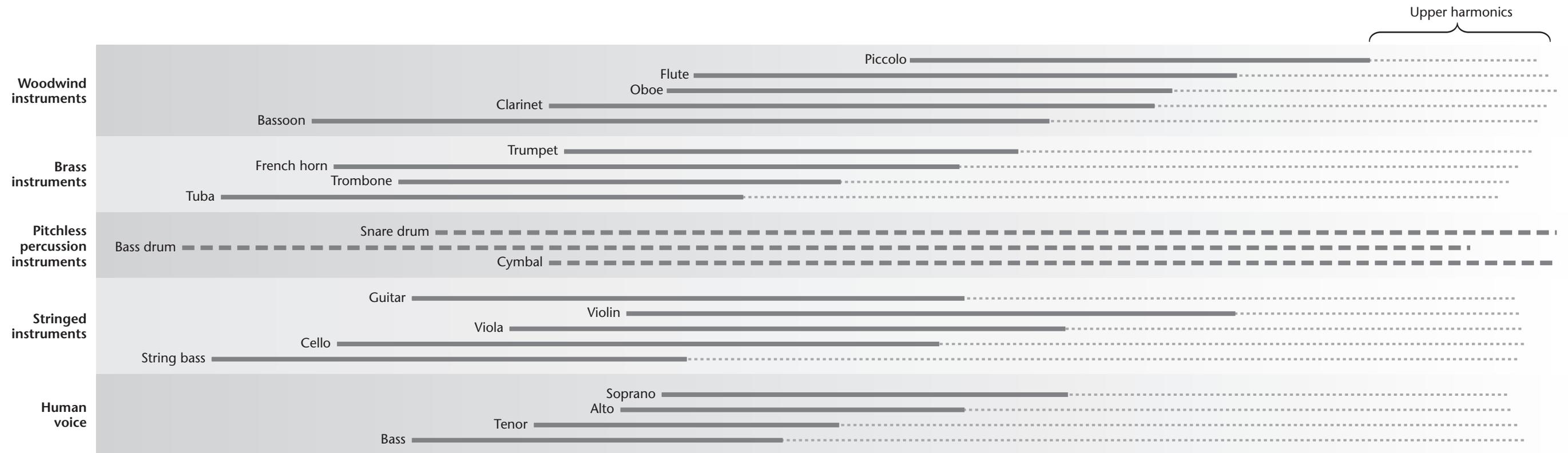


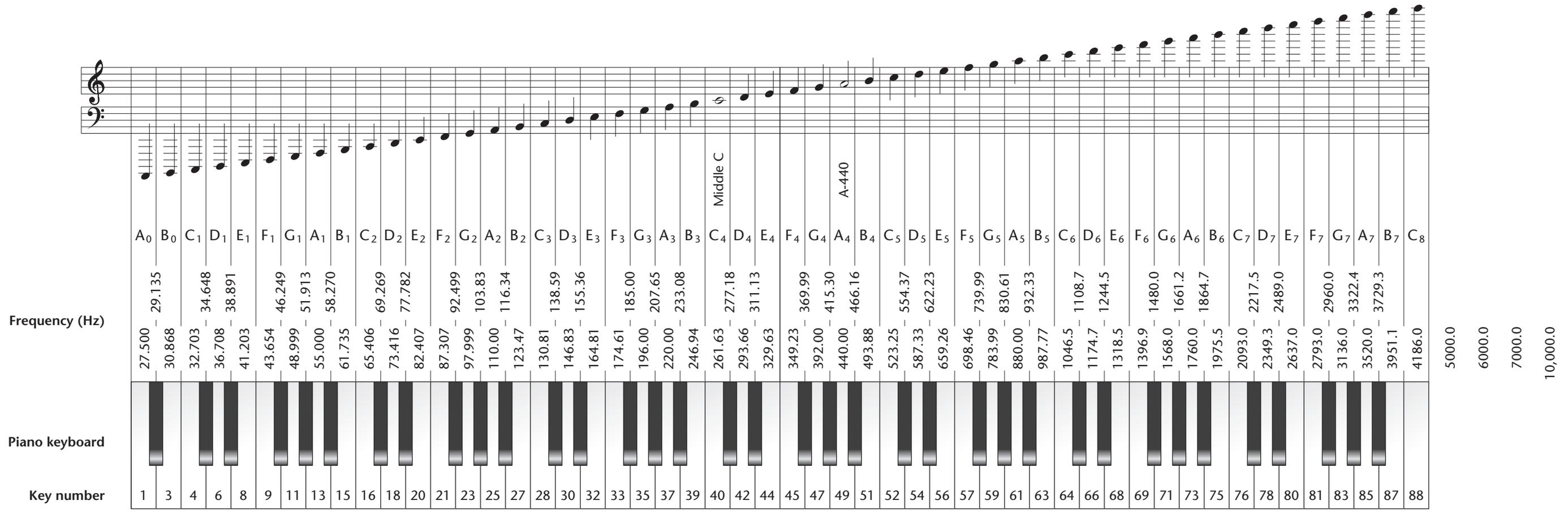
# Audio *in* Media

10<sup>TH</sup> EDITION

Stanley R. Alten



Upper harmonics



# Audio *in* Media

## **The Wadsworth Series in Broadcast and Production**

Albarran, *Management of Electronic Media*, Fifth Edition

Alten, *Audio Basics*

Alten, *Audio in Media*, Tenth Edition

Eastman/Ferguson, *Media Programming: Strategies and Practices*, Ninth Edition

Gross/Ward, *Digital Moviemaking*, Seventh Edition

Hausman/Benoit/Messere/O'Donnell, *Announcing: Broadcast Communicating Today*,  
Fifth Edition

Hausman/Benoit/Messere/O'Donnell, *Modern Radio Production*, Ninth Edition

Hilliard, *Writing for Television, Radio, and New Media*, Tenth Edition

Hilmes, *Connections: A Broadcast History Reader*

Hilmes, *Only Connect: A Cultural History of Broadcasting in the United States*,  
Fourth Edition

Mamer, *Film Production Technique: Creating the Accomplished Image*, Sixth Edition

Meeske, *Copywriting for the Electronic Media: A Practical Guide*, Sixth Edition

Zettl, *Sight Sound Motion: Applied Media Aesthetics*, Seventh Edition

Zettl, *Television Production Handbook*, Eleventh Edition

Zettl, *Television Production Workbook*, Eleventh Edition

Zettl, *Video Basics*, Seventh Edition

Zettl, *Video Basics Workbook*, Seventh Edition

Zettl, *Zettl's VideoLab 4.0*



# Audio *in* Media

10<sup>TH</sup> EDITION



## Stanley R. Alten

Syracuse University

with contributions by **Douglas Quin**, Syracuse University



WADSWORTH  
CENGAGE Learning™

Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States

**Audio in Media, Tenth Edition**  
**Stanley R. Alten**

Publisher: Michael Rosenberg

Development Editor: Megan Garvey

Assistant Editor: Erin Bosco

Editorial Assistant: Rebecca Donahue

Media Editor: Jessica Badiner

Executive Brand Manager: Ben Rivera

Senior Market Development Manager:  
Kara KindstromSenior Marketing Communications Manager:  
Linda YipSenior Content Project Manager:  
Michael Lepera

Senior Art Director: Marissa Falco

Manufacturing Planner: Doug Bertke

Senior Rights Acquisition Specialist:  
Mandy Groszko

Production Service/Compositor: Ideas to Images

Text and Cover Designer: Gary Palmatier,  
Ideas to Images

Cover Image: © iStockphoto.com/Domofon

© 2014, 2011, 2008 Wadsworth, Cengage Learning

ALL RIGHTS RESERVED. No part of this work covered by the copyright herein may be reproduced, transmitted, stored, or used in any form or by any means graphic, electronic, or mechanical, including but not limited to photocopying, recording, scanning, digitizing, taping, Web distribution, information networks, or information storage and retrieval systems, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without the prior written permission of the publisher.

For product information and technology assistance, contact us at  
**Cengage Learning Customer & Sales Support, 1-800-354-9706.**

For permission to use material from this text or product, submit  
all requests online at [www.cengage.com/permissions](http://www.cengage.com/permissions)  
Further permissions questions can be emailed to  
[permissionrequest@cengage.com](mailto:permissionrequest@cengage.com)

Library of Congress Control Number: 2012955452

ISBN-13: 978-1-133-30723-5

ISBN-10: 1-133-30723-X

**Wadsworth**20 Channel Center Street  
Boston, MA 02210  
USA

Cengage Learning is a leading provider of customized learning solutions with office locations around the globe, including Singapore, the United Kingdom, Australia, Mexico, Brazil, and Japan. Locate your local office at [international.cengage.com/region](http://international.cengage.com/region)

Cengage Learning products are represented in Canada by  
Nelson Education, Ltd.

For your course and learning solutions, visit [www.cengage.com](http://www.cengage.com)

Purchase any of our products at your local college store or at our  
preferred online store [www.cengagebrain.com](http://www.cengagebrain.com)

Instructors: Please visit [login.cengage.com](http://login.cengage.com) and log in to access  
instructor-specific resources.

Printed in the United States of America

1 2 3 4 5 6 7 16 15 14 13 12

This is an electronic version of the print textbook. Due to electronic rights restrictions, some third party content may be suppressed. Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. The publisher reserves the right to remove content from this title at any time if subsequent rights restrictions require it. For valuable information on pricing, previous editions, changes to current editions, and alternate formats, please visit [www.cengage.com/highered](http://www.cengage.com/highered) to search by ISBN#, author, title, or keyword for materials in your areas of interest.



