

# Table of Contents

<b>Contents</b> .....	<b>i</b>
<b>Preface</b> .....	<b>ix</b>
<b>3. RIGGING</b> .....	<b>127</b>
<b>3.1 Shell Dimensions</b> .....	<b>129</b>
3.1.1 Hull Size .....	129
3.1.1a Hull Size Dimensions .....	129
3.1.1b Boat Size Measurement Table .....	130
3.1.1c Boat Cross Section .....	131
3.1.2 Seat Above Water Height. ....	131
3.1.2a Seat Above Water Height .....	132
3.1.2b Vertical Oar Angle .....	133
3.1.2c Seat Track Angle , .....	133
3.1.3 Hull and Rigger Stiffness .....	134
3.1.3a Hull Longitudinal Stability .....	134
3.1.3b Hull Torque Stiffness .....	135
3.1.4 Boat Weight. ....	136
3.1.4a World Rowing Minimum Boat Weights ..	136
<b>3.2 Oar Dimensions</b> .....	<b>137</b>
3.2a Oar Parts .....	137
3.2.1 Oar Length Adjustment .....	137
3.2.1a Oar Length Measurement .....	138
3.2.2 Inboard Adjustment .....	138
3.2.2a Inboard .....	138
3.2.2b Oar Handle Finish Overlap Sweep ....	139
3.2.2c Oar Handle Finish Split Sculling .....	139
3.2.3 Outboard .....	140
3.2.4 Blades .....	140
3.2.4a Blade Dimensions .....	140
3.2.4b Blade Area Chart .....	141
3.2.4c Simpson's Rule .....	141
3.2.5 Shaft Stiffness .....	142
3.2.5a Concept 2 Shaft Stiffness .....	142
3.2.5b Concept 2 Shaft Stiffness Table .....	143

- 3.2.6 Oar Handle Grip . . . . . 144
  - 3.2.6a Oar Handle Dimensions . . . . . 144
- 3.2.7 Oar Pitch . . . . . 144
  - 3.2.7a Oar Pitch . . . . . 145
- 3.2.8 Oar Balance Point . . . . . 146
  - 3.2.8a Oar Balance Point . . . . . 146
- 3.3 Athlete Information . . . . . 147**
  - 3.3.1 Athlete Stroke Length . . . . . 147
    - 3.3.1a Work Distance . . . . . 148
    - 3.3.1b Athlete Stroke Length on Erg . . . . . 148
  - 3.3.2 Athlete Power . . . . . 149
    - 3.3.2a 500m Split to Watts Conversion . . . . . 149
  - 3.3.3 Athlete Weight . . . . . 150
  - 3.3.4 Athlete Skill . . . . . 150
- 3.4 Rigging Length . . . . . 151**
  - 3.4.1 Length Ratio . . . . . 151
    - 3.4.1a Stroke Length Ratio . . . . . 152
  - 3.4.2 Adjusting Outboard Stroke Length . . . . . 153
    - 3.4.2a Stroke Length Adjustments . . . . . 154
  - 3.4.3 Stroke Arc Angle . . . . . 155
  - 3.4.4 Blade Slip . . . . . 155
    - 3.4.4a Blade Slip . . . . . 156
    - 3.4.4b Warre Diagram . . . . . 157
    - 3.4.4c Propeller Motion . . . . . 157
  - 3.4.5 Effective Stroke Length . . . . . 158
    - 3.4.5a Effective Stroke Length . . . . . 158
- 3.5 Rigging Load . . . . . 159**
  - 3.5a Load Dimensions . . . . . 159
  - 3.5.1 Spread and Span . . . . . 159
  - 3.5.2 Levers . . . . . 160
    - 3.5.2a Lever Classes . . . . . 160
    - 3.5.2b Third Class Lever . . . . . 161
  - 3.5.3 Blade Area . . . . . 161
  - 3.5.4 Rigging For Load . . . . . 162
- 3.6 Stroke Position . . . . . 163**

