Book Reviews

Weaponeering: Conventional Weapon System Effectiveness

M.R. Driels

American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Reston, VA 20191, USA. 2004. 473pp. Illustrated. $69.95 (AIAA members); $100.95 (non-members). ISBN 1-56347-665-7.

This is a comprehensive book that provides and builds upon first principles to construct more and more sophisticated models for determining the effectiveness of conventional weapon systems.

The first section of the book gives an introduction to the subject of weaponeering and how typical munitions are operated and establishes the mathematical and statistical methods used throughout the book. Methods for determining the effectiveness of air-to-surface, surface-to-surface and various forms of mines are covered. Each section begins with a simple model that is built upon until a relatively complex methodology is developed. Along the way many examples are given to demonstrate the developed principles.

The last section of the book deals with target acquisition and the physiological aspects of target detection and identification. Methods are developed which could be used with the high fidelity trajectory and target damage models to produce an end-to-end weapon system performance model.

This book does tend to deal with unguided munitions and only ground targets. What detail is given to the modelling of guided weapons is sparse which is a little disappointing given that most weapon systems now entering service are guided.

This book would be of use to those in the military to gain a better understanding of the factors that are involved in determining the planning of an airborne mission or bombardment on a surface target. It would also be useful in industry to obtain an insight into how the weapons they are designing and producing are likely to be utilised and the factors used to predict their military effectiveness.

If you do read this book I would suggest downloading the relevant examples that are provided in this book prior to reading it. Having read the book I felt frustrated that the electronic format of the examples was not provided. Only after coming to the end of the book did I discover the instructions for obtaining the examples on a back fly-sheet after the index.

Rodney Irvine, MRAeS

Aircraft Loading and Structural Layout

D. Howe

Professional Engineering Publishing, Northgate Avenue, Bury St Edmunds, Suffolk IP32 6BW, UK. 2004. 591pp. Illustrated. £120. ISBN 1-86058-432-2.

The introduction, Chapter 1, lists acceptable levels of risk for various systems, pilot error, terrorism and acts of god. One fatal accident in a million miles is acceptable but an order of magnitude better is the author's goal. Chapter 2 charts the evolution of structural design requirements from 1907, via an article, The Stresses in Wings, the RAF method of investigation (*Flight* 1913) to FAR/JAR, Def Stan and Mil Spec codes of today. Use is made of these codes throughout the text.

Symmetric, asymmetric and ground load cases with flight envelope values of n for different classes of aircraft are given in Chapter 3. Roll, pitch, yaw, side-slip, instantaneous rudder and engine out considerations lead on to three highly mathematical chapters. Over 500 symbols are defined.

Rigid Airframe Dynamics, Chapter 4, is the longest by far. Topics include: longitudinal trim, stick fixed static margin, lateral stability, force/moment/inertia and aerodynamic effects. Canard, tail-less and all-moving tail layouts, but not the unstable aircraft, are considered. The equations of motion are linearised and non-dimensional derivatives are discussed.

Chapter 5, Flight Manoeuvre Loads, uses numerous equations from control theory to predict the interaction between motivator input and flight response. Accelerations and loads resulting from instantaneous step, exponential, sinusoidal, checked and unchecked modes are considered. Models of Atmospheric Turbulence, Chapter 6, covers gust n/v diagrams, gust gradients and turbulence. There is an interesting section on continuous turbulence, frequency content and spectral density. The author favours mission analysis but offers a design envelope approach, as implementation of the former is difficult.

Ground loads encountered in take-off and landing are considered in Chapter 7, where energy dissipation, runway surfaces, tyre types, spin-up, spin-back braking and one wheel landing sum up the content. Loading on Individual Airframe Components, Chapter 8, includes emergency alighting g load requirements, not to be confused with a full crash case for which only basic aims are listed. Engine mounting, cabin and fuel tank pressurisation receive attention but hydraulic shock does not.

Subsonic and Supersonic Air-Load Distributions are considered in Chapter 9. Swept wings, delta wings and wing–body flows are discussed but nothing is said about the blended wing body concept. The author follows Schrenk (1940), Glauert lifting line (1948) and lists Vortex Latice, Wessinger and Multhopp as references. These methods are without section headings and are not in the index.

