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Book Reviews

History of rocketry and astronautics, AAS History Series, Vol. 19, edited by J. D. Hunley, Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California 92198, USA, 1997, pp. 306, $60.

The volume is a collection of 14 papers presented at the 24th History Symposium of the International Academy of Astronautics held in 1990. This volume marks a change in the series editorship. R. Cargill Hall, who has been the series editor of the AAS History Series for many years, is succeeded by Donald E. Elder. However, the general get-up and grouping of the papers remains unchanged. The papers presented in the volume pertain to four categories: Rocketry and astronautics–concepts, theories and analysis; Liquid and solid propellant rockets: 1880–1945; Rocketry and astronautics after 1945, and Pioneers of rocketry and astronautics.

The volume begins with an interesting exposition of the background and initial dual planet mission studies of the project EMPIRE (early manned planetary interplanetary round trip expedition), which was an offshoot of the proposition made by Werner Von Braun to reach Mars in the early 1950s. Project EMPIRE evolved extensive research and development work on nuclear propulsion. F.P. Dixon had mentioned the salient features of this project in Vol. 17 of the AAS History Series, which was covered by the present reviewer earlier. The next article traces the origin of gravity-propelled interplanetary space travel. The innovative idea of 'gravity-propelled' or 'swing-by' trajectory marked a key propulsion breakthrough which opened up the entire solar system to exploring using relatively small, chemically propelled rockets. The contribution of Michael Minovitch in solving the restricted three-body problem is cited in detail.

The legacy of Hermes, a contract between the Army Ordnance Department and the General Electric Company, to exploit War II German rocket development is sketched by Julian Braun. Under this contract were acquired documents, rocket hardware and people who had developed the V-2 rocket. Captured hardware loaded in 841 trucks was trans-shipped to White Sands Proving Grounds in New Mexico. A select group of 118 captured German rocket scientists led by Werner von Braun were also brought under operation Paperclip. Konrad Donnenberg, who was one of the German scientists brought to the US cites his own account of involvement in various missions, starting from his first assignment in Peenemunde to improve the propellant injection system of A-4(V-2) rockets. After coming to the US, he contributed to the Saturn/Apollo program.

Like the US, the Soviet Union got its share of the German rocket scientists—152 experts with their families to be exact, in the late 1946. The participation of German specialists in the development of Soviet missile technology in the early post-war period, however, was not as fruitful. Although the German scientists were paid at par with the Soviet counterparts, by late 1950s, they all were taken off from secret projects and were working on themes unrelated to rocketry and finally were sent back to GDR in 1951. Though much less documented, France also hired a hundred German engineers from Peenemunde, but apparently made no significant contribution as per an account by P. Jung in the story of the French guided ground-to-air missile SE 4300. Although it proved to be useful for testing various systems, and made over 125 launches, it was finally abandoned because of higher operational cost.

The evolution of the Titan Rocket—Titan I to II—as a backup Intercontinental Ballistic Missile (ICBM) system to the already existing Atlas ICBM is detailed by a former president of the Martin Marietta Corp., which designed the overall Titan system. The two-stage liquid-fuelled Titan I weighing 100 tons at launch had a range of 5500 nautical miles and could be launched from underground silos. A total of 163 Titan I were built; the system was deactivated in 1965 to be replaced by Titan II, which was capable of carrying a 7500-pound re-entry vehicle to a distance of 6000 nautical miles. The next article describes the engineering development of the Apollo Lunar Module. Both in ascent and descent stages the module used hypergolic (self-igniting) propellants. Many problems involving propellant leakage, coolant crystal formation, etc., were resolved in the development stage; in the end, it was an extraordinary success.

Part 2 of the story of 'Black Betsy', the 6000 C-4 rocket engine, by the renowned historian Frank Winter recalls the remarkably successful and long career of the power plant which propelled the Bell X-1 aircraft that achieved the world's first supersonic manned flight in 1947, and examines its use in Douglas D-558-2 sky rocket, XF-91, MX-774 test missile as interim powerplant for the X-15 and up to sonic wind rocket-propelled supersonic icesled. Part I of the 'Black Betsy' story appeared in the AAS History Series, Vol. 17, which was also covered by the present reviewer.

