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NASA TECH BRIEF

Land Landing Couch Dynamics Computer Program

A preliminary design study was initiated to select a landing impact-absorption system that can be incorporated in an Apollo-type command module with minimum structural modification and (1) provides a stable landing platform, (2) prevents vehicle overturning and damage to the structure, and (3) permits reuse of the spacecraft with refurbishment after landing. The study, which encompasses preliminary design and limited stability analysis of candidate systems, is concerned with mechanical systems, i.e., devices that require contact with the landing surface to absorb impact energy.

In the preliminary design phase of the study, stability and structural evaluations of candidate design concepts were conducted. These tradeoffs led to the recommendation that two concepts be studied further to identify an optimum system. One concept employs a 6-legged augmented heat shield; the other concept uses an extended aft heat shield and 12 radially deployed skids.

In a later phase of the study, preliminary design and structural and stability analyses were performed to obtain the weight and volume required to apply MISDAS (Mechanical Impact System Design for Advanced Spacecraft) to a 14,000-pound spacecraft. Major structural and landing system components were sized; tradeoff analyses determined that both landing systems were stable for the design conditions but required crew attenuation systems for vertical landing velocities above 15 fps, and that roll control of the spacecraft during landing is needed when effective ground coefficients of friction above 0.35 are encountered.

To perform the landing stability studies, analytical computer programs were developed that calculate and record the motion of the spacecraft about three axes as a function of time after ground contact. The programs consider variation in spacecraft vertical and horizontal velocity, attitude and orientation, shock strut load-stroke characteristics, and ground coefficient of friction. The stability analysis of the six-legged vehicle with segmented heat shield was performed with a new computer program which describes the vehicle's motion about three axes. An existing Apollo two-body stability analysis computer program was modified to describe the geometry of the vehicle with deployed heat shield and radial skids. The stability investigations indicated that both design concepts can perform stable landings over the specified design envelope of horizontal and vertical velocities, landing attitudes, and ground conditions.

Details of the analytical computer programs are contained in the final technical report: *Mechanical Impact System Design for Advanced Spacecraft (MISDAS)*, by A. I. Bernstein, SID 66-409, 13 May 1966, North American Aviation, Inc.

Notes:

1. The programming language is Fortran IV.
2. Machine requirements are an IBM-7094 computer system.
3. Copies of the technical report are available from:
   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10233

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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