# Sound Recording Practice

Second edition

andbook compiled by the Association of Professional Recording Studios

# SOUND RECORDING PRACTICE

A Handbook compiled by the Association of Professional Recording Studios

Edited by JOHN BORWICK

Second edition

London
OXFORD UNIVERSITY PRESS
New York Toronto
1980

# Oxford University Press, Walton Street, Oxford 0x2 6DP OXFORD LONDON GLASGOW NEW YORK TORONTO MELBOURNE WELLINGTON CAPE TOWN NAIROBI DAR ES SALAAM KUALA LUMPUR SINGAPORE JAKARTA HONG KONG TOKYO DELHI BOMBAY CALCUTTA MADRAS KARACHI

ISBN 0 19 311920 X

© Oxford University Press 1980

First published 1976 Second edition 1980

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of Oxford University Press

Filmset and printed in Great Britain by BAS Printers Limited, Over Wallop, Hampshire

## SOUND RECORDING PRACTICE

### **Foreword**

As a contribution to recording knowledge and standards, the Association of Professional Recording Studios is proud to present this handbook. It collects in a single volume a distillation of the experience and knowledge of a score of sound-recording experts. Whilst the authors have all been chosen from those engaged in this exciting field in the British Isles, their work is universally recognized by the success of British recordings as well as by the use of British equipment in studios throughout the world.

Studio personnel, both senior and junior, have a duty to keep abreast of developments in the technical and artistic spheres of their profession and ever since the APRS was formed in 1947, one of its prime aims has been the encouragement of the highest technical and operational standards.

The pace of technical advance was never greater than it is today and yet, ironically, harassed studio managers, engineers, and producers have less time than ever to sift through the numerous magazines and manufacturers' brochures in search of all this complex and vital data. I believe, therefore, that this comprehensive manual will provide a most useful digest of the present state of the recording art—a bird's-eye view of the work and ideas of people engaged at all stages in the chain of sound recording.

The needs of the aspiring entrant to the profession have not been overlooked. Reading this book will, by itself, provide an invaluable grounding in the special terminology of recording and something of the flavour of the atmosphere which pervades this exciting and ever-changing medium. There are numerous references to existing literature and international standards, and a substantial glossary of terms.

I would like to thank everyone concerned with the production of this handbook and I commend it heartily to all those with an interest in sound recording at the professional level.

Jacques Levy Chairman Association of Professional Recording Studios

### Editor's Preface to Second Edition

The best news you can give to the editor and authors of a fairly technical handbook is that the first edition, including a second printing, has practically sold out and a new edition is required. When the book covers the equipment and operational techniques in so fast-moving an industry as sound recording, the chance to update the text and illustrations is particularly welcome.

All the authors have scrutinised their respective chapters—and those of their colleagues—and we are confident that this Second Edition is not only bigger but better than ever. The meteoric rise in the importance of digital techniques and automation in recent years has made two completely new chapters necessary (Chapters 6 and 7) besides making waves that have spread out into many other chapters too. The other major difference in this edition is that the untimely death of W. H. Livy obliged us to look for a new author for Chapter 22, 'Disc Cutting', and Sean Davies, rather than revising the original text, has bravely volunteered to tackle the subject anew—and his approach will commend itself to new and old readers alike.

John Borwick, Haslemere, Surrey

### Contents

#### **TECHNICAL INTRODUCTION**

Chapter One	The Programme Chain	By John Borwick	,
The making	of a gramophone record		3
Stage 1: plar	nning		3
	ect recording to tape		3
	paration of the production r	naster	5
	e-to-disc transfer		$\epsilon$
Stage 5: disc			$\epsilon$
	ss production		6
	keting and distribution		6
	nestic playback		7
	nd digital recording		7
Units			8
Quality criter	ria		11
1 Frequenc	cy response		11
2 Dynamic	range		12
3 Distortion	n		13
4 Noise			14
5 Wow and			16
6 Crosstalk			17
THE STUDIO			19
Chapter Two	The Acoustics By Al	ex Burd (Sandy Brown As	
Background i			Joeintes/
Sound insular	tion		21
Acoustic qua			24
coustic qua	uity		27