In the Pioneers of rocketry and astronautics section, the works of Alfred Maul, a pioneer of camera rockets; Jean-Jacques Barre, a French engineer of rockets and astronautics, and the role of the Russian scientist, S. P. Korolev, as design engineer of launchers for Sputnik and Vostok, are cited. Maul apparently launched his first model of camera rocket as early as 1904. Barre worked on liquid rockets based on LOX-alcohol in the early stages. Korolev, of course, is well known for the overall development of the Russian rocketry and is remembered as the man who beat the US in the race to the moon.

The variety of topics covered under the AAS History Series makes an interesting reading. This volume is no exception. Getting to know what went on in multi-million dollar projects, be it the story of Titan rockets or Black Betsy or the project EMPIRE—from their inception to conclusion—is indeed exciting for those interested in science reading. Research students working in the general area of rocketry will enjoy going through it, all the more. Bound in blue hard cover as usual, it has a portrait of the first man to make a space flight, Yuri A. Gagarin (1934–1968), on its front cover.

Department of Aerospace Engineering S. R. JAIN
Indian Institute of Science
Bangalore 560 012

History of rocketry and astronautics, AAS History Series, Vol. 20, edited by J. D. Hunley, Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California 92198, USA, 1997, pp. 330, $60.

The volume covers 15 papers presented at the 25th History Symposium of the International Academy of Astronautics held in Montreal in 1991. As usual, the papers are divided into five sections. The Early solid propellant rocketry section includes French rocketry (1739–1872). Interestingly, the early solid rockets in France were developed with Indian know-how. The alliance of France with Tippu Sultan in the 1780s resulted in the transfer of information. Napoleon pushed the solid rocket programme but it died out soon after his defeat at Waterloo. The rejuvenation of military rockets started in 1846. With the pioneering work of Susane, France had an operational system in 1850s. But soon after, the cannon capability improved and resulted in the disappearance of the solid rocket, not only from France but also from the world scene.

In the Concepts, theories and analyses section, gravity propulsion research at UCLA and JPL, 1962–64, is described. This article is in continuation of the one published in the previous volume of the AAS

History Series (Vol. 19) which was covered by the present reviewer. Essentially, a detailed account of Micheal A. Minovitch's pioneering work in solving the restricted three-body problem, and his proposal that this solution could be used for propelling a space vehicle around the entire solar system from planet to planet, without using any reaction propulsion, is presented. It is worthwhile to note that Minovitch completed this work even before he completed his Ph. D.!

Several interesting papers have been included in the section on rocketry and astronautics after 1945. Under the Navaho cruise missile program which was conceived soon after World War-II, several basic technologies pertaining to ramjets and turbojets, new rocket engines running on kerosene, airframes for supersonic vehicles, etc., were established. The development of Jupiter propulsion system at North American Aviation, Inc., accomplished in just over one year, was possible because the major engine components were already in an advanced stage of development under the Navaho and Atlas Missile program. Project Farside, conceived in 1955, was designed to furnish a low-cost method for penetrating the Earths' magnetosphere and even reaching beyond the moon, using a four-stage solid-propellant balloon-launched rocket vehicle. The project was operated under the US Air Force and data obtained were never disclosed, even to its designer, Fred Singer, of the University of Maryland, who prepared the instrumentation. The historical development of segmented rockets prior to their use as space booster is sketched by K. Klager of the Aerojet Corp. Since large-size monolithic solid-propellant grains are difficult to cast and transport, the segmented grain technology, which permits casting the grain in pieces and bonding them together at the launch site itself, helped in eliminating these problems.

The forerunner of all French rockets burning unsymmetrical dimethyl hydrazine (UDMH) and N_2O_4 was named 'Coralie' in the 1960s. The propellants were pressure-fed using a liquid-fuelled gas generator. The experience of Coralie led the way to the engines which powered the first and second stages of Ariane. A short story of the Black Arrow launcher, which made England the sixth nation in the world to orbit its own satellite, Prospero, in 1971, reveals the rather lukewarm approach of Britain to get into the launcher technology of its own. Instead, the UK relied on European Launcher Development Organisation (ELDO) to launch commercial payloads. Another article in this section reveals the story of Vela satellite program, an orbital network of space sensors deployed by the US in the 1960s to monitor compliance with the limited nuclear test ban treaty. The 12 satellites launched as a part of this program at altitudes around 6500 miles were equipped with X-ray, gamma ray and neutron detectors to monitor high-altitude nuclear explosions. Vela program provided a wealth of information in several important disciplines of space science besides monitoring the critically important test ban treaty till 1984, when it ended.

