CONTENTS

Acknowledgements

1. STRENGTH AND THE MUSCULAR SYSTEM
   Objectives
   What is Strength?
   The Origins of Strength Training Science
   Pioneers of Strength Training
   The Divergence of Training Philosophies
   The Modern Era Dawns
   The Fundamental Principle of Strength Training
   Strength Deficit

   1.1 Preliminary Issues
   1.1.1 Resistance Training for Different Purposes
   1.1.2 Factors limiting Strength Production

   Trainability
   Neuromuscular Efficiency
   Biomechanical Efficiency
   Psychological Factors
   Pain and Fear of Pain
   Injury and Fear of Injury Fatigue

   1.2 Fundamental Biomechanics of Strength
   Biomechanics and Training
   Initial Implications of Mechanics
   Mass and Acceleration Issues
   Muscle Tension and Training Stimulus
   Application of Basic Biomechanics

   1.3 A Philosophy of Physical Training
   Fitness, Preparedness and Work Capacity

   1.4 Specificity in Training

   1.5 Strength and Fitness

   1.6 The Nature of Strength
   Determinants of Strength
   Shock Training and Plyometrics
   Strength and Connective Tissue

   1.7 The Muscle Complex
   1.7.1 The Structure of Muscle
   Further Muscle Research
   1.7.2 A Model of the Muscle Complex
   Further Information on Collagenous Tissues
   The Structure and Function of Ligaments and Tendons
   Mechanical Loading of Collagenous Tissue
   The Role of Stored Elastic Energy
   The Influence of Exercise on Connective Tissue
   A Modified Muscle Model
   1.7.3 Implications of the Muscle Model for Flexibility
   1.7.4 The Relationship between Stability and Mobility

   1.8 Classification of Muscle Actions

   1.9 Cocontraction and Ballistic Movement

   1.10 Types of Muscle Action
   Quasi-isometric Action

   1.11 The Triphasic Nature of Muscle Action
1.12 Types of Muscle Fibre ................................................................. 55
   Slow and Fast Twitch Muscle Fibres
   Muscle Protein Isoforms
   Muscle Fibres and Training
   Further Aspects of Muscle Plasticity
   The Implications of Ballistic Research

1.13 The Mechanism of Muscle Growth ........................................... 65
   The Effects of High versus Moderate Intensity Exercise

1.14 Neurophysiological Aspects of Exercise ................................... 69

1.15 Bioenergetics and the Energy Systems ..................................... 73
   1.15.1 The Energy Systems and Types of Activity ............................ 74
   1.15.2 Energy Mechanisms .......................................................... 75
   1.15.3 The Short-Term Energy System ......................................... 76
   1.15.4 The Intermediate Energy System ....................................... 77
   1.15.5 The Long-Term Energy System .......................................... 78
   1.15.6 Implications for Physical Conditioning ............................... 79
   1.15.7 Hormonal Factors and Strength Training ............................. 82

1.16 Adaptation and the Training Effect ........................................ 82
   The Effects of Stress
   1.16.1 The General Adaptation Syndrome ..................................... 83
      Adaptive Reconstruction versus Supercompensation
   1.16.2 The Biochemistry of Adaptation in Sport .............................. 85
      The Specificity of Biochemical Adaptation
      The Sequence of Biochemical Changes during Training
   1.16.3 General Theories of the Training Process ............................. 87
      Single-Factor Model of Training
      Two-Factor Model of Training
      The Concept of Progressive Overload Training
   1.16.4 A Model of Physical Fitness .............................................. 91

2. SPORT SPECIFIC STRENGTH TRAINING .................................... 95
   Special Strength Training
   The Russian System of Classifying Athletes
   The Early Stages of Strength Training

2.1 Schemes for Perfecting Movements ........................................ 97
   2.1.1 Increasing the Working-Effect of Movements ........................ 97
   2.1.2 Perfecting the Motor Structure of Sports Movements ............. 100
      The Kinematic Pair
      The Kinematic Chain
      The Kinematic System
   2.1.3 Perfecting the Kinesiological Pattern of Movements ............. 105

2.2 Specialisation to Develop Sports Mastery ............................... 107
   2.2.1 Specific Forms of Producing Muscular Strength .................... 107
   2.2.2 Sports Implications of Strength Indices .............................. 109
   2.2.3 The Functional Topography of the Muscular System ............... 110
   2.2.4 Motor Specialisation in Developing Sports Mastery ............... 112
      Heterochronicity
      Specialisation Processes
2.3 Characteristics of Physical Fitness