#### xii Sound Recording Practice

Acoustic abso	rbers			32
Acoustic treatment of a studio				34
Variable acoustics				35
Studio screens	S			35
Control rooms	and listening rooms			36
Chapter Three	The Microphone (	Circuits By	y John Borwick	
The acoustica	I/mechanical convers	ion		38
The mechanic	al/electrical conversion	on		41
Care of micro	phones			44
Microphone se	ensitivity			45
Microphone c	ables			46
Balanced lines				47
Plugs and socl	kets			48
Phasing				49
Power for cap	acitor microphones			50
The patch bay				52
Microphone a	ccessories			53
Chapter Four	The Communicatio		By Ted Fletcher (Stancoil Ltd.)	
Talkback and	foldback in the small	studio		55
Talkback and	foldback in the large	studio		56
Talkback and foldback in broadcasting studios			59	
Lines, levels, and impedances				60
Solid state switching in communication systems				62
Light signalling	and cueing			63
THE EQUIPME	NT			65
Chapter Five	Mixing Consoles	By Richard St	wettenham	
Microphone in	puts			67
Noise .				68
Overload marg	tin			
Phantom powe				68 69
Gain settings	11 /		•	69
Filters and phas	se reversal			
Equalizers				70 70
Equalizer overlo	oad			70 72
				, 4

Insert po	ints			/2
The char	nnel fader			72
PFL, AFL,	and Solo			73
	sends from channel			74
•	lent outputs			74
•	nd quadraphonic panning			74
	routing to groups			76
Free grou				78
Mixing n				78
Groups				79
•	controlled amplifier grouping			79
The digit				80
Main out				80
	d outputs			81
Echo reti	ırn			81
Foldback	outputs			81
Multitrac	k monitoring			81
	om monitor			83
Main mo	nitor controls			83
Metering				83
Types of	meter			84
Talkback				86
Console	ayout and ergonomics			86
The 'in-li	ne' console			89
Chapter Six	Remote Control and Auto	mation	By Martin Jones	
			(Neve Electronics	
Tape rem	otes and autolocators		International Ltd.)	91
Remote o	control of gain		zed.,	92
Memorize	ed routing			93
Console a	automation			94
Further a	oplications of console automat	ion		100
The futur				101
Chapter Sev	en Digital Techniques	By Martin	Jones	
Analogue	and digital signals			103
	truth tables, and Boolean notat	ion		105
	unting and arithmetic			103
IC logic	•			107
Registers	and memories			109

#### xiv Sound Recording Practice

Magnetic tap	e and disc		111
Conversion between analogue and digital signals			112
Digital systen			113
Data buses			115
The compute	r and microprocess	or	117
-	d microprocessor o		118
Digital audio	•	•	120
_	and equalizers		121
The all-digital	-		124
Chapter Eight	Extra Facilities	By Michael Beville	
		(Audio & Design Recording Ltd.)	
Dynamic rang	ge	_	125
Automatic ga	in control		128
Limiters, com	pressors, and expar	nders	128
Limiting			129
Compression			130
	sus variable gain		130
Attack charac			132
Recovery time			133
Modulation e			134
Compression			135
Expander/gate			135
Combination			137
		(dynamic equalization)	138
Ducking or vo			140
Noise reduction			141
Dolby 'A' syst			142
Dolby 'B' syste			144
dbx noise red	uction system		144
Telcom C4			145
Equalizers			147
Graphic equal			148
Reverberation	d sweep equalizers		148
The echo char			149
			150
The reverberat			151
The reverberat			151
Tape reverbera Electronic dela	ation systems		152
Phasing and fla			152
. masing and he	41151115		153

