued*)
  - electrostatic discharge treatment, surface treatment, 873
  - overview, 857–858
  - rationale, 858–859
  - static causes, 858
- Steam and EtO sterilization, sterile disposable healthcare products, 694–695
- Steam injection/infusion, aseptic packaging, 42–43
- Steam sterilization, sterile disposable healthcare products, 695–696
- Steam-table trays, 937–938
- Steel
  - radiation effects, 796
  - recycling, 800–801
  - strapping materials, 862
- Steel cans, 144–155. *See also* Aluminum cans; Metal cans
  - carbonated beverages, 159–160
  - coatings, 153–154
  - corrosion, 149
  - decoration, 154
  - fabrication, 150–152
  - history, 144–145
  - metals, 149–150
  - performance, 148–149
  - product compatibility, 149
  - recycling, 345
  - shapes and sizes, 145–148
  - technology, 154
- Steel drums and pails, 318–324
  - construction, 319
  - history, 318–319
  - pails, 322–323
  - protection and lining, 319–321
  - regulation, 321–322
  - standards, 321
  - styles, 319
  - testing, 894
- Steel pressure containers, 776–778
- Sterilants, aseptic packaging, 42
- Sterile disposable healthcare products, 693–699
  - ethylene oxide sterilization, 696–697
  - overview, 693
  - radiation sterilization, 697–699
  - requirements, 693–694
  - steam and EtO sterilization, 694–695
  - steam sterilization, 695–696
- Sterile packaging. *See* Medical packaging
- Sterilization. *See also* Aseptic packaging; Canning; Medical packaging; Pharmaceuticals; Sterile disposable healthcare products
  - ethylene oxide sterilization, sterile disposable healthcare products, 696–697
  - microwave pasteurization and sterilization, 646–648
  - radiation effects, 796
  - radiation sterilization, sterile disposable healthcare products, 697–699
  - steam and EtO sterilization, sterile disposable healthcare products, 694–695
  - steam sterilization, sterile disposable healthcare products, 695–696
- Still liquid filling machinery, 390–397. *See also* Filling machinery
- Storage
  - bag-in-box packaging, liquid product, 50–51
  - bulk bags (flexible intermediate bulk containers), 52–53
- Strapping, 860–863
  - applications, 862
  - materials, 860–862
  - package and load characteristics, 862
- Stress, defined, marine environment, 595
- Stress cracking, polymers, 762
- Stretch film, 434–445. *See also* Closures
  - economics, 434–435, 436–437
  - environmental concerns, 442–443
  - history, 435–436
  - inspection and handling, 440–441
  - manufacture, 437–438
  - performance measurement, 438–440
  - problems, 441–442
  - selection, 437
  - terminology, 443–445
- Stretch-film wrapping machinery, 973–978
  - applications, 973–974
  - future trends, 977–978
  - history, 973
  - machinery, 975–977
  - prestretching film, 974–975
- Stretch packaging, plastic film, 423–424
- Styrene-acrylonitrile (SAN), nitrile polymers, 670
- Styrene-butadiene (SB) copolymers, 863–864
- Styrenics, plastic films, 163
- Sulfide black, corrosion, 142
- Sulfonation, surface and hydrocarbon-barrier modification, 866
- Sulfur dioxide, modified atmosphere packaging, 651
- Sulfur dioxide releasing pads, active packaging, 5
- Surface and hydrocarbon-barrier modification, 864–867
  - adhesion improvement, 864–865
  - hydrocarbon-barrier improvement, 865–866
  - overview, 864
- Surface resistance, electrostatic discharge protective packaging, 337–338
- Surface tension, polymer properties, 763–764
- Surface treatment, 867–874
  - abrasive technique, 867–868
  - chemical etching, 869
  - chemical priming, 869
  - cold-gas-plasma treatment, 870–872
  - corona treatment, 870
  - electrostatic discharge treatment, 873
  - evaporated acrylate coatings, 872
  - flame treatment, 869–870
