The Space Conveyor Could Revolutionize Space Travel

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Abstract

The proposed space conveyor is a mass transit system for launching vehicles into space that uses the energy of Earth's rotation to do the heavy lifting. In some respects, the space conveyor is similar to a space elevator in that they both consist of a ground station connected to a top station located some distance above the height of geostationary orbit. However, instead of being joined by a tether, the two stations are connected by a conveyor belt moving along rollers on both stations. Whereas with a space elevator, the climber must make a round trip from the ground to the top station and back before it can carry a second load, the space conveyor allows loads to be continuously attached to the moving conveyor belt, resulting in a vast increase in carrying capacity compared to the space elevator. Furthermore, if the height of the space conveyor is chosen so that the gravitational force acting on the conveyor belt and the attached conveyor cars is exactly balanced by the centrifugal force due to Earth's rotation, the only energy required to operate the space conveyor would be that which is necessary to offset the small losses due to friction on the bearings supporting the rollers as well as air resistance on the tiny fraction of the conveyor belt lying within Earth's atmosphere. This balance between the gravitational force and the centrifugal force will continue to hold even in the presence of a net upward flow of mass, as is expected to occur for some time after the space conveyor becomes operational, as humanity leaves Earth to explore and colonize the rest of the solar system, that energy difference being provided by the energy of Earth's rotation. It turns out that the minimum tensile strength required for the conveyor belt of the space conveyor is the same as that for the tether of the space elevator, so it follows that if the technology exists for constructing a space elevator, it likewise exists for constructing a space conveyor. Therefore, given the substantial advantages of the space conveyor as compared to the space elevator, namely, vastly increased carrying capacity as well as greatly reduced energy required per unit payload carried aloft, it makes sense to devote our resources to designing and building a space conveyor rather than a space elevator.

Nomenclature

g = force due to gravity alone at the equator
g_a = apparent (measured) force of gravity at the equator
g_h = gravitational acceleration at height h above the equator
g_t = "gravity" experienced in the top station (actually due to centrifugal force)
h = height above the equator
h_G = height of geostationary orbit (GEO)
h_t = height of the top station for energy-neutral operation
R = radius of Earth at the equator
T = length of Earth's sidereal day
v_t = speed of the top station relative to the center of Earth
ρ = density of the material out of which the tether or conveyor belt is fabricated
σ = lower bound on the required tensile strength of the tether or conveyor belt
ω = Earth's angular rotation speed

I. Background

As humanity leaves Earth to explore and colonize the rest of the solar system and possibly beyond, an important consideration is the mode of travel. Let us consider the possibilities.

A. Rockets

1. Chemically Powered

With chemically-powered rockets, which is the current method of space travel, most of the initial weight of the vehicle is the rocket fuel, most of which is expended in escaping Earth's gravity. The result is that the payload is only a small fraction of the gross weight of the rocket. Furthermore, there is little room for improvement in performance because the rocket fuels in current use are near the limit of energy density possible for chemical reactions.

2. Nuclear Powered

What about a nuclear-powered rocket? Regarding fission, whereas the fissionable material (uranium or plutonium) has an energy density much higher than that which is possible for a chemical rocket fuel, this advantage is largely offset by the large mass of the reactor necessary to contain and control the reaction as well as shield any personnel on board from the resulting radiation. Furthermore, unlike a chemically-powered rocket where the rocket fuel provides both the energy and reaction mass, a rocket powered by nuclear fission requires a material other than the nuclear fuel for the reaction mass, adding still more weight to the vehicle. The result is that the rocket is likely to be too heavy to even get off the ground, much less escape Earth's gravity. Finally, there is the risk that if such a rocket were to break apart in midflight, as was the case with the Challenger and Columbia disasters, it could release a considerable amount of radioactive material. Thus, fission-powered rockets are unlikely to be an option for the foreseeable future.

A rocket powered by nuclear fusion is a possibility, but the technology to contain the fusion reaction is in its early stages of development, so it is unlikely to be available in the near future, if ever.

B. Space Elevator

A space elevator has been proposed as an alternative space transportation system. In its most basic form, it consists of a tether anchored to the ground at one end and attached at the other end to a counterweight some distance above the height of GEO. The counterweight is held aloft by the centrifugal force resulting from Earth's rotation. To be of practical use, the counterweight would be a space station, herein referred to as the top station (aka, apex anchor), and serve as a platform for launching vehicles into deep space. A climber would ascend and descend the tether, transporting supplies and people between the ground and the top station.

An advantage of a space elevator, as compared to a rocket, is that whereas with a rocket, much if not most of the energy released by the rocket fuel is carried away by the spent fuel, the climber does not suffer from this energy loss and is thus able to carry loads aloft at a reduced energy cost per unit payload.