Other specia	l effects		154
The future of	f auxiliary equipmer	nt	155
Chapter Nine	Monitoring Syste	ems By Stephen Court (Court Acoustics)	
Design philos	sophy		156
Split sub-bas	s monitors		158
Speaker eval	uation and installat	ion	160
System equa			163
Monitoring e	lectronics		166
Chapter Ten	Magnetic Tape	By Angus McKenzie (Angus McKenzie Facilities Ltd.)	
Tape types		McKenzie Facilities Ltd.)	170
Maximum op	perating level		170
Sensitivity	rerating level		170
Print-through	1		172
Modulation r			173
Spooling cap	ability		175
Dropouts and			175
Velour effect			176
Background r			177
Intermodulat			178
	play characteristics		178
Metering			179
Head wear ch	naracteristics		179
Erasure The final choi	00		180
me imai choi	ce		180
Chapter Eleven	Tape Machines	By Angus McKenzie	
Mechanical cons	siderations		183
1 Robustne	<del></del>		183
	transport		184
3 Tape ten			185
4 Wow and			187
5 Scrape flo 6 Footage			188
7 Capstan	and timing counters	S	189
	drive and speed acc and braking	curacy	189
	nechanical noise		191
J General I	nechanical Hoise		193

#### xvi Sound Recording Practice

10	Editing facilities	193
11	Head block and heads	194
Ele	ectrical considerations	197
-	1 Replay amplifiers	198
2	2 Erase, bias, and record head drive	198
3	3 The record amplifier	199
1	Multitrack recorders	200
E	Battery-operated portable recorders	202
F	Remote and automatic controls	203
F	Relays and hum fields	204
ı	Input and output sockets	205
[	Digital recording	206
Ch	apter Twelve Mobile Control Rooms By Richa	and Courses and a
	,	rd Swettenham
	Sound insulation and internal acoustic treatment	212
	Air conditioning	213
	Power supplies and regulation	213
	Interior layout	216
	New facilities	218
	Microphone boxes	219
	Cables and drums	219
r	Non-technical facilities	221
Cha	apter Thirteen Equipment Alignment By Angus	McKenzie
т	The replay head and amplifier	
	Replay head adjustment	222
	Multitrack replay heads	224
	The record amplifier	225
	Bias and erase circuits	226
	setting bias level	227
	etting up the record head	228
	he erase head	230
	loise reduction systems	231
	Guides and rollers	232
	ape speed	233
	he use of test tapes	233
	Vhich make of tape?	234
	umming up	235
٠,		236

Chapter Fourteen	Maintenance	By L. G. Harris (Olympic Sound Studios)
Basic requirement	ts	233
Maintenance pro	cedures	238
Logging of faults		239
Connecting leads		24
Standby facilities	•	242
Test tapes		243
Studio loudspeak	ers	24
TECHNIQUES		247
Chapter Fifteen	Speech and Drama	By Derek Taylor
A single voice		252
Two or more voic	es	252
Drama		257
Mono drama		258
Sound effects		261
Stereo drama		262
Quadraphonic so	und	267
Binaural stereo		268
Chapter Sixteen	Classical Music	By Trygg Tryggvason (Music
		Centre, University of East Anglia)
Purist techniques		273
Microphone system		274
Spaced microphor	ne systems	276
Preparations		277
Solo performers		281
Chamber music		283
Vocal music		285
Orchestral music		287
Opera		290
Conclusion		295
Chapter Seventeen	Synthesized Musi	c By Tristram Cary (Department of Music, University of Adelaide)
Basic requirements	for synthesis	*
Subtractive synthe	sis	297
,		299

