Contents

Illus	tration	S	ix
	itribute		χv
Ack	nowled	lgements	xvi
Intr	oduct	ion	1
1	The	need for feedback	8
	IAN .	M. FRANKS	
	1.1	The coaching process and its problems	8
	1.2	Feedback	8
	1.3	The need for objective information	12
	1.4	Summary	15
2	The	nature of feedback	17
	NICC	LA J. HODGES AND IAN M. FRANKS	
	2.1	Distinguishing information sources	17
	2.2	Augmented feedback: knowledge of results (KR) and	
		performance (KP)	19
	2.3	Demonstrations and instructions	25
	2.4	Augmented information summary and conclusions	38
3	The	use of feedback-based technologies	40
	DARI	O G. LIEBERMANN AND IAN M. FRANKS	
	3.1	Introduction	40
	3.2	Video information as a source of feedback	40
	3.3	Automated systems as a source of complex information	43
	3.4	Training in three-dimensional virtual environments	46
	3.5	Tele-remote training and analysis	49
	3.6	Laser technology in static and dynamic conditions	50
	3.7	Temporal feedback in skill training	51

vi Contents

	3.8	The use of force sensors to deliver feedback about	
		pressure, time, and direction	55
	3.9	Eye-movement recording technology	56
	3.10	On coaches' attitudes to the use of feedback-based technology	57
	3.11	Conclusions	58
4		tional analysis – a review of the literature	59
	MIKE	HUGHES AND IAN M. FRANKS	
	4.1	Introduction	59
	4.2	Historical perspective	60
	4.3	Methodological issues	61
	4.4	The development of sport-specific notation systems	
		(hand notation)	61
	4.5	Computerised notation	80
	4.6	Summary	103
	4.7	The future of notational analysis	104
5	Sport	ts analysis	107
	MIKE	HUGHES AND IAN M. FRANKS	
	5.1	Introduction	107
	5.2	Creating flowcharts	107
	5.3	Levels of analysis - the team, subsidiary units	
		and individuals	113
	5.4	Summary	117
6	How	to develop a notation system	118
		HUGHES AND IAN M. FRANKS	
	6.1	Introduction	118
	6.2	Examples of data collection systems	118
	6.3	Data collection systems in general	126
	6.4	Examples	128
	6.5	General steps in analysis	132
	6.6	Different types of data	134
	6.7	Summary	140
7	Exam	nples of notation systems	141
	MIKE	HUGHES AND IAN M. FRANKS	
	7.1	Introduction	141
	7.2	Individual sports	141
	7.3	Team sports	151

		Contents	Vii
1		use of performance indicators in performance analysis	166
	MIKE	HUGHES AND ROGER BARTLETT	
	8.1	Summary	166
	8.2	Introduction	166
	8.3	Analysis of game structures	172
	8.4	Conclusions	187
•	9 Anal	lysis of notation data: reliability	189
	М. Н	UGHES, S.M. COOPER AND A. NEVILL	
	9.1	Introduction	189
	9.2	The nature of the data, the depth of analysis	191
	9.3	Consistency of percentage difference calculations	193
	9.4	Processing data	194
	9.5	Visual interpretation of the data (Bland and Altman plot)	195
	9.6	Statistical processes and reliability	201
	9.7	Conclusions	203
1		blishing normative profiles in performance analysis HUGHES, STEVE EVANS AND JULIA WELLS	205
	10.1	Introduction	205
	10.2	•	207
	10.3	Conclusions	225
1	1 Mod	els of sports contests – Markov processes, dynamical	
	•	ems and neural networks	227
	TIM	MCGARRY AND JÜRGEN PERL	
	11.1	Introduction	227
	11.2	Sport and chance	227
	11.3		236
	11.4	- · · · · · · · · · · · · · · · · · · ·	242
1.		suring coaching effectiveness MORE AND IAN M. FRANKS	243
	12.1	Instruction	243
	12.2	Teaching and coaching effectiveness	244
	12.3	,	244
	12.4	•	248
	12.5	Identification of effective verbal coaching strategies	251
	12.6	Summary	256

viii Contents

13	From	analysis to coaching	257
	MIKE	HUGHES AND IAN M. FRANKS	
	13.1	Examples of the applications of analysis systems to	
		coaching practice	257
	13.2	Tactical performance profiling in elite level senior squash	263
	13.3	Rugby union – a game of change	269
	13.4	Summary	271
Glos	ssary		272
Refe	rences	and Bibliography	274
Inde	x		302

