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Widely known and used throughout the astrodynamics and aerospace engineering communities, this teaching text was developed at the U.S. Air Force Academy. Completely revised and updated 2013 edition.

Advanced Technology for Human Support in Space was written in response to a request from NASA's Office of Life and Microgravity Sciences and Applications (OLMSA) to evaluate its Advanced Human Support Technology Program. This report reviews the four major areas of the program: advanced life support (ALS), environmental monitoring and control (EMC), extravehicular activities (EVA), and space human factors (SHF). The focus of this program is on long-term technology development applicable to future human long-duration space missions, such as for a hypothetical new mission to the Moon or Mars.

An argument that we have a moral duty to explore other planets and solar systems--because human life on Earth has an expiration date. Inevitably, life on Earth will come to an end, whether by climate disaster, cataclysmic war, or the death of the sun in a few billion years. To avoid extinction, we will have to find a new home planet, perhaps even a new solar system, to inhabit. In this provocative and fascinating book, Christopher Mason argues that we have a moral duty to do just that. As the only species aware that life on Earth has an expiration date, we have a responsibility to act as the shepherd of life-forms--not only for our species but for all species on which we depend and for those still to come (by accidental or designed evolution). Mason argues that the same capacity for ingenuity that has enabled us to build rockets and

land on other planets can be applied to redesigning biology so that we can sustainably inhabit those planets. And he lays out a 500-year plan for undertaking the massively ambitious project of reengineering human genetics for life on other worlds. As they are today, our frail human bodies could never survive travel to another habitable planet. Mason describes the toll that long-term space travel took on astronaut Scott Kelly, who returned from a year on the International Space Station with changes to his blood, bones, and genes. Mason proposes a ten-phase, 500-year program that would engineer the genome so that humans can tolerate the extreme environments of outer space--with the ultimate goal of achieving human settlement of new solar systems. He lays out a roadmap of which solar systems to visit first, and merges biotechnology, philosophy, and genetics to offer an unparalleled vision of the universe to come. As a technical organization, charged with performing groundbreaking and pathfinding challenges on a daily basis, NASA has long valued the role of its Chief Engineers and Lead Systems Engineers. Although it takes a team to accomplish our missions and no members are unimportant, the Chief Engineers and Lead Systems Engineers who we look to lead our technical teams are critical to the success of our endeavors. It is this corps of dedicated, experienced, and passionate problem solvers and leaders who battle the technical headwinds that face every project, finding often hidden solutions and overcoming seemingly insurmountable obstacles to create paths to success. Furthermore, it is that indomitable spirit of ingenuity and perseverance that defines the Agency. Developing our Chief Engineers and Lead Systems Engineers is a commitment of the NASA engineering community, and one of our tenets for excellence. This development ensures our corps of engineers obtain the depth of technical acumen that they require, first as discipline engineers and then as Chief Engineers

and Lead Systems Engineers, but also the associated management skills and experience to ensure they can interact with the rest of the project team and with program, Center, and Agency leadership. What's more, this development also ensures that NASA Chief Engineers and Lead Systems Engineers proficiently serve as leaders of their own technical teams, and that's what this book is all about. These technical leaders are critical to successfully implementing the three safety tenets we inherited from the Apollo program. These include the following: Strong in-line checks and balances. This means that engineers check their fellow engineers, and that no one checks their own homework. 1. Healthy tension between responsible organizations. In NASA today that is the programs and the three Technical Authorities (Engineering, Safety, and Health and Medical). Each organization has to be on equal footing with separate but equal chains of command to allow issues to be raised independently and provide the healthy tension to create organizational checks and balances. 2. "Value-added" independent assessment. "Value-added" means you bring in outside technical experts to peer review critical issues. Having a fresh set of eyes on a problem can provide a different perspective, leverage different experiences and result in more robust solutions. 3. NASA arrived at these three tenets through considerable blood, sweat, and loss, and our commitment to them is now inscribed in our Agency governance. As Chief Engineers and Lead Systems Engineers, your role in this is paramount, and achieving excellence in this is an expectation of your job. Serving in this role is not an easy task, but it is a tremendously reward¬ing one. You are the leaders of your technical teams, owners of the technical baseline, standard bearers of engineering best practices, decision makers, risk mitigators and problem solvers. You are Chief Engineers and Lead Systems Engineers, the title of which should say it

all.

