of the human femur, made it the basis of his trajectory hypothesis and his "law of bone transformation."

Key developments following this beginning are discussed by Roesler.

Other papers in this volume are also excellent. Currey is a fascinating speaker with a broad perspective. Hayes' article is a superior stereological study of the trabecular bone. Woo's paper on long bone remodeling contains many new data. And there are many others on which I will not comment. This volume is highly recommended to bioengineers.

Y. C. Fung, UCSD

Perspectives in Biomechanics, Vol. 1, Parts A and B. Edited by H. Reul, D. N. Ghista, and G. Rau. The first of a series of mongraphs edited by D. N. Ghista. Part A, 528 pages, Part B, 363 pages. $214.50 (2 Vols). Harwood Academic Publishers, New York, Chur, London, 1980.

Biomechanics is mechanics applied to biology. It indeed covers a very broad territory. The area covered by this volume is described by the following chapter headings:

1 Towards an effective theory-to-medical practice approach in biomechanics, by D. N. Ghista, R. Reul, G. Rau, M. Waschmann
2 Solid mechanics in biomedicine, by H. G. Kingsbury, J. L. Nowinski, T. W. Chou
3 Fluid mechanics in cardiovascular flow, by T. J. Pedley, T. K. Hung, and R. Skalak
4 Human micro and macro heat transfer, in vivo and clinical applications, by W. J. Yang.
5 System theory in biomedicine, by R. Rosen
6 Mechanics of walking and running, by R. M. Alexander
7 Ergonomics in medicine, by R. Barnotat and G. Rau
8 Mechanics in agriculture, by A. T. Johnson
9 Homeokinetic physics of societies, by Iberall, H. Soodak, and C. Arensberg
10 Dynamic response and protection of the human body and skull in impact situations, by R. H. Huston and N. Perrone
11 Mechanisms, evaluation, prognosis, and management of head and neck injury, by King Liu
12 Spinal mechanics: kinematics, kinetics, and mathematical models, by M. M. Panjabi and A. A. White, III
13 The impact of biomechanics on the neuromuscular rehabilitation, by L. Vodovnik, T. Bajd, and A. Kralj
14 Compartment analysis in biomedicine, by M. Kwahara.
15 Biomechanics of neuro-sensory systems, by E. Biondi, F. Grandori, A. Pedotti, and R. Schmid
16 The mechanics of the interaction between ventilation and perfusion, by S. Cameron
17 Kinematic theory of function and evaluation of articular joints, by Y. Youm
18 Selection criteria for polymeric implant application with representative modifications for increased acceptability, by J. W. Boretos

These articles survey the fields covered, and present selected lists of references up to about 1978. But a perspective is a personal thing, and different persons see different things in the same field. For example, the motion or locomotion of man and animals is treated several times in this book; by Kingsbury et al. in Chapter 2, by Huston and Perrone in Chapter 10, by Liu in Chapter 11, and by Youm in Chapter 17. They are all good. But the substances are very different, and the lists of references differ to a surprising degree. Some references considered basic and central in importance by one author are not mentioned at all by another.

There are lots of very good passages in this volume. Overall this is a very useful reference book. Its wide coverage will broaden people's views on biomechanics.

Y. C. Fung, UCSD

Osteoarthromechanics, edited by Dhanjoo N. Ghista, Ph.D., 485 + x pages, $49.50. McGraw-Hill, New York, 1981. Copyright by Hemisphere Publishing Co.

This book opens with a chapter by Subrata Saha on the dynamic strength of bone, which contains a very useful survey and lists of data. The second chapter is by J. L. Nowinski on the effects of holes and perforations on the strength and stress distribution in bone elements. This contains detailed analyses of holes with mathematical details given in several appendixes. Chapter 3 by R. Collins and H. B. Kingsbury presents a comprehensive review of the theories on the lubrication of human articular joints, and experimental results. Chapter 4 by James Pugh is entitled "Biomechanical Aspects of Osteoarthritic Joints: Mechanisms and noninvasive detection." The pathological changes in the tissues are discussed thoroughly, and the method of impact testing as a noninvasive diagnostic technique is presented with some detail. I find this an excellent chapter. Chapter 5, "Finite-element applications in joint-replacement design and analysis," by Thomas P. Andriacchi and Steven J. Hampton, presents the finite element method succinctly. Design applications are emphasized in the discussions. The next chapter, 6, by Peter S. Walker, is on Artificial Joints. It presents the history of the subject, the kinematics, kinetics and materials of artificial joints, and their design and performance. It is an excellent survey.