Illustrations

Figures

1.1	A simple schematic diagram representing the coaching process	12
2.1	Schematic diagram to illustrate how the learning process is	
	affected by various augmented information sources	18
2.2	Individual trial data represented as Lissajous figures (relative	
	motion plots) across acquisition and in retention for an	
	exemplar participant in the no-instruction group from	
	experiment 1	31
2.3	Individual trial data represented as Lissajous figures (relative	
	motion plots) across acquisition and in retention for an	
	exemplar participant in the in-phase instruction group from	
	experiment 1	32
3.1	A javelin throwing performance and the major variables that	
	could affect the final distance of throw	45
3.2	Examples of the tangential velocity-time profiles of the	
	relevant joints in tennis serve before and after training	53
3.3	Asymmetries between the left and right legs during the	
	support (heel-strike to toe-off time)	54
4.1	The shot codes, or suggestive symbols, used by Sanderson	
	(1983) for his data-gathering system for squash	63
4.2	The data-gathering sheets and example data of the shot	
	codes, or suggestive symbols, used by Sanderson (1983) for	
	his data-gathering system for squash	64
4.3	Example from some of Sanderson's data showing frequency	
	distribution of all shots, winners and errors	65
5.1	Hierarchical structure of a model for representing events	
	that take place in a team game such as field hockey, soccer,	
	basketball, water polo	109
5.2	Simple schematic flowchart for soccer	110
5.3	Core elements of any analysis system of performance	111
5.4	Simple flowchart for squash	112
5.5	Primary level game analysis – team	114

5.6	Individual analysis	116
6.1	Simple scatter diagram for recording position of loss of	
	possession for soccer	119
6.2	Simple scatter diagram for recording position of loss of	
	possession, and the player involved, for soccer	120
6.3	Simple scatter diagram for recording position of loss of	
	possession, and the player, and the action involved, for soccer	121
6.4	Definition of position on a representation of a field hockey	
	pitch	123
6.5	Definition of position on a representation of a field hockey	
	pitch oriented to analysing attacking moves	124
6.6	Alternative definition of position on a representation of a	
	field hockey pitch oriented to analysing attacking moves	125
6.7	Example of the distribution of the frequency of shots per player	136
6.8	A different way of presenting the same data of the distribution	
	of the frequency of shots per player as in Figure 6.7	137
6.9	Example of a frequency distribution of actions in a field	
	hockey match showing numbers of passes, runs, etc. in each	
	area of the pitch	137
6.10	Example of a frequency distribution of errors in a field hockey	
	match showing numbers of errors made in each area of the	
	pitch	138
6.11	Representation of three-dimensional data distribution using	
	two-dimensional graphs	139
6.12	Example of sequential data - path to a shot on goal in field	
	hockey	140
7.1	Division of the court into six cells for analysis of tennis	142
7.2	(a) Notation of data using the system for tennis; (b) schematic	
	representation of data used in the example in (a)	143
7.3	Example of the tennis data - gathering system	144
7.4	Distribution of the types of punches thrown by Tyson in the	
	Bruno-Tyson match (1989)	149
7.5	Distribution of the types of punches thrown by Bruno in the	
	Bruno-Tyson match (1989)	149
7.6	Distribution of jabs by both fighters on a round-by-round	
	analysis (Bruno-Tyson, 1989)	151
7.7	Schematic representation of the basketball court in order to	
	define position cells for a data-gathering system	152
7.8	Representation of the number of completed passes	157
7.9	Representation of the number of uncompleted passes	157
7.10	Representation of the number of clearances	158
7.11	Representation of the percentage of activities throughout the	
	first half	158
7.12	Schematic diagram of a soccer pitch showing suggested	
	divisions of the playing area into a grid for notation	160