*To the sweetest sounds:  
Claudette,  
Ariane, and Renee*

# Brief Contents

<b>Part I</b>	<b>Principles</b>	<b>1</b>
1	Sound in Production	2
2	Sound and Hearing	6
3	Acoustics and Psychoacoustics	25
<b>Part II</b>	<b>Technology</b>	<b>47</b>
4	Loudspeakers and Monitoring	48
5	Microphones	73
6	Mixers, Consoles, and Control Surfaces	115
7	Recording	142
8	Synchronization and Transfers	162
9	Signal Processors	172
10	Audio and the Internet	196
<b>Part III</b>	<b>Production</b>	<b>209</b>
11	The Speaking Voice, Voice-Overs, and Narration	210
12	Dialogue	225
13	Studio Production: Radio and Television	251
14	Field Production: News and Sports	267
15	Sound Design	306
16	Sound Effects	319
17	Music Underscoring	346
18	Production for Mobile Media	368
19	Game Sound	375
20	Music Recording	402
<b>Part IV</b>	<b>Postproduction</b>	<b>451</b>
21	Editing	452
22	Mixing: An Overview	482
23	Premixing and Rerecording for Television and Film	493
24	Music Mixdown	510
25	Mixing for Mobile Media	534

Preface	xxix
<b>STRUCTURE OF THE BOOK</b>	xxix
Part I: Principles	xxix
Part II: Technology	xxx
Part III: Production	xxx
Part IV: Postproduction	xxx
<b>ACKNOWLEDGMENTS</b>	xxx

## **Part I Principles** 1

---

### **1 Sound in Production** 2

---

<b>THE IMPORTANCE OF SOUND IN PRODUCTION</b>	2
<b>EVALUATING THE FINISHED PRODUCT</b>	3
Intelligibility	3
Tonal Balance	3
Definition	3
Spatial Balance and Perspective	3
Dynamic Range	4
Clarity	4
Airiness	4
Acoustical Appropriateness	4
Source Quality	4
<b>PRODUCTION VALUES</b>	4

### **2 Sound and Hearing** 6

---

<b>THE SOUND WAVE</b>	6
<b>FREQUENCY AND PITCH</b>	7
<b>AMPLITUDE AND LOUDNESS</b>	9
The Decibel	9
SOUND-PRESSURE LEVEL	11

**FREQUENCY AND LOUDNESS** 11  
    Equal Loudness Principle 11  
    Masking 13

**VELOCITY** 14

**WAVELENGTH** 14

**ACOUSTICAL PHASE** 14

**TIMBRE** 16

**SOUND ENVELOPE** 17

**ANALOG AND DIGITAL SOUND** 18

**THE HEALTHY EAR** 18

**HEARING LOSS** 21  
    Safeguards against Hearing Loss 22

---

### **3 Acoustics and Psychoacoustics** 25

**SPATIAL HEARING** 25  
    Haas and Precedence Effects 26  
    Binaural versus Stereo Sound 26

**DIRECT, EARLY, AND REVERBERANT SOUND** 26  
    Reverberation and Echo 27

**MATCHING ACOUSTICS TO PROGRAM MATERIAL** 28

**STUDIO DESIGN** 29  
    Noise 29  
    Sound Isolation 30  
    Room Dimensions 32  
    Room Shape 34  
    Room Acoustics 36  
        ABSORPTION AND REFLECTION 36  
        DIFFRACTION 38  
        DIFFUSION 38  
        VARIABLE ACOUSTICS 38

**CONTROL ROOM DESIGN** 38

**PROJECT AND HOME STUDIOS** 39

**ERGONOMICS** 44

## Part II Technology 47

---

### 4 Loudspeakers and Monitoring 48

---

<b>LOUDSPEAKER SYSTEMS</b>	49
Powering Systems	49
Crossover Network and Drivers	49
PASSIVE AND ACTIVE CROSSOVER NETWORKS	50
<b>SELECTING A MONITOR LOUDSPEAKER</b>	51
Frequency Response	51
MONITORING WITH POOR-QUALITY LOUDSPEAKERS	52
Linearity	52
Amplifier Power	52
Distortion	53
INTERMODULATION DISTORTION	53
HARMONIC DISTORTION	54
TRANSIENT DISTORTION	54
LOUDNESS DISTORTION	54
Dynamic Range	54
Sensitivity	54
Polar Response	54
Arrival Time	57
Polarity	57
<b>MONITOR PLACEMENT</b>	58
Monitoring Stereo	59
Far-Field Monitoring	60
Near-Field Monitoring	61
Monitoring Surround Sound	62
<b>MONITOR CONTROLLERS</b>	65
<b>CALIBRATING A LOUDSPEAKER SYSTEM</b>	65
Calibrating the 5.1 Surround System	65
<b>EVALUATING THE MONITOR LOUDSPEAKER</b>	67
Monitoring in an Unfamiliar Control Room	68
<b>HEADPHONES AND IN-EAR MONITORS</b>	69
Headphones and Hearing Loss	69
In-Ear Monitors	70

### 5 Microphones 73

---

<b>OPERATING PRINCIPLES</b>	73
Impedance	73
Transducing Elements	74
MAGNETIC INDUCTION	74
VARIABLE CAPACITANCE	75

- Dual-Element Microphones    75
- GENERAL TRANSDUCER PERFORMANCE CHARACTERISTICS**    75
- DIRECTIONAL CHARACTERISTICS**    77
  - Polar Response Diagrams    78
- SOUND RESPONSE**    80
  - Frequency Response    81
  - Overload Limit    82
  - Maximum Sound-Pressure Level    82
  - Sensitivity    82
  - Self-Noise    82
  - Signal-to-Noise Ratio    82
  - Proximity Effect    83
  - Hum    84
  - Humbucking    84
- MICROPHONE MODELER**    85
- MICROPHONE ACCESSORIES**    85
  - Windscreens and Pop Filters    85
  - Shock Mounts    85
  - Cables    85
  - Connectors    87
  - Microphone Mounts    88
- MICROPHONE CARE**    88
- SPECIAL-PURPOSE MICROPHONES**    91
  - Lavalier Microphones (Mini-Mics)    91
  - Shotgun Microphones    92
  - Parabolic Microphone System    93
  - Headset and Earset Microphones    93
  - Contact Microphones    93
  - Boundary Microphones    95
  - Noise-Canceling Microphones    96
    - NOISE SUPPRESSION    96
  - High-Definition Microphones    96
  - Digital Microphones    97
  - USB Microphones    97
    - USB MICROPHONE CONVERTER    98
    - HIGH-DEFINITION MICROPHONE FOR LAPTOP COMPUTERS    98
  - Multidirectional Microphones    99
    - SYSTEM MICROPHONES    99
    - STEREOPHONIC MICROPHONES    100
    - MIDDLE-SIDE MICROPHONES    101
  - Infinitely Variable Pattern Microphones    101
  - Binaural and Surround-Sound Microphone Systems    101
    - BINAURAL MICROPHONE HEAD    102
    - SOUNDFIELD MICROPHONE SYSTEM    103

HOLOPHONE MICROPHONE SYSTEM	104
ATMOS 5.1 SURROUND MICROPHONE SYSTEM	104
SCHOEPS SURROUND MICROPHONE SYSTEM	104
DPA SURROUND-SOUND MICROPHONE SYSTEMS	106
Other Special-Purpose Microphones	106
<b>WIRELESS MICROPHONE SYSTEM</b>	<b>107</b>
Transmitter, Antenna, and Receiver	108
Microphones	108
Basic Architectures	108
Frequency Assignment and Use	109
Transmission Systems	109
Transmission Range	109
MULTIPATH	109
Diversity Reception	109
GUIDELINES FOR THE SETUP AND USE OF ANTENNAS	110
Audio Circuitry	112
Sound Quality	112
Power Supply	112

## **6** **Mixers, Consoles, and Control Surfaces** 115

<b>MIXERS</b>	115
Sound in Electrical Form	116
LINE LEVEL (+4 dBm AND -10 dBV)	117
Hybrid Interface	117
<b>CONSOLES</b>	117
Analog and Digital Consoles	118
On-Air Broadcast Consoles	118
Production Consoles	120
INPUT SECTION	120
MASTER SECTION	125
MONITOR SECTION	126
ADDITIONAL FEATURES	126
<b>CHANNEL STRIPS</b>	126
<b>DIGITAL CONSOLES</b>	126
<b>METERS</b>	129
VU Meter	129
Peak Meters	131
LED METERS	131
PLASMA DISPLAYS	131
PEAK PROGRAM METER	131
Optimizing Digital Levels	132
Metering and Digital Audio Workstations	132

- PATCHING** 132
  - General Guidelines for Patching 134
  - Plugs 134
  - Computer Patching 134
- CONSOLE AUTOMATION** 135
  - Types of Automation Systems 135
    - VOLTAGE-CONTROLLED AUTOMATION 135
    - MOVING-FADER AUTOMATION 135
    - SOFTWARE-CONTROLLED AUTOMATION 135
    - MIDI-BASED AUTOMATION 135
  - Operating Modes 135
  - Advantages of Console Automation 136
  - Disadvantages of Console Automation 136
- CONTROL SURFACES** 136

---

## 7 Recording 142

- ANALOG AND DIGITAL RECORDING** 142
  - DIGITAL AUDIO** 143
    - Sampling 143
      - OVERSAMPLING 144
    - Quantization 145
      - AUDIO DATA RATE 145
  - RECORDING SYSTEMS** 145
    - Memory Recorders 147
    - Hard-Disk Recorders 149
    - Storage Capacity 149
    - Mixer/Recorder 149
    - Recorder/Interface/Controller 151
    - Smartphone and Tablet Recorder Apps 151
  - DIGITAL AUDIO WORKSTATIONS** 151
    - Computer-Based Digital Audio Workstation 151
      - ANALOG-TO-DIGITAL AND DIGITAL-TO-ANALOG CONVERTERS 153
      - SOUND CARD 153
    - Integrated Digital Audio Workstation 153
      - SERVER 153
      - STORAGE AREA NETWORK 155
  - DIGITAL AUDIO NETWORKING** 155
  - DISTRIBUTION SYSTEMS** 155
    - Recordable, Rewritable, and Interactive Compact Discs 155
    - Digital Versatile Disc 156

High-Density Optical Discs	156
BLU-RAY DISC	157
OTHER OPTICAL DISC FORMATS	157

**CONNECTORS** 158**AUDIO FOR VIDEO RECORDING** 158**AUDIO ON FILM** 158**8 Synchronization and Transfers** 162**TIME CODES** 162