3.6a	<i>Stroke Position</i> . . . . .	163
3.6.1	Oar Catch Angle Sweep . . . . .	165
3.6.1a	<i>Catch Length</i> . . . . .	165
3.6.1b	<i>Catch Angle Sweep</i> . . . . .	166
3.6.1c	<i>Catch Angle Table – Sweep</i> . . . . .	167
3.6.1d	<i>Stroke Placement Footstop Adjustment</i> . . . . .	168
3.6.1e	<i>Stroke Placement Rigger Adjustment</i> . . . . .	169
3.6.2	Oar Catch Angle Sculling. . . . .	170
3.6.2a	<i>Sculling Catch Length</i> . . . . .	170
3.6.2b	<i>Catch Angle Table - Sculling</i> . . . . .	171
3.6.2c	<i>Catch Angle from Catch Split</i> . . . . .	172
3.6.2d	<i>Oar Handle Finish Split</i> . . . . .	173
3.6.3	Oar Turning Forces . . . . .	174
3.6.3a	<i>Oar Turning Forces</i> . . . . .	174
3.6.3b	<i>Turning Forces on Boat</i> . . . . .	175
<b>3.7</b>	<b>Rigging Adjustments</b> . . . . .	<b>177</b>
3.7.1	Rigger Placement . . . . .	179
3.7.1.1	Footstop Adjustment . . . . .	179
3.7.1.1a	<i>Athlete Finish Position</i> . . . . .	179
3.7.1.1b	<i>Oar Handle Finish Split Distance</i> . . . . .	180
3.7.1.2	Rigger Alignment . . . . .	180
3.7.1.2a	<i>Rigger Alignment</i> . . . . .	181
3.7.1.3	Boat Trim . . . . .	181
3.7.1.3a	<i>Hull Trim</i> . . . . .	182
3.7.1.3b	<i>Centre of System Mass</i> . . . . .	182
3.7.2	Spread/Span . . . . .	183
3.7.2.1	Spread. . . . .	183
3.7.2.1a	<i>Spread</i> . . . . .	183
3.7.2.1b	<i>Spread Measurement</i> . . . . .	184
3.7.2.2	Span. . . . .	184
3.7.2.2a	<i>Span Dimension</i> . . . . .	185
3.7.2.2b	<i>Centering Pins</i> . . . . .	186
3.7.3	Pin Angle . . . . .	187
3.7.3a	<i>Pin Angles</i> . . . . .	187
3.7.3.1	Lateral Pin Angle. . . . .	187
3.7.3.1a	<i>Lateral Pitch</i> . . . . .	188
3.7.3.1b	<i>Measuring Layout on Oarlock</i> . . . . .	189
3.7.3.2	Parallel Pin Angle . . . . .	190
3.7.3.2a	<i>Parallel Pin Angles</i> . . . . .	190

- 3.7.3.3 Pitch Change Through Stroke . . . . . 191
  - 3.7.3.3a Stroke Angles . . . . . 191
  - 3.7.3.3b Pitch Angle Change Table . . . . . 192
- 3.7.4 Oarlock Pitch . . . . . 195
  - 3.7.4a Oarlock Pitch . . . . . 195
  - 3.7.4b Oarlock Bushing Location . . . . . 196
  - 3.7.4c Oarlock Bushing Top View . . . . . 196
  - 3.7.4d Pitch Adjustment Table . . . . . 197
- 3.7.5 Oarlock Height . . . . . 199
  - 3.7.5a Oarlock Height . . . . . 199
  - 3.7.5b Seat Measuring Point . . . . . 200
  - 3.7.5c Oarlock Measuring Point. . . . . 200
  - 3.7.5d Measuring Oarlock Height. . . . . 201
- 3.7.6 Work Through . . . . . 203
  - 3.7.6a Work Through. . . . . 203
  - 3.7.6b Measure Work Through. . . . . 204
- 3.7.7 Footstop Adjustments . . . . . 205
  - 3.7.7.1 Footstop Angle . . . . . 205
    - 3.7.7.1a Footstop Angle . . . . . 205
    - 3.7.7.1b Footstop Angle Adjustment . . . . . 206
  - 3.7.7.2 Footstop Height . . . . . 207
    - 3.7.7.2a Footstop Height . . . . . 207
    - 3.7.7.2b Measuring Footstop Height . . . . . 208
    - 3.7.7.2c Foot Stretcher . . . . . 209
    - 3.7.7.2d Shoe Plate . . . . . 209
  - 3.7.7.3 Heel Separation . . . . . 209
    - 3.7.7.3a Heel Separation . . . . . 209
  - 3.7.7.4 Shoe Splay Angle . . . . . 210
    - 3.7.7.4a Shoe Splay Angle . . . . . 210
    - 3.7.7.4b Shoe Splay Angle Table . . . . . 212
  - 3.7.7.5 Shoe Size . . . . . 212
- 3.7.8 Footstop Distance . . . . . 213
  - 3.7.8a Footstop Distance . . . . . 213
  - 3.7.8b Finish Oar Handle Positions . . . . . 214
- 3.7.8.1 Catch Length . . . . . 214
  - 3.7.8.1a Catch Length . . . . . 214
  - 3.7.8.1b Catch Angle Table – Sweep . . . . . 215
- 3.7.8.2 Sculling Catch Length . . . . . 216
  - 3.7.8.2a Sculling Catch Length . . . . . 216
  - 3.7.8.2b Catch Angle Table – Sculling . . . . . 217

