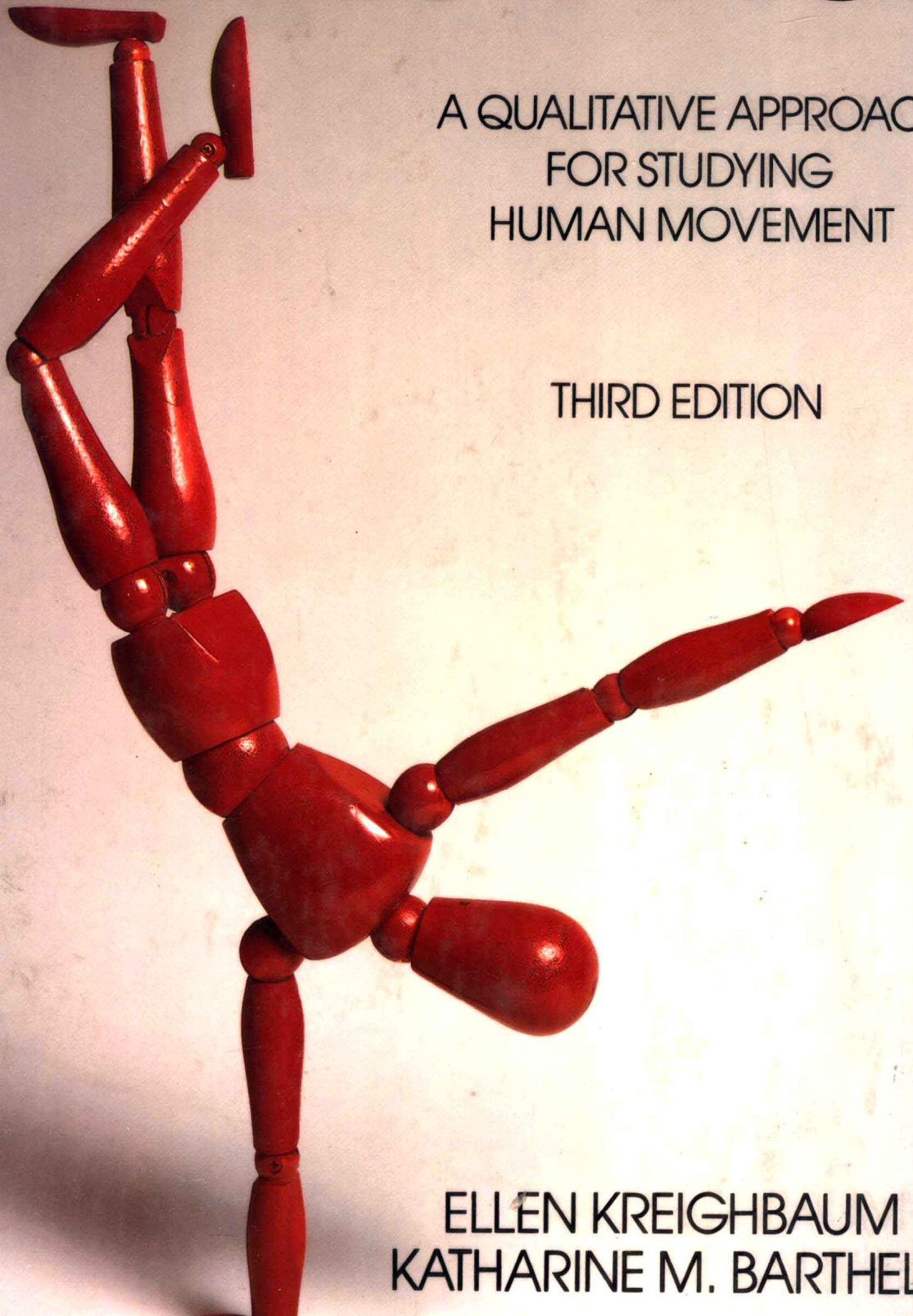
BIOMECHANICS



A QUALITATIVE APPROACH FOR STUDYING HUMAN MOVEMENT

THIRD EDITION

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BIOMECHANICS

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The authors dedicate this text to their parents, who guided, influenced, and instilled attitudes necessary to pursue such a task; to professional colleagues, who inspired and encouraged their questioning; and to their students, whose comments and criticisms were an integral part of the text development, and who provided the main reason for its writing.