SMPTE Time Code	162
MIDI Time Code	163
Time Formats with Computer-Based Recorder/Editors	163

**SYNCHRONIZING DIGITAL EQUIPMENT** 163

Converter	163
Jitter	164
Driver Support and Latency	165

**FRAME RATES** 165

Drop Frame and Non-Drop Frame	165
-------------------------------	-----

**SYNCHRONIZING SOUND AND PICTURE IN FILM** 166

Time Code Synchronization	166
Head and Tail Synchronization Points	167

**TRANSFERS** 167

Analog-to-Analog Audio Transfers	167
Analog-to-Digital Audio Transfers	167
Digital-to-Digital Audio Transfers	168
Transferring Audio Files for Accompanying Video	169
Altering Audio in Transferring for Special Effects	170

**9 Signal Processors** 172**BEING EFFECTS-HAPPY** 172**CATEGORIES OF SIGNAL PROCESSORS** 172**PLUG-INS** 173**STAND-ALONE SIGNAL PROCESSORS VERSUS PLUG-INS** 173**SPECTRUM PROCESSORS** 174

Equalizers	174
FIXED-FREQUENCY EQUALIZER	175
GRAPHIC EQUALIZER	175
PARAMETRIC EQUALIZER	175
PARAGRAPHIC EQUALIZER	176
DYNAMIC EQUALIZER	176

- Filters 176
  - HIGH- AND LOW-PASS FILTERS 177
  - BAND-PASS FILTER 177
  - NOTCH FILTER 177
- Psychoacoustic Processors 178
- TIME PROCESSORS 178**
  - Reverberation 178
    - DIGITAL REVERB 178
    - ACOUSTIC CHAMBER REVERB 180
    - PLATE REVERB 180
    - CONVOLUTION REVERB 180
    - COMMON REVERB EFFECTS 181
    - CHOOSING A REVERBERATION SYSTEM 182
    - REVERBERATION AND AMBIENCE 182
  - Delay 182
    - DIGITAL DELAY 182
    - USES OF DELAY 182
    - FLANGING 183
    - PHASING 184
    - MORPHING 184
    - PITCH SHIFTING 184
- DYNAMIC PROCESSORS 186**
  - Compressor 186
    - BROADBAND AND MULTIBAND (SPLIT-BAND) COMPRESSORS 188
    - DYNAMIC EQUALIZER 190
  - Limiter 190
  - De-esser 190
    - USES OF COMPRESSORS AND LIMITERS 190
  - Expander 190
  - Noise Gate 191
- NOISE PROCESSORS 192**
- MULTIEFFECTS SIGNAL PROCESSORS 192**
  - Voice Processors 192
- OTHER PLUG-IN PROGRAMS 193**
- FORMAT COMPATIBILITY OF PLUG-INS 194**

---

## 10 Audio and the Internet 196

- DATA TRANSFER NETWORKS 197**
  - Local-Area Networks 197
  - Wide-Area Networks 197
  - Servers 197
  - Clients 197
- CLOUD COMPUTING 198**

<b>AUDIO FIDELITY</b>	199
Connection Speed	199
File Manipulation	200
REDUCING THE SAMPLING FREQUENCY	200
REDUCING THE WORD LENGTH	200
REDUCING THE NUMBER OF CHANNELS	200
REDUCING PLAYING TIME BY EDITING	200
USING INSTRUMENTAL MUSIC INSTEAD OF VOCAL-BASED TRACKS	201
Compression	201
File Formats	202
Downloadable Nonstreaming Formats	202
Downloadable Streaming Formats	204
TRANSMISSION OF STREAMING FORMATS	204
Progressive Download Formats	204
<b>ONLINE COLLABORATION</b>	204
<b>PODCASTING</b>	205

## **Part III Production** 209

---

### **11 The Speaking Voice, Voice-Overs, and Narration** 210

---

<b>FREQUENCY RANGE</b>	210
<b>SOUND LEVEL</b>	211
<b>DISTRIBUTION OF SPECTRAL CONTENT</b>	211
<b>INFLUENCES OF NONVERBAL SPEECH ON MEANING</b>	212
Emphasis	212
Inflection	212
Speech Patterns	212
Pace	213
Mood	213
Accent	213
<b>BASIC CONSIDERATIONS IN MIKING SPEECH</b>	213
Acoustics in the Speech Studio	214
Phase and Polarity	214
PHASE	214
POLARITY	214
Microphones for the Speaking Voice	215
SOUND QUALITY	215
Directional Pattern	215
MIC-TO-SOURCE DISTANCE	216
<b>VOICE-OVERS AND NARRATION</b>	217

**VOICE ACTING** 217  
    Voice Quality 217  
    Message 217  
    Audience 217  
    Word Values 218  
    Character 218  
    Prerecorded Voice Collections 218  
    Automating Voice-Overs 218

**RECORDING VOICE-OVERS** 219  
    Using Compression 221  
    Voicing-Over Background Music or Sound Effects 222  
    Backtiming and Deadpotting 222

**NARRATION** 223

## 12 Dialogue 225

---

**THE IMPORTANCE OF DIALOGUE RECORDING** 225

**THE PRODUCTION-RECORDING CREW** 226  
    Sound Mixer 226  
    Boom Operator 226  
    Cable Person 226

**RECORDING DIALOGUE IN MULTI- AND SINGLE-CAMERA PRODUCTION** 226  
    Using the Boom 226  
        BLOCKING 227  
        PERAMBULATOR BOOM 227  
        FISHPOLE BOOM 228  
        PERSPECTIVE 232  
    Using Wireless Body Microphones 234  
        PERSPECTIVE 235  
        PLACEMENT 235  
        USING TWO OR MORE WIRELESS MICROPHONES 236  
        CONTROLLING LEVELS 236  
    Plant Microphones 237  
    Multiple Miking with Different Mounts 238

**RECORDING DIALOGUE IN THE FIELD** 238  
    Preproduction Planning 238  
        SELECTING A LOCATION 239  
        DEALING WITH UNWANTED SOUND 239  
        PRERECORDED MATERIAL 239  
        OTHER EQUIPMENT AND MATERIALS 239  
        BLOCKING AND REHEARSING 240

Production Dialogue Recording	241
SIGNAL PROCESSING AND PRODUCTION RECORDING	241
RECORDING	242
REALITY PROGRAMS	243
Production Sound-Effect Recording	244
Noise Reduction	244

**HOW DIRECTORS CAN HELP THE AUDIO CREW** 245

**PRODUCTION RECORDING AND THE SOUND EDITOR** 245

**AUTOMATED DIALOGUE REPLACEMENT** 245

Purpose and Process	246
Microphone Selection and Technique	247
Loop Groups	248
Automated Dialogue Replacement in the Field	248
Dialogue Rerecording: Pros and Cons	249

## **13 Studio Production: Radio and Television** 251

<b>MIKING THE SINGLE SPEAKER IN RADIO</b>	251
Space and Perspective: Monaural, Stereo, and Surround Sound	253

**RADIO INTERVIEW AND PANEL SETUPS** 254

**RADIO DRAMATIZATIONS** 255

Single-Microphone Technique	255
MICROPHONE SELECTION AND MOUNTING	256
CREATING PERSPECTIVE	256
CREATING MOVEMENT	256
Multimicrophone Technique	256
Stereo Microphone Technique	257
PERSPECTIVE	258
Surround-Sound Technique	258

**MIKING SPEECH FOR MULTICAMERA TELEVISION** 258

**NEWS AND INTERVIEW PROGRAMS** 259

**PANEL AND TALK PROGRAMS** 260

Choosing a Microphone	260
MINI-MIC	260
HAND MIC	261
BOOM MIC	261
DESK MIC	261
Controlling Multiple Sound Sources	261
Miking the Audience	263
“Producing” Audience Response	264
Audience Reaction in Stereo and Surround Sound	265

**14** **Field Production: News and Sports** 267

- MOBILE NEWS GATHERING** 267
  - Radio MNG 268
    - MICROPHONES 268
    - RECORDER 269
    - MICROPHONE MIXER 270
    - HEADPHONES 270
    - TRANSMISSION 271
    - MOBILE UNIT 272
  - Guidelines for Submissions from the Field 272
  - Television MNG 272
    - CAMCORDER 272
    - MICROPHONES 273
    - CAMCORDER AUDIO INPUTS, OUTPUTS, AND CONTROLS 274
    - COMPUTER TABLET 275
    - TRANSMISSION AND MOBILE UNITS 276
  - News Production 276
    - PREPRODUCTION 276
    - PRODUCTION 277
    - TRANSMISSION AND MIX-MINUS 279
- ELECTRONIC FIELD PRODUCTION** 279
  - Small-Scale EFP 280
    - RADIO 280
    - TRANSMISSION 280
    - TELEVISION 280
  - Large-Scale EFP 280
- MULTICAMERA EFP** 282
  - Remote Survey 282
  - Portable Mixing Systems 283
  - Field Intercom Systems 283
  - Production of Speeches and News Conferences 285
    - SETTING UP YOUR OWN MICROPHONES 285
    - PUBLIC-ADDRESS PICKUPS 285
    - SPLITTING MICROPHONES 285
    - MULTIPLE PICKUPS 286
    - AUTOMATIC MICROPHONE MIXER 286
    - PRECAUTIONS TO TAKE 287
- PRODUCTION OF SPORTS PROGRAMS** 288
  - Television Sports Audio 288
    - THE ANNOUNCERS 288
    - THE CROWD 288
    - THE ACTION 290
    - THE PLAYERS 290
    - THE BANDS 290
    - MIXING THE ELEMENTS 290
    - STEREO SOUND 301
    - SURROUND SOUND 302
  - Radio Sports Audio 304
    - MIKING 304

