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Title and Abstract:

REVOLUTIONARY TECHNOLOGIES FOR AFFORDABLE LUNAR DEVELOPMENT BY 2015: ELEMENTS OF AN INTEGRATED SYSTEMS PLAN

Large scale development of space is severely curtailed by two fundamental limitations: (1) the very high cost, low efficiency, and low versatility of space transportation systems, and (2) the high cost and low efficiency of systems for providing large amounts of electric power in space and on the moon. Indeed, the demise of NASA's hopes for returning to the moon "to stay" and proceeding with manned exploration of Mars is traceable directly to extremely high costs associated with "business as usual" *vis a vis* space transportation and power.

The clear need for radical innovations led me in 1991 to create technology development efforts at NASA HQ directed toward optimum solutions to these problems. All key technology requirements were quantified by our studies, and several research and development efforts were funded. Building upon previous technologies developed for other defense and civilian applications, this work continued through the 1990's at various NASA research centers and in private industry. Much progress was made in several parallel R&D projects, leading to an integrated systems plan having many advantages. In this talk, I will review the overall rationale for this work, discuss tradeoff issues, and outline system advantages quantitatively. The next talk, by James Powell *et al* will provide technical details of the most remarkable innovative concept.

Key technologies recommended include highly innovative MagLev catapults for ground-to-space launch, high power laser energy beaming from Earth to space, moderate thrust plasma propulsion in space, and *in situ* fuel and life support production on the moon. This paper outlines how all of these innovations are readily reachable from existing states-of-the-art and can be realized within a decade. The combined cost benefits will make full commercial development of cislunar space affordable. A particularly interesting aspect of this approach is that it makes feasible many synergistic initiatives having high value

for future commercial and government space development. Several examples will be discussed.

Adoption of a completely coordinated systems plan such as NASA implemented in the Apollo project is the essential *sine qua non* for success of the recommended program.