A limitation inherent in a space elevator is that the climber must make a round trip from the ground to the top station and back before it can ascend the tether with another load. Depending on the speed of the climber, the trip can take several days each way.

II. Space Conveyor

A. Operation

An alternative to a space elevator, proposed by the author, is a space conveyor. Like a space elevator, the space conveyor has a ground station connected to a top station some distance above the height of GEO. However, instead of being joined by a tether, the ground station is connected to the top station by a conveyor belt moving along rollers at both stations. The space conveyor is illustrated in Fig.1; Fig. 2 is a close-up of the ground station.

The conveyor belt is powered by motors connected to the rollers at the ground station. Spaced along the conveyor belt at equal intervals are attachment sites. In order to attach to the conveyor belt, a conveyor car is accelerated along a track using magnetic levitation and catches up with and hooks onto an attachment site moving along the bottom of the conveyor belt. Conveyor cars arriving from the top station unhook themselves when they reach the bottom of the conveyor belt. The track leads to a holding area (not shown), where the conveyor cars are loaded and unloaded. A similar procedure is used to attach and detach the conveyor cars at the top station, except that the conveyor cars are taken into the interior of the top station for loading and unloading.

The trip from the ground station to the top station is likely to take several days, depending on the speed of the conveyor belt, so the passengers and crew will need to be provided with cabins as well as the supplies necessary for life support, including oxygen, since only a tiny fraction of the journey is within Earth's atmosphere. Solar energy collectors on the exterior of the conveyor cars could provide electricity for the latter. Those conveyor cars carrying only freight would, of course, have no need to carry life support supplies.

The top station could be supplied with power by solar energy collectors thereon. Additionally, power could be efficiently transmitted from the ground station to the top station via the conveyor belt and converted to electricity by electrical generators connected to the rollers at the top station. Furthermore, the conveyor belt itself could be made into a giant solar energy collector by covering its outer surface with a flexible photovoltaic array.

The top station could house facilities for scientific research as well as serve as a platform for telescopes to observe the universe since there would be no atmosphere to blur the view. Also, the top station could accommodate tourists. However, the primary purpose of the top station would be to provide a platform for launching vehicles into deep space.

The spacecraft would be constructed from components brought up by conveyor cars, stored in the interior of the top station, and released from a portal at the top of the top station. On return, the arriving spacecraft would be held in place by a net, electromagnet, or other grasping device and taken into the interior of the top station.

To explore the solar system outside of Earth's orbit, the spacecraft would be released from the top station when Earth is between the sun and the top station, giving the spacecraft an initial speed with respect to the sun equal to the sum of Earth's orbital speed and the speed of the top station relative to Earth, thus giving the spacecraft a boost on its journey to a destination in the outer solar system. When the destination of the spacecraft is somewhere inside of Earth's orbit, the spacecraft would be released when the top station is between Earth and the sun, thereby causing the spacecraft to initially fall toward the sun in an elliptical orbit.