## **15 Sound Design** **306**

---

<b>SOUND DESIGN AND THE SOUND DESIGNER</b>	<b>306</b>
<b>"EARS"</b>	307
Listening	307
<b>ANALYTICAL AND CRITICAL LISTENING</b>	307
Analytical Listening	307
Critical Listening	308
<b>THE PARADOX IN DESIGNING AND LISTENING TO SOUND TODAY</b>	309
<b>ELEMENTS OF SOUND STRUCTURE AND THEIR EFFECTS ON PERCEPTION</b>	310
<b>THE VISUAL EAR</b>	311
<b>FUNCTIONS OF SOUND IN RELATION TO PICTURE</b>	311
Sound Parallels Picture	311
Sound Defines Picture	311
Picture Defines Sound	312
Sound and Picture Define Effect	312
Sound Counterpoints Picture	312
<b>STRATEGIES IN DESIGNING SOUND</b>	312
Script Analysis	313
INFLUENCE OF SOUND DESIGN ON MEANING	314
Achieving Effects in Selected Program Materials	316
SPOT ANNOUNCEMENT	316
ACTION DRAMA	316
CINÉMA VÉRITÉ DOCUMENTARY	317
ANIMATION	317

## **16 Sound Effects** **319**

---

<b>CONTEXTUAL SOUND</b>	<b>319</b>
<b>NARRATIVE SOUND</b>	<b>320</b>
Descriptive Sound	320
Commentative Sound	320
<b>FUNCTIONS OF SOUND EFFECTS</b>	<b>320</b>
Breaking the Screen Plane	320
Defining Space	320
Focusing Attention	321
Establishing Locale	321
Creating Environment	321
Emphasizing Action	321
Intensifying Action	321
Exaggerating Action	322
Depicting Identity	322

- Setting Pace 322
- Providing Counterpoint 322
- Creating Humor 322
- Creating Metaphor 322
- Creating Paradox 322
- Creating Irony 322
- Symbolizing Meaning 322
- Animating Inanimate Objects 323
- Unifying Transition 323
- Silence 323
- TYPES OF SOUND EFFECTS 324**
  - Hard and Soft Sound Effects 324
  - Foley Sound Effects 324
  - Ambience Sound Effects 324
  - Electronic Sound Effects 324
  - Design Sound Effects 324
- PRODUCING SOUND EFFECTS 324**
- PRERECORDED SOUND-EFFECT LIBRARIES 324**
  - Advantages of Sound-Effect Libraries 324
  - Disadvantages of Sound-Effect Libraries 326
    - DYNAMICS AND TIMING 326
    - AMBIENCE 326
    - FIXED LENGTH OF SOUND EFFECTS 326
    - CHOOSING SOUNDS FROM THE TITLES 327
    - SOUND QUALITY 327
  - Manipulating Recorded Sound Effects 327
    - ALTERING PLAYING SPEED 327
    - PLAYING SOUND BACKWARD 328
    - LOOPING 328
    - USING SIGNAL PROCESSING 328
  - Sampling Frequency 328
- LIVE SOUND EFFECTS 328**
  - Producing Sound Effects in the Studio 329
  - Vocally Produced Sound Effects 329
  - Foley Sound Effects 329
    - EXAMPLES OF FOLEY EFFECTS 331
    - COMPONENTS AND CONTEXT OF A FOLEY SOUND EFFECT 334
    - MIKING AND PERSPECTIVE IN FOLEY RECORDING 335
    - PREPARING FOR FOLEY RECORDING 336
  - Production Sound Effects 336
  - Collecting Sound Effects in the Field 337
  - Ambience Sound Effects 338
- ELECTRONICALLY GENERATED SOUND EFFECTS 339**
  - Synthesized Sound Effects 339
  - Computer-Generated Sound Effects 340

Sampling	340
THE SAMPLEFILE	340
TIPS FOR RECORDING SAMPLES	341
MIKING	341
Design Sound Effects	341
<b>ORGANIZING A SOUND-EFFECT LIBRARY</b>	341
Naming Produced Sound-Effect Files	342
<b>SPOTTING</b>	343
Spotting Sound Effects	343

## **17** **Music Underscoring** 346

---

<b>USES OF MUSIC IN A PRODUCTION</b>	347
<b>MUSIC CHARACTERISTICS</b>	347
Melody	347
Harmony	347
Tempo	348
Dynamic Range	348
Style	348
Musical Instruments and Their Associations	349
<b>FUNCTIONS OF MUSIC UNDERSCORING</b>	349
Branding	349
Creating Humor	349
Depicting Identity or Characterization	350
Establishing Locale	350
Emphasizing Action	351
Evoking Atmosphere, Feeling, or Mood	351
Fixing Time	351
Heightening Dialogue	351
Intensifying Action	351
Providing Counterpoint	351
Recalling or Foretelling Events	351
Setting Pace	351
Smoothing Action Scenes	351
Songs as Interior Monologue or Narrative	352
Unifying Transitions	352
<b>MUSIC IN SPOT ANNOUNCEMENTS</b>	352
<b>CREATIVE CONSIDERATIONS IN UNDERSCORING</b>	352
Tone	353
Style	353
Role	353
Genre or Non-genre	353

- Original or Compilation 354
  - ORIGINAL SCORES 354
  - COMPILATION SCORES 354
- Spotting 354
- Placement 355
- APPROACHES TO UNDERSCORING 356**
- PRODUCTION MUSIC LIBRARIES 360**
  - Advantages of Production Music Libraries 360
  - Disadvantages of Production Music Libraries 360
- CUSTOMIZED MUSIC PROGRAMS 361**
- CUSTOMIZED MUSICAL INSTRUMENT PROGRAMS 362**
- COMPOSING YOUR MUSIC 362**
- COPYRIGHT AND LICENSES 362**
- USING MUSIC FROM COMMERCIAL RECORDINGS 365**
- USING MUSIC FROM SAMPLE CDs AND THE INTERNET 365**
  - Music Sampling and Copyright 365
- ORGANIZING A MUSIC LIBRARY 366**

## **18 Production for Mobile Media 368**

---

- AUDIO PRODUCTION FOR MOBILE MEDIA 369**
  - Recording and Audio Input 369
- MOBILE DEVICES AS CONTROLLERS 372**

## **19 Game Sound 375**

---

- DESIGNING AUDIO FOR INTERACTIVITY 375**
  - Sound Design for Linear Media 376
  - Sound Design for Interactive Media 376
  - Audio Potential in Interactive Media 377
- SYSTEM RESOURCES 378**
  - Adapting to Shared System Resource Limitations 379
- THE PRODUCTION PROCESS 381**
  - Preproduction 381
    - THE CREATIVE CREW 381
    - PROOF-OF-CONCEPT DEVELOPMENT 381
    - DEVELOPMENT FOR DIFFERENT PLATFORMS 382
    - PRODUCTION 383
    - COLLECTING AND RECORDING AUDIO 383
    - ASSETS 383
    - BASIC INTERACTIVITY 384

COMPLEX INTERACTIVITY	384
CREATING COMPLEX INTERACTIVITY	385
PRODUCING SOUND EFFECTS	388
PRODUCING MUSIC	390
PRODUCING DIALOGUE AND NARRATION	392
Postproduction	393
<b>ANATOMY OF A GAME SEQUENCE</b>	394
Transient Sound-Effect Assets	394
Moving Sound Effects	394
Intermittent Dialogue	395
Specific Dialogue	396
Environment	397
Music Underscoring	398
<b>DEBUGGING</b>	398
<b>USER PLAYBACK</b>	399

## 20 Music Recording 402

---

<b>SIX PRINCIPLES OF MIKING</b>	403
<b>BASIC APPROACHES TO MIKING MUSICAL INSTRUMENTS</b>	403
<b>CLOSE MIKING</b>	403
<b>DISTANT MIKING</b>	404
Distant-Miking Stereo Arrays	404
COINCIDENT MIKING	404
NEAR-COINCIDENT MIKING	405
SPACED MIKING	405
OTHER TYPES OF STEREO MICROPHONE ARRAYS	407
Stereo-Miking an Ensemble	407
<b>ACCENT MIKING</b>	407
<b>AMBIENCE MIKING</b>	408
<b>SPECIFIC APPROACHES TO MIKING MUSICAL INSTRUMENTS</b>	408
<b>DRUMS</b>	408
Characteristics	409
Tuning the Drums	410
Miking	411
Reducing Drum Leakage	416
<b>ACOUSTIC STRING INSTRUMENTS</b>	417
Plucked String Instruments	417
CHARACTERISTICS	417
MIKING	417
Bowed String Instruments	419
CHARACTERISTICS	419
MIKING	420

Struck String Instruments: Piano 423  
    CHARACTERISTICS 423  
    MIKING 423

**WOODWINDS** 426  
    Characteristics 426  
    Miking 427

**BRASS** 428  
    Characteristics 429  
    Miking 429

**ELECTRIC INSTRUMENTS** 431  
    Miking the Amplifier Loudspeaker 432  
        LESLIE LOUDSPEAKER CABINET 432  
    Recording Electric Bass 432  
    Recording Electric Guitar 432  
    Musicians' Amplifiers 435

**VIRTUAL INSTRUMENTS** 435

**VOCALS** 436  
    Timbre 437  
    Dynamic Range 437  
    Breathing, Popping, and Sibilance 438  
    Acoustics 438  
    Reflections 438  
    Mic-to-Source Distance versus Style 438  
    Isolating the Vocalist 439  
    Backup Harmony Vocals 439  
        VIRTUAL HARMONY 439  
    Choirs 440

**MIKING STUDIO ENSEMBLES** 440

**RECORDING FOR SURROUND SOUND** 440  
    Direct/Ambient Surround-Sound Miking 441  
    Direct Surround-Sound Miking 449