The rest of the book, about half of the volume, is concerned with the spine. It begins with Chapter 7 by the Dutch authors A. W. M. Schijvens, C. J. Snijders, J. M. Seroo, and J. G. N. Snijder, on the mechanics of the spine: analysis of its flexibility and rigidity, postural control, and correction of the pathological spine. This is a good, simple, introductory chapter. The analysis of standing and sitting is very good. The next chapter, 8, by Lars Sonnerup, is entitled "Stress and strain in the intervertebral disk in relation to spinal disorders." Chapter 9, by Gordon C. Robin and Zvi Yosipovitch, is entitled "The biomechanics of thoracic and lumbar spine fractures: their fixation and stabilization." Chapter 10, by J. E. Lonstein and R. B. Winter, is entitled "Mechanics of the deformity and treatment in scoliosis, kyphosis, and spine fractures." The final chapter, 11, by Rae R. Jacobs and D. N. Ghista, is entitled "A biomechanical basis for treatment of injuries of the dorsolumbar spine."

Thus it is seen that the spinal mechanics is given a major share of attention. The style of most of the chapters remains physical and physiological as opposed to mathematical and computational.

The whole book is lucid and concise, well illustrated and well printed. I recommend it highly.

Y. C. Fung, UCSD

Cardiovascular Fluid Dynamics, by Uric Dinnar, Ph.D. 252 pages, U.S. $69.95, Foreign $79.95, CRC Press, Inc., Boca Raton, Flordia.

After a brief introduction of the cardiovascular bed as a system, and some elements of physiology of the circulatory system, the book begins with a chapter on the properties of flowing blood, then goes on to the structure and physiology of blood vessels, propagation of waves in arteries, pulsatile flow in rigid and elastic tubes, analog models of the circulation, the heart as a pump, blood flow in the microcirculation, and finally, fluid mechanics of thrombus formation. Thus in a relatively small space it surveys the arterial blood flow, some aspects of microcirculation, heart, and blood. No specific reference is made to the specialized circulatory systems of various organs. Features of flow in vein caused by its collapsibility are not discussed.

The text is mathematical. It leads the reader quickly to the mathematical formulation of the problem and the solutions and interpretations. In many places the mathematical level required of the reader seems to be quite low. So is the required mechanics level. In other places only advanced students can benefit.

A great strength of this book is its conciseness. For a reader with adequate mathematical preparation this book presents the solutions of a large number of important problems, with sufficient details so that it is not difficult to follow.

Weaknesses are few. If some of them remain, they probably crept in because of the desire to be brief. For example, on discussing the flow properties of blood, a section "The effect of slip at the wall" is presented on pp. 38–40. In this section the author said that "in the arterial system there are numerous minute branches that carry blood out of the main flow. A simple representation of this arrangement can be made by assuming that the walls of the vessels are made of a porous material. Even if the radial component is very small, and can be neglected, there is still the longitudinal component that must be introduced into the boundary condition." The author then made this longitudinal velocity to be proportional to the shear stress on the wall, and quote Jone's (1966) paper for the effect of this added term. What he did not explain is why the longitudinal component "must be" introduced. What experimental basis does it have? Is this in conflict with other theories? Just because the result seems to be in the right direction does not justify that it "must be" correct. The concept of "no-slip" condition for a viscous flow in contact with a solid boundary is always puzzling to the students. On what basis is the "no-slip" condition to be believed? In this book the no-slip condition was introduced casually, and then destroyed equally casually. I believe that the student will be confused to no end. The author is probably aware of this, because he said at the end of the section that "this analysis should be used very carefully since it introduces the concept of slip as a continuous slip." But he did not say how carefully, or careful in which way. He only adds one sentence mysteriously and lets the whole discussion end: "In reality a particle moving near the boundaries will be acted upon by a repellent force (34), causing the particle to move at a slower speed than the continuous (plasma), thus forming a completely different flow condition at the boundaries."