3.7.8.2c *Catch Angle from Catch Split* . . . . . 218

3.7.9 Oar Length and Inboard . . . . . 219

    3.7.9a *Oar Measurements* . . . . . 219

    3.7.9.1 Oar Length . . . . . 219

        3.7.9.1a *Oar Length Measurement* . . . . . 219

    3.7.9.2 Inboard . . . . . 219

        3.7.9.2a *Inboard* . . . . . 219

    3.7.9.3 Outboard . . . . . 220

        3.7.9.3a *Outboard* . . . . . 220

**3.8 Rigging Charts . . . . . 221**

    3.8a *Athlete Stroke Length* . . . . . 221

    3.8b *500m Split to Watts Conversion Table* . . . . . 222

    3.8c *Weight Conversion Table* . . . . . 223

    3.8d *Oar Handle and Blade Path* . . . . . 224

    3.8e *Athlete Information and Rigging Standard* . . . . . 225

    3.8f *PARA Rigging Standards* . . . . . 227

    3.8g *Rigging Chart Index* . . . . . 228

Rigging Charts

	WOMEN	MEN	PARA	
	page	page		page
EIGHT (8)	230	246	PR1 W1x	262
FOUR (4-)	232	248	PR1 M1x	264
COXED FOUR(4+)	234	250	PR2 Mix2x	266
PAIR (2-)	236	252		
QUAD (4x)	238	254		
COXED QUAD (4x+)	240	256		
DOUBLE (2x)	242	258		
SINGLE (1x)	244	260		

**3.9 Individual Rigging . . . . . 269**

    3.9a *Individual Rigging Dimensions* . . . . . 270

    3.9.1 Rigging for Comfort . . . . . 271

    3.9.2 Rigging for Crew Timing . . . . . 272

        3.9.2a *Individual Rigging for Timing* . . . . . 273

    3.9.3 Rigging for Stroke Position . . . . . 274

        3.9.3a *Individual Stroke Position Adjustments* . . . . . 275

- 3.10 Rigging Analysis . . . . . 277**
  - 3.10.1 Camera Setup and Video Capture . . . . . 278
    - 3.10.1a On-Land Camera Setup . . . . . 279*
    - 3.10.1b Camera Setup (Boat or Vehicle) . . . . . 281*
  - 3.10.2 Video Analysis Software . . . . . 282
  - 3.10.3 Identification of Oar/Blade Positions . . . . . 282
    - 3.10.3.1 Identify Full Reach Frame Time. . . . . 283
    - 3.10.3.2 Identify Blade Entry Frame Time . . . . . 283
    - 3.10.3.3 Identify Oar Perpendicular Frame Time . . . . . 283
    - 3.10.3.4 Identify Blade Extraction Frame Time . . . . . 283
      - 3.10.3.4a Blade Extraction Point. . . . . 284*
    - 3.10.3.5 Identify Blade Feather Frame Time. . . . . 284
    - 3.10.3.6 Identify Full Reach 2 Frame Time. . . . . 284
    - 3.10.3.7 Identify Blade Entry 2 Frame Time . . . . . 284
  - 3.10.4 Drive Time . . . . . 284
  - 3.10.5 Blade Slip . . . . . 285
  - 3.10.6 Effective Stroke Length . . . . . 287
  - 3.10.7 Stroke Position . . . . . 288
  - 3.10.8 Stroke Rate . . . . . 288
  - 3.10.9 Stroke Ratio . . . . . 289
  - 3.10.10 Measure Boat Movement and Speed . . . . . 290
  - 3.10.11 Measure Oar Catch and Finish Angles . . . . . 291
    - 3.10.11a Oar Catch Angle . . . . . 291*
  - 3.10.12 Rigging Analysis Record Chart . . . . . 292
    - 3.10.12a Rigging Analysis Record Chart . . . . . 293*
  - 3.10.13 Hull Trim Angle . . . . . 294
    - 3.10.13a System Balance Point . . . . . 294*
    - 3.10.13b Hull Markings . . . . . 295*
    - 3.10.13c Measuring Trim . . . . . 295*
  - 3.10.14 Measuring Environmental Conditions . . . . . 296
    - 3.10.14a Clock Face Wind Direction. . . . . 297*
    - 3.10.14b Rowing Course Wave Scale . . . . . 298*
- 3.11 Advanced Rigging. . . . . 299**
  - 3.11.1 Stroke Rate . . . . . 299
    - 3.11.1a Stroke Rate Evaluation . . . . . 302*
    - 3.11.1b Stroke Rate and Stroke Ratio Data . . . . . 303*

3.11.2 Stroke Ratio . . . . .	304
3.11.2a Stroke Ratio Table A . . . . .	305
3.11.2b Stroke Ratio Table B . . . . .	305
3.11.3 Drive Time . . . . .	306
3.11.3a Adjusting Crew Drive Time . . . . .	307
3.11.3b Drive Time Data . . . . .	308
3.11.4 Effective Stroke Length . . . . .	308
3.11.4a Effective Stroke Length Data . . . . .	309
3.11.4b Distance Per Stroke Table . . . . .	310
3.11.5 Blade Slip . . . . .	311
3.11.5a Blade Slip Data . . . . .	311
3.11.5b Blade Slip Adjustment . . . . .	312
3.11.6 Stroke Position . . . . .	313
3.11.6a Stroke Position Adjustments . . . . .	313
3.11.6b Stroke Position Data . . . . .	314
3.11.7 Rigging Adjustment for Conditions . . . . .	315
3.11.7a Rigging Adjustment for Conditions . . . . .	316
<b>3.12 References . . . . .</b>	<b>317</b>
<b>3.13 Glossary Index . . . . .</b>	<b>319</b>

# Contents