A development history of the Vostok spacecraft used for the first manned spaceflight, which orbited Yuri Gagarin in 1961, reveals adoption of approaches noted for maximum design simplicity and reliability of all systems. The challenge to ensure safety of the first manned spaceflight in a situation where no previous experience of piloted space missions was achievable was met with remarkable success. Two more articles are presented in this section on Russian rocketry—one on the construction and testing of the first Soviet automatic interplanetary stations and the other on the role of academician Sergei P. Korolev in the development of space rocket vehicles for lunar exploration with the help of manned spaceship.

The section on pioneers of rocketry and astronautics gives a poignant biography of Hermann Oberth (1894–1989), the man known as the 'father of space flight'. Oberth, born in Transylvania (later on he became a German citizen) was captivated by the possibility of space travel from his childhood days. His Ph. D. thesis in astronomy submitted in 1922 was rejected, as it was considered "too fantastic". By publishing a book, *Die rakete zu den rlanetenraumen* (*The rocket into interplanetary space*), in 1923, he became the intellectual leader of an international space travel movement. Basically he was a theorist. Although he developed several modern concepts of the space travel for the first time, he was left out of the V-2 development. Crazy, it may sound, but he believed in mystic and occult phenomena and also in UFOs.

In general, the articles are classified as per the norms of the series. There is however an oddity. The article entitled "The Romanion inventor Paul Popovatz's contribution to jet propulsion theory and practice", which is included in the section Development of liquid and solid propellant rockets, 1880–1945. It should have appeared under the biography section. Overall, the articles chosen are informative and well researched. Space scientists and research students will certainly enjoy going through them. Bound in blue hard cover, as usual, the volume has on its front cover a portrait of Ernst A. Steinhoff (1908–1987), a pioneer in the field of guidance systems.

Department of Aerospace Engineering
Indian Institute of Science
Bangalore 560 012

S. R. JAIN

Survey of knot theory by A. Kawauchi, Birkhauser Verlag-AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1996, pp. 444, SFr. 98.

The study and classification of knots in three-dimensional space began about a hundred years ago and has now grown into a very specialized and active area of mathematical research. In the recent years it has even come to have applications to other areas of science and therefore has formed a common ground of investigation for researchers from these areas as well.

The history of knot theory can be traced back to the 19th century when physicists were pondering on the nature of atoms. Lord Kelvin, one of the leading physicists of his time, put forward in 1867 an imaginative and ambitious idea that atoms were knotted vortex tubes of ether. Although this idea did not go too far, Kelvin's collaborator P. G. Tait later undertook an extensive study of knots. He enumerated them in terms of the number of crossings of a plane projection of these knots, called the *knot diagram*, and also made certain observations [T] which have since come to be known as 'Tait's conjectures'. Then on, the study of knots became a topic of great interest for mathematicians.

Formally, a *knot* is a circle embedded in the three dimensional space $\mathbf{R}^3$ (or the 3-sphere $\mathbf{S}^3$). The embedded image of several entangled circles is called a *link*. In order to distinguish between two knots (or links) one finds and compares a number or more generally an algebraic system which is invariant under a self-homeomorphism of $\mathbf{R}^3$ (or $\mathbf{S}^3$); such an expression is called a *knot invariant* and these invariants play a very important role in knot theory. One of the early achievements in this direction was the discovery of the *Alexander polynomial* [A] of a knot (or a link). Although it did not help prove the Tait conjectures, it was an extremely useful knot invariant and greatly simplified the effective classification of knots. The Alexander Polynomial is derived from the fundamental group of the complement $\mathbf{R}^3 - k$ of a knot k in $\mathbf{R}^3$. For more than 50 years this remained the only knot invariant of its kind. It was therefore a pleasant surprise and a major breakthrough when, in 1984, Vaughan Jones discovered another polynomial invariant of knots and links [J] which was far more subtle and this achievement eventually earned him the prestigious Fields Medal in 1990—the highest honour in mathematics. The advantage of *Jones polynomial* over the Alexander polynomial is that it distinguishes a knot and its mirror image while the Alexander polynomial on the other hand always takes on the same value in both the cases.

One of the main objectives of the present book, as the title suggests, is to put together much of these exciting developments and provide a coherent account of the significant results. The original Japanese edition of this expanded English version, also by Akio Kawauchi, grew out of a regular monthly seminar in Japan and, therefore, is a collective effort of mathematicians who have worked in and contributed to the subject in an essential way, Kawauchi himself being one of them.