There are other passages with which the reviewer cannot agree, but they are minor. Overall, this is a very good contribution.

Y. C. Fung, UCSD

Mathematics for Biomedical Applications, by Stanton A. Glantz, 435 pages. $24.50. University of California Press, Berkeley, California, 1979.

The author said in the preface that this text has its origin in an applied mathematics course he developed in Stanford University Cardiology Division. "Because this audience is traditionally skeptical about the value of mathematics, the first two chapters formulate more-or-less real problems in terms of differential equations, but defer solving these equations until Chapter 3. Chapter 3 summarizes direct methods to solve linear ordinary differential equations." The rest of the chapters presents the method Laplace transformation, ways to characterize linear processes, Fourier analysis, spectra, and filters, and digital computers and numerical methods. In an appendix a review of calculus is presented.

The choice of examples close to cardiologists's interests is a strong feature of this book. For a course to teach linear ordinary differential equations to physicians, this would be my choice of a textbook.

Y. C. Fung, UCSD

Advances in Fluid Mechanics, edited by Egon Krause. 361 pages. Being Proceedings of a Conference Held at Aachen, March 26–28, 1980 and Vol. 148 of the series *Lecture Notes in Physics*. Springer-Verlag, Berlin, Heidelberg, New York, 1981.

The conference referred to in the title was organized to commemorate the dedication of the new building of the Aerodynamisches Institute in Aachen. It followed a tradition. In 1929 the Aerodynamisches Institute inaugurated the first extension of its building with a scientific meeting to which the then director of the Institute, Theodore von Kármán, invited scientists from all over the world. The present conference was a sequel 50 years later, organized by its present director, Dr. Egon Krause.

Von Kármán is a great name in mechanics. He did not work directly on biomechanics, but his influence is felt in all branches of biomechanics. It is not surprising, then, to find a large and substantial program of biomechanical research in progress at the Aerodynamisches Institute in Aachen. This program includes work on heart valves, blood circulation, peristalsis, microcirculation, etc. Embedded in an Institute famous for its high quality in mechanics research, this program is proceeding very well, and has acquired a character quite unique in the world.

This volume contains 14 lectures. Other than F. Schultz-Grunow's historical survey and Hans Liepmann's observations on engineering and culture, it contains papers on numerical analysis by H. O. Kreiss and V. Rusanov, R. W. MacCormack, and R. Peyret, vortex dynamics by L. Ting, aircraft aerodynamics by J. E. Green, boundary-layer shock-wave interaction in transonic flow by Sirieix, Delery, and Stanewsky, conformapping of multiply-connected domains by Prosnak, boundary-layer waves and transition by F. X. Wortmann, shear flow by Eckelmann.

On biomechanics there are two papers: "Biological flow in deformable vessels," by Y. C. Fung, and "Steady transport of material in the artery wall," by C. G. Caro. Both articles are in the nature of a general survey addressed to an audience which is composed of experts in fluid mechanics but not necessarily specialized in biomechanics.

Y. C. Fung, UCSD

A Series of Doctoral Dissertations from the Netherlands

On January 20–23, 1982, I attended the Third Meeting of the European Society of Biomechanics, which was held in the University of Nijmegen, Nijmegen, The Netherlands. I presented a plenary lecture, and visited colleagues at the University, and was given a number of doctoral theses. In Holland, a doctoral thesis must be published as a book at considerable expense to the candidate. One friend said the presentation of his thesis and getting through the ceremony cost him DF 10,000 (or approximately $4000.). These theses can be purchased from the authors. The following are from the University of Nijmegen:

Some Fundamental Aspects of Human Joint Replacement: Analysis of Stresses and Heat Conduction in Bone Prosthesis Structures, by Rik Huiskes, 1979. Also published as Supplementum No. 185 of *Acta Orthopaedica Scandinavica*, Munksgaard Copenhagen, 1980, 208 pages.

The Alinear Viscoelastic Properties of Human Skin in Vivo for Small Deformations, by Pieter Wijn 1980, 325 pages.

A Three-Dimensional Mathematical Model of the Human Knee Joint, by Jacobus S. H. M. Wismans, 1980, 143 pages.

Strength and Ingrowth Aspects of Porous Acrylic Bone