The earlier chapters are well presented and give a good overview of what control allocation means and how it is designed. However, it is evident that the quality of the discussion in later chapters of the book is rather patchy. Some of the explanatory material is lacking in descriptive precision and mathematical rigour, and would benefit from more considered presentation. In particular, it would help if the controller design decisions are supported with some explanation as to how these are expected to influence flying qualities.

However, these are minor criticisms and the book should appeal to postgraduate researchers and to engineers engaged in advanced flight control system design and evaluation.

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Aerospace Materials and Material Technologies. Vol.1: Aerospace Materials

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This highly informative reference source is the latest in a series, inspired and approved by the Indian Institute of Metals. The work is offered in two volumes; Volume 1 addresses chemical/physical/mechanical compositions and properties. Volume 2 (to be reviewed at a later date) deals with material technologies, processing, testing, structural design and special evolving techniques.

Volume 1 Part 1, 'Metallic Materials', covers all important aerospace metals from light alloys to high temperature refractory materials.

Prized for low density, Mg alloys – discussed in Chapter 1 'Magnesium Alloys' – are widely used for casting secondary structures such as gearbox casings. Wrought alloys are also available and were used for Primary Structures, c1940-1960, but suffer from poor workability, poor corrosion resistance, low ductility and rapid loss of strength above 100°C.

'Aluminium Alloys for Aerospace Applications' (Chapter 2) ranges from Duralumin, c.1919, to current alloys (7075, 7055, and 7088) double the strength. Official tempering classifications, age hardening procedures, the effect of alloying elements and a general assessment of strengths are topics all well covered – creep excluded. Although creep is briefly considered in Chapters 1 and 9, the effect of creep on aluminium alloys is not mentioned in Chapters 2 and 3. The chance to discuss the development of engine alloy RR58, in preference to stainless steel or titanium for the Primary Structure of Concorde, has been missed.

'Aluminium-Lithium Alloys' (Chapter 3) summarises the development of first, second and third generation alloys. Lithium being the lightest metal in the periodic table offers weight savings and improved properties when introduced as an alloy element in 1–2.5% amounts. The authors state (quite rightly) that 1% of Lithium reduces density by about 3% and increases the elastic modules by an estimated 6%. See Table 3.1 for chemical properties and Table 3.2 and graphs for mechanical properties. The reader should, however, be wary of Fig 3.1 which shows the basic values grossly and linearly extrapolated with questionable slopes.

'Titanium Sponge Production and Processing for Aerospace Applications' (Chapter 4) is an unusual topic for any book, but details sourcing and processing procedures that transform so-called sponges into usual forms which are discussed in the following chapters 'Titanium Alloys, Parts 1 and 2'.

In 'Titanium Alloys: Part 1 – Physical Metallurgy and Processing' (Chapter 5), readers new to Physical Metallurgy will learn a lot about how crystal structures are formed; how, at a critical temperature, a body-centred cubic lattice may switch to a close packed hexagonal form; how changes in alloy constituents affect elastic properties, deformation modes, etc. Processing procedures are also discussed. The authors believe these alloys are destined to replace aluminium alloys, steels and nickel-based super alloys for sub-600°C compressor applications.

'Titanium Alloys: Part 2 – Alloy Development, Properties and Applications' (Chapter 6) includes more about secondary processing and microstructures of titanium alloys. The authors claim that the usage of alloys is increasing at the expense of the widely used alloy Ti-6Al -4V and claim in the summary, Section 6.3, that "the usage of titanium alloys can only grow, the only impediment being cost".

'Aero Steels: Part 1 – Low Alloy Steels' (Chapter 7) are defined as any steels in which the alloying elements: Mn, Si, Ni, Cr, Mo, V, N and Co amount to less than 8% by weight of the total, although the use of steel has declined from 40% to 15% in recent years. The authors value steel for its strength, toughness, low cost and wide availability, the versatility of steel in its many forms being unmatched.