7.13	Schematic representation of the netball court for divisions of the playing surface	162
8.1	Hierarchical technique model of the long jump	167
8.2	Contour map of the distance a javelin travels as a function	
	of two release parameters, with all others held constant	168
8.3	Game classification	173
8.4	Subcategorisation of net and wall games, with some common	
	examples	173
8.5	Some factors that contribute to success or improved	
	performance in net and wall games	174
8.6	Subcategorisation of invasive games, with some common	,
	examples	179
8.7	Some factors that contribute to success or improved	
	performance in invasive games	179
8.8	Subcategorisation of striking and fielding games, with some	
	common examples	183
8.9	Some factors that contribute to success or improved	103
0.,	performance in striking and fielding games	184
9.1	A correlation of the two sets of data before and after the	,
	extra lines of data were deleted	192
9.2	Definition of positional cells across the squash court area	194
9.3	The data added by column to give the positional frequency	177
, ,,	of rally-ending shots in the example squash match data	194
9.4	A Bland and Altman plot of the differences in rally length	177
· · ·	plotted against the mean of the rally length from the two tests	196
9.5	The overall data from the reliability study, the intra-operator	170
7.5	test, presented as a function of the accuracy of each operator	197
9.6	The data from the reliability study, the intra-operator test,	171
7.0	presented as a function of the action variables and the operator	199
9.7	The data from the reliability study, the inter-operator test,	199
7.1	presented as a function of the action variables and the	
	operators	200
10.1	Examples of the variation of the cumulative mean with	200
10.1	increasing number of games analysed: mean number of rallies	
	per game	210
10.2	Example of percentage difference plot: mean number of shots	210
10.2		215
10.3	per game Example of percentage difference plot: mean number of rallies	213
10.5	per match	215
10.4	•	213
10.4	Example of percentage difference plot: player A's winners when player A loses the game	214
10.5	· ,	216
10.3	Example of percentage difference plot: mean number of shpts	217
10.6	per rally by match	216
10.0	Example of percentage difference plot: player A's errors when	217
	player A loses the game	217

XII Illu	strations

10.7	Inter-operator reliability and intra-operator reliability, using a modified Bland and Altman plot to demonstrate the	
	percentage differences	217
10.8	Using percentage difference distribution to display the pattern for the number of matches required to establish elite player movement profiles for the shot start position and for the	
	different positions at the 'T'	220
10.9	Aggregate percentage of passes completed in or from each of	
	the selected pitch positions for unsuccessful teams	221
10.10	Aggregate comparison of the percentage of possession that is	
	lost either in or from each of the four positions of the pitch	
	for unsuccessful teams	222
10.11	Number of matches that need to be notated to achieve a	
	critical number of tackles and passes representative of	
	elite-level women's rugby	223
10.12	Number of matches that need to be notated to achieve	
	stability in the number of kicks and rucks representative of	
	elite-level women's rugby	223
10.13	Number of matches that need to be notated to achieve	
	stability in the number of mauls and scrums representative of	
	elite-level women's rugby	224
10.14	Accumulated means of attacking positions of elite volleyball	
	teams	224
10.15	Accumulated means of attacking positions of non-elite	
	volleyball teams	225
11.1	Stochastic (Markov) processes for the sequence of shots and	
	outcomes produced in a squash rally	232
11.2	Learning step and information clusters on a Kohonen feature	
	map	239
11.3	Squash processes on the court and process clusters on a squash	
	network	240
13.1	The prime target area to where the ball should be crossed	260
13.2	Example of 16 cell division of squash court	264
13.3	Example of shot frequency summary data	266
13.4	Examples of various screens of data available	266
13.5	Example of shot option analysis	267
13.6	Example of 'momentum analysis' graph	268
m 11		
Table	es	
5.1	Some actions, and their respective outcomes, for soccer	110
6.1	A simple frequency table for basketball	121
6.2	Comparison of descriptive match data for different levels of	
	competitive players	135
6.3	Comparison of nationally ranked players to county players:	
	shot patterns that have differences in frequency	135

