JOURNAL OF GUIDANCE, CONTROL, AND DYNAMICS
Vol. 27, No. 4, July–August 2004

Book Reviews

BOOK REVIEWS published in this section reflect the opinions of their individual authors. They are not necessarily the opinions of the Editors of this journal or of AIAA.

Publishers are invited to send two copies of new books for review to Dr. Christopher D. Hall, Mail Code 0203, Department of Aerospace and Ocean Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0203.

Formulas for Dynamic Analysis

Ronald L. Huston and C. Q. Liu, Marcel Dekker, 2001, 624 pp., $175.00, ISBN 0-8247-9564-4

This massive collection of material presents many of the basic procedures in modern engineering dynamics, numerous simple examples, and some introductory material associated with more advanced topics. The text collects the work and experiences of the first author in the field of dynamics, which spans roughly 30 years, resulting in a book of 14 chapters and more than 600 pages. The authors' objective is that the text be used as a reference that summarizes the principal equations of dynamics and their underlying theoretical bases. It is intended to be a ready source of information on dynamics for students, practitioners, and researchers in all branches of engineering and science, and which can serve as a self-study text or reference text for course adoptions. The authors present the fundamental procedures with their associated equations, generally with representative examples, but with sparse if not minimal theory. They attempt to convey the appropriate tools (formulas) so that the reader might effectively perform potentially sophisticated dynamics analysis with only modest background or experience.

The volume begins with an introduction to basic concepts and assumptions, basic terminology, and a review of units, as well as a review of Newton's Laws of Motion and other fundamental concepts. Chapter 2 reviews vector algebra and preliminary considerations. The topics include differentiation of vectors as well as the manipulation/description of vector quantities using rotation dyadic and direction cosines. The next two chapters are devoted to kinematics and kinetics of particles. Chapters 6–10 present tools and methods for performing more general rigid-body dynamics analysis. Rigid-body kinematics is presented first, followed by a more general treatment of body orientation in a spatial context. Subsequent chapters are devoted to rigid-body mass distribution, rigid-body kinetics, and finally a collection of rigid-dynamics formulations. Chapters 12–14 generalize the material from Chapters 6–10 so that the presented tools are more conducive to the analysis of general and complex multi-rigid-body systems.

In general, the book is clearly written. The organization is acceptable, but this reviewer would have preferred a different order of presentation. For example, the topic of orientation and transformation matrices appears first for particles in Chapter 2, then again for rigid bodies in Chapter 7, and yet again for multibody systems in Chapter 13. A similar statement can also be made about the authors' treatment of the topics of kinematics and kinetics as they relate to particles, rigid bodies, and multibody systems. The presentation of the material, albeit correct, appears somewhat fragmented. Additionally, this reviewer is critical of some points and statements made by the authors.

Specifically, the authors discuss D'Alembert's principle, but they make no mention of the more powerful and widely used "generalized form" of D'Alembert's principle.[1] Moreover, what the authors refer to as D'Alembert's principle is actually an oversimplification. D'Alembert actually segregated the applied forces into "given" forces and "constraint" forces. Only the given forces accompanied the inertia forces on the same side of the equals sign, because "the totality of constraint forces may be disregarded in the dynamics of systems of particles."[2] The authors correctly indicate that the equation they present for Lagrange's equation, which involves the Lagrangean L, is valid only for conservative systems. However, the authors do not mention that this equation is not always valid even for conservative systems. This more classical representation, which involves the use of the Lagrangean, will yield incorrect results in situations (seldom encountered with mechanical systems) where the system potential energy is a function of velocity, for example, as with charged particles moving in a magnetic field.

The figures are very simple line diagrams but most often convey the intended points well. In a few cases, the provided diagrams may not be as clear as wished. The authors' delivery of material shows an intent that the student or practitioner will pick up the material and apply the appropriate formulas through example and analogy rather than through understanding. Little theory is presented in the text, and, when provided, the derivations vary significantly in level of detail. For example, the authors provide a detailed derivation of the rotation tensor and its relation to the direction cosine matrix, but the provided derivation of Kane's Equations is not a real derivation. Similarly, the derivation of Lagrange's formulation is light. Additionally, the authors mention only the restricted form of Hamilton's principle and make no mention of generalized momenta (which can be particularly valuable in the treatment of impacts in multibody systems) in their discussion of impulse and momentum. This omission appears inconsistent with the authors' inclusion of other formulas and sections associated with multibody systems.

