HOW CECIL RHODES COULD HAVE BUILT A SPACE ELEVATOR TO THE MOON

By Francis Graham, Kent State University

"To think of these stars that you see overhead at night, these vast worlds which we can never reach. I would annex the planets if I could; I often think of that. It makes me sad to see them so clear and yet so far."
--Cecil Rhodes (1853-1902) 1

One of the physical faults of Jules Verne's From the Earth to the Moon [2,3,4] is simply that humans could not make the trip in the fashion depicted. It is possible, of course, to build a giant gun to shoot a projectile to the moon, if the barrel is evacuated and sealed at the top with a thin airtight membrane. From all evidence, the great gun designer Gerald Bull (1928-1990) , if he had not been murdered, and if he had been supplied with the money, could have built it[5]. But the accelerations of the takeoff would be enormous and would kill all the occupants [6]. The survival of the occupants of Verne's Moon Gun "Columbiad" was pure literary license [7].

Jules Verne, H.G. Wells [8], and others have inspired imitators of their writing style in science fiction using 19th century backdrops, a genre called "steampunk". Steampunk seeks to provide an interesting story while remaining within the confines of the culture and engineering possibilities of the period from 1835 to about 1914. This works well because science fiction itself is an offshoot of the Enlightenment [9] and Enlightenment values guided human activity in that time period. Steampunk offers stories involving inventions that could have been invented in the 19th century but were not.

So, in this spirit I want to describe how the great colonizer and financier of the British Empire, Cecil Rhodes, could have built a space elevator to the moon if some extraordinary luck had come his way.

Space elevators have been extensively considered in modern times[10,11]. Lunar elevators studied so far involve two step procedures or procedures with terminal disconnection[12], or the technology of aliens [13].

The first problem with a space elevator to the moon is this: while the moon has one hemisphere directed to the Earth at all times, the Earth does not reciprocate. The Earth spins underneath the moon, so the cable would wrap up or you would have disconnection at the Earth terminus, the moon passing through the local meridian once each 25 hours approximately.

However, our 19th century engineers realize this and construct, on the 61st south parallel of latitude, a circular railroad track high on pilings and caissons driven into the continental shelf surrounding Antarctica. This track would be 19,407 km (or 12,126 miles) in circumference. This is not an insuperable job for the 19th century as the Trans-Siberian Railroad was longer.

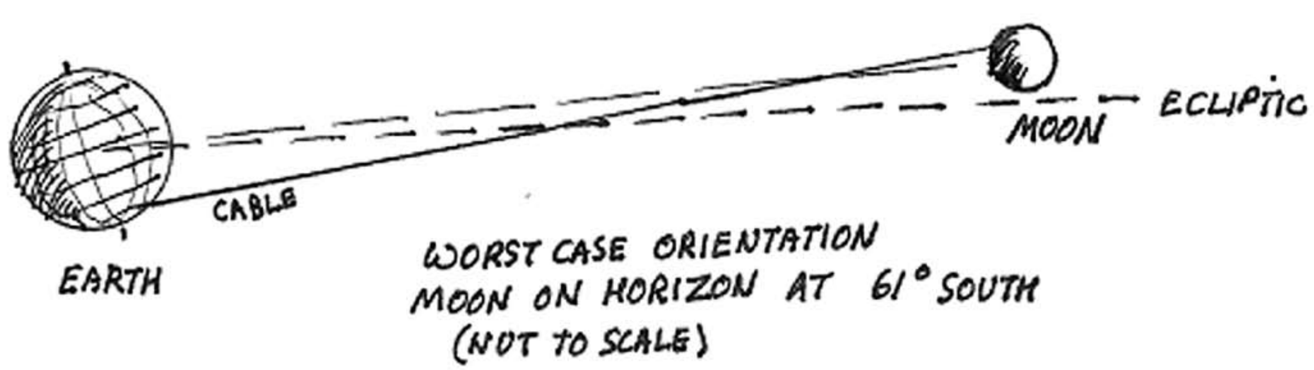

Figure 1: The moon is always in the sky of the 61st south parallel.