Public places are places where all citizens, irrespective of their race, age, religion, or class level (social or economic), cannot be excluded. It serves to improve the lifestyle experience of its inhabitants, as well as promote social connections. All citizens are responsible for it and are interested in it, and the intervention for change must be the responsibility of all without exception. As such, bottom-up urban planning is essential for urban environments and for transforming nightlife in public places in order to create more meaningful experiences and instill a greater sense of identity and community. Transforming Urban Nightlife and the Development of Smart Public Spaces analyzes the patterns of transformations of nightlife in public life. The book investigates urban nightlife transformations and the challenge of enhancing the sense of belonging in sensitive areas such as local communities and historical sites. The chapters present new insights to control the chaotic intervention related to the elements of traditional or digital technology, whether from citizens themselves or local authorities. The objective also is to document urban nightlife transformations that enhance the sense of belonging in historical sites. Important topics covered include urban-gamification, digital urban art, urban socio-ecosystems, and reimagining space in the urban nightlife. This book is ideal for urban planners, developers, social scientists, technologists, civil engineers, architects, policymakers, government officials, practitioners, researchers, academicians, and students who are interested in urban nightlife and nightscape and the smart technologies used for transformation.

The goal of this book is to allow you to begin with a "blank sheet of paper" and design a space mission to meet a set of broad, often poorly defined, objectives. You should be able to define

the mission in sufficient detail to identify principal drivers and make a preliminary assessment of overall performance, size, cost, and risk. The emphasis of the book is on low-Earth orbit, unmanned spacecraft. However, we hope that the principles are broad enough to be applicable to other missions as well. We intend the book to be a practical guide, rather than a theoretical treatise. As much as possible, we have provided rules of thumb, empirical formulas, and design algorithms based on past experience. We assume that the reader has a general knowledge of physics, math, and basic engineering, but is not necessarily familiar with any aspect of space technology. This book was written by a group of senior engineers with over 800 years of collective space experience. It reflects the insight gained from this practical experience, and suggests how things might be done better in the future. From time to time the views of authors and editors conflict, as must necessarily occur given the broad diversity of experience. We believe it is important to reflect this diversity rather than suppress the opinions of individual authors.

From Voyager to Stardust, this complete guide to NASA's deep space probes features a DVD containing thousands of pictures and videos captured by the journeying probes. 250 photos, 100 in full color.

One of the Washington Post's 20 Books to Read This Summer A riveting history of the epic orbital flight that put America back into the space race. If the United States couldn’t catch up to the Soviets in space, how could it compete with them on Earth? That was the question facing John F. Kennedy at the height of the Cold War—a perilous time when the Soviet Union built the wall in Berlin, tested nuclear bombs more destructive than any in history, and beat the United States to every major milestone in space. The race to the heavens seemed a race for

survival—and America was losing. On February 20, 1962, when John Glenn blasted into orbit aboard Friendship 7, his mission was not only to circle the planet; it was to calm the fears of the free world and renew America's sense of self-belief. Mercury Rising re-creates the tension and excitement of a flight that shifted the momentum of the space race and put the United States on the path to the moon. Drawing on new archival sources, personal interviews, and previously unpublished notes by Glenn himself, Mercury Rising reveals how the astronaut's heroics lifted the nation's hopes in what Kennedy called the "hour of maximum danger." Following on from the hugely successful previous editions, the third edition of Spacecraft Systems Engineering incorporates the most recent technological advances in spacecraft and satellite engineering. With emphasis on recent developments in space activities, this new edition has been completely revised. Every chapter has been updated and rewritten by an expert engineer in the field, with emphasis on the bus rather than the payload. Encompassing the fundamentals of spacecraft engineering, the book begins with front-end system-level issues, such as environment, mission analysis and system engineering, and progresses to a detailed examination of subsystem elements which represent the core of spacecraft design - mechanical, electrical, propulsion, thermal, control etc. This quantitative treatment is supplemented by an appreciation of the interactions between the elements, which deeply influence the process of spacecraft systems design. In particular the revised text includes * A new chapter on small satellites engineering and applications which has been contributed by two internationally-recognised experts, with insights into small satellite systems engineering. * Additions to the mission analysis chapter, treating issues of aero-manouevring, constellation design and small body missions. In summary, this is an outstanding textbook for aerospace

engineering and design students, and offers essential reading for spacecraft engineers, designers and research scientists. The comprehensive approach provides an invaluable resource to spacecraft manufacturers and agencies across the world.