2.3.1 The Structure of Physical Fitness

2.3.2 The Interrelation between Motor Abilities

General and Partial Connections
Essential and Non-essential Connections
Positive and Negative Connections
Direct and Indirect Connections

2.3.3 The Structure of Motor Abilities

2.3.4 General Concepts of the Structure of Physical Fitness

3. FACTORS INFLUENCING STRENGTH PRODUCTION

3.1 The Regimes of Muscular Work

3.2 Qualitative Characteristics of Strength

3.2.1 Explosive Strength

Quickness and Reactive Ability
Speed, Speed-Strength and Quickness

3.2.2 Strength-Endurance

3.3 The Influence of External Conditions on Strength

3.3.1 The Influence of the Pre-working State of the Muscles

3.3.2 The Effect of the Load on Speed of Muscle Contraction

Contraction Speed and Strength in Acyclic Activity
Limitations of the Force-Velocity Relationship
Contraction Strength and Speed in Cyclic Activities

3.3.3 The Effect of Strength on Speed of Muscle Action

Speed-Strength and Strength-Speed
The Interrelation between Strength and Other Fitness Factors

3.3.4 The Relationship between Strength and Posture

3.3.4.1 Strength Variation with Postural Change

3.3.4.2 Strength, Safety and Pelvic Tilt

3.3.4.3 The Effect of Head Position on Strength

3.3.4.4 Strength, Symmetry and Limb Alignment

3.3.5 The Dependence of Strength on Bodymass

3.3.6 The Relationship between Strength and Height

3.3.7 The Relationship between Strength and Age

3.3.8 The Relationship between Strength and Gender

3.3.9 The Increase in Human Strength over Time

3.4 Factors increasing the Working Effect of Strength

3.4.1 The Warm-up and Pre-Activity Preparation

3.4.2 The After-effect of Muscle Activity

3.4.3 Additional Movement

3.4.4 Preparatory Movement

3.4.5 Coordination in Muscular Work

3.4.6 Efficiency of Energy Expenditure

3.4.7 Emotion and other Psychological Factors

3.4.8 The Effect of Cold Application

3.4.9 Breathing and Strength Production

3.4.10 Strength Development and Proprioception

3.5 Flexibility and Sporting Performance

3.5.1 A Definition of Flexibility

3.5.2 The Effects of Stretching

3.5.3 The Neuromuscular Component of Flexibility

3.5.4 Components of Joint Flexibility
3.5.5 Parameters of Flexibility .........................................................179
3.5.6 Soft Tissue Biomechanics and Flexibility .................................180
Flexibility, Stability and Muscle Activity
3.5.7 The Influence of Exercise on Connective Tissue ............................182
3.5.8 Stretching Techniques ..........................................................183
The Use of Ballistic Stretching
3.5.9 Low Flexibility versus Non-Functional Muscle Tension ..................187

3.6 The Stretching Matrix System ..................................................188
Is Stretching Always Necessary?

3.7 The Movement Matrix System ...............................................193
Limitations of Anatomical Movement Analysis

4. THE MEANS OF SPECIAL STRENGTH TRAINING ..........................201
4.1 The Problem of Training Means ...........................................201
4.1.1 Characteristics of Strength Increase ......................................201
4.1.2 The Effect of Strength Training Means ..................................204
Algebraic Relations and Training
Steps Towards Structuring the Training Process
4.2 Different Means of Strength Development ..................................207
4.2.1 Electrostimulation ..............................................................208
4.2.1.1 The Physiological Effects of Electrostimulation ......................208
4.2.1.2 Reasons for Conflicting Research .......................................209
4.2.1.3 Clinical Applications of Electrostimulation ..........................210
4.2.1.4 Further Research Findings .............................................213
4.2.1.5 An Integrated Theory of Electrostimulation .........................214
4.2.1.6 The Use of Electrostimulation in Training ............................214
   The Integrated Use of Electrostimulation
   Sports Functional Electrostimulation
   Overtraining and Restoration
   Concluding Remarks
4.2.2 Resistance and Strength Training ........................................216
4.2.3 Kinetic Energy and Strength Processes ..................................220
4.2.4 Isometric Training .............................................................223
   Isometric Training and Angular Specificity
   Isometric Endurance
   Recovery after Isometric Activity
   Other Aspects of Isometric Activity
   Loadless Training
4.2.5 Eccentric Training ..............................................................230
4.2.6 Isokinetic and Other Training Means ....................................231
4.2.6.1 The Isokinetic Training Method .......................................231
4.2.6.2 Limitations of the Isokinetic Method ..................................233
   Fundamental Biomechanics of Isokinetic Devices
   Recommended Strength Ratios
   Functional Anatomy
   Muscle Physiology
   The Importance of Specificity
   Concluding Remarks
4.2.6.3 Static-Dynamic Methods ..................................................236
4.2.6.4 Choice of Muscle Training Regimes ...................................236
4.2.7 The Use Of Training Machines ............................................237
4.2.7.1 Functional Resistance Machines .......................................237
4.2.7.2 Non-Functional Resistance Machines .................................238
### 6. ORGANISATION OF TRAINING