The book is organized in 17 chapters (including Chapter 0!), six appendices and an exhaustive list of references. In fact, the reference section together with Appendix F, which lists all the knots up to 10 crossings and gives other useful data like the types and symmetries of these knots, their Alexander, Skein and Kaufmann polynomials, etc., fills nearly half of the book. This user-friendly aspect is just appropriate for a book intending to present a survey of knot theory.

It begins with an excellent prelude to the study of knot theory wherein the basic notion of a knot and what it means to mathematically distinguish between given two kinds is first introduced. Then on the contents of various chapters and appendices are discussed briefly and clearly which, in addition to giving an account of what is in the book, introduces the reader to different aspects in the study of knots. The first four chapters deal with topics which are both basic and essential for this study. Chapter 0 describes, in sufficient detail, the piecewise linear category (PL category), the setting in which the discussion throughout the book is done. Chapter 1 discusses the various presentations of knots and links in the plane, Chapter 2 three standard examples of links—2-bridge links, torus links and pretzel links—which occur often in later chapters and Chapter 3 with compositions of links, i.e., constructing new links from given links, and decompositions, i.e., breaking up links into smaller components which are simpler and easier to handle.

A *trivial knot* or the *unknot* is a standard circle, i.e., the boundary of a disk. Just as a trivial knot is the boundary of a disk, so is every non-trivial knot the boundary of a surface (which is not a disk). Such a surface called a *Seifert surface* is not necessarily unique for a given knot. Nevertheless, one can look for suitable invariants associated to Seifert surfaces (which can also be constructed for links), both algebraic and topological, which is the subject matter of Chapters 4 and 5. Chapter 6 deals with the complement spaces of links in $\mathbf{S}^3$ (or $\mathbf{R}^3$) called link complements (referred to as link exteriors in this book) and invariants associated to these spaces as well as their fundamental groups called *link groups*.

Having done enough groundwork by now, Alexander polynomial of a link is defined in Chapter 7 which discusses the effective ways towards their computation. Chapters 8 and 9 cover the central topic (quite literally too), 'the Jones polynomial', which triggered on much significant development since its discovery in 1984. Besides a brief discussion of Jones polynomial invariant of links from topological as well as algebraic viewpoints this chapter also touches upon the Kaufmann polynomials, and other link invariants. The subsequent chapters discuss various other aspects connected with knots and links: Chapter 10 deals with notions of certain symmetries that can be associated to knots and their role in distinguishing a kind of knots; Chapter 11 with determining the extent of the complexity of a given knot from the trivial knot (or the unknot) by the so-called unknotting. This *unknotting number* is yet another knot invariant which is usually difficult to compute; Chapter 12 with the problem of when is there a 'cobordism' between two knots; Chapter 13 and 14 discuss the 2-knots, i.e., embeddings of $\mathbf{S}^2$ in $\mathbf{S}^4$ or $\mathbf{R}^4$, analogous to the classical knots; Chapter 15 studies embeddings of spatial graphs instead of embeddings of just circles. This has applications in chemistry since the formula of a molecule can be thought of as graph whose vertices are the atoms in the molecule and the edges represent the covalent bonding between the atoms. The study of embeddings of these graphs in analogy with that of knots has been found to be extremely useful in the practical problem of artificially synthesizing certain molecules. It is just appropriate that this currently hot topic of knot theory which arose while studying the nature of atoms and their atomic structures has in recent years come to have applications in distinguishing chemical components by their molecular structures. Chapter 16 discusses the more recent results of Vassiliev and Gusarov following the discovery of the Jones polynomial. These invariants, called the Vassiliev–Gusarov invariants, form an algebra of numerical link invariants which have been found to determine the Jones, Skein and Kauffmann polynomials also.

The material in the Appendices supplement the main contents very well. Appendix A proves the various equivalent conditions for two links to be of the same type; Appendix B quickly but clearly recalls the highlights of the theory of covering spaces while Appendices C and D do the same of the canonical decompositions, Heegard splittings and Dehn surgery descriptions in the theory of 3-manifolds. And Appendix E discusses certain general duality theorems which are very useful in the study of topology of knot and link complements. Appendix F, as said before, gives a lot of useful empirical data of knots with respect to their crossing numbers; presently, I believe, this list is complete only up to crossing number 14 and this book lists up to 10 crossings.

