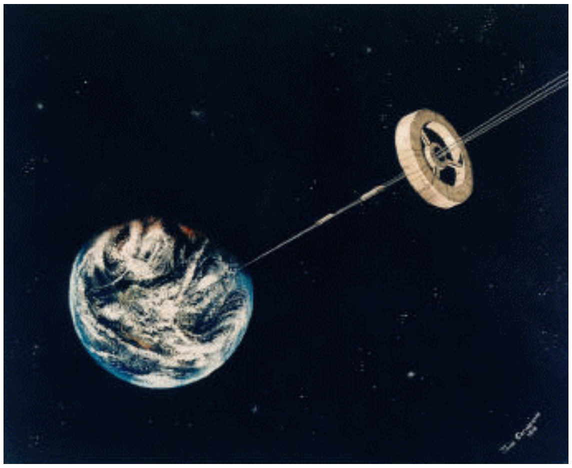
Space Elevator History



Jerome Pearson, President of STAR, Inc., conceived the idea of the space elevator in 1969 at the NASA Ames Research Center, and perfected the concept in the early 1970s, when he was at the Air Force Research Laboratory in Ohio. He published his ideas in an international journal that first brought the idea to the attention of the entire world of spaceflight researchers. Sir Arthur Clarke, living in Sri Lanka, consulted with Pearson in the late 1970s in writing his novel, "The Fountains of Paradise," which brought Pearson's idea of the space elevator to an even larger audience. Sir Arthur included in the book an appendix that credited Pearson.

The idea of a "stairway to heaven" is as old as the Bible, and includes the Tower of Babel and Jacob's Ladder. Modern thought on space elevators goes back to Konstantin Tsiolkovski, a school teacher in St. Petersburg, Russia, who did a "thought experiment" on a tower into space. Tsiolkovski imagined tall towers and cosmic railways, and discovered what we now call the geostationary altitude for a spacecraft, at which point the gravitational and centrifugal forces on a body in a one-day orbit are in balance. Tsiolkovski calculated the synchronous altitudes for the five visible planets, and the sun, but concluded that building such a real tower into orbit was impossible.

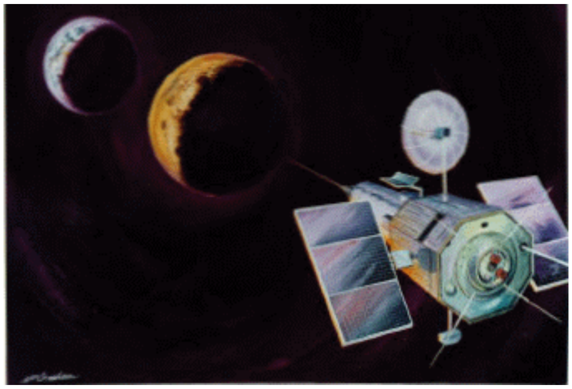
In the 1960s, Leningrad engineer Yuri Artsutanov discovered how to build a real structure for the space elevator, but published no technical papers; his ideas appeared in a Sunday supplement to Pravda, and their significance was not recognized in the West. In 1966, a group of oceanographers led by John Isaacs at the Scripps Institute of Oceanography, La Jolla, California, again discovered the concept. But they proposed such a thin wire that it would be cut by micro-meteorites almost instantly, and was therefore completely impractical. Two other near-discoveries were by Sutton and Diederich in 1967 and Collar and Flower in 1969, who proposed lowering a stationary satellite on a long cable, but they did not extend this to the space elevator.

Pearson, unaware of the earlier work, independently discovered the concept, but published it in the international journal *Acta Astronautica*, and thus gave the space elevator to the international aerospace community for the first time. His discovery included using the space elevator for zero-net-energy space launching, and for launching payloads from the elevator tip to reach other planets without requiring rockets. He also was first examine the dynamics of actually lifting payloads up the elevator, and found limitations on the speeds of ascent, akin to the critical velocities of a rotating shaft and the periodic loads from soldiers marching on a bridge.