Foreword

Authoring a textbook is like becoming a parent. It is a mixture of joy, a measure of heartache, considerable pride, and lots of work! It begins in rapture, sometimes planned, often not. If the timing and conditions are right, conception takes place, followed by a finite period of gestation when the myriad parts develop and are integrated into a complete functioning organism capable of life on its own. At birth (or publication of the first edition, whichever side of the simile you choose to adopt), the organism is, at the same time, complete and incomplete. It has the basic framework and all the organs necessary for survival, but it is yet an infant.

The first revision can be likened to adolescence when the awkwardness of rapid growth occurs and must be accomodated. The second revision signals the arrival of early adulthood where self-identity has been achieved and responsible contribution becomes the accepted calling.

Ellen Kreighbaum and Kathy Barthels, in the creation of this textbook, have been good parents. Their basic conception was magnificent, that of producing a source book for students, teachers, and researchers which emphasizes the qualitative aspect of studying human movement. It fulfilled a need in the field of movement analysis that had been largely ignored. The addition of concept modules and enhanced understanding sections in the first revision (second edition) provided necessary growth, development, and strength. This, the second revision (third edition) of the textbook, marks its status as a fully developed body of knowledge. Its uniqueness remains the authors' dedication to presenting a way of analyzing movement that is purposely qualitative. New to this edition are requisite refinements, knowledge updates, the dedication of a separate chapter for biomechanical analysis, and the addition of a new chapter on instruments that facilitate the analysis process.

Just as an adult retains certain identifiable features of his or her childhood, the same is true of this treatise on biomechanics. The authors have remained true to their "original intent and perspective," that of "promoting an understanding of biomechanical principles that govern the effectiveness of human movement

skills" within a "conceptual" and "qualitative" framework. Three foundational features of the original work remain clearly evident in this new edition. They are:

1. The importance of biomechanical principles. Principles are accepted basic rules that guide action. They attempt to explain why the body moves in certain ways, why it obeys the laws of physics/mechanics. They provide insight and allow generalizing to take place in the application of knowledge.
2. The belief that knowledge of such principles can improve performance. The insight gained from understanding biomechanical principles speeds motor skill learning. The principles provide goals to be achieved in the performance. They offer a template against which performance can be compared.
3. The importance of a conceptual/qualitative approach in learning these principles. How one learns new concepts frequently is as important as what those new concepts are. The emphasis here is always on getting the "idea" or the "big picture" first, then filling in the details. It's not that the details are unimportant. They are essential. It's just that, in the initial stages of understanding a complex body of knowledge, too many details can sometimes impede progress. In skilled motor performance, it's the old "paralysis by analysis" phenomenon.

New features are also evident in this mature organism. Of particular interest are the following:

1. A separate chapter for biomechanical analysis which brings to life the application of the principles of this science.
2. The addition of a chapter on instruments that facilitate the analysis process.

It is an honor for me to present this complete work to you. I do it confidently and proudly as one announcing the graduation of a prized student. I have watched her grow and have even played a small part in her development. She has helped many others along the way, including me. She now takes her place as a competent and complete contributor in the ever improving and expanding field of biomechanical analysis.

Orwyn Sampson

Biomechanics Instructor
United States Air Force Academy

Preface

The revision of this text was undertaken for the following reasons: (1) to present an expanded and more thorough analysis system for explicit use by the teacher and coach, (2) to update material and expand the references and suggested readings sections following each chapter, and (3) to modify organization and content in response to readers' comments and suggestions.

The third edition of this text is in keeping with the original intent and perspective of the authors. Thus, it is focused on promoting an understanding of the biomechanical principles that govern the effectiveness of human movement skills. Furthermore, the focus is on presenting appropriate biomechanical information within conceptual frameworks that are based on the common overall performance objective of those skills being analyzed. In keeping with the AAHPERD Kinesiology Academy Guidelines and Standards, the conceptual, qualitative approach has been maintained to facilitate the student's grasp of the ideas presented.