The history-making astronaut, aerospace engineer and respected advocate for space colonization outlines a plan for taking humans to Mars within the next quarter century, posing business-specific arguments while outlining practical strategies for travel and planetary homesteading.

Progress in space safety lies in the acceptance of safety design and engineering as an integral part of the design and implementation process for new space systems. Safety must be seen as the principle design driver of utmost importance from the outset of the design process, which is only achieved through a culture change that moves all stakeholders toward front-end loaded safety concepts. This approach entails a common understanding and mastering of basic principles of safety design for space systems at all levels of the program organisation. Fully supported by the International Association for the Advancement of Space Safety (IAASS), written by the leading figures in the industry, with frontline experience from projects ranging from the Apollo missions, Skylab, the Space Shuttle and the International Space Station, this book provides a comprehensive reference for aerospace engineers in industry. It addresses each of the key elements that impact on space systems safety, including: the space environment (natural and induced); human physiology in space; human rating factors; emergency capabilities; launch propellants and oxidizer systems; life support systems; battery and fuel cell safety; nuclear power generators (NPG) safety; habitat activities; fire protection; safety-critical software development; collision avoidance systems design; operations and on-

orbit maintenance. * The only comprehensive space systems safety reference, its must-have status within space agencies and suppliers, technical and aerospace libraries is practically guaranteed * Written by the leading figures in the industry from NASA, ESA, JAXA, (et cetera), with frontline experience from projects ranging from the Apollo missions, Skylab, the Space Shuttle, small and large satellite systems, and the International Space Station. * Superb quality information for engineers, programme managers, suppliers and aerospace technologists; fully supported by the IAASS (International Association for the Advancement of Space Safety)
Stenciled on many of the deactivated facilities at Cape Canaveral Air Force Station, the evocative phrase “abandoned in place” indicates the structures that have been deserted. Some structures, too solid for any known method of demolition, stand empty and unused in the wake of the early period of US space exploration. Now Roland Miller’s color photographs document the NASA, Air Force, and Army facilities across the nation that once played a crucial role in the space race. Rapidly succumbing to the elements and demolition, most of the blockhouses, launch towers, tunnels, test stands, and control rooms featured in Abandoned in Place are located at secure military or NASA facilities with little or no public access. Some have been repurposed, but over half of the facilities photographed no longer exist. The haunting images collected here impart artistic insight while preserving an important period in history.
Manned Spacecraft Design Principles presents readers with a brief, to-the-point primer that includes a detailed introduction to the information required at the preliminary design stage of a manned space transportation system. In the process of developing the preliminary design, the book covers content not often discussed in a standard aerospace curriculum, including

atmospheric entry dynamics, space launch dynamics, hypersonic flow fields, hypersonic heat transfer, and skin friction, along with the economic aspects of space flight. Key concepts relating to human factors and crew support systems are also included, providing users with a comprehensive guide on how to make informed choices from an array of competing options. The text can be used in conjunction with Pasquale Sforza's, Commercial Aircraft Design Principles to form a complete course in Aircraft/Spacecraft Design. Presents a brief, to-the-point primer that includes a detailed introduction to the information required at the preliminary design stage of a manned space transportation system Involves the reader in the preliminary design of a modern manned spacecraft and associated launch vehicle Includes key concepts relating to human factors and crew support systems Contains standard, empirical, and classical methods in support of the design process Culminates in the preparation of a professional quality design report

This book is based on class notes for a course in the MS program in Systems Engineering at Johns Hopkins University. The program was a cooperative effort between senior systems engineers from the Johns Hopkins University Applied Physics Laboratory and the Westinghouse Electric Company. The authors were part of the curriculum design team as well as members of the faculty.

