LUNAR CRANE SYSTEM

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In many lunar construction scenarios mechanical cranes in some form will be indispensible in moving large masses around with various degrees of fine positioning. While thorough experience exists in the use of terrestrial cranes, new thinking is required about the design of cranes to be used in extraterrestrial construction. The primary driving force for this new thinking is the need to automate the crane system so that space cranes can be operated as telerobotic machines with a large number of automatic capabilities. This is true because in extraterrestrial construction human resources will need to be critically rationed.

The design problems of mechanisms and control systems for a lunar crane must deal with at least two areas of performance. First, the automated crane must be capable of maneuvering a large mass, so that when the mass arrives at the target position there are only small vibrations. Secondly, any residue vibrations must be automatically damped out and a fine positioning must be achieved. For extraterrestrial use there are additional challenges to a crane design—for example, to design a crane system so that it can be transformed for other construction uses. This initial project in crane design does not address such additional issues, although they may be the subject of future CSC research.

To date the Center has designed and analyzed many mechanisms. The fundamental problem of trade-offs between passively stabilizing the load and actively controlling the load by actuators has been extensively studied. The capability of 3D dynamics modeling now exists for such studies. A scaled model of a lunar crane has been set up and it has been most fruitful in providing basic understanding of lunar cranes. Due to an interesting scaling match-up, this scaled model exhibits the load vibration frequencies one would expect in the real lunar case.

Using the analytical results achieved to date, a laboratory crane system is now being developed as a testbed for verifying a wide variety of mechanisms and control designs. Future development will be aimed at making the crane system a telerobotic testbed into which external sensors such computer vision systems, and other small robotic devices such as CSC lunar rovers, will be integrated.