  - fluorination process, 872–873
  - liquid cleaning technique, 868–869
  - overview, 867
  - ultraviolet/ozone process, 872
- Surface winders, slitting and rewinding machinery, 846–847
- Surgical devices, oriented polyester film, 414
- Suspended-tray conveyor, 275
- Sustainable use, environment, 343
- Sweden, 551
- Switzerland, 551
- Synthetic paper, 724
- Synthetic waterborne adhesives, 24
- Tabletop chain conveying, 265–266
- Tachistoscopic research, consumer research, 259
- Tags, 875–879
- Taiwan, 350
- Tamper-evident packaging, 879–882
  - aluminum foil, 462
  - best feature, 882
  - bottle and jar closures, 212–213, 216
  - child-resistant packaging, 199–204
  - consumer preferences, 880
  - economics, 880–881
  - effectiveness, 882–883
  - FDA rule, 880
  - history, 879–880
  - lidding, 562
  - plastic bottle design, 99
  - selection, 881
- Tape
  - gummed, 883
  - pressure-sensitive, 883–887. *See also* Pressure-sensitive tape
- Tear bands, bottle and jar closures, 213
- Technical Association of the Pulp and Paper Industry (TAPPI), carton terminology, 178
- Temperature
  - aroma barrier testing, 40
  - aseptic packaging, 42, 43
  - food canning, 123–124
  - indicators, described, 500–501
  - permeability (of aromas and solvents), 729–730
  - polymer properties, 759–760
  - time and temperature indicators, 499–500, 926–927
- Tension, strapping materials, 861
- Tension bands, defined, marine environment, 592
- Terrorism, tamper-evident packaging, 879–880
- Testing. *See also* Law and regulation
  - aroma barrier testing, 38–41
  - bulk bags (flexible intermediate bulk containers), 53
  - bulk packaging, 122
  - child-resistant packaging, 200–202
  - consumer packages, marketing effectiveness, 887–890
  - corrugated boxes, 102–103, 105
  - electrostatic discharge protective packaging, 336–339
  - forensic packaging, 463–465
  - glass container manufacturing, 483–484
  - heat sealing, 827
  - leak testing, 558–561
  - oxygen scavengers, 690
  - packaging materials, 890–895
    - bags, 890–891
    - bottles, 891
    - boxes, 891–893
    - bulk containers, 893
    - cans, 893



- cartons, 893
- drums and pails, 894
- permeation, 895–898. *See also* Permeation testing
- plastic bottle design, 97–98
- plastic pails, 706
- polymer properties, 758–765
- pressure-sensitive tape, 883–884
- product fragility, 901–906. *See also* Product fragility testing
- radiation effects, 798
- shelf life, 832–835
- shipping containers, 906–909
- slipsheets, 844
- vibration, 957
- Test marketing, consumer research, 259, 887–890
- Textile bags, testing, 891
- Thermoplastic polyesters. *See* Polyethylene terephthalate (PET)
- Thermal insulation, foamed plastics, 455–456
- Thermal process, aseptic packaging, 42
- Thermal shock, glass container design, 475
- Thermal-thermal transfer printers, computer applications, 231
- Thermodegradation, polymers, 762–763
- Thermoform/fill/seal, 910–914
  - applications, 910
  - horizontal form/fill/seal pouch, 467
  - machinery, 911–912
  - materials, 912–914
- Thermoforming, 914–921
  - cut-sheet, 920
  - ionomers, 528–529
  - machinery, 919–920
  - overview, 914
  - polypropylene (PP), 767
  - process, 914–919
  - rigid plastic containers, 110–111
  - rigid polyvinyl chloride (PVC) film, 429–431
  - technology, 921
  - tooling, 920
  - twin-sheet, 920–921
  - vacuum packaging, 950
- Thermophysical properties, polymer properties, 759–760
- Thermoplastic closures, bottle and jar closures, 215
- Thermoplastic polymer, hot-melt adhesives, 24
- Thermoplastic starch, biodegradable materials, 78–79
- Thermoset polyester, dual-ovenable packaging, 644
- Thermosets, bottle and jar closures, 215
- Thermosetting plastics, 921–926
