PREFACE

The drive toward the manned exploration of the moon is the most daring and costly single engineering project in history. The audacity of the concept, the giant resources to be mobilized, and the enormous cost that will be involved make it imperative that the program decisions be prompt and correct.

This book describes in part the technical base on which such decisions must rest. Through the medium of papers prepared by specialists in most of the related fields, it attempts to give a view of the lunar exploration problem as seen in mid-1962. Some of the material is certain to be ephemeral, only of transient value, as were many papers on nuclear energy published during the opening of the nuclear age. Some of it, however, is basic. Three years after the first impact of a man-made object on the moon, and in the year when men floated weightless for a million miles, U. S. specialists understood the main technical outlines of the problem, even if they could not match these achievements. U. S. rockets delivered one malfunctioning spacecraft to the moon, shot two others into heliocentric orbits, placed a planetary craft on course to Venus, and propelled three astronauts into flawless orbital flights. In this book both the technical foundations of these achievements and some of the problems of their execution are described.

Although it is recognized that this book cannot cover all technical fields and does not discuss all foreseeable problems, it is anticipated that it will serve as valuable point of departure for investigators interested in specific technical problem areas. To this end the authors have been encouraged to include as much bibliographic material as possible. The technical papers are organized into six sections that follow the various stages of accomplishment of a lunar mission, involving landing on or orbiting the moon and returning to the earth.

One of the factors that make the exploration of the moon extremely difficult is the demanding environment for which the spacecraft must be designed. The spacecraft is required to operate in cislunar space, in the near vicinity of the moon, and on the lunar surface itself. The data derived from the various satellite programs have yielded relatively firm knowledge of the cislunar environment. However, there is no clear understanding of the lunar environment from the standpoint of spacecraft design specifications.

The first section, therefore, is devoted to the problem of trying to define the lunar environment. To this end, Dr. Kopal describes his theories on the lunar environment itself, as it relates to the internal structure of the moon. The following papers describe some activities that are currently under way to achieve a reasonable theory concerning what might be encountered in some of our initial lunar flight programs.

The second section explores the problems associated with the limitations imposed upon lunar missions by the launch vehicles and launching facilities. Launch, midcourse, and rendezvous techniques are covered. Because of the marginal performance capabilities of the present U. S. launch vehicles in terms of space missions, the Atlantic Missile Range must be utilized to enhance performance by taking advantage of the eastward rotation of the earth. It also will be necessary to perform some kind of rendezvous techniques for some of the larger, more sophisticated future programs, until very large boosters are available. Parking orbits will become increasingly important. Also, because of the necessity for interim use of ballistic missiles as the basic launching vehicles for the space program, the accuracy requirements for the space mission demand guidance refinements, which are accomplished through midcourse maneuvers.

The third section looks at the spacecraft systems and techniques required for lunar missions. Here, the technology and specific subsystems are discussed in relation to the requirements imposed by specific lunar mission objectives. Such topics include the constraints imposed by placing a man in the system, the considerations of designing a tanking system in the light of the expected meteoroid problems, and the thermal problems anticipated for space suit operation outside of controlled environments.

The fourth section deals with the actual landing on the moon and the subsequent surface operations. Since the landing phase is critical in the Apollo abort considerations, the first paper discusses the abort problem for various aspects of the near-lunar modes. The next paper discusses a concept of rendezvous on the lunar surface, considering primarily the requirements for precision landings. Two papers cover the actual operations on the surface: one discusses point-to-point communications on the surface based upon the currently available information; the other explores the problems associated with trying to operate any type of complicated machinery on the surface, in view of the time lag inherent in communicating with the moon. A discussion of the simulation of the manned lunar landing is related to the importance of assuring success in the manned lunar program.

The fifth section covers the lunar launch, return, flight re-entry, and subsequent landing on earth. The lunar launching aspects are seen to be particularly complex when viewed in the light of the size of the operation and the numbers of people involved in launching simply a sounding rocket from earth. When coupled with the attendant time delays associated with the earth-moon communication distance, this operation is formidably complex. In returning to the earth, many problems also will have to be solved, not the least of which is assuring that the spacecraft is returned so as to be ready for landing at a preselected spot. The re-entry, of course, is most critical and represents one of the major design constraints due to the heating and gravity problems. Either the ballistic or the aerodynamic type of re-entry presents problems which, in many respects, govern the entire mission concept. The landing is also a matter of great technological concern, in relation to absorbing the landing shocks and then locating and recovering the astronaut.

The sixth section reports the status of the projects which represent the present U. S. lunar exploration program. This program integrates the technologies developed in the preceding sections into four discrete projects. It is important that these projects maintain schedules and prove out and demonstrate the techniques and technologies that will be required to carry out the overall national objective of landing men on the moon by the end of the decade.

It seems appropriate in a book on this subject to acquaint the reader with certain matters of national policy relating to the lunar program. To this end, statements by persons having authoritative knowledge of the thinking of the U. S. Air Force, the National Aeronautics and Space Administration, and the U. S. Atomic Energy Commission are included in this volume in the Appendix. Although they write as individuals and not as officials, their thoughts are worthy of attention.

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