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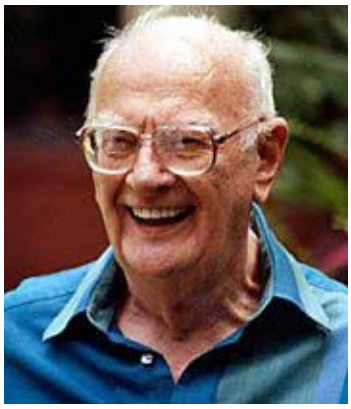
Space Elevators (The Moon)



Arthur C. Clarke

WHEN NEIL ARMSTRONG stepped out onto the Sea of Tranquillity in that historic summer of 1969, the science fiction writers had already been there for two thousand years. But history is always more imaginative than any prophet: no one ever dreamt that the first chapter of lunar exploration would end after only a dozen men had walked upon the Moon. Neither did anyone imagine, in those heady days of *Apollo*, that the solar system would be lost — at least for a long while — in the paddy fields of Vietnam.

Yet it was not the first time that ambition had outrun technology. In the Antarctic summer of 1911-12, ten men reached the South Pole, and five returned. They used only the most primitive of tools and energy sources — snowshoes, dog sleds, their own muscles. Once the pole had been attained, it was abandoned for nearly half a century. And then, in the International Geophysical Year (1957-58), humans came back with all the resources of modern technology — and they stayed. For more than 40 years now, summer and winter, men and women have been living and working at the South Pole.

So it will be with the Moon. When we go back, it will be in vehicles that make the Saturn V look like a clumsy, inefficient dinosaur of the early Space Age. And this time, we will stay — and slowly extend onward to the planets, beginning with Mars. In 1969, the giant multistage rocket, discarded piecemeal after a single mission, was the only way of doing the job. That the job should be done was a political decision, made by a handful of men. (I have only recently learnt that Wernher von Braun used my *The Exploration of Space* (1952) to convince President Kennedy that it was possible to go to the Moon.) As William Sims Bainbridge pointed out, space travel is a technological mutation that should not really have arrived until the 21st century. But thanks to the ambition and genius of von Braun and Sergei Korolev, and their influence upon individuals as disparate as Kennedy and Khrushchev, the Moon — like the South Pole — was reached half a century ahead of time.

If Nasa resumes lunar missions by 2018, that timing would be just about right: it will be only a year short of the 50th anniversary of Neil Armstrong's famous "one small step". But banking on solid rocket boosters to escape from Earth, as being planned, will not represent a big technological advance over the Apollo missions.

Even if the spacecraft are reusable, it will still cost hundreds of thousands of dollars to launch every kilogram into space. I think the rocket has as much future in space as dog sleds in serious Antarctic exploration. Of course, it is the only thing we have at the moment, so we must make the best use of it.

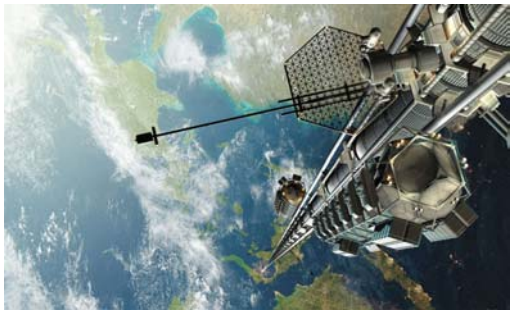
But I would urge Nasa to keep investing at least a small proportion of its substantial budget in supporting the research and development of alternatives to rockets. There is at least one idea

that may ultimately make space transport cheap and affordable to ordinary people: the space elevator. First conceived by a Russian engineer, Yuri Artsutanov, in 1960, it was reinvented by a group of American scientists a decade later. And it's based on a simple — yet daring — concept.

Today's communications satellites demonstrate how an object can remain poised over a fixed spot on the Equator by matching its speed to the turning Earth, 22,300 miles (35,780 km) below. Now imagine a cable linking the satellite to the ground. Payloads could be hoisted up it by purely mechanical means, reaching orbit without any use of rocket power. The cost of launching payloads into orbit could be reduced to a tiny fraction of today's costs. The space elevator was the central theme in my 1978 science-fiction novel *The Fountains of Paradise* (soon to be a Hollywood movie). When I wrote it, I considered it little more than a fascinating thought experiment. At that time, the only material from which it could be built — diamond — was not readily available in sufficient megaton quantities. This situation has now changed, with the discovery of the third form of carbon, C60, and its relatives, the Buckminsterfullerenes. If these can be mass-produced, building a space elevator would be a completely viable engineering proposition.

What makes the space elevator such an attractive idea is its cost-effectiveness. A ticket to orbit now costs tens of millions of dollars (as the millionaire space tourists have paid). But the actual energy required, if you purchased it from your friendly local utility, would add only about a hundred dollars to your electricity bill. And a round trip would cost only about one tenth of that, as most of the energy could be recovered on the way back.

Once built, the space elevator could be used to lift payloads, passengers, prefabricated components of spacecraft, as well as rocket fuel up to Earth orbit. In this way, more than 90 per cent of the energy needed for exploration of the solar system could be provided by Earth-based energy sources.



Looking even farther ahead, one could see the virtual elimination of the rocket except for minor orbit adjustments. By extending the elevator, it would act as a giant sling, and payloads could be shot off to anywhere in the solar system by releasing them at the correct moment. Of course, rockets would still be responsible for the journey back to Earth — at least until elevator/slings were constructed on the other planets. If this ever happens, the most expensive component of travel around the solar system would be for life support — and inflight movies.

As its most enthusiastic promoter, I am often asked when I think the first space elevator might be built. My answer has always been: about 50 years after everyone has stopped laughing. Maybe I should now revise it to 25 years.