  - processing systems, 921–923, 924–925
  - structures, 924
  - types, 925
- Thermotropic liquid-crystalline polymers (TLCP), 569–572
  - chemistry, 569
  - films, 570–572
  - overview, 569
  - sources, 569–570
- Thermx, dual-ovenable packaging, 644
- Thickness (caliper), paperboard, 718
- Thread-engagement bottle and jar closures, 208–209
- Time-fill fillers, filling machinery, still liquid, 394
- Time-temperature indicators, described, 499–500, 926–927
- Tin
  - radiation effects, 796
  - recycling, 800–801
  - steel cans, 149–150
- Tin cans. *See* Steel cans
- Tinplate can
  - aerosol containers, 28–31
  - hot-fill technology, 493
  - pressure containers, 780
- Tissue papers, described, 716–717
- Top-load cartoning machinery. *See* Cartoning machinery (top-load)
- Topside, paperboard, 718
- Total quality management (TQM), 927–929
  - alignment, 928
  - change management, 927–928
  - customer focus, 928
  - customer-supplier relations, 929
  - economics, 928
  - employee involvement, 929
  - future trends, 929
  - integrated packaging design and development, 514
  - overview, 927
  - strategy, 928
- Tow conveyor, 275
- Toxins. *See* Hazardous materials
- Trademarks, law and regulation (Europe), 549
- Trade shows, exhibitions, 362–365
- Transfer molding, thermosetting plastics, processing systems, 922, 924–925
- Transfer roll coaters, coating equipment, 222
- Transparent glass on plastic food-packaging materials, 445–448
- Transportation
  - bulk bags (flexible intermediate bulk containers), 52–53
  - distribution hazard measurement, 303–307
  - distribution packaging, 307–310
  - economics, 330
  - export packaging, 365–370. *See also* Export packaging
  - fiber drums, 314–315
  - law and regulation (Europe), 549
  - logistical/distribution packaging, 572–579. *See also* Logistical/distribution packaging
  - multiwall bags, 66
  - plastic pails, 705–706
- Transportation codes, 929–931
  - carrier rules, 929–930
  - federal regulations, 930
- Tray former/loader case loading, 193
- Trays
  - barrier-foam, 931–933
  - foam, 933–937
  - retortable packages, 810–811
  - steam-table, 937–938
- Tray-style folding cartons, 183
- Triboelectricity, 336–337, 338, 764
- Trimmer conveyor, 270
- Triple-seal style closure, cartoning machinery (top-load), 175
- Triplex, paperboard, 718
- Trolley conveyor, 276
- Tube filling, 939–941
- Tubes, collapsible, 941–945
  - future trends, 945
  - history, 941–942
  - laminated, 944–945
  - metal, 942
  - plastic, 942–944
- Tube-style folding cartons, 182–183
- Tubular coextrusion machinery. *See* Coextrusion machinery
- Tuck-style carton, defined, 178
- Turbine-meter volumetric fillers, filling machinery, still liquid, 393
- Twin seal, plastic bags, 67–68
- Twin-sheet thermoforming, 920–921
- Tyvek, medical packaging, 611–612
- Ultrasonic sealing, heat sealing, 825
- Ultraviolet-curing technology
  - offset container printing, 300
  - screen printing, 303
- Ultraviolet light resistance, plastic drums, 316
- Ultraviolet/ozone process, surface treatment, 872
- Ultraviolet stabilizing agents, additives, plastic, 13
- Unbalanced-pressure fillers, filling machinery, still liquid, 391–392
- Underliner, paperboard, 718
- Uniform Classification Committee (UCC)
  - gummed tape, 883
  - plastic pails, 706
  - steel drums and pails, 321
- Uniform Freight Classification (UFC)
  - fiber drums, 314
  - steel drums and pails, 321
  - transportation codes, 930
- Uniform load, defined, marine environment, 592
- Unit-dose packaging, pharmaceutical packaging, 734–735
- United Kingdom, 551–552
- United Nations
  - bulk bags, 449
  - fiber drums, 315
  - intermediate bulk containers, 519–521
