SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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DESIGN CONCEPTS FOR A MANNED ARTIFICIAL GRAVITY RESEARCH FACILITY

Abstract

Before mankind attempts long-term manned bases, settlements, or colonies on the moon or Mars, it seems prudent to determine whether people exposed to lunar or Martian gravity levels experience continuing physiological deterioration, as they do in micro-gravity. If these problems do occur in partial gravity, then it will also be important to develop and test effective countermeasures, because the countermeasures could have drastic effects on manned exploration plans and facility designs.

Such tests can be done in low earth orbit, using a long slowly rotating dumbbell that provides Martian gravity at one end, lunar gravity at the other, and lower values in between. To cut Coriolis effects by half, one must cut the rotation rate of an artificial gravity facility by half, and this requires a 4X longer facility. The paper argues that ground-based rotating room tests have uncertain relevance, so allowable rotation rates are not yet known. Because of this uncertainty, the paper presents 4 different structural design options that seem suited to rotation rates ranging from 0.25 to 2 rpm. This corresponds to overall facility lengths ranging from 120m to 8km. The paper also discusses early flight experiments that should allow selection of a suitable rotation rate and hence facility length and design.

For most of the design options, "trapeze" tethers can deploy outward from the Moon and/or Mars nodes. This allows capture of visiting vehicles from low-perigee orbits, and accurate passive deorbit. (Vehicles can also do a more traditional rendezvous, and can dock with a free-fall node at the facility CM.) The facility can be co-orbital with ISS, Bigelow, and other manned facilities. It would allow their crews to re-accommodate to earth gravity in stages (Moon, Mars, earth), rather than all at once.

The paper addresses key design trades, overall layout, assembly, spin-up, facility expansion, contingencies, transfer between nodes and between facilities, precursor missions, and operational derivatives for use in long-duration manned exploration missions.