



# IDSS COMMENTARIES (59/2006)

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## **Does Singapore's Destiny Lie in Outer Space? Space Elevator project could be a start**

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SINGAPORE has long been a regional transportation hub. However, its future may lie not in the mundane great circle routes of container shipping and air transportation, but rather in the high frontiers of space.

Currently, the Civil Aviation Authority of Singapore is reviewing plans to construct a "commercial tourist spaceport" to launch Russian-built sub-orbital space planes carrying wealthy tourists on the ultimate theme park ride. This is an interesting experiment, but Singapore can do more by taking advantage of its unique features to exploit the far frontier. One such possibility is the construction of the world's first space elevator here.

[A space elevator would exploit both Singapore's proclivity for high technology as well as its only natural resources -- human ingenuity and geographical location. While there are many speculative reasons for the construction of such a system, the absence of energy resources would form Singapore's primary interest in a space elevator: unlimited and cheap power from enormous space based solar arrays.

The idea of a space elevator has long been confined to the speculative realms of science fiction. Recent progress in novel materials such as carbon nano-tubes has lifted it from that status, such that companies have begun to invest in the idea of building such a structure by 2018 at the latest. Indeed, Liftport Inc. has a running countdown on its web page tracking the date to the very second. Although the exact date of when such technologies actually enter into operation may be somewhat inexact, the science of space elevators is no longer fictional; the challenges of bringing the idea to fruition is now simply a question of practical engineering and capital investment.

### **The Gravity Well**

The idea behind the space elevator stems from the enormous cost of lifting payloads into orbit. Imagine you are trapped at the bottom of a deep well, staring up at the sky. Simply jumping out of it is humanly impossible. This is the same problem that faces those who wish to orbit material around the earth. The higher the orbit, the more energy that needs to be expended moving the payload there. When the United States sent three men to the moon, it required the Saturn V rocket, a nearly 3 million kilogram contraption that was, in effect, simply a series of enormous fuel tanks designed to lift both itself and the ultimate package of the command and service modules and the lunar lander. Some 60% of that massive machine

had already been discarded by the time the latter combination fired their engines, sending the astronauts to the moon. Despite advances in rocket technology, the situation remains the same today.

More than anything else, it is the serious cost, both in terms of energy and the absolute expense of building and launching rockets, that is the most significant barrier to any space application. Each space shuttle launch costs roughly half a billion dollars. The International Space Station was originally set to cost US \$8.3 billion dollars but has actually cost more than twice that. Further, the ISS orbits relatively close to the earth, between 450 to 750 km high. Even at that cost, the ISS does relatively little in the way of science, especially since the grounding of the space shuttle has prevented its completion to date. The cost of lifting a single kilogram into orbit remains fixed at about US \$20,000 -- too expensive for all but the most limited of applications and the smallest of packages.

Rockets must expend a huge amount of energy in order to place even small satellites and vehicles into orbit. As the Saturn V amply demonstrated, rockets are a devil's bargain in that to lift larger payloads, larger rockets must be built. But larger rockets themselves weigh still more, and thus there is an inevitably diminishing return associated with their construction. The second problem that comes with the huge energies associated with them is the fact that a rocket is essentially a machine for directing the energies of an explosion. As such, they are an inherently dangerous technology as the numerous disasters that have afflicted all space programmes have demonstrated. Inevitably, they will explode in an uncontrolled fashion during launch, further limiting their utility for everyday use.

### **How the space elevator works**

The space elevator would change all this by exploiting the challenges posed by gravity, rather than trying to fight them. A space elevator consists of a counterweight that orbits above the surface beyond geostationary orbit, at about 96,000 km away. It is secured to the ground by a thin filament made of carbon nanotubes. Material can be carried into space along this filament by the actual elevator device, thus freeing payloads from having to carry heavy propulsion technology. Freed from the devil's bargain, launch costs would fall nearly one thousand fold, to about US \$200 a kilogram. Once reaching the orbital platform, material could be launched into still higher orbits or out into interplanetary and interstellar trajectories, much as a child might shoot a stone using a sling shot, by taking advantage of the earth's rotation. As the angular velocity experienced by the orbital platform would be greatest at the equator, Singapore's geographical location is ideal.

Cost estimates for constructing an elevator range from US \$6 to \$10 billion dollars, however. The biggest single question, then, is why would we want to construct such a technological marvel? Space enthusiasts promise the attractions of mining asteroids, space tourism, colonisation of other worlds, and similarly vague projects. The problem with all of these ventures is the enormous risks and initial capital costs that must be sunk into them before they even begin to return profit. Even in the clear commercial case of mining other heavenly bodies, the cost and difficulty of mining terrestrial minerals is hardly such that we need to find alternate sources off planet.

### **Benefits outweigh the heavy cost?**

Nevertheless, there is at least one sound economic reason for desiring to lift enormous

payloads into space: energy. As the economies of China and India develop, it is clear that oil prices will only climb higher. The slow motion natural disaster of global warming provides additional impetus for finding clean alternates to burning fossil fuels. Yet in space, solar power, unaffected by the vagaries of weather, is available for the taking. Power collected by huge farms of solar arrays could be harmlessly microwave-beamed back to ground stations, a deal which would seem difficult to refuse for an energy dependant state like Singapore (and an energy challenged region such as Southeast Asia).

The additional attraction of Singapore is that it is one of the few terrestrial locations near the equator that enjoys political stability, excellent logistical connections, a strong economy, and a highly educated population. While a project like a space elevator will inevitably involve many nations, there are few other places more ideal for the actual location of such a project. It seems safe to suggest that there are few projects that Singapore could pursue with the potential for securing its prosperity in a world of growing economic and energy competition.

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