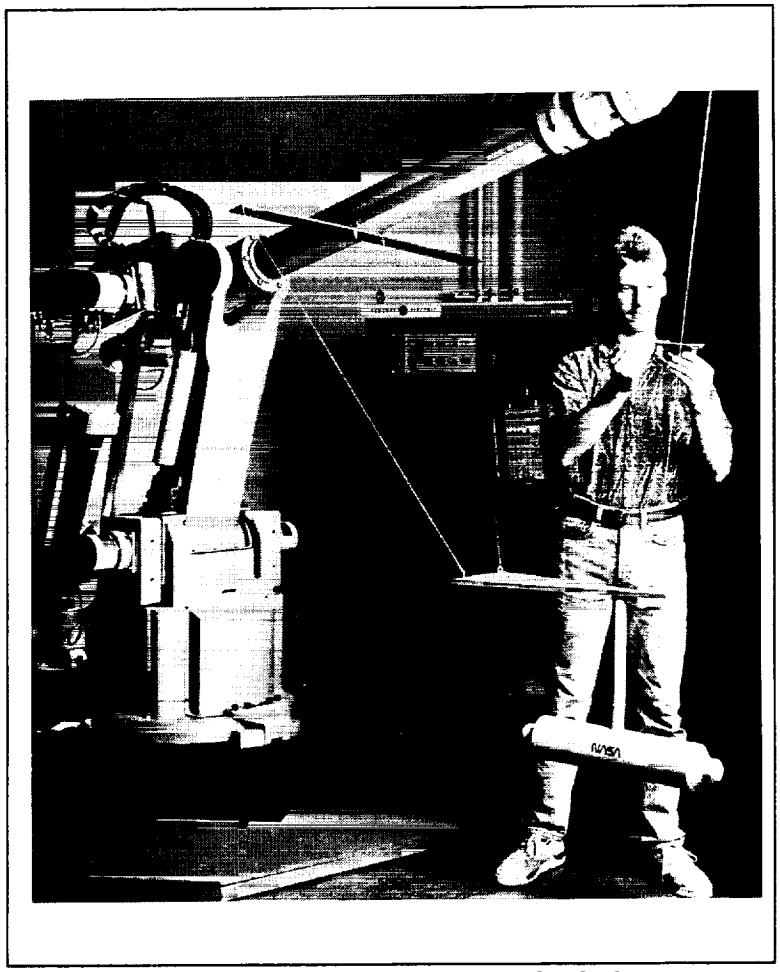

Fig 10.1 Scale model of a lunar crane design with robotic arm

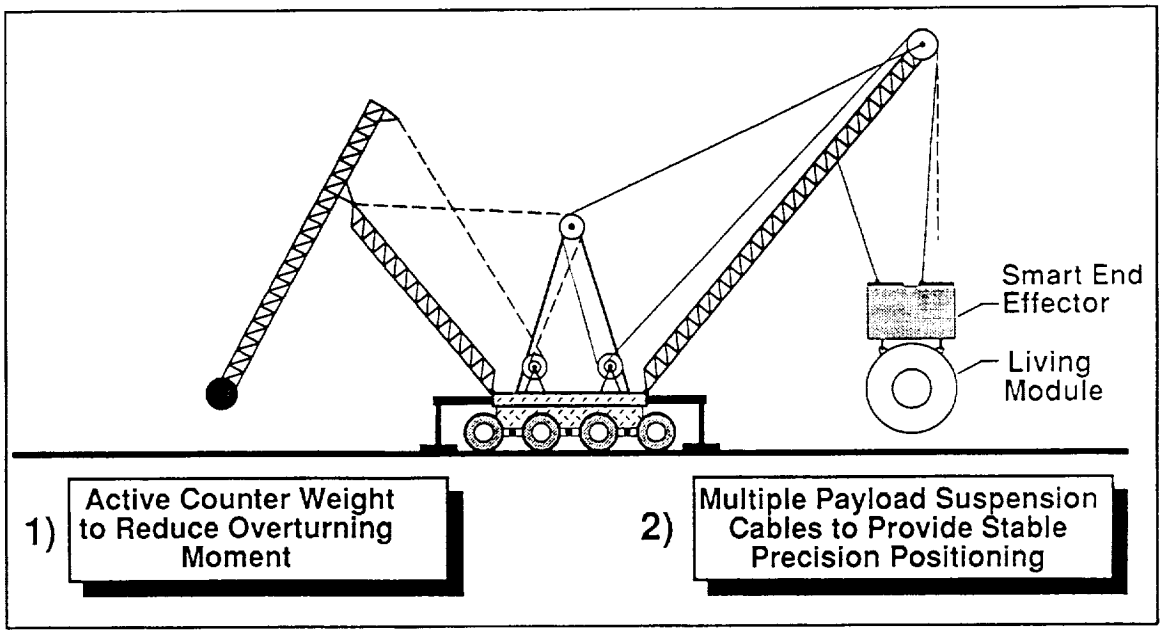

Fig 10.2 Counter-balanced actively-controlled lunar crane incorporating two new features for improved performance