and the second of the second o

#### xviii Sound Recording Practice

The voltage conti	rolled analogue s	ynthesizer 30
Additive synthesis	_	30
Computer additiv		30
FM synthesis	,	30
Other methods o	f synthesis	30
Conclusion	,	30
Chapter Eighteen	Location Reco	rding By Robert Auger (Bob Auger Associates)
Formal sessions		30
1 Choice of loca	ation	31
2 Acoustic cons	iderations	31
3 Control rooms	5	31
4 Communication	ons	31
5 Recording ope	era	31
6 Recording faci		31
Public performanc	es	31
1 Setting up		
<ol><li>Splitting micro</li></ol>	phone outputs	31
3 Theatre perfor		31
	f concert recordi	ngs 31
Chapter Nineteen	The Dâle of the	31
	The Rôle of the	Producer By John Culshaw
Technical revolution	ons	320
Effects in opera	_	32:
Relationships with	others	32.
Job opportunities		325
Chapter Twenty	Popular Music	By Peter Tattersall (Strawberry Recording Studios)
Setting up the sess	ion	327
Studio layout		327
Microphones		
Grouping of chann	els	328 329
Routing of channel	s to tracks	329
Special facilities		331
Limiting and con	npression	
Equalization unit	S	332
,	_	332

	Conten	ics Air
Phasing Tape echo Extra delay an Gain expande De-essers		332 332 333 333 333
Sounds		334
The drums Bass guitar Lead guitar Acoustic guita Piano Electric piano Vocals Orchestral ins		334 335 336 337 338 338 338
Reduction		338
Overdubbing		339
Tape machine o	peration	340
Chapter Twenty-or	ne Popular Electronic Music By John Keating	g
The new method		341
Some problems	and their solutions	343
	ngs of Love'	343
•	s in Hi-Fi'	346
	Electronic Philharmonic Orchestra'	349
Example 4 'In S	earch of Atlantis'	352
MANUFACTURIN	G PROCESSES	355
Chapter Twenty-Tv	wo Disc Cutting By Sean Davies (S. W. Davie	es Ltd.)
Basic principles		357
Variable pitch re		360
The stereophonic		362
The cutting head		362
The recording an		364
The cutting lathe		365
Special signal pro	ocessing	367
Distortions due to	o the mechanics of the system	367
The control cons	ole	368

#### xx Sound Recording Practice

Other disc formats Practical points			369 369
Chapter Twenty-three	Disc Manufacture	By E. B. Pinniger (The British Homophone Ltd.)	
Terminology		,	371
A brief history			372
Metallization			374
Plating			375
Preparing the stampe	r		380
Faults			381
Future developments	•		381
Pressing materials			382
The pressing cycle			383
Injection moulding			385
Pressing faults			387
Foil sampler records			387
Electroforming: facts a	and formulae		388
References			388
Chapter Twenty-four	Tape Duplicating	By John B. Schefel (The	<u> </u>
_		Tape Duplicating Com	pany)
Tape mastering			390
High speed tape dupli			391
Tape tailoring and win			393
Labelling and packagin	ng		396
64:1 duplicating			397
ALLIED MEDIA			399
Chapter Twenty-five	Sound Broadcasting	By Glyn Alkin (BBC	
<del>-</del>		Welsh Region)	
The broadcasting netw	ork	Ŭ	402
1 The continuity suite	e		
2 Transmission links	-		402
Dulan I I I			403
Pulse code modulation			403
1 Sampling			404
2 Quantizing			404

- Landa Janko - Maria (Maria)

3 Coding	404
4 Bandwidth	405
5 Pre-emphasis and de-emphasis	405
6 Compounding	406
7 Multi-channel links	406
Television sound in syncs	406
Technical quality	408
Automatic monitors	408
Local comparison	409
Remote comparison	409
Modulation range	410
Amplitude modulation	411
Frequency modulation	412
Programme meters	413
1 The VU meter	414
2 The Peak Programme Meter	414
The need for rules	415
The importance of listening levels	416
Live broadcasting technique	417
Audience reaction	418
Chapter Twenty-six Television By Glyn Alkin	
The required quality of sound	419
The required character of sound	420
Microphone technique	420
Microphones in shot	421
Hand-held microphones	421
Stand microphones	422
Stand/hand-held microphones	422
Extension tube microphones	422
Personal microphones	423
Capacitor personal microphones	424
Radio microphones Super-directional microphones	424
Line (gun) microphones	425
Microphone booms	426
Music	427 429
Live light music balance	430
	730