Indeed the book covers almost all aspects in the study of knots. There are also, supplementary notes at the end of each chapter which in a sense ties up the discussion in the chapter and enlists any interesting questions therein. Being a highly active field much significant progress has been made in recent years since the book was written and this book is thus an ideal reference tool for much that has happened in knot theory before. A sort of unified approach with which the book is compiled makes such a back-referencing easy and quick; in other words, this book is a must for all the university and research institute libraries.

Every effort has been made to include all the major developments before 1995. However, the work of Kronheimer and Mrowka which settled a conjecture, due to John Milnor, about unknotting numbers for Torus knots and subsequent generalizations has not been discussed. Although proofs are not provided to many of the results stated, the book is self-contained in the sense that every attempt has been made to motivate and appreciate these results and proper reference is given where a proof can be found. Proofs are given, wherever possible, within the scope of the book.

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SPIC Mathematical Institute
Chennai 600 017

C. S. ARAVINDA

Fractal geometry in architecture and design by Carl Bovill, Birkhauser Verlag AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1996, pp. 195, SFr. 58.

Geometric shapes have traditionally been described using Euclidean geometry. This description, however, is neither suitable nor adequate for many natural shapes and patterns. This inadequacy was first highlighted by Benoit Mandelbrot in the 70s and he evolved a new discipline of fractal geometry to describe such shapes. Mandelbrot discovered that many natural objects display some sort of self-similarity wherein small parts of an object are similar to large parts of the object. Therefore, as one zooms in on the object, one sees the same details recurring on smaller and smaller scales. Such objects are best described as fractals. Fractals have an interesting property that they typically (not always) have a fractional dimension. Fractals can be used to describe not only objects but also natural time series data (like geophysical time records). Study of fractals has seen explosive growth over the last two decades. Fractals are found to play an important role in chaotic dynamics. They are also used in efficient image-compression techniques.

The book under review gives a lucid non-technical introduction to fractal geometry with emphasis on applications to architecture and design. Even though it is meant primarily for architects, the first six chapters should be accessible to undergraduates in any discipline.

After giving a brief introduction to the field in the first chapter, the author describes some basic fractals in the next chapter. Other than the usual examples such as the Cantor set and Koch curve, the author also gives other more unconventional examples like the dragon curve, climatological data, architectural designs, etc. All examples are well illustrated with figures.

Chapter 3 introduces the concept of fractal dimensions. This is one of the best chapters in the book. It emphasizes the inadequacy of conventional Euclidean concepts like length to describe fractals. It introduces the concept of self-similar dimension through simple examples. The related measured dimension is illustrated through a detailed analysis of the process of measuring the length of British coastline using maps of Britain. The author clearly demonstrated that the length of the coastline keeps increasing as the size of the measuring instrument decreases. In contrast, he shows that the circumference of a regular non-fractal object like a circle approaches a limiting value when the same process is carried out in this case. He also describes the relationship between self-similar and measured dimensions in some detail. The popular box-counting dimension is introduced by going through, in detail, the measurement of fractal dimension of the coastline of California at Sea Ranch including off-shore islands.

The first half of Chapter 4 introduces iterated function systems (IFS) which were popularized by M. Barnsley. It describes how fractals can be generated as attractors of an IFS. It illustrates the process through the generation of a fern-like object using simple self-affine transformations. The basic mathematics behind affine transformations is described. The second half of the chapter deals with Julia and Mandelbrot sets. The brevity of treatment of these sets is understandable since they have been extensively catalogued and analyzed in other popular books. Simple facts regarding complex numbers are also included for the mathematically challenged reader.

Chapter 5 deals with random fractals, Hurst exponents, curdling and other topics. This is a very useful chapter since these concepts (which have applications in many disciplines) are often omitted in many conventional books on fractals. Using the Archimedes midpoint displacement method and its generalizations, the author illustrates how fractal curves and their random counterparts can be generated. There are several figures explaining the process. The author then introduces the concept of Hurst exponent and lucidly explains a simple algorithm for computing it through excellent illustrative figures. At the end of the chapter, the process of curdling and computing the fractal dimension of the resultant fractal dust is described (again aided by several figures).

Chapter 6 introduces the concepts of white, brown and $1/f$ noises. Examples from sheet music are given and the Hurst exponent calculated from it. The author relates the fractal dimension to the proportion in which order and surprise are intermixed in a given pattern—from all order in a straight line with dimension 1 to all surprise in a white noise with dimension 2 (neither of which is very interesting).