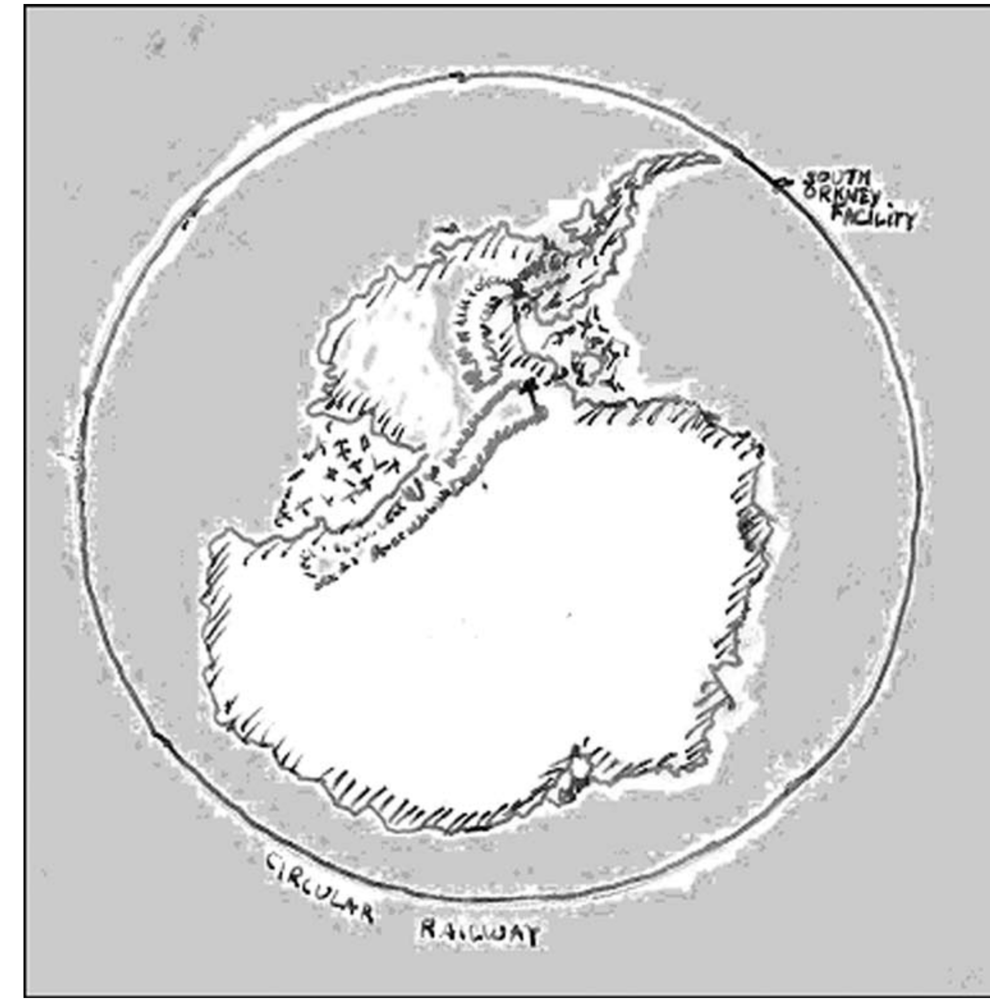

Figure 2: Railway around Antarctica

The moon will always be on or above the horizon for some part of this circular track, the farthest points south for which this situation exists. Therefore we require a locomotive to dash around it in 25 hours; a speed of 485 miles per hour is required. That this is about 4 ½ times faster than the fastest locomotives of the 19th century is daunting, but keep it mind it is not even an order of magnitude greater. The 19th century engineers would design the fastest locomotives that steam could possibly drive. Because it is likely that the locomotive would often fail and require maintenance on a side track, a spare locomotive always runs with it. The trick would be designing a track that would keep at least one locomotive on and running continuously at such high velocities.

The locomotives would carry one car, and that would have the terminus of a long cable that would stretch to Sinus Medii on the moon. A cable car would then traverse up and down carrying passengers and cargo. Because of the varying distance between the Earth and moon, an enormous spool of additional cable, sufficient to span the variation between the moon at apogee and perigee, is at Sinus Medii. This spool is so large it can be seen by telescope from the Earth, as the Great Wall of China can be seen by telescope from the moon. The cable cars themselves would be steam powered, heated by the emanations of radium since we would assume industry would be quick to exploit the discoveries of Henri Becquerel and the Curies. Perhaps the locomotives themselves might be similarly powered.