---

## Part IV Postproduction 451

---

### 21 Editing 452

**DIFFERENCES BETWEEN EDITING SOUND AND EDITING PICTURE** 452

**DIGITAL EDITING** 453

**BASIC EDITING FUNCTIONS** 453  
    Editing Example 456

<b>GENERAL GUIDELINES</b>	456
Edit Decision List	458
<b>PREPARING TO EDIT</b>	459
Know the Script	459
Preview the Tracks	459
Chart the Tracks	460
Organize the Edit Tracks	460
Name the Files	461
Drive Management	461
<b>EDITING SPEECH</b>	461
Identifying Sounds That Make Up Words	461
Editing Similar and Dissimilar Sounds	463
Emphasis and Inflection	464
Ambience	464
Changing Words	466
<b>EDITING DIALOGUE</b>	467
General Guidelines for Editing Dialogue to Picture	467
Composite Dialogue	469
Dialogue Database	469
Dialogue Processing	469
RING-OFF	469
ADDITIVE AMBIENCE	470
DEFECTIVE OR UNUSABLE DIALOGUE	470
SYNCHRONIZING DIALOGUE TO PICTURE	470
<b>EDITING SOUND EFFECTS</b>	470
Building Backgrounds	470
Building Effects	471
Matching Perspective	472
Guidelines for Editing Sound Effects	472
<b>EDITING MUSIC</b>	473
Cutting to Resolution	474
Preserving Tempo	474
Repetitive Measures	474
Looping	474
Key Signature	475
Comping	475
VERTICAL COMPING	476
HORIZONTAL COMPING	476
LAYERED COMPING	476
Style and Texture	476
Editing Music to Picture	477
Automatic Music Editing	477

<b>TRANSITIONS</b>	477
Segue and Cut	478
Crossfade	478
Soft Cut	479
Fade-Out/Fade-In	479
Audio-Leading-Video and Video-Leading-Audio	479
<b>LISTENING FATIGUE</b>	480

## **22** **Mixing: An Overview** 482

---

<b>MAINTAINING AESTHETIC PERSPECTIVE</b>	483
<b>MIXING FOR VARIOUS MEDIA</b>	483
Radio	484
Television	485
Film	487
Digital Disc	487
Multimedia	488
<b>MIXING VERSUS LAYERING</b>	488
Layering: Sound with Picture	488
Layering: Music	490
Perspective	490
<b>METERING</b>	491
<b>MIXING AND EDITING</b>	491

## **23** **Premixing and Rerecording for Television and Film** 493

---

<b>PREMIXING FOR TELEVISION AND FILM</b>	493
Dialogue and Narration	495
Ambience	496
Sound Effects	496
Music	496
<b>THE RERECORDING MIX</b>	496
<b>SPATIAL IMAGING OF STEREO</b>	497
Scale	497
Perspective	498
Localization of Talk and Dialogue	498
Sound Effects	499
Music	499
<b>SPATIAL IMAGING OF SURROUND SOUND</b>	499

<b>MIXING FOR SURROUND SOUND</b>	500
Center Channel	500
Surround Channels	500
Bass Management	501
Track Assignment	501
General Approaches to Mixing Surround Sound	501
Downmixing to Stereo	503
<b>DIALNORM, THE CALM ACT, AND DYNAMIC RANGE CONTROL</b>	504
Dialnorm	504
The CALM Act	504
Dynamic Range Control	505
<b>RERECORDING LOGS</b>	505
<b>COMPATIBILITY: STEREO-TO-MONO AND SURROUND-TO-STEREO</b>	507
Stereo-to-Mono Compatibility	507
Surround-to-Stereo Compatibility	508

## 24 Music Mixdown 510

---

<b>PREPARING FOR THE MIXDOWN</b>	511
Characteristics of a Successful Mix	511
Characteristics of an Amateur Mix	511
Setting Up	512
Recordkeeping	513
<b>SIGNAL PROCESSING</b>	514
Equalization	514
EQ: HOW MUCH, WHERE, AND WHEN?	514
EQUALIZATION AND SEMANTICS	516
Approaches to Equalizing Selected Instruments	517
DRUMS	517
OTHER INSTRUMENTS	519
Compression	520
Reverberation: Creating Acoustic Space	522
Delay: Enhancing Acoustic Space	522
Electronic Sounds	523
<b>SPATIAL IMAGING OF MUSIC</b>	523
<b>STEREO</b>	523
<b>SURROUND SOUND</b>	524
Center Channel	524
REVERBERATION	528
Surround Channels	528
LFE Channel	528
Downmixing to Stereo	528
<b>AESTHETIC CONSIDERATIONS IN SURROUND-SOUND MIXING</b>	529

## 25 **Mixing for Mobile Media** 534

---

**EQUALIZATION** 534

**DYNAMIC COMPRESSION AND NORMALIZATION** 536

**EVOLVING AND EMERGING AESTHETICS** 537

Appendix: Occupations in Audio 539

Selected Bibliography 542

Glossary 550

Index 573

In audio production, technique and technology have always been inextricably linked: technique cannot be carried out without technology, and technology without technique is mindless. At no time in the history of audio has this been more evident than it is today. Advances in technology have made it possible to produce sound in an almost limitless variety of ways, increasing the possibilities for creative invention and aesthetic fulfillment. Moreover, these advances have made audio production accessible and affordable to just about anyone interested in the field whether professional or hobbyist. These advances notwithstanding, there are constants: basic principles in the behavior of sound and in the production and the evaluation of a high-quality product.

Through its more than three decades as the market-leading audio text, *Audio in Media* has tried to balance the relationship between technique and technology and continues to do so in this edition with the understanding that human creativity, vision, and “ears” are central to a production’s ultimate success. It is up to the engineer to make a production sound good; it is up to the recordist to make it sound interesting.

Changes in the field occur almost daily. This makes it impractical to try to cover the amount of audio gear out there. Therefore the examples displayed throughout the book are to provide a sense of what is available at this writing. Because there are so many different types of computers and software programs in use in an ever-changing landscape, the relationship of computers to audio production is covered only as it applies to producing program materials and not to computer technology, software programs, or operational details. There are many books on the market that address these areas, to say nothing of the manuals provided with computers and software programs.

As with previous editions, the tenth edition covers all the major audio and audio-related media: radio, television, film, music recording, game sound, the Internet, and, new with this edition, mobile media.

Content is designed for beginning- and intermediate-level study, yet the experienced practitioner will find the

material valuable as a reference even after a course of study is completed. The organization facilitates reading chapters in or out of sequence, based on need and level of background, with little disruption to continuity.

This edition has been reorganized to better complement subject flow. Overall the chapters are more focused, to make the distribution of content easier to locate and assign. All chapters have been updated and refined. Several of the changes are in response to reviewers’ recommendations.

Each chapter is preceded by an outline of its main headings and concluded with a list of its main points. Key terms are identified in ***bold italic*** and defined in the glossary. There are more than 100 new and revised illustrations.

The book’s website features a variety of resources for students, including chapter summaries, flashcards, key terms, main points, a media glossary, information on occupations in audio media, and web links. For instructors there is a password-protected online *Instructor’s Manual* to help guide discussion in the classroom, as well as additional exercises and test banks.

## STRUCTURE OF THE BOOK

### Part I: Principles

Chapter 1, “Sound in Production,” introduces the role of audio in media and provides a context for evaluating the finished product.

Chapter 2, “Sound and Hearing,” deals with the physical behavior of sound and its relationship to our psycho-physical perception of sound stimuli. It also includes a section about the importance of caring for your ears and healthy hearing.

Chapter 3, “Acoustics and Psychoacoustics,” develops the material in chapter 2 as it applies to the objective behavior of received sound, its subjective effect on those who hear it, and how these factors affect studio and control room design and construction. A new section covers project and home studios.

## Part II: Technology

Chapter 4, “Loudspeakers and Monitoring,” deals with the relationship between loudspeaker selection and control room monitoring, including expanded coverage of surround-sound monitoring, new material about monitoring with poor-quality loudspeakers, dynamic range tolerances, and monitor controllers. It also includes a revised section on headphones.

Chapter 5, “Microphones,” discusses their principles, characteristics, accessories, and types. The chapter has been reorganized to improve subject flow by first covering basic principles and accessories and then discussing various types of microphones.

Chapter 6, “Mixers, Consoles, and Control Surfaces,” has been reorganized to improve continuity. It adds mixers to the coverage of signal flow and design of broadcast and production consoles—analogue and digital—and control surfaces. There is a revised section on sound in electrical form. Sections about meters, patching, and console automation are also included. Because of the many different types, models, and designs of consoles in use and their various purposes, the approach to the material in this edition is generic so that the basic principles are easier to grasp and apply.

Chapter 7, “Recording,” has also been reorganized to improve subject flow. It covers basic digital theory; recording systems; digital audio workstations; CDs, DVDs, and high-density optical formats; and film audio formats. New material includes smartphone and tablet recording apps, connectors, and digital audio for video recording.

Chapter 8, “Synchronization and Transfers,” covers these fundamental aspects of production and post-production.

Chapter 9, “Signal Processors,” discusses their general principles—both stand-alone and plug-ins—and their effects on sound. There are new sections about overdependence on signal processing in production and specialized plug-ins.

Chapter 10, “Audio and the Internet,” covers Internet sound quality. It includes a new section on cloud computing and discussions of online collaborative recording and podcasting.

## Part III: Production

Chapter 11, “The Speaking Voice, Voice-Overs, and Narration,” focuses on the delivery and the signification of nonverbal speech. Coverage includes speech intelligibility, basic considerations in miking and recording speech,

and factors in the delivery, production, and functions of voice-overs and narration.

Chapter 12, “Dialogue,” deals with production recording and automated dialogue replacement of recordings made in the studio and on-location. It includes a refined section on the importance of dialogue recording and a new section on the production recording crew.

Chapter 13, “Studio Production: Radio and Television,” covers microphone and production techniques as they apply to studio programs in radio and television.

Chapter 14, “Field Production: News and Sports,” concentrates on producing news and sports on-location and includes new material about mobile news gathering and the growing use of the smartphone and the computer tablet in data collection, production, and transmission. Several of the illustrations related to sports production have been updated.

Chapter 15, “Sound Design,” introduces the nature and the aesthetics of designing sound, the basic structure of sonic communication, the sound/picture relationship, and strategies for designing sound. It includes a section on the importance of having “ears”—the ability to listen to sound with judgment and discrimination. The chapter also serves as a foundation for the two chapters that follow, “Sound Effects” and “Music Underscoring.”