The authors' terse presentation of associated theory will make the book attractive to some users and unattractive to others. Applications-oriented students, instructors, and practitioners will probably approve of this format and like the text, which often reads similar to a handbook with its many useful summary tables of formulas. By comparison, theory and/or fundamentals-oriented individuals will most probably not appreciate it. Thus the appropriateness of this volume as a course text critically depends on the instructor's teaching goals and style. It should serve well as a reference for the practitioner with modest dynamics experience.

On the negative side, the material presented in this book seems to duplicate that presented by the first author in another of his books, *Dynamics of Mechanical Systems.*[4] At roughly 750 pages, that competing text is longer and contains more applications-oriented sections, but it has the same derivations and uses many of the same figures and examples. The discussions are not identical, but they are sufficiently similar (although the order of presentation is somewhat different) that one must have some reservation about the need for this new text.

References

[1]Meirovich, L., *Methods of Analytic Dynamics*, McGraw–Hill, New York, 1988.

[2]Rosenberg, R. M., *Analytic Dynamics of Discrete Systems*, Plenum, New York, 1977.

[3]Josephs, H., and Huston, R. L., *Dynamics of Mechanical Systems*, CRC Press, Boca Raton, FL, 2002.

Kurt Anderson
Rensselaer Polytechnic Institute

Newton's Tyranny: The Suppressed Scientific Discoveries of Stephen Gray and John Flamsteed

David H. Clark and Stephen P. H. Clark, W. H. Freeman and Co., 2001, 188 pp., $23.95, ISBN 0716742152

For those of us who make our living applying Newton's laws of motion, enjoying a book that tries to take our hero down a few notches is at best a guilty pleasure. Taken on its own terms, however, *Newton's Tyranny: The Suppressed Scientific Discoveries of Stephen Gray and John Flamsteed* proves to be an entertaining account of a fertile period in the history of science. The authors, David H. Clark and Stephen P. H. Clark, make the case that we owe some gratitude for the technological advances of the eighteenth century to several of Newton's contemporaries, at least one of whom Newton himself may have barred from receiving well-deserved recognition. David Clark is a well-known historian and a former research director at the Engineering and Physical Sciences Research Council in the United Kingdom. Stephen Clark teaches history in London and is David Clark's son. The authors are eager to revise the viewpoint of three centuries of hagiographers (the Clarks' term), which is that Isaac Newton's contributions are those of a selfless, near-saint of a man. Instead, the Clarks interpret events in a way that depicts Newton's actions as self-serving, tyrannical (also their term), and even cruel.

Newton's vengefulness and his habit of alienating his colleagues are well documented. This work is one of several recent revisionist histories that portray Newton as an obsessive, fervidly quarrelsome figure, including Michael White's *Isaac Newton: The Last Sorcerer* (Helix Books, 1998), which describes his involvement with alchemy and heretical Christian beliefs. The contribution of *Newton's Tyranny* to this field is the Clarks' explanation of how Newton hamstrung the career of Stephen Gray, a dyer and amateur scientist.

The book spans several decades, the 1660s through the 1720s, when modern science was in its infancy. Isaac Newton published his *Philosophiae Naturalis Principia Mathematic* during this period. The first edition of that work, published in 1687, builds on the earlier work of Copernicus, Kepler, and Galileo and demonstrates mathematically his universal law of gravitation, among other things. During this time John Flamsteed was Astronomer Royal at Greenwich, where he was engaged in a decades-long effort to provide precise star catalogues and other astronomical observations. Newton hoped to apply his laws to the motion of the moon with the help of Flamsteed's observations. In doing so not only would he confirm his own theories, but by predicting the moon's motion he also hoped to provide a "killer app" for the problem of longitudes, the pressing question of how to determine a ship's longitude at sea. Newton was impatient for Flamsteed's observations. The Clarks argue that Flamsteed's unwillingness to release the observations until they were completed to his exacting standards upset Newton to the point that he malevolently chose to use his influence at court to force the premature publication of Flamsteed's life's work. Ultimately Newton would purge even grudging acknowledgment of Flamsteed's contributions from the second edition of the *Principia*. (John Harrison would famously solve this problem in 1762, when he would demonstrate a clock accurate to 5 s during an 81-day journey from England to Jamaica. His demonstration showed the feasibility of propagating forward a known longitude at the start of a voyage using only simple measurements during the trip. Despite all of Newton's machinations, good clock making rather than ingenious theories cracked this nut.)