As Space Elevator designers know, steel is totally inadequate for a space elevator, such a cable spontaneously breaking of its own weight after just 12 miles. A pure diamond crystal is the only 19th century hope [14], and indeed diamond fibers can be altered to single crystals by a process using infrared [15]. Unfortunately, although Cecil Rhodes controls many diamond mines, all of the known diamond reserves on Earth are inadequate for

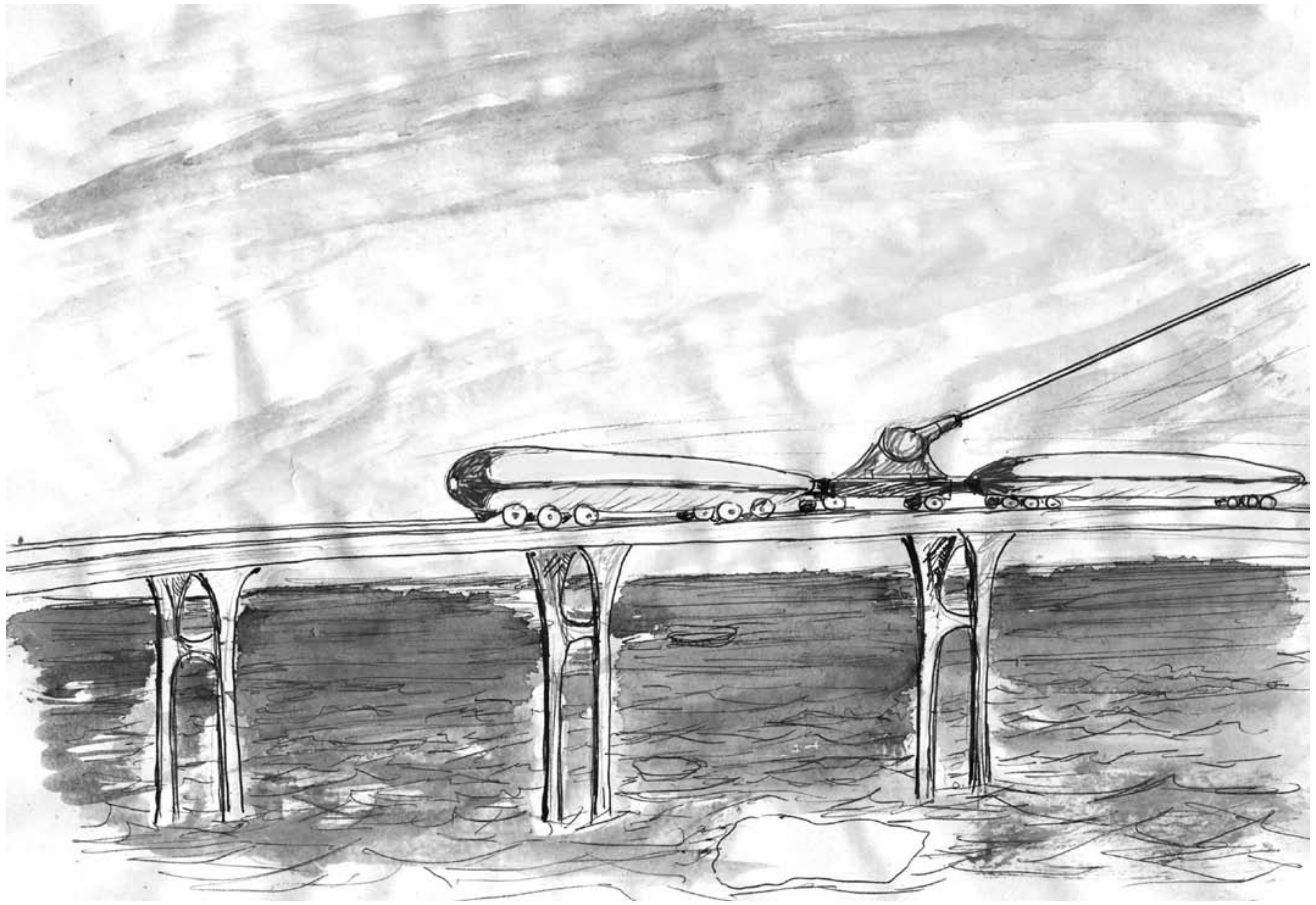

Figure 3: High speed locomotives carry around cable terminus.

the construction of the 225,000 mile diamond cable.