Chapter 16, “Sound Effects,” has been expanded and includes the functions of sound effects; types of sound effects; prerecorded sound-effect libraries; and producing and recording sound effects in the studio and in the field, with updated examples. The new section on the types of sound effects includes hard, Foley, ambience, electronic, and design effects.

Chapter 17, “Music Underscoring,” addresses music’s informational and emotional enhancement of visual content. Sections that include examples of film underscores, customized music programs, and organizing a music library have been updated. There is a new section that considers composing original scores.

Chapter 18, “Production for Mobile Media,” is new. It covers the particular production and aesthetic challenges of producing audio today when so many listeners are hearing the sound through mobile devices such as smartphones and tablets.

Chapter 19, “Game Sound,” introduces the preproduction, production, and postproduction of audio for games and how they are similar to and different from handling audio for television and film.

Chapter 20, “Music Recording,” focuses on studio-based recording of live music. It includes the character-

istics of musical instruments, ways to mike them, and various approaches to miking ensembles for stereo and surround sound.

## Part IV: Postproduction

Chapter 21, “Editing,” describes the techniques of digital editing. It also addresses the differences between editing sound and editing picture; organizing the edit tracks; drive and file management; the aesthetic considerations that apply to editing speech, dialogue, music, and sound effects; and the uses of transitions.

Chapter 22, “Mixing: An Overview,” is the first of four grouped chapters covering mixing. This chapter introduces the final stage in audio production, when sounds are combined and processed for mastering, final duplication, and distribution. It includes coverage of mixing for the various media, the role of metering in assessment, troubleshooting, and new material on technical standards and delivery requirements when mixing for broadcast networks and film studios.

Chapter 23, “Premixing and Rerecording for Television and Film,” includes coverage of the procedures for the premix and rerecording stages; spatial imaging of stereo and surround sound; dialnorm; the CALM Act; dynamic range control; and stereo-to-mono and surround-to-stereo compatibility.

Chapter 24, “Music Mixdown,” is devoted to processing and mixing a music recording for stereo and surround sound.

Chapter 25, “Mixing for Mobile Media,” is new. It covers the considerations in signal processing and aesthetics when mixing for audio heard through media such as smartphones and tablets.

## ACKNOWLEDGMENTS

The success of *Audio in Media* over the years has been due in large part to the interest, advice, and guidance of teachers and practitioners in the field who have been so forthcoming with their expertise. Whatever success the tenth edition enjoys is due in no small measure to their continued guidance and good advice.

To the following reviewers of the tenth edition, I offer my sincere gratitude for their insightful suggestions that helped direct this revision: Caryn Clippert, Towson State University; Matt Holmes, Hennepin Technical College, Eden Prairie Campus; Steven Keeler, Cayuga County Community College; John S. Klotz, Temple University; Mark Pfaff, Indiana University–Purdue University Indian-

apolis; Heather Polinsky, Central Michigan University; and Paul Schneider, University of Houston.

To the following industry and academic professionals for their contributions go my thanks and appreciation: James Abbott, professor of audio engineering, School of Music, Syracuse University; Fred Aldous, senior mixer, Fox Sports; Bruce Bartlett, author and engineer; Ben Burt, sound designer; Poppy Crum, Dolby Laboratories; Michael Curry, senior audio producer, MLB Network; Charles Deenen, audio director, Electronic Arts/Maxis; Lee Dichter, rerecording mixer, Sound One; Bob Dixon, director, sound design and communications, NBC Olympics; Andy Field, owner, producer, and writer, FieldVision Productions and reporter for WABC-TV News; Steve Haas, founder and president, SH Acoustics; Tomlinson Holman, president of THM Corporation and professor of cinema-television, University of Southern California; House Ear Institute; Dennis Hurd, Earthworks, Inc.; Kent Jolly, audio director, Electronic Arts/Maxis; Skip Lievsay, sound designer and rerecording mixer; Nick Marasco, chief engineer, WAER-FM, Syracuse; Charles Maynes, sound designer and sound-effect editor; Steve Mellace, technical director, MLB Network; Marty O’Donnell, Bungie Studios; Stuart Provine, sound designer and sound-effect editor; Elliot Scheiner, music producer-engineer; Frank Serafine, composer and sound designer, Serafine Productions; Michael Shane, Wheatstone Corporation; and Marcos Taboas, research assistant, Syracuse University.

Continued thanks go to Nathan Prestopnik, multimedia developer, for drafting the original material on game sound in the previous two editions that remains current.

To the folks at Wadsworth Cengage Learning go my sincere gratitude for their support and high standards: Michael Rosenberg, publisher, for his enlightened supervision; Megan Garvey, associate development editor for being caring, capable, and a pleasure to work with in shepherding this edition; Rebecca Donahue, editorial assistant, for always helping smooth the way; and Michael Lepera, senior content project manager, for his assistance coordinating the departments involved in pulling the book together.

As always, I continue to be impressed by the considerable talents and the good sense of project manager and art director Gary Palmatier and copyeditor Elizabeth von Radics of Ideas to Images. I have been so fortunate over the years to have been the beneficiary of their indispensable contributions, which have been a key reason for the success of *Audio in Media*.

Stanley R. Alten

*The great power of our craft . . . comes from the fact that we are not tied to the literal “truth” of an event.*

*We are free to re-associate sounds and images, and the power of cinema is such that the audience will be inclined to accept them. This metaphoric sound should strive to create a purposeful and fruitful tension between what is on the screen and what is kindled in the mind of the audience.*

*—Walter Murch, Academy Award–winning sound designer and editor*

*I will always sacrifice a technical value for a production value.*

*—Bruce Swedien, music producer/sound engineer*

*Murphy’s Law of Recording:  
Anything that can sound different will.*

*—Anonymous*

P A R T

I

# Principles

- 1 Sound in Production
- 2 Sound and Hearing
- 3 Acoustics and Psychoacoustics

# 1

## Sound in Production

### IN THIS CHAPTER

The Importance of  
Sound in Production

Evaluating the  
Finished Product

Production Values

Sound brings the world into a person; the ear points inward. Sight takes a person into the world; the eye points outward. What we hear affects what we see. Sound and sight are not alternatives, however. The senses function as a democracy—a concept that has been lost because of the dominance of the eye. Each sense serves its own “constituency” and is uniquely suited to its role in the sensorial realm. The senses are also interdependent. To overlook the function of one is to miss their overall impact on a human being’s relationship to, and perception of, the physical world, particularly when it comes to the contributions of audio in media.

### THE IMPORTANCE OF SOUND IN PRODUCTION

Sound is elemental. It affects people in ways they do not realize. It is integral to much of what we know and feel. Sound provides all sorts of information related to the mental processes of knowledge, reasoning, memory, judgment, and perception and to emotion, feeling, and mood.

Sound is omnidirectional; it is everywhere. It can be layered and simultaneous—one sound can be added to another without displacement. It is attention demanding. Comprehending and assimilating aural information requires active listening. Sound communication is a dynamic activity. “Listening with the ear is inseparable from listening with the mind.”<sup>1</sup>

---

1. Michael Chion, *Audio-Vision: Sound on Screen*, trans. and ed. Claudia Gorbman (New York: Columbia University Press, 1994), p. 33.

What also enhances the power of sound, paradoxically, is its visual component. As one sage observed, “He who has ears to hear sees!” For decades radio drama created pictures in the “theater of the mind.” Sound adds a visual dimension to radio news and documentary. Songs stir images. Sound in visual media, even from off-screen, often excites an image. A shot can show a cowboy sauntering down a street in the Wild West, but the sounds of a blacksmith’s hammering, a saloon’s player-piano, and horses’ hooves put a town around the cowboy in the mind’s eye.

Try watching a program or film without the sound. Then close your eyes and only listen to the sound. On average you will find that it is the sound that provides more of the information and impact than the picture.

When it comes to production values, sound works its magic in many ways. Consider how well-crafted audio in any medium engages and transports us. Disregarding the influence of sound can lead to problems that become disconcerting and distracting, if not disturbing, to audiences. Attention to sound is too often overlooked, or left to the last minute, to the detriment of a production; it is an effective and relatively low-cost way to improve production values and help ensure artistic success.

## EVALUATING THE FINISHED PRODUCT

Before beginning the journey through the basics of sound and audio production, it may be useful to provide a context as to what the sonic goals should be in producing the end product.

What makes good sound? Ask 100 audio specialists to evaluate the same material and undoubtedly you will get 100 different responses. That is one of the beauties of sound: it is so personal. Who is to tell you that your taste is wrong? If it satisfies you as a listener, that is all that matters. When sound is produced for an audience, however, professional “ears” should temper personal taste. To this end there are generally accepted standards that audio pros agree are reasonable bases for artistic judgment.

Before discussing these standards, a word about the monitor loudspeakers is in order. Remember that the sound you evaluate is influenced by the loudspeaker reproducing it (and the acoustics of the room). You must therefore be thoroughly familiar with how the loudspeaker affects sonic reproduction. If a sound is overly bright or unduly dull, you have to know whether that is the result of the recording or the loudspeaker. Remember, a good way to familiarize yourself with a loudspeaker’s

response is to listen on the monitor system to a few test discs and well-produced commercial recordings with which you are thoroughly familiar until you are confident about its response characteristics (see chapter 4 for an in-depth discussion of loudspeakers and monitoring).

### Intelligibility

It makes sense that if there is narration, dialogue, or song lyrics, the words must be intelligible. If they are not, meaning is lost. But when working with material over a long period of time, the words become so familiar that it might not be apparent that they are muffled, masked, or otherwise difficult to distinguish. In evaluating intelligibility it is therefore a good idea to do it with fresh ears—as though you were hearing the words for the first time. If that does not give you the needed distance from the material, ask someone else if the words or lyrics are clear.

### Tonal Balance

Bass, midrange, and treble frequencies should be balanced; no single octave or range of octaves should stand out. Be particularly aware of too much low end that muddies and masks sound; overly bright upper midrange and treble that brings out sibilance and noise; absence of brilliance that dulls sound; and too much midrange that causes the harshness, shrillness, or edge that annoys and fatigues.

