

Preface

The aim of this book is to summarize the significant principles and research results in injury biomechanics for graduate students and professionals in the field of automotive safety. It is based on several decades of injury research and grew out of a course in computer modeling of impact biomechanics that I developed and taught for many years. Since modeling requires basic knowledge of the biomechanics of impact, a lot of material related to impact injury was included in the course. As a result, this book provides the reader with not only the models available to simulate impact on the human body but also the fundamental knowledge of impact biomechanics. It covers injury to the entire body, from head to toe, and it discusses the four main areas of the field, namely, mechanical response, injury mechanisms, human tolerance, and simulation of impact to various body regions.

The book is organized by body region with topics of special interest added at the end. Head injury is emphasized because there is currently no cure for this injury, and it is hoped that the detailed information provided will lead to effective prevention of this injury. Topics of interest to the automotive safety engineer include side impact and car-pedestrian impact. The book concludes with a chapter on sports-related impact (contact) injuries in football and baseball. A significant portion of the material covered is based on the work done at Wayne State University by myself; my colleagues Dr. King H. Yang, Dr. John M. Cavanaugh, and Dr. David Viano; and my former and current graduate students, A. Al-Bsharat, P. Begeman, B. Deng, A. El-Bohy, N. Hakim, W. Hardy, Y. Huang, A. Irwin, R. Jadischke, K. Krieger, N. Mital, A. Padgaonkar, P. Prasad, J. Ruan, B. Smith, S. Tennyson, P. Vulcan, K. Yang, and C. Zhou whose work is referenced in this book. The work of former students of Dr. King Yang and that of Toyota visiting scholars are also acknowledged. Dr. Yang's former students are X. Jin, J. Hu, J. Lee, H. Mao, C. Shah, K. Wang, and L. Zhang, and the Toyota visiting scholars are S. Hayashi, M. Iwamoto, Y. Kitagawa, and A. Tamura. To all of them, I owe a debt of gratitude as well as to many unnamed individuals who have provided assistance.

Since biomechanics is an interdisciplinary field, some basic understanding of mechanics (dynamics) as well as human anatomy will be helpful. However, I have

had biology majors with no background in physics, and mechanical and electrical engineers with no training in anatomy take and pass my course. A fair amount of statistics is used to assess the probability of an injury, and, for those who have no background in statistics, some additional reading on statistics will be helpful. To fully appreciate the mathematics behind the modeling of impact events, some knowledge of differential equations is required.

The problems at the end of each chapter take the form of multiple choice questions to test the student's ability to grasp the concepts and to determine if the student can sort out the correct answer from the many facts and figures presented in the text.

Finally, I urge the reader to keep in mind this mantra: "You cannot prevent an injury unless you know its cause." Several examples are cited in the book, and some of the unsolved problems are due precisely to a lack of understanding or knowledge of their cause(s).

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