This is where Rhodes would need a stroke of luck. We suppose an expedition led by one of his employees, who looks a bit like Alan Quatermain, has discovered an enormous plug of solid diamond 1000 meters wide extending to the Earth's mantle. Later astronomers would realize this is a gigantic meteorite, from the carbon core of a planetary nebula, disrupted into a million bits by a binary companion before it could collapse into a white dwarf, and which had soon solidified into diamond. One of those shards most fortunately traversed interstellar space to arrive at our planet, and providentially skimmed the Earth's atmosphere several times so the atmosphere accidentally acted as an aerobrake, and it landed intact in the Oligocene, neither vaporizing nor causing a mass extinction. Yes, it would be extraordinary luck, indeed. But possibility is the stuff of science fiction.

Rhodes would immediately realize that introducing this great mass of diamond on the market would make diamond cheaper than coal so that locomotives would burn diamond and quite ordinary people would shovel diamond into their fireplaces and home furnaces. So Rhodes would make the only rational choice: he would use the diamond as capital and build a cable car to the moon.

People and cargo are introduced to the fast moving cable terminus by transfer locomotives from side railways, transferring onto the cable car when the transfer locomotive matches the speed of the cable-bearing locomotive and cable platform. Then the cable car is transferred upward on the diamond cable to the moon.

A final thought must be given to how Mr.

Rhodes might get the other end of the cable to the moon in the first place. A very thin starter cable is blasted to the moon by a projectile in the usual Verne manner. Although it has terminus disconnect, care is taken so that the disconnected terminus is nudged to the north or south pole. Then, when the moon and cable are above the horizon in either of those places, a mechanical climber can be attached, and it takes a slightly thicker cable up, and then another, even thicker still, in series until the desired thickness sufficient to support the cable car and cable weight is reached. Finally, workmen go up to Sinus Medii with supplies of oxygen and water in pressure suits and finish the system. Of course it will be arduous and dangerous work.

The base on the moon is named Rhodes City, of course. Having accessed the moon, which has enormous resources but no indigenous people, Mr. Rhodes uses Carnegie as a model and gives up all property in South Africa but his mother lode diamond mine. He deigns to bestow upon all people there magnificent libraries, schools, universities, parks, sanitation and housing, which gifts, though munificent, pale in comparison to the mineral wealth he can now extract from his exclusive transportation to and from the moon.

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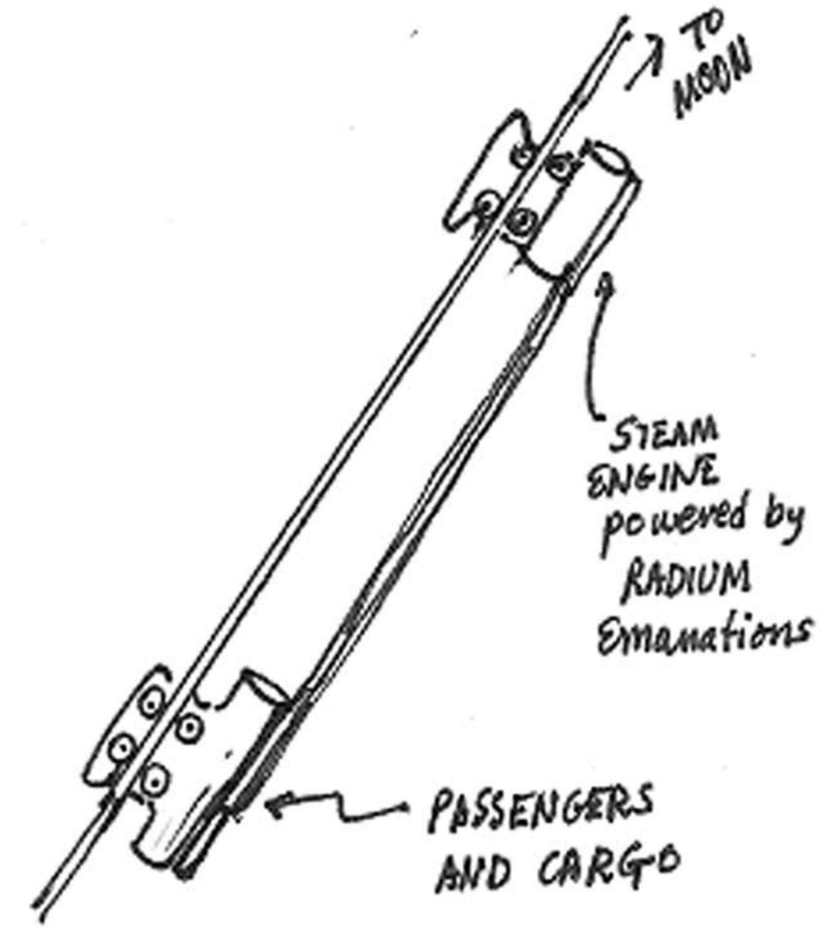