**6.1 The Development of Training Organisation**

- Ways of Organising Training ......................................................... 314

**6.2 Periodisation as a Form of Organisation**

- Definitions and Fundamental Concepts
- Preparatory Phases of Training
- Further Phases and Principles
- Acquisition and Stabilisation of Technical Skills
- 6.2.1 Types of Periodisation .......................................................... 319
- 6.2.2 Calculation of the Parameters of Periodisation ......................... 323
  - Drawing up the Periodisation Scheme
  - Cybernetic Programming and Periodisation
  - Training Intensity, Heart Rate and Other Tests
  - Non Technological Testing
- 6.2.3 The Relationship between Intensity and Volume ....................... 332

**6.3 The Periodisation Controversy** .................................................. 333

- Chronobiology and Periodisation

**6.4 Training as an Objective of Management** .................................... 336

**6.5 Prerequisites for Organising Training** ....................................... 338

**6.6 Basic Management Theory** ....................................................... 339

- 6.6.1 Human Needs and Motivation ................................................ 339
  - Maslow’s Hierarchy of Needs
  - Other Theories of Needs
  - Expectancy Theory of Motivation
- 6.6.2 Management Models ............................................................... 342
  - The Traditional Model
  - The Managerial Grid
  - Situational Leadership
  - The Leadership Continuum
  - Decision Making and Problem Solving

**6.7 Classification of Sports** ............................................................. 345

**6.8 Characteristics of the Training Process** ...................................... 346

- 6.8.1 Adaptation to Intense Muscular Work ...................................... 346
- 6.8.2 Structural-Functional Specialisation in Training .......................... 350
- 6.8.3 The Structure of Special Physical Preparedness ........................... 352

**6.9 Preparedness and the Training Load** .......................................... 352

- 6.9.1 The Training Load and its Effect ............................................. 352
- 6.9.2 Factors determining the Training Effect .................................... 355
- 6.9.3 The Contents of the Loading .................................................. 356
  - Specificity of the Load
  - Training Potential of the Loading
- 6.9.4 The Volume of the Training Load ............................................ 358
- 6.9.5 The Organisation of Training Loads ........................................ 359

**6.10 The Long-Term Delayed Training Effect** ................................... 362

- The Delayed Training Effect and Long Duration Work
- Concluding Comments

**6.11 The Dynamics of Training in the Annual Cycle** ........................... 368
6.12 Principles of Programming and Organising Training ........................................ 368
  6.12.1 Forms of Constructing Training ................................................................. 368
  6.12.2 Organisational Aspects of Structuring Training ........................................... 368
    Complex Training
    Unidirectional Training
    Concentrated Loading
    Problems with Concentrated Loading
    The Use of Concentrated Loading
    Use of the Conjugate Sequence System
  6.12.3 Constructing Training by Functional Indicators ........................................... 374

6.13 Primary Aims in Programming Training .......................................................... 378

6.14 Models for Structuring Annual Training ......................................................... 379
  Examples of Descriptive Modelling
  The Composition of the Concentrated Loading Volume
  6.14.1 A Model for Sports requiring Explosive Strength ........................................ 383
  6.14.2 A Model for Medium Duration Endurance Sports ....................................... 384
  6.14.3 A Model for Long Duration Endurance Sports ............................................. 385
  6.14.4 A Model for Sports requiring Tricyclic Periodisation ................................ 386
  More Advanced Use of Concentrated Loading
  6.14.5 Practical Principles of Programming ......................................................... 389

6.15 A Sequence for Programming Annual Training .................................................. 389

6.16 Managing the Training Process ........................................................................ 391

6.17 The Future of Programming Training ............................................................... 392

7. STRENGTH TRAINING METHODS ..................................................................... 393

7.1 Bodybuilding and Other Strength Training Methods ......................................... 394
  Maximal Methods
  Supramaximal Methods
  Circa-maximal Methods
  Submaximal Methods
  Reactive Methods
  Miscellaneous Methods
  Methods for Overcoming Barriers
  Concluding Remarks