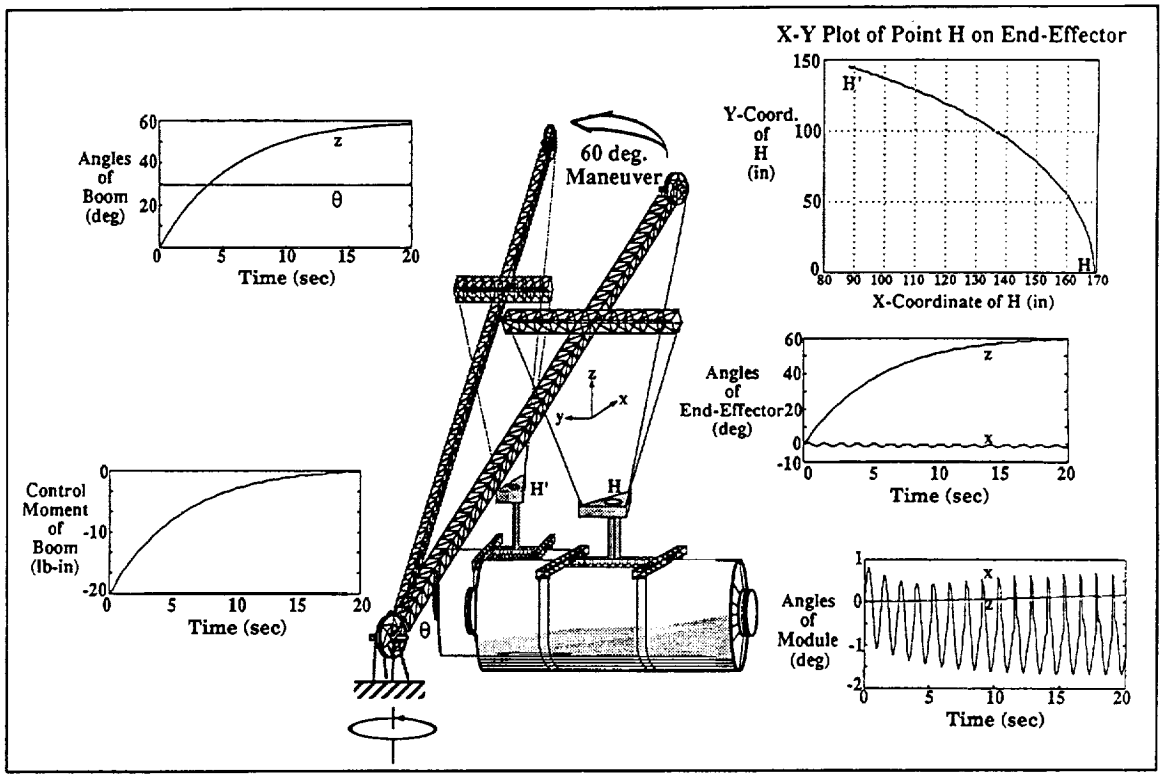

Fig 10.3 Slewing simulation results

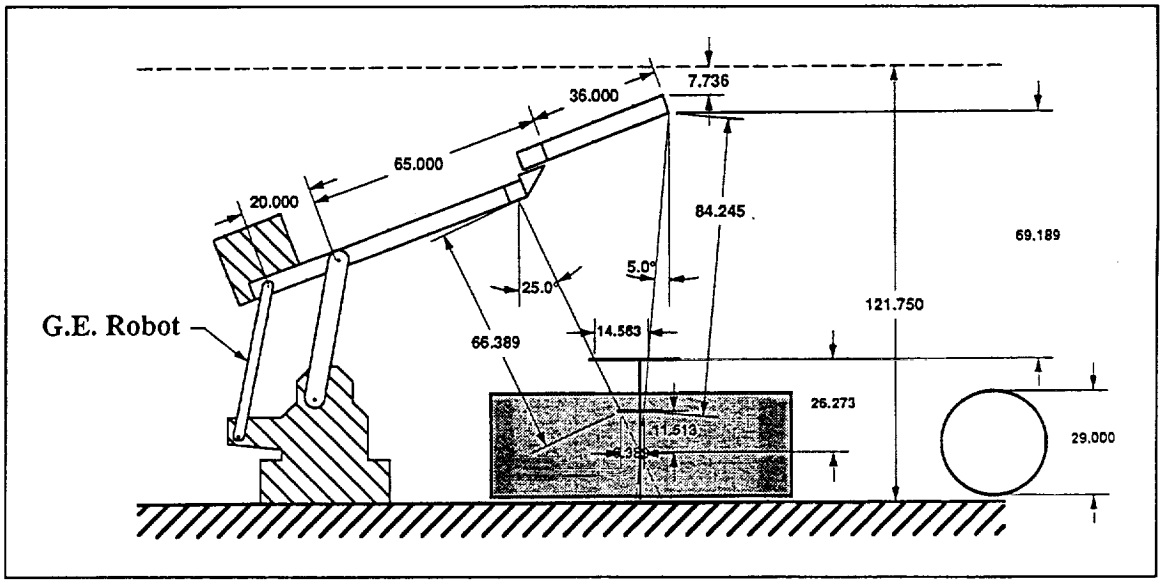