	Illustrations	xiii
6.4	Shooting data from the 1990 soccer World Cup	136
7.1	Symbols used in the data-gathering system for boxing	147
7.2	Sample data from the Tyson-Bruno fight (1989) using the	
•	data-gathering system for boxing	148
7.3	Collated data of total punches thrown	149
7.4	Analysis of the number of types of punches thrown by both	
	boxers	150
7.5	The number of punches thrown while holding	150
7.6	The number of jabs thrown in each round	150
7.7	A demonstration of how the notation system works	153
7.8	Each player has designated areas in which she must play	162
7.9	Example of a record sheet for simple data-gathering for	
	notation of netball	163
7.10	Data processed from a notated netball match (part only)	164
8.1	Published performance indicators used in notational analysis	169
8.2	Categorisation of different performance indicators that have	
	been used in analyses of net or wall games	174
8.3	Categorisation of different performance indicators that have	
	been used in analyses of soccer, an example of invasion games	180
8.4	Categorisation of different performance indicators that have	
	been used in analyses of cricket, an example of striking and	
	fielding games	184
9.1	An analysis of the different statistical processes used in	
	reliability studies in some randomly selected performance	
	analysis research papers	189
9.2	An analysis of the different statistical processes used in	
	subsequent data analyses in some randomly selected	
	performance analysis research papers	190
9.3	The total shots per game	191
9.4	The arithmetic differences in the positions recorded by the two	
	analysts	195
9.5	Data from a rugby match notated twice by five different	
	operators and presented as an intra-operator reliability analysis	197
9.6	Data from a rugby match notated twice by five different	
	operators and the differences for each operator expressed as a	
	percentage of the respective mean	198
9.7	Data from a rugby match notated twice by five different	
	operators and the mean for each operator expressed as a	
	difference from the overall respective mean and then	
	calculated as a percentage of the overall mean for each	
_	respective variable	199
9.8	Data from a rugby match notated twice by five different	
	operators and the differences for each operator expressed as a	
	percentage of the overall mean for each respective variable	200
9.9	Correlation and X ² analysis applied to the intra-operator data	.
	from Table 9.8	201

xiv Illustrations

9.10	Testing and comparing the efficacy of correlation and X ²	
	analysis in testing reliability of non-parametric data	201
9.11	Kruksal-Wallis and ANOVA applied to the different variables	
	for the five operators for inter-operator reliability	202
9.12	Manipulation of some sample data to test the sensitivity of	
	Kruksal-Wallis and ANOVA for inter-operator reliability	203
10.1	Some examples of sample sizes for profiling in sport	206
10.2	Levels of confidence between numbers of matches and playing	
	standards	208
10.3	Description information of the matches analysed	211
10.4	The means and limits of error of shots by game (Figure 10.5)	212
10.5	Overall summary of $N_{(E)}$ for all variables measured at each	
	limit of error	214
10.6	Analysis of the stability of the profiles of winning shots and	
	errors	218
10.7	Games that player A wins - player A data	218
10.8	Number of matches required to establish movement profiles of	
	elite women squash players using percentage errors of between	
	5% and 10%	219
10.9	Number of matches that need to be analysed to achieve a true	
	average that represents the population	222
11.1	Shot - response profile for an individual player	230
11.2	Winner-error profile for an individual player	231
13.1	Comparison of crosses played in front of and behind defences	
	in the 1986 and 1998 World Cups with respect to strikes on	
	goal and goals scored	259
13.2	Comparison of types of crosses in the 1986 and 1998 World	
	Cups with respect to strikes on goals and goals scored	259
13.3	Analysis of shot types from crosses for the 1998 World Cup	262
13.4	Evolution of international rugby union, 1971–2000	269