"Human spaceflight: mission analysis and design" is for you if you manage, design, or operate systems for human spaceflight! It provides end-to-end coverage of designing human space systems for Earth, Moon, and Mars. If you are like many others, this will become the dog-eared book that is always on your desk -and used. The book includes over 800 rules of thumb and sanity checks that will enable you to identify key issues and errors early in the design

processes. This book was written by group of 67 professional engineers, managers, and educators from industry, government, and academia that collectively share over 600 years of space-related experience! The team from the United States, Austria, Canada, France, Germany, Japan, and Russia worked for four-and-one-half years to capture industry and government best practices and lessons-learned from industry and government in an effort to baseline global conceptual design experience for human spaceflight. "Human spaceflight: mission analysis and design" provides a much-needed big-picture perspective that can be used by managers, engineers and students to integrate the myriad of elements associated with human spaceflight.

"The purpose of 'Human spaceflight operations : lessons learned from 60 years in space' is to share collective experience on human spaceflight operations. The lessons learned are applicable to anyone working in the space industry as part of a current or future national or international space program, private space enterprise, human, or robotic mission. The book's chapters cover the primary technical disciplines related to spaceflight operations. In each case, the essential concepts and evolution of the systems and technology are discussed in some detail, but the focus is on how spaceflight operations are performed. Lessons learned are derived from incidents that occurred during actual space missions. Some of these lessons are explained directly by the astronauts who experienced them firsthand"--

Reducing Space Mission Cost is the first complete treatment of the technology, process, and problems in the most critical areas of modern spaceflight. The demand to reduce cost is unrelenting. This pioneering book addresses all aspects of this problem, including: Technology and processes for reducing cost Cost reduction in mission engineering, spacecraft design,

manufacture, launch, and operations Implementation methods and problems The price of reducing cost 10 detailed case studies of what works in practice in: Science missions Interplanetary probes Communications spacecraft Test and Applications missions Beginning on the inside front cover, this book provides real cost data on a variety of missions, systems, and subsystems. According to the authors: `Reducing mission cost is hard enough if you know what the real costs are, and virtually impossible if you don't.' This book challenges traditional methods, yet recognizes that all space programs are run to minimize cost within the rules under which they are built and flown. It provides practical recipes for reducing cost in both new and ongoing missions and discusses what works, what government can do to help, and what methods intended to reduce cost may be counterproductive and unintentionally increase cost. As shown on the inside rear cover, the case studies described in the book have reduced total mission cost by 80% to more than 90% with respect to projections by traditional cost methods. This book is a follow-on to the now standard text and reference, Space Mission Analysis and Design, also edited by Drs. Wertz and Larson. It is required reading for professionals, students, and managers in astronautics or space sciences and managers or scientists involved in space experiments. This book shows that reducing space mission cost, without reducing reliability, is as possible as it is important for the future of space exploration.

The untold story of a national trauma—NASA’s Challenger explosion—and what really happened to America’s Teacher in Space, illuminating the tragic cost of humanity setting its sight on the stars You’ve seen the pictures. You know what happened. Or do you? On January 28, 1986, NASA’s space shuttle Challenger exploded after blasting off from Cape Canaveral. Christa McAuliffe, America’s “Teacher in Space,” was instantly killed, along with

the other six members of the mission. At least that's what most of us remember. Kevin Cook tells us what really happened on that ill-fated, unforgettable day. He traces the pressures—leading from NASA to the White House—that triggered the fatal order to launch on an ice-cold Florida morning. Cook takes readers inside the shuttle for the agonizing minutes after the explosion, which the astronauts did indeed survive. He uncovers the errors and corner-cutting that led an overconfident space agency to launch a crew that had no chance to escape. But this is more than a corrective to a now-dimming memory. Centering on McAuliffe, a charmingly down-to-earth civilian on the cusp of history, The Burning Blue animates a colorful cast of characters: a pair of red-hot flyers at the shuttle's controls, the second female and first Jewish astronaut, the second Black astronaut, and the first Asian American and Buddhist in space. Drawing vivid portraits of Christa and the astronauts, Cook makes readers forget the fate they're hurtling toward. With drama, immediacy, and shocking surprises, he reveals the human price the Challenger crew and America paid for politics, capital-P Progress, and the national dream of "reaching for the stars."