7.2 PNF as a Training System .................................................................................. 403
  7.2.1 Definition and Scope of PNF .......................................................................... 404
  7.2.2 Relationship of PNF to Physical Conditioning ................................................ 405
  7.2.3 The Fundamentals of PNF ............................................................................. 405
    7.2.3.1 The Principles of PNF ............................................................................... 405
    7.2.3.2 Procedures of PNF .................................................................................... 406
    7.2.3.3 Patterns of PNF ....................................................................................... 407
    7.2.3.4 Positions and Postures of PNF .................................................................. 410
    7.2.3.5 Pacing in PNF ......................................................................................... 410
  7.2.4 Modifications to PNF ..................................................................................... 410
    Pattern Deviations and Safety Factors
  7.2.5 Functional Neuromuscular Conditioning ...................................................... 411

7.3 Combinations of Resistance Methods ............................................................... 411
  Scientific Analysis of Different Combinations ...................................................... 412
  Accelerated Powermetrics .................................................................................... 415

7.4 Muscle Training .................................................................................................. 416
  7.4.1 A Summary of Movements of the Joints ....................................................... 416
  7.4.2 Examination of Some Joint Actions ............................................................... 418
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>Use of the Strength Training Compendium</td>
</tr>
<tr>
<td>7.6</td>
<td>Training for Hypertrophy?</td>
</tr>
<tr>
<td>8.</td>
<td>DESIGNING SPORT SPECIFIC STRENGTH PROGRAMMES</td>
</tr>
<tr>
<td>8.1</td>
<td>Preliminary Considerations</td>
</tr>
<tr>
<td>8.2</td>
<td>Needs Analysis and Sports Modelling</td>
</tr>
<tr>
<td>8.3</td>
<td>The Training Programme</td>
</tr>
<tr>
<td>8.4</td>
<td>Classification of Exercises for Sports Training</td>
</tr>
<tr>
<td>8.5</td>
<td>Overtraining</td>
</tr>
<tr>
<td>8.6</td>
<td>Restoration and Stress Management</td>
</tr>
<tr>
<td>8.7</td>
<td>The Use Of Testing</td>
</tr>
<tr>
<td>8.8</td>
<td>Injury and Safety in Strength Training</td>
</tr>
<tr>
<td>8.9</td>
<td>Safety and Training Apparel</td>
</tr>
<tr>
<td>8.10</td>
<td>Safety and Machine Training</td>
</tr>
<tr>
<td>8.11</td>
<td>Protection by the Muscles</td>
</tr>
</tbody>
</table>

### 8.1 Preliminary Considerations
- Selection of Training Needs
- General Fitness Issues
- Injuries
- Training to Avoid Injury
- Training of the Soft Tissues

### 8.2 Needs Analysis and Sports Modelling
- Components of the Training Programme
- Statute of Fitness Limitations
- The Minimax Principle and Training Economics
- List of Popular Resistance Exercises

### 8.3 The Training Programme
- Categorisation of Fundamental and Additional Exercises
- General Preparatory Exercises in Weightlifting
- List of Exercises in Weightlifting Training
- Examples of Powerlifting Exercises
- Examples of Hybrid Lifting Exercises

### 8.4 Classification of Exercises for Sports Training
- Principles of Exercise Classification
- Classification of Weightlifting Exercises
- Examples of Powerlifting Exercises
- Examples of Hybrid Lifting Exercises

### 8.5 Overtraining
- Stress and Restorative Measures
- Application of Restorative Measures
- Restorative Means
- Massage Methods
- Massage Variables
- Further Fundamentals of Sports Recovery
- Complexes and Periodisation in Restoration
- Research into Restoration Methods
- Sports Science and Stress Management

### 8.6 Restoration and Stress Management
- Stress and Restorative Measures
- Application of Restorative Measures
- Restorative Means
- Massage Methods
- Massage Variables
- Further Fundamentals of Sports Recovery
- Complexes and Periodisation in Restoration
- Research into Restoration Methods
- Sports Science and Stress Management

### 8.7 The Use Of Testing
- The Vertical Jumping Test
- Muscle Strength Ratios
- Work Capacity and Functional Pressure Tests

### 8.8 Injury and Safety in Strength Training
- Biomechanics of the Injury Process
- General Biomechanical Causes of Injury
- Injury Prevention by Imperfection Training

### 8.9 Safety and Training Apparel
- Lifting, Belts and Breathing
- Shoes and Safety
- Shoe Design
- Shoes in the Weights Facility

### 8.10 Safety and Machine Training

### 8.11 Protection by the Muscles