

Applied Biomechanics – Concepts and Connections

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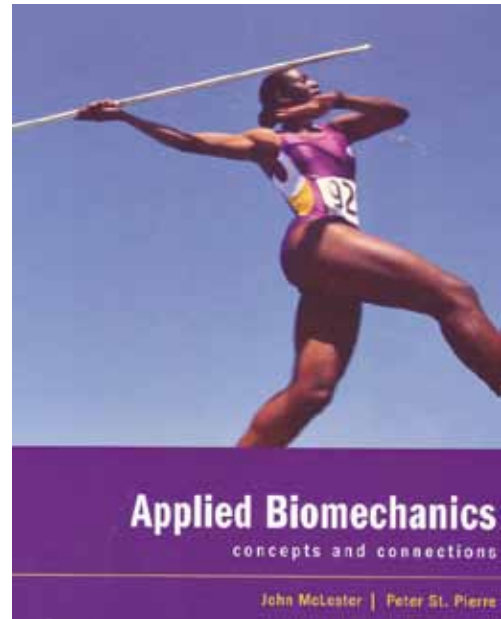
by John McLester & Peter St. Pierre

Belmont, CA: Thomson Wadsworth, 2008, 409 pp., ISBN: 978-0-495-10586-2

The view underlying this textbook is that much of education is compartmentalised. The authors hold that all too often, individual courses within a curriculum are presented with little regard for other, related courses. As they believe that fundamental to the ability to think critically and to synthesise information is an understanding of the interconnectedness of all information, the goal of their textbook is to make relevant connections between the physics of human movement and its application to related topics of study.

To meet the objectives of providing a clear understanding of the topics in the field of biomechanics and to relate those topics to other fields of study, each chapter has been constructed with a Concepts section and a Connections section. The Concepts are the core of understanding the mechanics of movement. The Connections are designed to show how the Concepts are used in the many diverse areas within the movement sciences.

The structure of the book is devised so that each chapter builds upon elements of all previous chapters. In spite of this, the chapters can stand alone, with only a minimal amount of preface required. This design enables great flexibility both in reading the book and in adapting the text to meet the specific needs of a particular audience. The rationale for the chosen sequence of chapters is as follows:



Chapter 1 (“Biomechanics and Related Movement Disciplines”) is designed to introduce the student to both the textbook and the discipline. The reader will learn the special features of the book and the ways in which its design will enhance their understanding of biomechanics and its connection to other fields. In addition, the reader will be introduced to terminology used in the various disciplines that are discussed throughout the book. For example, adapted motion, biomechanics, exercise physiology, kinesiology, kinetics, kinematics, motor control, motor development, motor

learning, and pedagogy are defined. By providing a clear definition of each discipline and its related terminology, this chapter enhances readers' understanding of the connections between the disciplines.

Chapter 2 (“Describing the System and Its Motion”) gives readers the tools necessary to describe the motion of a system, the system's location within the environment, and the type of motion exhibited. They must pay attention to aspects of the motion that they perhaps have ignored to this point. The placement of this chapter is important, because it provides examples that lead readers to classify several movements, but it engages them in a relatively low level of movement analysis. Higher-level movement analysis is covered immediately in the next chapter.

Chapter 3 (“Paradigms for Studying Motion of the System”) introduces readers to various qualitative and quantitative methods of studying and analysing motion. Qualitative methods are introduced before quantitative ones to give an understanding of how to “look at” or “see” movement before becoming concerned with analysing it technically. Within the quantitative methods, graphical methods are presented before trigonometric methods to enable once again practice the skill of “visualizing” forces before learning the trigonometric methods upon which the graphical methods are based.

In **Chapter 4** (“Interaction of Forces and the System”), the concept of force is further elucidated, and the various forces both encountered by and acting within the system are introduced. The forces covered in this chapter are explained in greater detail in later chapters to further knowledge of force application. Readers are also introduced to Newton's laws for the first time. More detailed coverage of Newtonian laws comes in later chapters to show application and interrelationship.

In **Chapter 5** (“Linear Motion of the System”), readers will gain a deeper understanding of velocity and acceleration, and of the influence of gravity on the system. The concepts of kinematics are covered before kinetics, because

kinematic equations and terminology are helpful in explaining kinetic concepts to the student. Newtonian laws are described in greater detail, especially the relationships among force, mass, and acceleration. Concepts of linear motion are discussed in terms of their relationship to Newton's laws and energy transfer.

Chapter 6 (“Angular Motion of the System”) is very important to the understanding of biomechanics, because angular motion is present during any movement of the musculoskeletal system and during almost all sports activities. The concept of torque is introduced, and Newtonian laws are discussed in relationship to angular motion. Topics in this chapter are developed in a format similar to that of Chapter 5. So once again, the concepts of kinematics are covered first, to enhance student understanding of kinetics. The concepts in this chapter are discussed as analogues of topics in the previous chapter on linear motion. In this way, the reader will realise that there is a theme to physical laws and mathematical derivations.