In particular, the analysis section has been expanded greatly and has been developed into a separate chapter. Chapter 9, *Observing and Analyzing Performance*, presents a complete format for analysis. The teacher or coach is led through the initial steps of identifying the overall performance objective of the skill, the mechanical principles governing the accomplishment of that objective, and the identification of the critical features of performance that the coach can observe. Using this format, the practitioner should be able to identify and correct misplaced, unnecessary, or detrimental aspects of performance. The analysis chapter is placed after the modules and chapters dealing with anatomy or basic mechanics and before the chapters dealing with movement performances.

The text has remained qualitative as much as possible. Where necessary, equations are used with numerical examples so that the student can obtain a feel for the relative importance of the concept being presented. For those who use quantitative material in their classes, these relationships are presented in the appendixes for convenient reference. Furthermore, the third edition includes

a chapter on biomechanics instrumentation in which the tools for quantitative analysis are described thoroughly. For those who incorporate data collection in their laboratory experiences, the chapter should serve as a valuable overview of those instruments used currently in biomechanics laboratories and at data collection sites.

The organization of the text into modules and chapters has been maintained from the second edition. The modules present basic biomechanical (anatomical or mechanical) material necessary for the understanding of groups of mechanically similar skills that follow in the chapters. For example, basic musculoskeletal information in Modules A and B and basic mechanical concepts of forces and torques in Modules C, D, and E are presented before the application of these concepts to the upper extremity, lower extremity, and trunk in Chapters 3–6. The authors firmly believe in the necessity of synthesizing anatomy and mechanics and applying them to the biological structure. Thus, we have not consented to organizing the text into an anatomy section followed by a mechanics section and finally an application section as many textbooks are prone to do. While this may be more difficult for some initially, the final result will encourage a unification of the bio- and the mechanics and, we hope, will minimize the dichotomy of the two, which has been prevalent in the past.

The module and chapter organization also facilitates ease of use for instructors who have many different approaches to teaching kinesiology or biomechanics. One may begin a course at any chapter or module. The modules and chapters that contain prerequisite information to this starting point are listed at the beginning of that chapter or module. Thus, the instructor need assign only those prerequisites to present the material in the chosen order. With this organizational scheme, virtually any order of presentation is possible. An anatomically based course could use Modules A–E and Chapters 1–7. A mechanically based course could use Modules C–K and Chapters 1 and 8–17.

The Understanding sections have been maintained and revised, and expanded where appropriate. These sections can be used for assignments, as a springboard for class discussion, or for laboratory work. The answers and points of discussion for the questions in the Understanding sections are given in the *Instructor's Manual*. Also included is useful information and direction for the instructor such as sources of biomechanics information from the literature, from professional organizations, and from professional meetings.

A further source of information is in the expanded and detailed lists of References and Suggested Readings, which follow each module and chapter. While some of these sources may exceed the level of understanding for some, they are important and useful for becoming familiar with the leading edge of the frontiers of biomechanics. They may also be important sources for reports and assignments.

Finally, the illustrations and photographs have been modified in some cases and expanded in others. In this edition, as in the last two editions, the authors have created their own illustrations and photographs. The authors believe that the application of a concept can be enhanced with the use of a quality illustra-

tion, and thus the illustrations should be used as a source of information as well as an example of concepts presented in the text.

Contributions from several individuals to the production of this edition are appreciated. We wish to thank sincerely the following people:

Brigitte Kohler, who did the final inking of the authors' original illustrations in the first edition, most of which are included in this edition

Bob Schwarzkopf, Jeannie Zumwalt, Don Jensen, and Rozan Pitcher, who served as subjects for some of the illustrations or for photographs

Carol Sanford, Marge Burgess, and Raeann Magyar, who assisted in various ways to complete the third edition

Orwyn Samson, who graciously consented to write the foreword to the third edition and whose comments and suggestions have been used to revise and improve the text.

E.K.
K.B.

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