Chapter 8 is titled 'Aero Steels: Part 2 – High Alloy Steels'. High Alloy Steels are steels in which the alloying content exceeds 8%. The reader may note: the keywords to Chapters 7 and 8 are almost identical, having much in common with other chapters. Low alloy steels are deemed suitable for high load density application, such as landing gears, whilst high alloy managing steels are here recommended for missile castings, forgings, recoil springs, bearings and transmission shafts.

In 'Nickel-Based Superalloys' (Chapter 9), numerous refractory superalloys, based on combinations of Fe, Ni, Co and Cr and lesser amounts of N, Mo, Ta, Nb, Ti and Al are discussed. Strength and processing issues are considered in detail. The reader is told single crystal nickel based superalloy manufacture is in its sixth generation of development (see Section 9.6). The alloys high strength at temperatures up to 650°C, combined with low temperature ductility, is particularly prized. But note claims made in Chapter 6.

'Structural Intermetallics' (Chapter 10) comprises a comprehensive study of crystal structure and composition of nickel, titanium, iron, aluminides, niobium and molybdenum-based silicides. Another interesting feature is the inclusion of many thermal equilibrium phase diagrams, which illustrate the complexity of numerous metallurgical issues. For practical applications, see figures 10.7 and 10.8 on page 242.

Many readers will associate the bronzes with huge marine propellers and other exposed marine components, all of which need to be resistant to salt water corrosion. With regard to aerospace applications, the subject of Chapter 11, the abstract recommends aluminium bronze and silicon bronze as suitable for anti-friction bearing cages, whilst oil impregnated sintered bronzes also have their uses.

'Niobium and Other High Temperature Refractory Metals for Aerospace Applications' (Chapter 12) places niobium close to nickel in density. Normally processed by powder sintering, it is sometimes refined by melting under vacuum. The authors report that current research is aimed at improving workability.

Part II 'Composites' (Chapter 13) introduces GLARE, a glass reinforced aluminium laminate, first introduced in the 1970s and currently used as a primary structure on the Airbus A380. Four grades of GLARE are identified: type 2A for stringers, 2B for butt straps, grades 3 and 4A for fuselage skins, and 5 for horizontal stabiliser and leading edges. Structural Compositions are summarised in Table 13.1, page 292.

In 'Carbon Fibre Polymer Matrix Structural Composites' (Chapter 14), Fig 14.1 shows how the structured use of CFRP has progressed from a few percent on the F-15A (c.1970) to 50% on the Boeing 787 (c.2011), to 52% on the A350 (c.2015). The current percentage use of composites and metallic are compared in a pie chart Fig 14.2. Twenty-six highly informative pages are devoted to strength, repair and safety issues.

'C/C and C/SiC Composites for Aerospace Applications' (Chapter 15) traces the development of these materials from early Space Shuttle days. Early sections are mainly to do with processing. Later sections cover high temperature strength and thermal protection. Numerous examples of aerospace components are shown in subsequent figures.

'Ceramic Matrix Composites (CMCs) for Aerospace Applications' (Chapter 16) are judged to be superior to polymer/metal composites, on the grounds of higher strength, higher melting point, higher hardness, lower coefficient of thermal expansion and better chemical inertness. Typical properties for a 'baker's dozen' of CMCs are given in Table 16.2. Processing details and pictorial examples are also included.

'Nanocomposites Potential for Aero Applications' (Chapter 17) reveals that nanocomposites have a matrix phase and a reinforcement phase similar to conventional composites, the only difference being the nano size of reinforcement used, typically 100 nm or less. The present status and limitations of these relatively new materials is truthfully stated as ongoing. Research is summarised in Section 17.7.

Part III 'Special Materials' begins with 'Monolithic Ceramics for Aerospace Applications' (Chapter 18) and heralds these materials as enabling and in certain cases the only choice for numerous 21st century applications. With melting temperatures up to 3900°C, alumina, zironia, silicon nitride and silicon carbide are the frontrunners and said to be candidates for hypersonic flight.

'Nano-enabled Multifunctional Materials for Aerospace Applications' (Chapter 19) introduces nanoplate, nanofibre, and nanoparticle innovations. The structure of single and double carbon nanotubes, rolled from Graphene, are illustrated and characteristics discussed. Ablative Char (used to protect spacecraft from superheated gases) and super hydrophobic coatings (used to counter ice build-up on leading edges) are interesting topics, along with Optical Photolithography and several other initiatives discussed in this chapter.