Fig 10.4 One-sixth scale lunar crane model

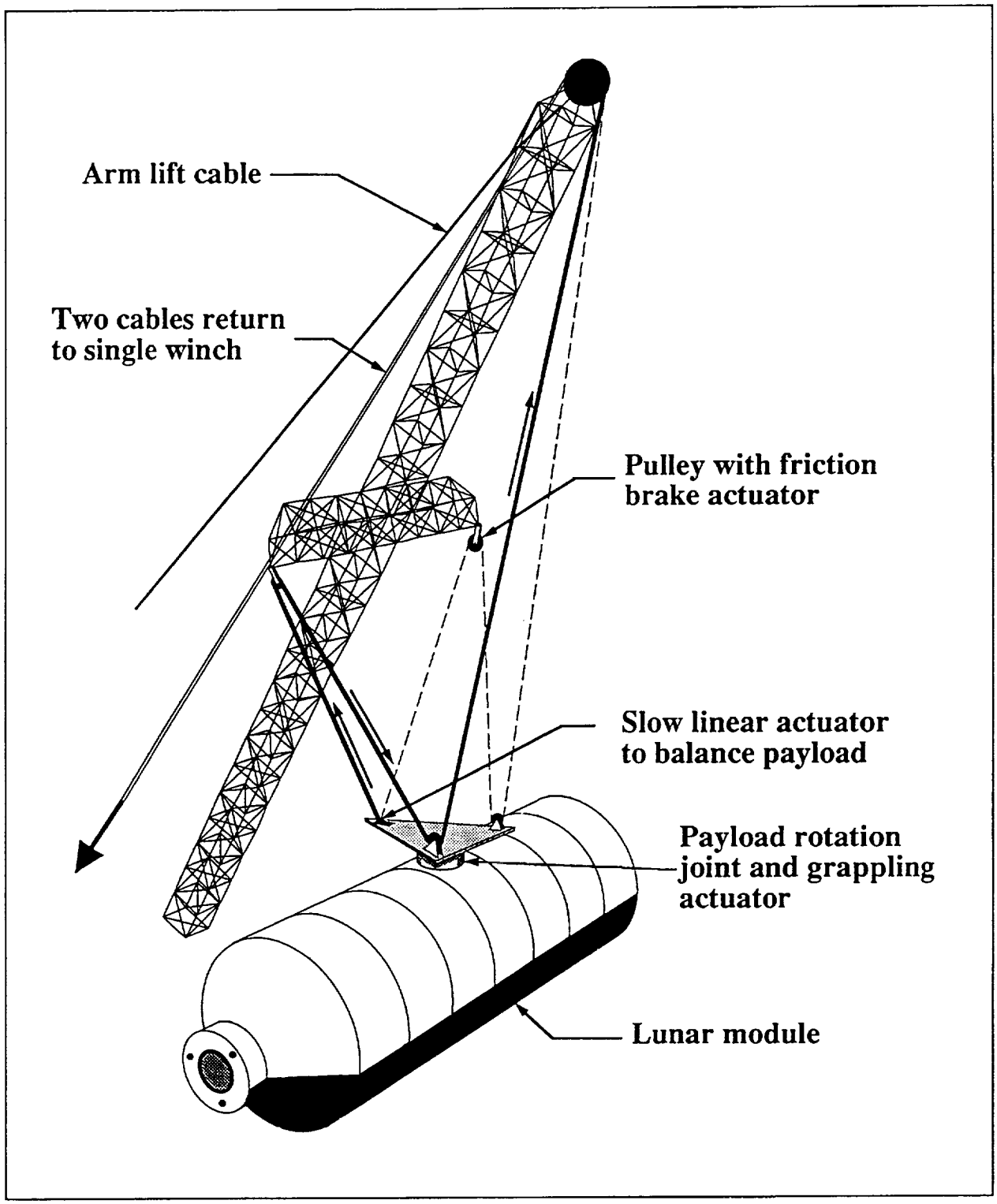

Fig 10.5 Lunar crane with modified Stewart platform