Hans Moravec had been thinking along similar lines, and seeing the Pearson orbital tower publication led him to propose rotating space towers unconnected to a planet or moon, for catching and throwing space payloads to different orbits. Artsutanov had also proposed this concept in 1969, but it was not known to Moravec.

Pearson later extended the space elevator idea to the moon, using the Lagrangian points as balance points in lieu of the geostationary orbit, and discovered that such a "lunar anchored satellite" could be used to bring lunar materials into high Earth orbit cheaply. Pearson published the first paper on the lunar space elevator concept at the 1977 L5 Society Conference in London, and then published his journal article in March of 1979. Interestingly, Artsutanov published a paper on a lunar space elevator just one month later, without either author being aware of the other!

Paul Birch of England conceived of a



dynamic space elevator, in the form of a hollow ring about the Earth with a super-orbital wire inside it. The resulting unbalanced centrifugal force would support shorter space elevators hanging from the ring, producing a low-altitude space elevator. Payloads could be lifted along the elevators to the orbital ring, and then accelerated to orbital velocity. Keith Lofstrom proposed a smaller launch loop with a moving conductor inside, to lift itself above the atmosphere and launch payloads into orbit. Rod Hyde of Lawrence Livermore Laboratory conceived of another dynamic space elevator, supported vertically by electromagnetic disks being fired from the base upward, and then deflected down by a magnetic driver at the top. The reaction force would keep the tower stable to any altitude, but of course payloads at the top would not have orbital velocity unless the tower reached at least synchronous altitude over the equator.

Paul Penzo then extended the idea of space elevators and tethers to Phobos, the closer the moon of Mars. He also proposed using a rotating tether to attach a spacecraft to asteroids, to change its orbit without rockets, like a gravitational assist. Pearson and Guy Pignolet of Germany almost simultaneously conceived of the idea of a rotating tube about an asteroid to throw asteroidal material into space, providing rocket thrust to retrieve the asteroid. Another possibility is to use the Artsutanov-Moravec rotating tether to catch suborbital payloads and throw them into Earth orbit. The payloads could be launched either by rockets or by electromagnetic guns.

One fundamental problem of building the space elevator is the phenomenal strength of materials required to support its mass over the 35,800-km height to geostationary orbit. Artsutanov and Pearson recognized that carbon "whiskers" representing perfect-crystal structures, might be one way to achieve the required strength. When carbon nanotube structures were discovered, it was realized immediately by Richard Smalley at Rice University in Houston, Texas and by Boris Yakobson at North Carolina State University that these super-strength materials would make the space elevator possible.

Using these ideas and proposed materials, Bradley Edwards proposed a practical scheme for constructing a space elevator about the Earth, and received NASA funding for a study. A workshop at NASA Marshall Space Flight Center produced a summary of the current state of the space elevator. However, it may still be a long time before such a space elevator is built about the Earth, because of its interference with all other Earth satellites. The orbit of any Earth satellite, except for geostationary satellites, would constantly intersect that of the space elevator structure, and would therefore require active avoidance.

On the other hand, it is possible to build Pearson’s lunar space elevator now, and use it to develop lunar resources and for lunar farside communication. It could also be constructed of existing composite materials, and does not require the super-strength of carbon nanotubes. The use of rotating tethers for asteroid retrieval is also possible now, and could even be used to rid the Earth of the danger of asteroid collisions, such as the one that killed the dinosaurs.

In an historic meeting in St. Petersburg Russia in August of 2006, the two inventors of the space elevator met for the first time, when Jerome Pearson visited Yuri Artsutanov and they talked, through an interpreter, outside the Hermitage Museum. Artsutanov related how he was given a sample of a high-strength material, and imagined a hanging cable that could be tapered to reach synchronous orbit. Pearson related how he was inspired by a description by Arthur Clarke of synchronous satellites “perched atop imaginary towers,” and figured out how to make the towers real. Artsutanov is long retired, but Pearson is still actively working in the field. In August, 2013, Pearson gave the keynote address to the International Space Elevator Conference in Seattle, and described how he assisted Sir Arthur on the technology of space elevators for Clarke’s novel, “The Fountains of Paradise.” See the keynote address.

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