Called "spellbinding" (Scientific American) and "thrilling...a future classic of popular science" (PW), the up close, inside story of the greatest space exploration project of our time, New Horizons' mission to Pluto, as shared with David Grinspoon by mission leader Alan Stern and other key players. On July 14, 2015, something amazing happened. More than 3 billion miles from Earth, a small NASA spacecraft called New Horizons screamed past Pluto at more than 32,000 miles per hour, focusing its instruments on the long mysterious icy worlds of the Pluto system, and then, just as quickly, continued on its journey out into the beyond. Nothing like this has occurred in a generation—a raw exploration of new worlds unparalleled since NASA's

Voyager missions to Uranus and Neptune—and nothing quite like it is planned to happen ever again. The photos that New Horizons sent back to Earth graced the front pages of newspapers on all 7 continents, and NASA's website for the mission received more than 2 billion hits in the days surrounding the flyby. At a time when so many think that our most historic achievements are in the past, the most distant planetary exploration ever attempted not only succeeded in 2015 but made history and captured the world's imagination. How did this happen? Chasing New Horizons is the story of the men and women behind this amazing mission: of their decades-long commitment and persistence; of the political fights within and outside of NASA; of the sheer human ingenuity it took to design, build, and fly the mission; and of the plans for New Horizons' next encounter, 1 billion miles past Pluto in 2019. Told from the insider's perspective of mission leader Dr. Alan Stern and others on New Horizons, and including two stunning 16-page full-color inserts of images, Chasing New Horizons is a riveting account of scientific discovery, and of how much we humans can achieve when people focused on a dream work together toward their incredible goal.

Fundamentals of Space Systems was developed to satisfy two objectives: the first is to provide a text suitable for use in an advanced undergraduate or beginning graduate course in both space systems engineering and space system design. The second is to be a primer and reference book for space professionals wishing to broaden their capabilities to develop, manage the development, or operate space systems. The authors of the individual chapters are practicing engineers that have had extensive experience in developing sophisticated experimental and operational spacecraft systems in addition to having experience teaching the subject material. The text presents the fundamentals of all the subsystems of a spacecraft

missions and includes illustrative examples drawn from actual experience to enhance the learning experience. It includes a chapter on each of the relevant major disciplines and subsystems including space systems engineering, space environment, astrodynamics, propulsion and flight mechanics, attitude determination and control, power systems, thermal control, configuration management and structures, communications, command and telemetry, data processing, embedded flight software, survuvability and reliability, integration and test, mission operations, and the initial conceptual design of a typical small spacecraft mission.

In recent decades, the number of satellites being built and launched into Earth's orbit has grown immensely, alongside the field of space engineering itself. This book offers an in-depth guide to engineers and professionals seeking to understand the technologies behind Low Earth Orbit satellites. With access to special spreadsheets that provide the key equations and relationships needed for mastering spacecraft design, this book gives the growing crop of space engineers and professionals the tools and resources they need to prepare their own LEO satellite designs, which is especially useful for designers of small satellites such as those launched by universities. Each chapter breaks down the various mathematics and principles underlying current spacecraft software and hardware designs.

"America's funniest science writer" (Washington Post) explores the irresistibly strange universe of life without gravity in this New York Times bestseller. The best-selling author of Stiff and Bonk explores the irresistibly strange universe of space travel and life without gravity. From the Space Shuttle training toilet to a crash test of NASA's new space capsule, Mary Roach takes us on the surreally entertaining trip into the science of life in space and space on Earth.

NASA operates a large number of space science missions, approximately three-quarters of which are currently in their extended operations phase. They represent not only a majority of operational space science missions, but a substantial national investment and vital national assets. They are tremendously scientifically productive, making many of the major discoveries that are reported in the media and that rewrite textbooks. Extending Science â€" NASA's Space Science Mission Extensions and the Senior Review Process evaluates the scientific benefits of missions extensions, the current process for extending missions, the current biennial requirement for senior reviews of mission extensions, the balance between starting new missions and extending operating missions, and potential innovative cost-reduction proposals for extended missions, and makes recommendations based on this review.