The timbre of the voice, sound effects, and acoustic instruments should sound natural and realistic. Music and sounds generated by electric and electronic instruments do not necessarily have to sound so, unless they are supposed to.

Ensemble sound should blend as a whole. As such, solos and lead voicings should be sonically proportional in relation to the accompaniment.

### Definition

Each element should be clearly defined—identifiable, separate, and distinct—yet, if grouped, blended so that no single element stands out or crowds or masks another. Each element should have its position in, and yet be a natural part of, the sound’s overall spectral range and spatial arrangement.

### Spatial Balance and Perspective

All sonic elements in aural space—stereo or surround sound—should be unambiguously localized; it should

be clear where various sounds are coming from. Their relationships—front-to-back and side-to-side—should be in proper perspective: dialogue spoken from the rear of a room should sound somewhat distant with appropriate ambience; an oboe solo should be distinct yet come from its relative position in the orchestra; a vocal should not be too far in front of an ensemble or buried in it; background music should not overwhelm the announcer; and crowd noise should not be more prominent than the sportscaster's voice.

Positional and loudness changes should be subtle and sound natural. They should not jar or distract the listener by jumping out, falling back, or bouncing side-to-side (unless the change is justified in relation to the picture). There should be no holes in the spatial imaging, nor should sounds be overly concentrated, creating sonic imbalance, masking, reduced definition, or a mishmash.

### **Dynamic Range**

Dynamic range is the range between the loudest and the softest signals a system can produce without distortion. Therefore the audio should be as wide as the medium allows, making sure that the softest sounds are easily audible and the loudest sounds are not distorted.

If compressed, sound should not seem squeezed, nor should it surge from quiet to loud and vice versa.

### **Clarity**

A clear recording is as noise-free and distortion-free as possible. Hum, hiss, leakage, phasing, smearing, blurring from too much reverberation, and distortion—all muddle sound, adversely affecting clarity.

### **Airiness**

Sound should be open and airy. It should not seem isolated, stuffy, muffled, closed-down, dead, lifeless, overwhelming, or oppressive.

### **Acoustical Appropriateness**

Acoustics, the properties of a room that affect the quality of sound, obviously must be good, but they must also be

appropriate. With picture the space in which a character is seen and the acoustic dimension of that space must match. With music the acoustics should complement the type of music being played. Classical music and jazz sound most natural in an open, relatively spacious environment. Acoustics for rock-and-roll can range from tight to open. In radio most on-air talent belongs in a drier acoustic environment to complement the lip-to-ear intimacy of the medium.

### **Source Quality**

When a recording is broadcast, downloaded, or sent on for mastering, there is usually some loss in sound quality. This occurs with both analog and digital sound. For example, what seems like an appropriate amount of reverberation when listening to a scene or a song in a studio may be barely discernible after transmission or transfer. As a general guideline, be aware that a source recording should have higher resolution than its eventual release medium.

## **PRODUCTION VALUES**

In dealing with production and production values, director Francis Ford Coppola uses a triangle to explain what the priorities should be. The top of the triangle says "Good." The bottom-left side says "Quick." The bottom-right side says "Cheap." You can connect only two of the sides but not all three. If the production is good and quick, it will not be cheap. If it is good and cheap, it will not be quick. And if the production is quick and cheap . . .

The degree to which you are able to develop and appraise production values is what separates the mere craftsperson from the true artist. Production values relate to the material's style, interest, color, and inventiveness.

Production values are the most difficult part of an evaluation to define or quantify because response is qualitative and intuitive. Material with excellent production values grabs and moves you. It draws you into the production, compelling you to forget your role as objective observer; you become the audience. When this happens it is not only the culmination of the production process but its fulfillment.

## M A I N P O I N T S

- ▶ Sound brings the world into a person; the ear points inward. Sight takes a person into the world; the eye points outward.
- ▶ Sound provides all sorts of information related to the mental processes of knowledge, reasoning, memory, judgment, and perception and to emotion, feeling, and mood.
- ▶ Disregarding the influence of sound can lead to problems that become disconcerting and distracting, if not disturbing, to audiences. Attention to sound is too often overlooked, or left to the last minute, to the detriment of a production.
- ▶ In evaluating a final product, factors that should be considered include intelligibility, tonal balance, definition, spatial balance and perspective, dynamic range, clarity, airiness, acoustical appropriateness, and source quality.
- ▶ Production values relate to the material's style, interest, color, and inventiveness.
- ▶ Material with excellent production values grabs and moves you, drawing you into the production and compelling you to forget your role as objective observer. When this happens it is not only the culmination of the production process but its fulfillment.

# 2

## Sound and Hearing

### IN THIS CHAPTER

The Sound Wave  
Frequency and Pitch  
Amplitude and Loudness  
Frequency and Loudness  
Velocity  
Wavelength  
Acoustical Phase  
Timbre  
Sound Envelope  
Analog and Digital Sound  
The Healthy Ear  
Hearing Loss

The term *sound* refers to three basic occurrences: the physical phenomenon of vibrations that set into motion longitudinal waves of compression and rarefaction propagated through molecular structures such as gas, liquids, and solids; the psychophysical perception of sound stimuli; and the physiological phenomenon that stimulates the sense of hearing.

### THE SOUND WAVE

*Sound* is produced by vibrations that set into motion radiating waves of compression and rarefaction propagated through a range of media such as gases, liquids, and solids.

*Hearing* occurs when these vibrations are received and processed by the ear and sent to the brain by the auditory nerve.

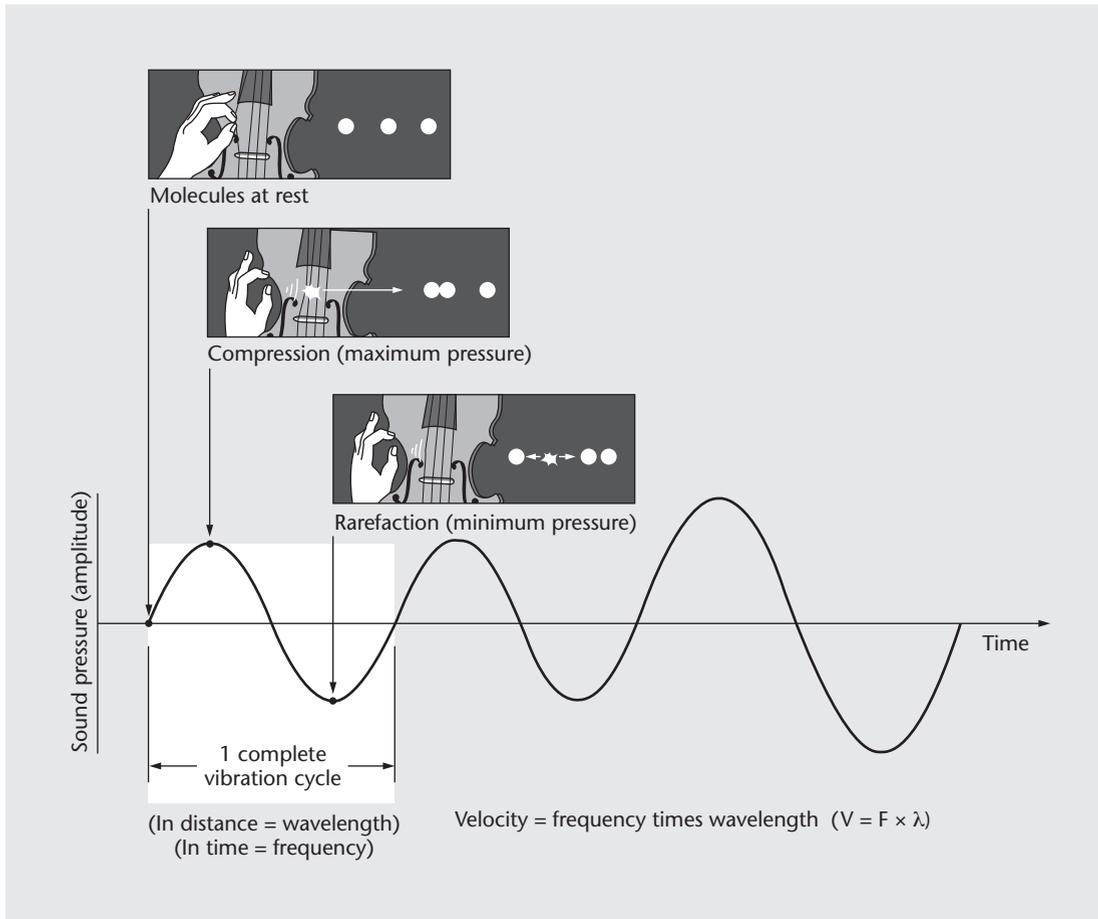
Sound begins when an object vibrates and sets into motion molecules in the air closest to it. These molecules pass on their energy to adjacent molecules, starting a reaction—a **sound wave**—which is much like the waves that result when a stone is dropped into a pool. The transfer of momentum from one displaced molecule to the next propagates the original vibrations longitudinally from the vibrating object to the hearer. What makes this energy transfer possible is a medium with the property of elasticity—whether gas, liquid, or solid. **Elasticity** is the phenomenon whereby a displaced molecule tends to pull back to its original position after its initial momentum has caused it to displace nearby molecules.

As the energy from a vibrating object moves outward, it compresses molecules closer together, increasing pressure. **Compression** continues away from the object as the momentum of the disturbed molecules displaces the adjacent molecules, producing a crest or peak in the sound wave. When a vibrating object moves inward, it pulls the molecules farther apart and thins them, creating a **rarefaction**. This rarefaction also travels away from the object in a manner similar to compression except that it decreases pressure, thereby producing a trough or valley in the sound wave (see 2-1). As the sound wave moves away from the vibrating object, the individual molecules do not advance with the wave; they vibrate at what is termed their *average resting place* until their motion stills

or they are set in motion by another vibration. To understand wave motion, we need to examine the components that make up a sound wave: frequency, amplitude, velocity, wavelength, and phase (see 2-1, 2-2, and 2-9).

