

## **Prologue**

*Lunar Bases and Space Activities of the 21st Century is a collection of short papers dealing with various aspects of a manned lunar base and the concomitant expansion of humanity into near-Earth space. Most of these papers were delivered at a symposium on the subject, sponsored by NASA and hosted by the National Academy of Sciences in Washington, DC, October 29–31, 1984. The program of the symposium reflected the structure of the Report of the Lunar Base Working Group, the output of a workshop sponsored by NASA and hosted by the Institute of Geophysics and Planetary Physics of the University of California. The Lunar Base Working Group, consisting of approximately 50 scientists, engineers, industrialists, and scholars, met during the week of April 23–27, 1984, at the Los Alamos National Laboratory to discuss the scientific, technological, and social issues associated with a permanently crewed facility on the lunar surface.*

*Although these meetings have been conducted and these papers are being published under NASA auspices, the work presented here is not a formal part of an advanced planning activity within the agency. Official NASA studies of lunar bases ceased in 1972. Since the early 70's, the program has focused on operations in low-Earth orbit (LEO) with the space shuttle and, more recently, with the space station. The past decade of fiscal, technical, and political pressure has discouraged all but very near-term planning and has given birth to pervasive conservatism in the body bureaucratic. This book, the symposium, and the precursor workshop are part of an ongoing effort to expand the discussion of future activities in the United States space program to include the era following the LEO space station.*

*In late 1981, Jeff Warner, Mike Duke, and I realized that the space transportation technology of the year 2000 would be capable of routinely carrying payloads to the Moon. At first our interest centered on the scientific groundwork for future lunar activities, but we soon became aware that a permanent lunar base has far-reaching implications for national policy, international relations, and American technology. In a conservative scenario, a lunar program would become the major space policy issue upon initiation of routine operations at the LEO space station, i.e., in the mid 1990's. However, the capabilities—and limitations—of the Space Transportation System are being established today. Thus, we argued, a low level*

*research program ought to be instituted now to develop rationale, investigate strategies, and explore technology associated with lunar development.*

*Over the past four years, such arguments have made small headway within NASA, in an institutional sense, for a variety of reasons. A lunar base project does not fall within the clear purview of any of the Associate Administrators. Therefore, sympathetic program managers find it difficult to provide steady support in the context of currently identified budget categories. Some involved in NASA planning believe that all of the future options should be characterized equally at a low level of detail. Finding commonality among all possible requirements is seen as the guiding principle for designers of the Space Transportation System. Stressing any one program could embarrass the agency, or worse, if future policy directions pointed elsewhere. Finally, initiation of discussion of manned lunar activities is frequently haunted by the ghost of Project Apollo. A common, and erroneous, assumption is that a lunar base requires a national commitment of the scale invoked by President Kennedy in 1961 during a time of perceived national crisis.*

*If NASA has been timid in advocating an ambitious civilian space program, perhaps the reason lies in the annual travail of the federal budget process. Any long-term line item raises concern in the Office of Management and Budget that another "entitlement" has been added to the uncontrollable Federal budget. NASA also has been described as an agency without a constituency. When civilian space expenditures are cut, no special interest group rises to protest. Yet, the public image of the space program is very positive. NASA is one of the most visible and, arguably, most successful Federal departments.*

*The fundamental question to be addressed squarely is what role civilian space activities will play in the future of the nation and, indeed, the world. If we plan to continue small, expensive, experimental programs in low-Earth orbit with its limited volume and dearth of resources, then a myopic policy will suffice, ignoring the next program until the present one is done. However, the scope of discussion in this book demonstrates that we stand on the brink of an explosion in space development potentially an order of magnitude greater than the current official vision. The increase in scale will be enabled by the utilization of space resources, e.g., from the Moon, to sustain and capitalize the space infrastructure. Inclusion of the Moon in the system will create new ways of doing business in the same sense that the space shuttle and the space station create new opportunities.*

*The promise of space development can be lost or seriously delayed by absence of planning. New manned landings on the Moon probably will result from politically inspired decisions, but human presence can be permanent only if lunar enterprises have economic value. An efficient space transportation infrastructure for shipping supplies and products is required. Extensive private sector involvement and*

*exploitation of lunar resources is implied. Present day space law and space policy are not structured to deal with future realities.*

*In this book many questions are raised, and a few answers are suggested. A collection of papers such as this one cannot be complete in coverage of the subject matter. Contributions were required to be short to keep the level of detail approximately equivalent, even when some aspects of lunar development are quite well studied and others have only been recently recognized. In reality, each section could be expanded into a book; many authors found the constraints on length burdensome. I have written short introductions to the sections to aid the reader in picking out common threads among manuscripts grouped together.*

*It is my hope that the discussions in this book will seed more interest and thought. The technological strength of this country is based on its breadth and depth of expertise, and space cannot be utilized effectively without attracting specialists to the relevant problems. The scope of the technical presentations here may increase the awareness of a broader community to the challenge of space development. Students who ask what fields of study lead to careers in the space program will find a wealth of topics. Policy makers may glimpse the gateway to a complex future with new solutions to old problems as well as new problems. The citizen who participates in the political process can find information to aid evaluation of various options offered to his representatives. In the long run, opportunities for participation abound not only for all walks of society in the United States but, indeed, throughout the world.*

*The successful effort to initiate and sustain public dialogue on the issues of lunar development has been the product of the time and interest of many capable, busy people. I particularly wish to acknowledge the work of Michael Duke and Barney Roberts of the NASA Johnson Space Center, Paul Keaton of the Los Alamos National Laboratory, and Larry Haskin of Washington University. I also extend my thanks for interest and encouragement from others too numerous to list. I anticipate sharing with all of you the reality of this vision.*

Wendell Mendell  
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