This book is a completely rewritten, updated, and expanded follow-on to the 3rd edition of Space mission analysis and design.

This book describes the most complex machine ever sent to another planet: Curiosity. It is a one-ton robot with two brains, seventeen cameras, six wheels, nuclear power, and a laser beam on its head. No one human understands how all of its systems and instruments work. This essential reference to the Curiosity mission explains the engineering behind every system on the rover, from its rocket-powered jetpack to its radioisotope thermoelectric generator to its fiendishly complex sample handling system. Its lavishly illustrated text explains how all the instruments work -- its cameras, spectrometers, sample-cooking oven, and weather station -- and describes the instruments' abilities and limitations. It tells you how the systems have functioned on

Mars, and how scientists and engineers have worked around problems developed on a faraway planet: holey wheels and broken focus lasers. And it explains the grueling mission operations schedule that keeps the rover working day in and day out.
Changing the focus of the multibillion-dollar global aerospace business toward smaller, lower-cost spacecraft is not happening solely due to technical, managerial, financial or market motivations. Rick Fleeter's second book on the small, low-cost space programmes which are the fastest-growing segment of aerospace activity, gives the reader a keen understanding of the full spectrum of factors driving this profound change. The text then goes beyond engineering technologies and management techniques to envision the tantalizing prospects microspace has in store for the industry, its present markets and those of the future.
This handbook is a companion to NPR 7120.5E, NASA Space Flight Program and Project Management Requirements and supports the implementation of the requirements by which NASA formulates and implements space flight programs and projects. Its focus is on what the program or project manager needs to know to accomplish the mission, but it also contains guidance that enhances the understanding of the high-level procedural requirements. (See Appendix C for NPR 7120.5E requirements with rationale.) As such, it starts with the same basic concepts but provides context, rationale, guidance, and a greater depth of detail for the fundamental principles of program and project management. This handbook also explores some of

the nuances and implications of applying the procedural requirements, for example, how the Agency Baseline Commitment agreement evolves over time as a program or project moves through its life cycle.

From the late 1950s to 1976 the U.S. manned spaceflight program advanced as it did largely due to the extraordinary efforts of Austrian immigrant George M. Low. Described as the "ultimate engineer" during his career at NASA, Low was a visionary architect and leader from the agency's inception in 1958 to his retirement in 1976. As chief of manned spaceflight at NASA, Low was instrumental in the Mercury, Gemini, and Apollo programs. Low's pioneering work paved the way for President Kennedy's decision to make a lunar landing NASA's primary goal in the 1960s. After the tragic 1967 Apollo 1 fire that took the lives of three astronauts and almost crippled the program, Low took charge of the redesign of the Apollo spacecraft, and he helped lead the program from disaster and toward the moon. In 1968 Low made the bold decision to go for lunar orbit on Apollo 8 before the lunar module was ready for flight and after only one Earth orbit test flight of the command and service modules. Under Low there were five manned missions, including Apollo 11, the first manned lunar landing. Low's clandestine negotiations with the Soviet Union resulted in a historic joint mission in 1975 that was the precursor to the Shuttle-Mir and International Space Station programs. At the end of his NASA career, Low was one of the leading figures in the development of the space shuttle in the early 1970s, and he was instrumental in NASA's transition into a post-

Apollo world. Afterward, he embarked on a distinguished career in higher education as a transformational president of Rensselaer Polytechnic Institute, his alma mater. Chronicling Low's escape from Nazi-occupied Austria to his helping land a man on the moon, The Ultimate Engineer sheds new light on one of the most fascinating and complex personalities of the golden age of U.S. manned space travel.