Figure 4: Cable car design

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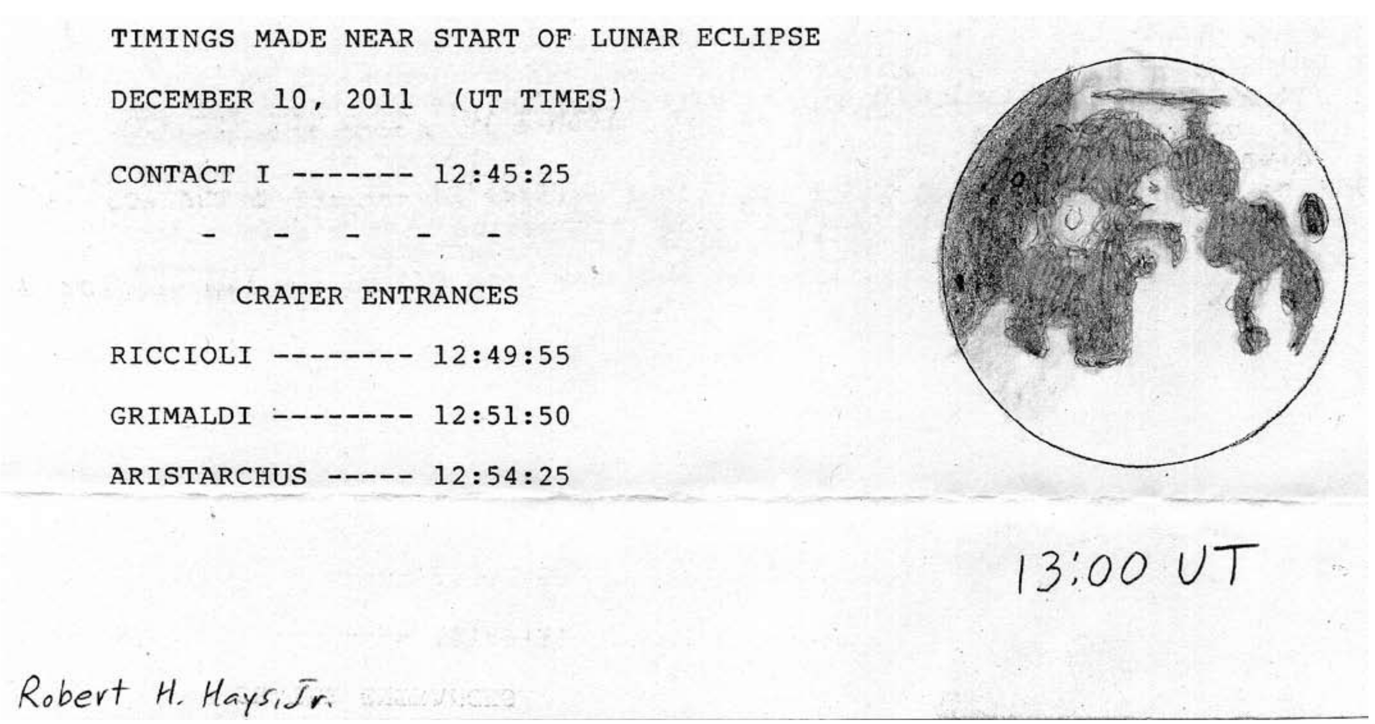
The December 10 Lunar Eclipse
by Robert H. Hays, Jr.