Chapter 10, Specification and Analysis of Repeated Loading contains ten potentially useful load spectra (plots of normal acceleration reached or exceeded v occurrences per hour of flight). The first of these is very well publicised but is presented here without the usual tabulated example. The author does explain the procedure but without an example the uninitiated has been known to get it wrong.

Ten pages on Aeroelasticity, Chapter 11, is barely enough to get the message over but the author does well to cover divergence, flutter, control reversal, structural response and damping in so few pages. Backlash, shroud distortion, aerofoil deformation, hinged doors and dive brakes, all appear on a single page. In Chapter 12, Derivation of Structural Design Data, the author states that low weight at an acceptable manufacturing cost is the fundamental problem but says little about choice of process, cost or cost/weight trade-offs. Airframe Materials and Applications, Chapter 13, contains three Ashby cloud plots which broadly indicate strength, stiffness, toughness v density properties of various materials. Two copper and four zinc based aluminium alloys are suggested for specific uses, with one alloy in Table 13.2 incorrectly called. The usefulness of steel and titanium alloys is acknowledged but no alloy tyres or properties are quoted. Elastic constants for seven commonly used materials and a few allowable stresses are recorded but more could be said about state of the art materials – GLARE, for example, is a material with potential. ARALL is an aluminium alloy ply employing aramid fibre reinforced laminates. Joints in composites are identified as their Achilles heel and continuous spiral winding is one answer, but not for large pressurised fuselages with doors and windows.

Chapter 14, The Role and Layout of Structural Members is a Mini Niu. As with Niu scale dictates that major members can only be drawn as thick single lines and much important detail is lost. (There is no obvious remedy for this.) In Chapter 15 entitled Synthesis Procedure, the author mentions a seamless computerised process based on artificial intelligence but the gist of the Chapter is analytical and no true method of synthesis is revealed.

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Important Departures from Elementary Theory, Chapter 16, includes the mathematical optimisation of stringer/skin panels but as the author points out, the proportions derived are rarely directly applicable. However, the efficiency curve is relatively flat and quite large departures from the mathematical ideal are possible without significantly affecting the weight. Structural Index (a concept which often governs the buckling case) appears in symbolic form, in Chapter 13, but without a sub-heading or inclusion in the index, its significance may be missed. A very basic tension field beam, without curvature or taper, is also discussed, with a few words on warping, axial constraint, diffusion and transport joints. Chapter 17, Conclusions, contains a short Bibliography (1958-2002) and the author concludes by offering four worked examples based on the Cranfield A1 aerobatic type, G-BCIT, shown on the dedication page.

This is a super book by a highly respected teacher, ideal for group project design but priced way beyond the means of individual students. Even the college librarian will be hard-pressed to justify purchase of more than a single copy.

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Classical Mechanics

J.R. Taylor

University Science Books, Sausalito, CA. 2004. Distributed by Macmillan Distribution, Houndmills, Basingstoke, Hampshire RG21 6XS, UK. 786pp. Illustrated. £41.99. ISBN 1-891389-22-X.

This book is aimed at physics undergraduates and, as such, does an excellent job. It is a long book, nearly 800 pages, but it is not heavy reading. Both the style and presentation are clear and one could easily imagine being in the presence of a capable lecturer.

The book is in two parts.The first part covers all the expected topics for theoretical dynamics including Lagrange's equations. The second part extends into Hamiltonian mechanics, nonlinear mechanics and chaos theory. I especially liked the chapter on special relativity which is clear, concise yet covers all the major concepts. The book concludes with a chapter on continuum mechanics.

The applications are, in the main, taken from fundamental physics together with basic problems to illustrate the mathematical procedures. There are many worked examples, plus further examples for the student with answers to half of them.

Because of the easy style of writing, the book would be of great help to engineering students as a reference book on the mathematical principles. Most of the examples deal with frictionless systems except for the chapter on vibration which deals with a single degree-of-freedom systems with viscous damping. Two and three degrees-of-freedom systems without damping are also included.

For a book which is very accurate it came as a great surprise to find a fundamental error when dealing with the simple case of a block sliding down a plane with dry friction. The intention was to apply the work energy method but in fact the author simply integrated the equation of motion. Another oddity occurs when considering the height of tides due to the gravitational attraction of the Moon, taking this as an example of the use of a non-inertial reference frame. Here the usual numerical result was obtained but the Earth Moon system was consider to be in linear acceleration rather than an orbiting system.

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