  - international standards, 526
  - plastic drums, 317
  - steel drums and pails, 321, 322
- U.S. Bureau of Alcohol, Tobacco, and Firearms (BATF), filling machinery, still liquid, 397
- U.S. Consumer Product Safety Commission (CPSC), child-resistant packaging, 199, 200, 202, 203
- U.S. Customary System (USCS), history, 638
- U.S. Department of Agriculture (USDA)
  - colorants, 255–256
  - edible film, 397



- U.S. Department of Agriculture (USDA)  
(*Continued*)  
filling machinery, still liquid, 397  
folding cartons, 181  
food additives, 552  
food canning, 128  
nutrition labeling, 675–680
- U.S. Department of Commerce, glass container manufacturing, 475
- U.S. Department of Defense (DOD)  
electrostatic discharge protective packaging, 336  
military packaging, 648–650  
steam-table trays, 938
- U.S. Department of Transportation (DOT)  
aerosols, 28, 789  
bulk bags, 448–449  
corrugated boxes, 103  
fiber drums, 310–311, 314–315  
hazardous materials labeling, 556  
intermediate bulk containers, 519, 521  
plastic drums, 317  
plastic pails, 705–707  
pressure containers, 775, 780, 781  
shipping container testing, 909  
steel drums and pails, 321, 322  
transportation codes, 930
- U.S. Environmental Protection Agency (EPA)  
aerosol propellants, 788, 790  
child-resistant packaging, 199, 202, 203  
inks, 511  
law and regulation (U.S.), 556  
poly(vinyl chloride) (PVC), 344  
recycling, 346  
solid waste, 344  
transportation codes, 930
- U.S. Federal Trade Commission (FTC)  
environmental regulation, 354  
labeling, 556, 557  
transportation codes, 930
- U.S. Food and Drug Administration (FDA), 552–555  
acrylic plastic polymers, 1, 2  
additives, plastic, 11  
aerosol propellants, 788  
aseptic packaging, 42  
bottle and jar closures, 212  
child-resistant packaging, 199  
closure liners, 205  
coextruded semirigid packaging, 241  
colorants, 255–256  
ethylene-vinyl alcohol (EVOH) copolymers, 358  
filling machinery, still liquid, 397  
folding cartons, 181  
food additive definition, 552  
food canning, 127–128  
food packaging, 552–555  
generally, 552  
high-density polyethylene (HDPE), 748  
hot-melt wax carton, 964  
labeling, 556  
linear and very low-density polyethylene (LLDPE and VLDPE), 752  
low-density polyethylene (LDPE), 758  
nutrition labeling, 674, 675–680  
pharmaceutical packaging, 733, 734, 735  
polypropylene (PP), 768  
poly(vinyl chloride) (PVC), 774  
printing, computer applications, 229  
recycling, 346  
steel cans, 150, 154  
surface and hydrocarbon-barrier modification, 865–866  
tamper-evident packaging, 880, 881
- U.S. National Bureau of Standards, metrication, 639
- U.S. Occupational Safety and Health Administration (OSHA)  
logistical/distribution packaging, 575  
styrene-butadiene (SB) copolymers, 864  
transportation codes, 930
- Unitization, marine environment, 590–591, 600–601
- Unitized loads, export packaging, 368
- Unit-of-use, pharmaceutical packaging, 735
- Universal Product Codes (UPC). *See also* Bar code  
beverage carriers, 168  
printing, computer applications, 228, 229
- Universities, education, 334–335
- Unscrambling, 946–947
- Unsealed-container filling system, filling machinery, still liquid, 392–394
- Unwinding, slitting and rewinding machinery, 847
- Urea, bottle and jar closures, 216
- Vacuum, food canning, 124
- Vacuum-bag coffee packaging, 948–949
- Vacuum closures  
capping machinery, 157  
tamper-evident, bottle and jar closures, 213
- Vacuum-filling systems, dry-product filling machinery, 386–387
- Vacuum metallizing, 629–638  
equipment, 635–637  
future trends, 637  
nylon, 685  
overview, 629–631  
thermal sources, 631–635
- Vacuum packaging, 949–955  