'MAX Phases: New Class of Carbides and Nitrides for Aerospace Structural Applications' (Chapter 20) bridges the gap between metals and ceramics. Discovered in the late 1960s, these so-called MAX phases were not successfully synthesised until 1996. Metallurgical studies suggest, "high rigidity and good machinability, along with good electrical and thermal conductivity". Applications are likely to include: rotating electrical contacts and bearings, heating elements, nozzles and heat exchangers.

'Shape Memory Alloys (SMAs) for Aerospace Applications' (Chapter 21) are here described as those alloys which undergo temperature dependent phase changes or respond to stress and magnetic fields, in like manners. Numerous pseudoelastic materials, such as Ag Cd, Cu Sn, Cu Zn and Ni Ti are identified. But the authors acknowledge that difficulties of incorporating SMAs into aircraft structures limit their use at the present time.

'Detonation Sprayed Coatings (DSC) for Aerospace Applications' (Chapter 22) addresses functional requirements that often dictate that the core and surface of a component are chemically and texturally different. The authors explain that DSC is principally a kinetic energy driven process, which is less reliant on heat transfer considerations and produces less oxidation and lower solidification stresses than other alternative methods. High Velocity Oxy-Fuel spray (HVOF) is discussed, as are special abradable and thermal barrier coatings.

Materials that change dimensions when exposed to an electric field or conversely produce an electrical charge when stressed are piezoelectric (strain gauges are an early example of use) and are discussed in 'Piezoceramic Materials and Devices for Aerospace Applications' (Chapter 23). The authors maintain that piezoelectric materials are increasingly used for sensors and actuators in vibration control, health monitoring, energy harvesting and self-powering micro aerial vehicles. Materials and fabrication issues are discussed.

Stealth normally means radar stealth, but as the authors point out in 'Stealth Materials and Technology for Airborne Systems' (Chapter 24), visual, infrared, electromagnetic and sound signatures are almost as important. All aspects of stealth are discussed from a materials point of view, but little is said of reflective shape design. Counter stealth and currently available stealth are issues discussed in Sections 24.8 and 24.9.

Aesthetic appeal and camouflage efficiency aside, the emphasis in 'Paints for Aerospace Applications' (Chapter 25) is on the selection and formulation of types of binder, pigments and solvents fashioned to meet specific needs. The essential requirements are good adhesion and high resistance to environmental erosion. Paints, like all other aspects of aviation, are subject to Airworthiness Certification requirements, ranging from composition, application, inspection and maintenance. These legal aspects are discussed in the text.

'Elastomers and Adhesives for Aerospace Applications' (Chapter 26) explains how vulcanisation promotes the formation of cross-linked polymer chains, thereby transforming runny sap bled from the rubber tree into firm but highly flexible viscoelastic solids. In addition to natural rubber, twelve structurally more complex synthetic rubber-like substances are discussed. See accompanying figures and Table 26.2 (based on ASTM D 1418) for lengthy chemical classifications and a motley of conflicting trade names.

The Voight Mathematical model, based on a spring/damper response analogy, is presented on pages 575–576. The concluding section on Adhesives offers much practical know-how to ISO 4588 (metals) and 3895 (plastics) standards, plus essential input on adhesion and surface preparation. Seven different types of adhesives are summarised and a long list of aerospace uses are tabulated towards the end of the chapter and book.

To paraphrase Professor Indranil Manna's words (pg x), "A considerable amount of materials data is compiled", albeit the promise of data-rich appendices at the end of each volume has not materialised. This omission does not, however, lessen the worth of what has been written, it being far more perplexing to find the book marketed without an index and the contents pages hidden deep into multi-faceted editorial commentary. This double whammy aside, the reviewer rates this book as one of the best Materials Science texts (of many) he has had the pleasure to study. The editors "wish (all their readers) Enrichment of Knowledge and Motivation". This is an excellent book to buy.

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