I had a good view of the December 10 lunar eclipse at its beginning. The local weather outlooks was good, but I decided to drive west for a longer view before sunset. I ended up watching the event from Iowa Falls, Iowa, where I had an excellent western horizon. Most of my visual observing was done with an 80mm refractor at 38x; I also used 10x50 binoculars. At 11h UT, 5 a.m., it was clear with a temperature of 7 degrees F. All timings are given in UT. A radio airing WWV was on continuously.

The penumbral shading was first definitely noticed at 12:10 with the refractor. It was a gray, steadily increasing shading until 12:40 when a brownish tint was noticed. I timed first umbral contact at 12:45:25. I was listening to the radio while the limb darkened substantially. (The timing is plus or minus 10 sec.} I also recorded three crater entrances early in the eclipse. I would watch the umbra's edge pass over the crater while listening to WWV and not the times. The moon was still high enough for the umbra's edge to be fairly well defined. These timings are shown on the accompanying sheet with a sketch. The timing of Riccioli refers to the dark spot on its floor. The timing of Grimaldi is the mean of opposite-side timings.

At 13:00, the portion inside the umbra was a uniform rusty red-brown color with a very narrow gray edge. Aristarchus was still visible. The umbral segment was easily seen with the binoculars though the moon was hardly a quarter of the way into the umbra at that time. Aristarchus faded out at 13:08, but the color of the umbra was still noticeable. The umbra's visibility at that altitude (about 4 degrees) probably meant a relatively bright totality later.

My view was clear up to that time, though the seeing was mediocre to fair. By 13:00, the seeing was poor, with air currents sweeping across the moon from south to north at the worst times. My view was cut off at 13:13 when the moon slipped behind some clouds that had quickly appeared in the west. I probably could have watched the eclipse for another ten minutes at my site. Those clouds overspread most of the sky in half an hour with the sun rising in the last bit of clear sky until later that day.



GRAIL
by Talon Brown

(It is very frustrating, attempting to piece together exactly what a spacecraft will do and how it will perform this task. Press releases aimed at the general public are too generalized for a full explanation and detailed explanations of data collected and methods involved are reserved, often for years, for researchers involved in the mission and people who can afford subscriptions to journals. This description was pieced together from a number of press releases listed below.)

The GRAIL spacecraft are currently in a near-polar elliptical orbit, circling every 2 hours. Beginning in March, the two satellites will send back radio signals so that scientists can begin to map lunar sub-surface features which will show any irregularities proving whether some areas are older than others. The mission should also shed light on the far side of the moon by gravity mapping, which is possible due to the fact that there are two orbiters communicating with each other. Gravity mapping requires careful tracking of changes in trajectory of an orbiting satellite. The lunar nearside has been mapped through Earth-based tracking of orbiters, but the farside has remained undone—there was no way for Earth-based tracking of satellites crossing out of our sight. The GRAIL spacecraft has two separate components which can track each other when crossing the farside. Sending the compiled data back to Earth will provide full lunar gravity maps. Gravity maps reveal significant data about subsurface planetary features and should show whether the moon is actually a formation of two moons that collided since, if the moon was a product of two moons, the crust on one side would be considerably thicker than on the other.

The telecom subsystem includes 2 S-band antennas to communicate with Earth, 2 X-band (8-12GHz) beacon antennas for Doppler LIDAR ranging measurements, done by sending LIDAR signals at the surface of the moon and measuring the time it takes for them to be bounced back against the speed of the LIDAR to find the distance the satellite is from the surface. In this way, small variations in the orbit of the GRAIL spacecraft can be tracked even on the farside. The craft communicate using an S-band (2-4 GHz) time transfer system antenna, which sends a time synchronization code back and forth between the spacecraft and a Ka-band (26.5-40GHz) ranging antenna for precision distance measurements between the spacecraft and Earth. All of these wavelengths are microwaves. The GRAIL satellites also each