air-removal system, 949–951  
cheeses, 953  
fish, 953–954  
fruits and vegetables, 954  
meats, 952–953  
modified atmosphere packaging, 651, 653–654, 657  
overview, 949  
poultry, 951
- Valve multiwall bag, 63, 64
- Valves, pressure containers, 781–783
- Vapor-corrosion inhibitor (VCI), marine environment, 590
- Vapor-phase inhibitor (VPI), marine environment, 590
- Vegetable parchment paper, described, 715
- Vegetables. *See* Fruits and vegetables
- Vertical case loading, 191–193
- Vertical chain conveyor, opposed-shelf type, 276
- Vertical form/fill/seal machinery, bag-in-box packaging, 46, 47, 48
- Vertical form/fill/seal pouch, 468–470
- Very low-density polyethylene (VLDPE). *See* Linear and very low-density polyethylene (LLDPE and VLDPE)
- Vials. *See* Ampuls and vials
- Vibrating-bin discharge, dry-product filling machinery, 386
- Vibration, 955–958  
cushioning design, 288  
defined, 955  
distribution hazard measurement, 303–307  
forced versus free, 955  
frequency and acceleration, 955–956  
measurement and analysis, 956–957  
product fragility testing, 904  
shipping container testing, 907–908  
sinusoidal versus random, 956  
strapping materials, 861  
terminology, 958  
testing, 957
- Vibratory conveying, 276
- Vibratory feeders, dry-product filling machinery, 385–386
- Vinylidene chloride copolymer (VDC), 958–961. *See also* Polyvinylidene chloride (PVDC) copolymer  
applications, 960–961  
characteristics, 959  
chemistry, 958–959  
overview, 958  
producers, 959–960  
properties, 961  
regulation, 961
- Vinyls, plastic films, 163
- Volume-cup fillers, filling machinery, still liquid, 393
- Water-based inks, acrylic-based, acrylic plastic polymers, 1
- Waterbath test, leakage testing, 899–900
- Waterborne systems, adhesives, 23–24
- Water-resistance test, shipping container testing, 908
- Water-resistant paper, 715
- Water-vapor transmission rate (WVTR). *See also* Moisture vapor transmission rate (MVTR)  
cellophane, 195  
edible film, 398, 399  
high-density polyethylene film, 405  
modified atmosphere packaging, 652  
permeability (of aromas and solvents), 725. *See also* Permeability (of aromas and solvents)  
permeation testing, 897  
polymer properties, 763  
shelf life, 831, 833  
surface and hydrocarbon-barrier modification, 866  
testing, 890  
transparent glass on plastic food-packaging materials, 445–448
- Water-vapor transmission test, shipping container testing, 908
- Waxed papers, described, 715–716
- Waxes, 962–964  
future trends, 964



- hot-melt wax carton, 962–964
  - overview, 962
  - technology, 964
- Web processing, roll handling, 817–819
- Weighing systems, dry-product filling machinery, 387–388. *See also* Checkweighers; Filling machinery
- Weight fillers, filling machinery, still liquid, 393–394
- Welding, spin, 964–966
- Welex system, coextrusion machinery, flat, 233–234
- Wet-glue labeling machinery, 539
- Wet-ink printing, computer applications, 230
- Wet-strength paper, described, 716
- Wettability, polymer properties, 764
- Wirebound boxes, 113–115
- Wire ties, bag closures, 220
- Wirewound-rod coater, coating equipment, 223
- Wisconsin, 353, 354, 556
- Wood boxes, 115–117
  - bulk packaging, 122
  - marine environment, 591, 596–597, 600
  - testing, 892
- wirebound boxes, 113–115
- Wood crate. *See* Crates; Wood boxes
- Working range, strapping materials, 860
- Workplace injury. *See* Occupational injury
- Wrapping machinery, 966–972
  - bundle-wrapping machines, 972
  - fold patterns, 967, 968–971
  - history, 966
  - machine attachments, 971, 972
  - multipack machines, 972
  - stretch-film, 973–978. *See also* Stretch-film wrapping machinery
  - terminology, 966–967, 970