With the second edition of Space Mission Analysis and Design, two changes have been introduced in the Space Technology Library. Foremost among these is the intro duction of the Space Technology Series as a part of the Space Technology Library. Dr. Wiley Larson of the US Air Force Academy and University of Colorado, Colorado Springs, will serve as Managing Editor for the Space Technology Series. This series is a cooperative effort of the Department of Defense, National Aeronautics and Space Administration, Department of Energy, and European Space Agency, coor dinated by the US Air Force Academy. The sponsors intend to bring a number of books into the series to improve the literature base in the fundamentals of space technology, beginning with the current volume. Books which are not a part of the Space Technology Series, but which also represent a substantial contribution to the space technology literature, will still be published in the Space Technology Library. As always, we welcome suggestions and contributions from the aerospace com munity.

This handbook consists of six core chapters: (1) systems engineering fundamentals discussion, (2) the NASA program/project life cycles, (3) systems engineering

processes to get from a concept to a design, (4) systems engineeringprocesses to get from a design to a final product, (5) crosscutting management processes in systems engineering, and (6) special topics relative to systems engineering. These core chapters are supplemented by appendices that provide outlines, examples, and further information to illustrate topics in the core chapters. The handbook makes extensive use of boxes and figures to define, refine, illustrate, and extend concepts in the core chapters without diverting the reader from the main information. The handbook provides top-level guidelines for good systems engineering practices; it is not intended in any way to be a directive. NASA/SP-2007-6105 Rev1 supersedes SP-6105, dated June 1995

Advanced space exploration is performed by unmanned missions with integrated autonomy in both flight and ground systems. Risk and feasibility are major factors supporting the use of unmanned craft and the use of automation and robotic technologies where possible. Autonomy in space helps to increase the amount of science data returned from missions, perform new science, and reduce mission costs. Elicitation and expression of autonomy requirements is one of the most significant challenges the autonomous spacecraft engineers need to overcome today. This book discusses the Autonomy Requirements Engineering (ARE) approach, intended to help software engineers properly elicit, express, verify, and validate autonomy requirements. Moreover, a comprehensive state-of-the-art of software engineering for aerospace is

presented to outline the problems handled by ARE along with a proof-of-concept case study on the ESA's BepiColombo Mission demonstrating the ARE's ability to handle autonomy requirements.

CubeSat Handbook: From Mission Design to Operations is the first book solely devoted to the design, manufacturing, and in-orbit operations of CubeSats. Beginning with an historical overview from CubeSat co-inventors Robert Twiggs and Jordi Puig-Suari, the book is divided into 6 parts with contributions from international experts in the area of small satellites and CubeSats. It covers topics such as standard interfaces, on-board & ground software, industry standards in terms of control algorithms and sub-systems, systems engineering, standards for AITV (assembly, integration, testing and validation) activities, and launch regulations. This comprehensive resource provides all the information needed for engineers and developers in industry and academia to successfully design and launch a CubeSat mission. Provides an overview on all aspects that a CubeSat developer needs to analyze during mission design and its realization Features practical examples on how to design and deal with possible issues during a CubeSat mission Covers new developments and technologies, including ThinSats and PocketQubeSats

The moon landing of 1969 stands as an iconic moment for both the United States

and humankind. The familiar story focuses on the journey of the brave astronauts, who brought home Moon rocks and startling photographs. But Apollo's full account includes the earthbound engineers, mounds of their crumpled paper, and smoldering metal shards of exploded engines. How exactly did the nation, step by difficult step, take men to the Moon and back? In The Apollo Chronicles, fifty years after the moon landing, author Brandon R. Brown, himself the son of an Apollo engineer, revisits the men and women who toiled behind the lights. He relays the defining twentieth-century project from its roots, bringing the engineers' work and personalities to bright life on the page. Set against the backdrop of a turbulent American decade, the narrative whisks audiences through tense deadlines and technical miracles, from President John F. Kennedy's 1961 challenge to NASA's 1969 lunar triumph, as engineers confronted wave after wave of previously unthinkable challenges. Brown immerses readers in key physical hurdles--from building the world's most powerful rockets to keeping humans alive in the hostile void of space--using language free of acronyms and technical jargon. The book also pulls back from the detailed tasks and asks larger questions. What did we learn about the Moon? And what can this uniquely innovative project teach us today?