In Chapter 7, the fractal concepts developed in the earlier chapters are applied to architecture. The author analyzes in detail the famous architect Frank Lloyd Wright's Robie House. By calculating the box-counting dimension of the elevation of the house at different scales, the author demonstrates that Wright's design has a progression of detail from large to small scale and is able to quantify it. Next, he performs a similar analysis for Le Corbusier's Villa Savoye. In this case, a lack of progression of detail at smaller scales is observed (the fractal dimension drops to 1 at these scales). The author attributes this to Le Corbusier's purism which called for materials to be used in a more industrial way as compared to Wright's organic architecture which captures nature's complexity. Such analyses can be useful to students of architecture in quantifying differences among various styles.

In the final chapter, the fractal concepts are applied to design. The author argues that many aesthetically pleasing planning grids, paintings, etc., display fractal characteristics. He further states that the design of buildings, etc., should be such that the fractal dimension of their elevation matches that of their background (mountains, coastline, etc.). This chapter (as is typical of the rest of the book) is richly illustrated with many figures.

In summary, the book under review is an excellent non-technical introduction to the field of fractal geometry and its applications to architecture. The large number of figures serve to clarify and illustrate various concepts introduced in the book.

Department of Mathematics
Indian Institute of Science
Bangalore 560 012

G. RANGARAJAN

Numerical analysis by G. Shankar Rao, New Age International (P) Ltd, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, India, pp. 256, Rs 135.

This book, supposedly written for the benefit of degree/post-graduate students, contains familiar topics found in most of the books on the same subject. Neither the topics included are at an advanced level nor are any attempts made to introduce the subject in a different style. The book does not match other standard books on numerical analysis such as *Numerical methods for scientific and engineering computation* by M. K. Jain, S. R. K. Iyengar and R. K. Jain which are available at a lower and affordable price, and contain a wealth of information which a student ought to know.

A number of examples are solved in the book under review and it can be used as a companion volume with other existing elementary textbooks/notes/guides to gain a working knowledge of numerical analysis.

Department of Mathematics
Bangalore University
Bangalore 560 001

K. S. HARINATH

Gas dynamics and jet propulsion by S. L. Somasundaram, New Age International (P) Ltd, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, India, pp. 281, Rs 95.

The book, aimed at engineering college students, has 7 chapters. This first 5 chapters deal with gas dynamics and a chapter each with gas turbines and propulsion systems. It devotes about 100 of the 290 pages to tables of properties of air and compressible flow, about a 100 to gas dynamics and about 60 to jet propulsion. The treatment of gas dynamics is much better, perhaps with the experience that the author has had in writing a book on the same theme earlier. A reading of these chapters does give some understanding of the subject to the reader. The main theme of the book appears to be to train students at problem solving—largely repetitive in nature. Because of this approach, the conveying of ideas/concepts is limited; somewhat reasonable for gas turbine engine, but poor for most other prime moves of jet propulsion.

The sections in the description of the propulsion systems like ramjets and rockets are also very poor. The entire description on rocket is dismissed in less than half a page—that too with blooming errors. It is better not to have presented the subject at all. I am not sure if the reason for this is the syllabus. An alternative path that the author could have taken is to reduce the gas dynamics tables, since they could be obtained from other sources as well, and used the space to describe other jet propulsion systems adequately.

On p. 126, the author has presented a comparison of gas turbine with reciprocating IC engine. There are several statements, which are only partly correct. Some which could be avoided are "Gas turbine engines are simple in construction". Perhaps I could say that diesel engines are much simpler in construction. These statements have no serious relevance in engineering. Another statement "gas turbine engine can be operated with cheaper and readily available fuels like peat coal, etc., whereas in the case of petrol and diesel engines the fuel requirements are specific and costlier". Nothing can be farther from truth than this. Diesel/gasoline engines draw air from ambient conditions and compress the air inside the cylinder. Hence, they can accommodate fuels like producer gas from coal/biomass, etc., but gas turbine engines should be designed around specific fuels like kerosene/diesel/methanol, etc., and aero engines are even more specific about the fuels.

Some part of the text seems to be missing on p. 155, second line from the top.

Finally, it is appropriate to conclude that there is not much to recommend in the book for readers other than students of the particular university where this may be a recommended book for study.

Department of Aerospace Engineering
Indian Institute of Science
Bangalore 560 012

H. S. Mukunda