In **Chapter 7** (“System Balance and Stability”), the concepts of force, gravity, torque, and centre of gravity introduced in chapters 1 through 6 are applied to situations in which stability and balance are of the utmost importance. Balance and stability are important concepts not only in sports situations but in activities of daily living, too. Understanding stability requires a base knowledge of both linear and rotary concepts, and stability is therefore covered after Chapters 5 and 6.

With prerequisite information covered in previous chapters (e.g., linear versus angular kinematics, torque, and stability), the student is introduced to machines in **Chapter 8** (“The System as a Machine”). The basic properties of machines are introduced, and then levers, wheel-axle arrangements, and pulley systems are covered in detail, as well as the musculoskeletal configurations that act as machines within the human body.

By **Chapter 9** (“System Motion in a Fluid Medium”), readers will have an in-depth under-

standing of linear motion, angular motion, equilibrium, and machines. With these concepts in mind, it is easier to comprehend concepts that apply when the system moves through fluids. For example, rotary motion through a fluid causes a curvilinear path. One must first understand rotary motion before understanding the behaviour of objects as they move through fluids. Drag and lift are more fully elucidated in the context of knowledge that students have gained since these topics were introduced in Chapter 4.

In **Chapter 10** (“The System as a Projectile”), projectiles are introduced. Projectiles are subject to linear, rotary, and fluid forces. Therefore, their flight can only be fully understood at this point in the text. Readers will gain an understanding of the mechanics of projecting an object for vertical and horizontal distance, as well as for accuracy. This chapter begins with a review of previously covered concepts that relate to projectiles and then elucidates the mechanisms by which these factors affect projection.

Chapter 11 (“Biomechanics of the Musculoskeletal System”) is designed to promote the understanding of biomechanics more deeply by applying previously learned concepts to the musculoskeletal system. Muscle physiology and contraction are covered in detail. In addition, the biomechanical implications of muscle location, shape, and design are dealt with, as well as how muscles work together to produce movement and reduce injury. The chapter applies many concepts previously covered in the text, to help the reader realise that the human body is the result of many interrelated biomechanical principles.

The last Chapter of the book (**Chapter 12**: “Connection by Application”) is a comprehensive analysis of a sport skill, using concepts from throughout the text. This is presented at this point because readers now know more specifically the aspects of movement upon which they should focus. Rather than just targeting individual concepts, as was done in previous chapters, this chapter gives an actual

example of motion analysis. Because no new concepts are introduced, this chapter consists completely of connections. The sport chosen for this chapter is golf because elements of every chapter must be considered in this sport.

This overview of McLester’s and St. Pierre’s book shows that, unlike most biomechanics books, their book follows a clear pedagogical structure:

- The Concepts section of each chapter is written to provide a clear understanding of the basic topics of the field of biomechanics. Within each Concepts section, Newtonian physics are included and applied in as many situations as possible. Also, an attempt is made to relate each individual topic to the other topics in that Concepts section. Further, each Concepts section of a given chapter refers to elements of other chapters, to enhance overall understanding of the field of Biomechanics.
- A Connections section is included at the end of each chapter, with the goal of enhancing the student’s understanding of the ways in which other movement-related disciplines apply the Concepts of that chapter. Connections are made most directly to the following fields: Exercise Physiology, Motor Behavior (Motor Control, Motor Development, and Motor Learning), Ergonomics, Injury Sciences (Physical Therapy and Sports Medicine), Pedagogy, Adapted Motion, and Sport Science.
- Within each chapter is a greatly summarised “Focus on Research” module that serves to show the diverse and interdisciplinary nature of research in the field of biomechanics. Research topics were chosen for their applicability to the Concepts and Connections within that chapter, but also the novelty of the experiment to the existing body of knowledge. Readers are made aware that experimental research in the field of biomechanics requires skill on the part of the researcher and complex technological instrumentation.
- Throughout each chapter the student is introduced to the mathematical equations that will enhance understanding of the overall concepts. Some equations are relatively straightforward and require only a brief explanation

and problem-solving sample. In other cases, readers are “walked through” Sample Problems that may be more complex or especially important to understanding the material in that chapter. In addition, Review Questions and Practice Problems are included at the end of each chapter to reinforce comprehension of the material and basic problem solving skills.

Apart from its underlying pedagogical perspective, the value of McLester’s and St. Pierre’s book lies in its focus on biomechanics as a highly integrated field of study that examines the forces acting upon, within, and produced by a body. Understanding the interrelated nature of the discipline of biomechanics will help the students to fully appreciate biomechanics and will motivate them to delve deeper into other aspects of movement and training science.

Reviewed by Jürgen Schiffer



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