From a long-term planning lead for the Mars Exploration Rover Project comes

this vivid insider account of some of NASA's most vital and exciting missions to the Red Planet, illustrated with full-color photographs—a wondrous chronicle of unprecedented scientific discovery and the search for evidence of life on Mars. "There are probably just a few of moments in human history when a small group of humans stood on the margins of a vast new world, and it is no stretch of the romantic imagination that the arrival of two rovers on the surface of another planet was surely one of them." Human exploration of Mars is the most ambitious and exciting scientific goal of the twenty-first century. Few people know as much about this fascinating planet as Dr. Larry Crumpler. As one of the long-term planning leads for the Mars Exploration Rover Project, he helped control the daily communications between NASA and the rovers roaming the planet to gather scientific data. Thanks to the Rover Project, we now know that the dry, red dust of the planet's surface hides a wet, possibly living history, and that conditions were present for the evolution of complex, organic life. In this magnificent compendium, Dr. Crumpler recounts the history of the Red Planet, from the earliest days when ancient astronomers turned their eyes to the heavens to the breakthrough discoveries being unearthed by modern technology today, including some of the first images from the latest rover, Perseverance. Paired with stunning, full-color photographs taken by rovers and NASA satellites images, this

magnificent “biography” of the red planet allows us to understand and experience it as never before. When the Spirit and Opportunity Rovers landed on Mars in January 2004, scientists expected them to function for 90 days. But those three months turned into fifteen years. With data gathered by the rovers, Dr. Crumpler and his fellow team members were able to reconstruct the planet’s stunning geological past, when it was once inundated with water, and perhaps could have supported microbial life. Dr Crumpler also reveals the joys and demands of life as a scientist taking part in these historic missions. Exploring fundamental questions about this remarkable planet that have intrigued us earthlings for years, Missions to Mars illuminates Mars’ significance in the solar system—and the human imagination.

From "America's nerviest journalist" (Newsweek)--a breath-taking epic, a magnificent adventure story, and an investigation into the true heroism and courage of the first Americans to conquer space. "Tom Wolfe at his very best" (The New York Times Book Review) Millions of words have poured forth about man's trip to the moon, but until now few people have had a sense of the most engrossing side of the adventure; namely, what went on in the minds of the astronauts themselves - in space, on the moon, and even during certain odysseys on earth. It is this, the inner life of the astronauts, that Tom Wolfe

describes with his almost uncanny empathetic powers, that made The Right Stuff a classic.

We're on the cusp of new era in the great adventure of space exploration. More than a half-century ago, humanity first hurled objects into space, and almost 50 years ago, astronauts first walked on the moon. Since then, we have explored Earth's orbit with shuttles, capsules, and space stations; sent robots to Mars, Venus, Mercury, Jupiter, Saturn, and Uranus; sampled a comet; sent telescopes into orbit; and charted most of our own planet. What does the future hold? In Space 2.0, space historian Rod Pyle, in collaboration with the National Space Society, will give you an inside look at the next few decades of spaceflight and long-term plans for exploration, utilization, and settlement. No longer the exclusive domain of government entities such as NASA and other national agencies, space exploration is rapidly becoming privatized, with entrepreneurial startups building huge rocket boosters, satellites, rocket engines, asteroid probes, prospecting craft, and even commercial lunar cargo landers to open this new frontier. Research into ever more sophisticated propulsion and life support systems will soon enable the journey to Mars and destinations deeper in our solar system. As these technologies continue to move forward, there are virtually no limits to human spaceflight and robotic exploration. While the world has waited

since the Apollo lunar program for the next "giant leap," these critical innovations, most of which are within our grasp with today's technology, will change the way we live, both in space and on Earth. A new space age—and with it, a new age of peace and prosperity on Earth, and settlement beyond our planet—can be ours. Speaking with key leaders of the latest space programs and innovations, Pyle shares the excitement and promise of this new era of exploration and economic development. From NASA and the Russian space agency Roscosmos, to emerging leaders in the private sector such as SpaceX, Blue Origin, Moon Express, Virgin Galactic, and many others, Space 2.0 examines the new partnerships that are revolutionizing spaceflight and changing the way we reach for the stars.