### FREQUENCY AND PITCH

When a vibration passes through one complete up-and-down motion, from crest to trough, it has completed one cycle. The number of cycles that a vibration completes in one second is expressed as its **frequency**. If a vibration completes 50 *cycles per second (cps)*, its frequency is 50 **hertz (Hz)**; if it completes 10,000 cps, its frequency is 10,000 Hz, or 10 **kilohertz (kHz)**. Every vibration has



**2-1 Components of a sound wave.** The vibrating object causes compression in sound waves when it moves outward (causing molecules to bump into one another). The vibrating object causes rarefaction when it moves inward (pulling the molecules away from one another).

a frequency, and humans with excellent hearing may be capable of hearing frequencies from 20 to 20,000 Hz. The limits of low- and high-frequency hearing for most humans, however, are about 35 to 16,000 Hz. Frequencies just below the *low end* of this range, called *infrasonic*, and those just above the *high end* of this range, called *ultrasonic*, are sensed more than heard, if they are perceived at all.

These limits change with natural aging, particularly in the higher frequencies. Generally, hearing acuity diminishes to about 15,000 Hz by age 40, to 12,000 Hz by age 50, and to 10,000 Hz or lower beyond age 50. With frequent exposure to loud sound, the audible frequency range can be adversely affected prematurely.

Psychologically, and in musical terms, we perceive frequency as *pitch*—the relative tonal highness or lowness of a sound. The more times per second a sound source vibrates, the higher its pitch. Middle C (C4) on a piano vibrates 261.63 times per second, so its fundamental frequency is 261.63 Hz. The A note above middle C has a frequency of 440 Hz, so the pitch is higher. The *fundamental* frequency is also called the *first harmonic* or *primary frequency*. It is the lowest, or basic, pitch of a musical instrument.

The range of audible frequencies, or the *sound frequency spectrum*, is divided into sections, each with a unique and vital quality. The usual divisions in Western music are called octaves. An *octave* is the interval between any two frequencies that have a tonal ratio of 2:1 (refer to the inside front and back covers of the book).

The range of human hearing covers about 10 octaves, which is far greater than the comparable range of the human eye; the visible light frequency spectrum covers less than one octave. The ratio of highest to lowest light frequency visible to humans is barely 2:1, whereas the ratio of the human audible frequency spectrum is 1,000:1.

Starting with 20 Hz, the first octave is 20 to 40 Hz; the second, 40 to 80 Hz; the third, 80 to 160 Hz; and so on (see inside back cover). Octaves are grouped into *bass*, *midrange*, and *treble* and are further subdivided as follows.

■ **Low bass**—first and second octaves (20 to 80 Hz). These are the frequencies associated with power, boom, and fullness. While there is generally little musical content in the lower part of this range, rap and hip-hop music in particular make effective use of this part of the frequency spectrum. In the upper part of the range are the lowest notes of the piano, organ, tuba, and bass and the fundamental of the bass (kick) drum. (As men-

tioned previously, a fundamental is the lowest, or basic, pitch of a musical instrument; see “Timbre” later in this chapter.) Sounds in these octaves need not occur often to maintain a sense of fullness. If they occur too often or at too loud a level, the sound can become thick or overly dense. With the exception of subwoofers, which are designed to handle low-end program material, most loudspeakers are capable of reproducing few, if any, of the first-octave frequencies. Loudspeakers capable of reproducing second-octave frequencies often do so with varying loudness levels.

■ **Upper bass**—third and fourth octaves (80 to 320 Hz). Most of the lower tones generated by rhythm and other support instruments such as drums, piano, bass, cello, and trombone are in this range. They establish balance in a musical structure. Too many frequencies from this range make it sound boomy; too few make it thin. When properly proportioned, pitches in the second, third, and fourth octaves are very satisfying to the ear because we perceive them as giving sound an anchor, that is, fullness or bottom. Too much fourth-octave emphasis, however, can muddy sound. Frequencies in the upper bass range serve an aural structure in the way the horizontal line serves a visual structure—by providing a foundation. Almost all professional loudspeakers can reproduce the frequencies in this range.

■ **Midrange**—fifth, sixth, and seventh octaves (320 to 2,560 Hz). The midrange gives sound its intensity. It contains the fundamental and the rich lower harmonics and overtones of most sound sources. It is the primary treble octave of musical pitches. The midrange does not necessarily generate pleasant sounds. Although the sixth octave is where the highest fundamental pitches reside, too much emphasis here is heard as a hornlike quality. Too much emphasis of seventh-octave frequencies is heard as a hard, tinny quality. Extended listening to midrange sounds can be annoying and fatiguing.

■ **Upper midrange**—eighth octave (2,560 to 5,120 Hz). We are most sensitive to frequencies in the eighth octave, a rather curious range. The lower part of the eighth octave (2,560 to 3,500 Hz) contains frequencies that, if properly emphasized, improve the intelligibility of speech and lyrics. These frequencies are roughly 3,000 to 3,500 Hz. If these frequencies are unduly emphasized, however, sound becomes abrasive and unpleasant; vocals in particular become harsh and lispy, making some consonants difficult to understand. The upper part of the eighth octave (above 3,500 Hz), on the other hand, contains

rich and satisfying pitches that give sound definition, clarity, and realism. Listeners perceive a sound source frequency in this range (and also in the lower part of the ninth octave, up to about 6,000 Hz) as being nearby, and for this reason it is also known as the *presence range*. Increasing loudness at 5,000 Hz, the heart of the presence range, gives the impression that there has been an overall increase in loudness throughout the midrange. Reducing loudness at 5,000 Hz makes a sound seem transparent and farther away.

■ **Treble**—ninth and tenth octaves (5,120 to 20,000 Hz). Although the ninth and tenth octaves generate only 2 percent of the total power output of the sound frequency spectrum, and most human hearing does not extend much beyond 16,000 Hz, they give sound the vital, lifelike qualities of brilliance and sparkle, particularly in the upper-ninth and lower-tenth octaves. Too much emphasis above 6,000 Hz makes sound hissy and brings out electronic noise. Too little emphasis above 6,000 Hz dulls sound.

Understanding the audible frequency spectrum's various sonic qualities is vital to processing spectral balances in audio production. Such processing is called *equalization* and is discussed at length in chapters 9 and 24.

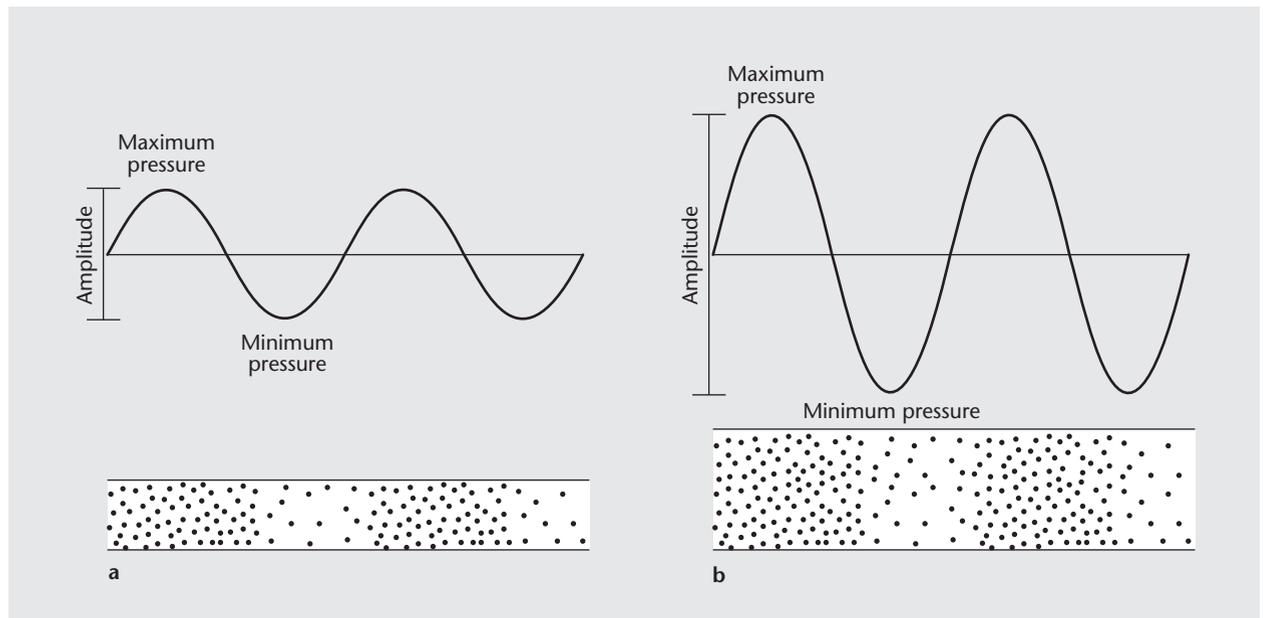
## AMPLITUDE AND LOUDNESS

We have noted that vibrations in objects stimulate molecules to move in pressure waves at certain rates of alternation (compression/rarefaction) and that rate determines frequency. Vibrations not only affect the molecules' rate of up-and-down movement but also determine the number of displaced molecules that are set in motion from equilibrium to a wave's maximum height (crest) and depth (trough). This number depends on the intensity of a vibration; the more intense it is, the more molecules are displaced.

The greater the number of molecules displaced, the greater the height and the depth of the sound wave. The number of molecules in motion, and therefore the size of a sound wave, is called *amplitude* (see 2-2). Our subjective impression of amplitude is a sound's loudness or softness. Amplitude is measured in decibels.

### The Decibel

The *decibel (dB)* is a dimensionless unit and, as such, has no specifically defined physical quantity. Rather, as a unit of measurement, it is used to compare the ratio of two quantities usually in relation to acoustic energy, such as



**2-2 Amplitude of sound.** The number of molecules displaced by a vibration creates the amplitude, or loudness, of a sound. Because the number of molecules in the sound wave in (b) is greater than the number in the sound wave in (a), the amplitude of the sound wave in (b) is greater.