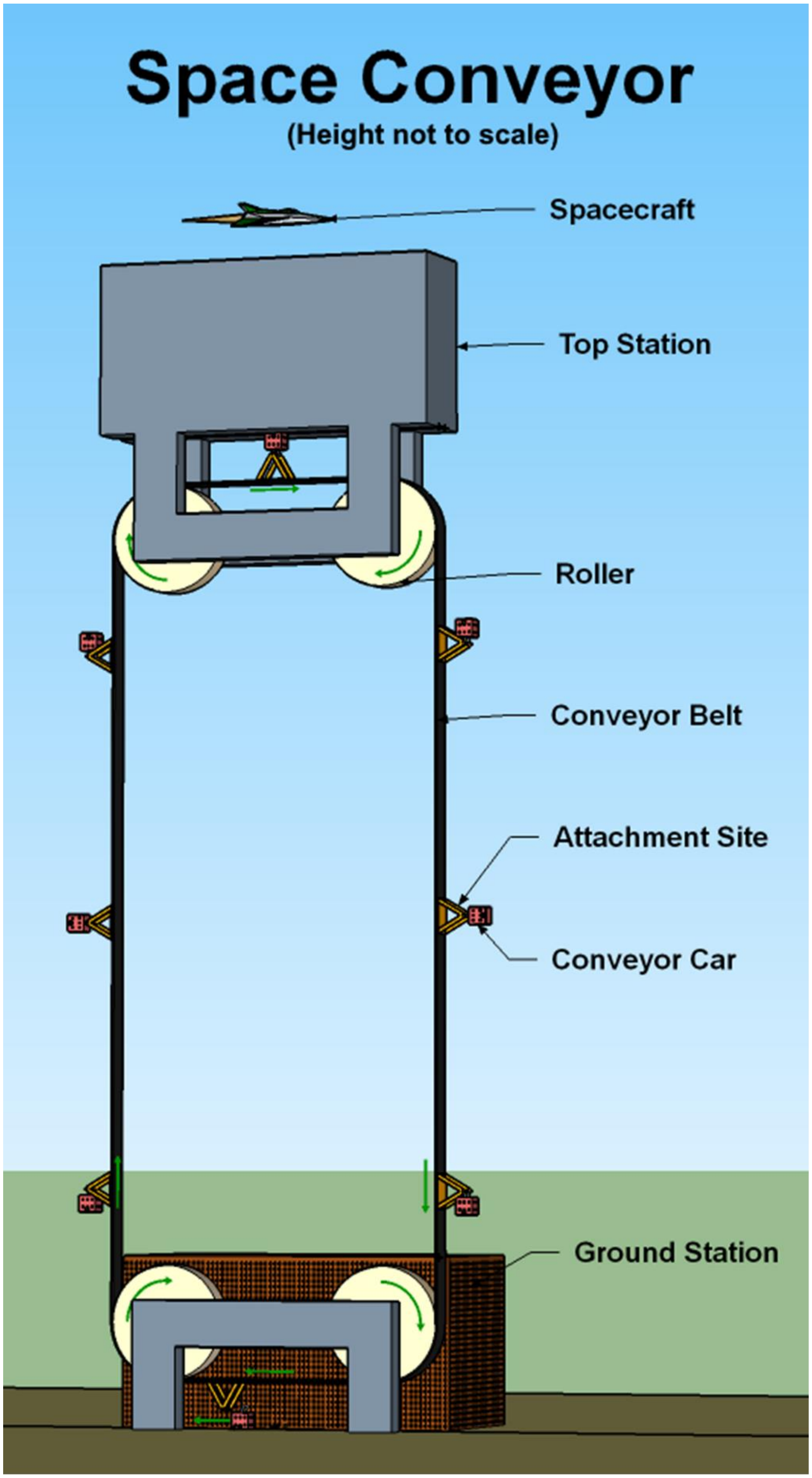

Figure 1. Space Conveyor

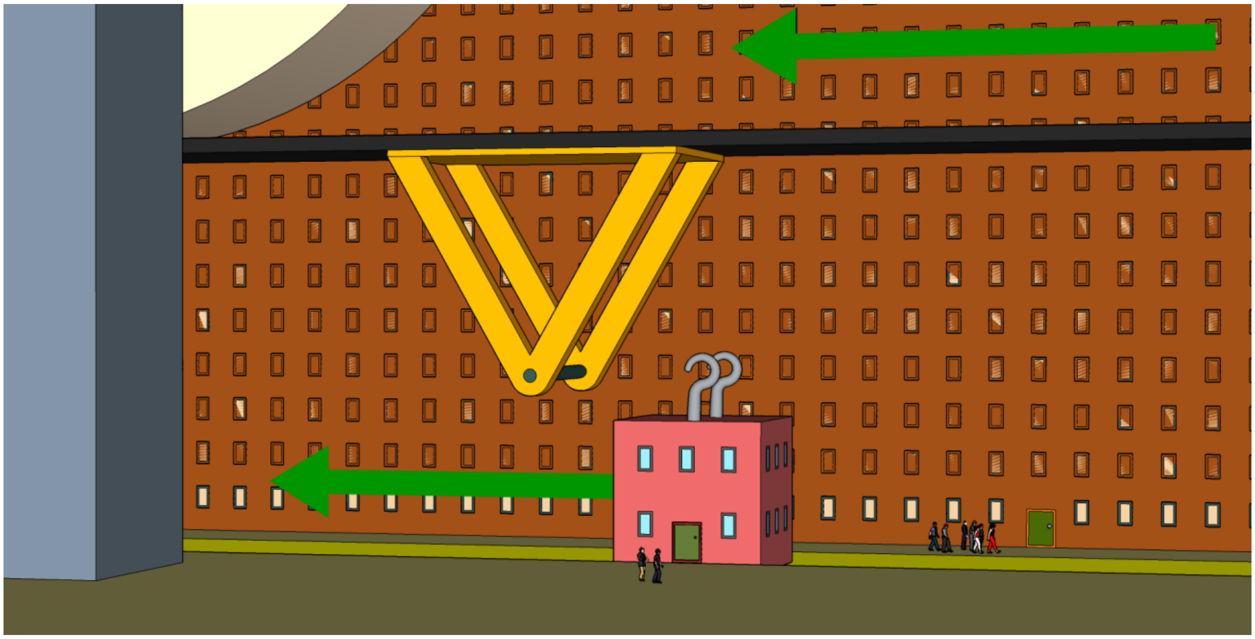

Figure 2. Ground Station

When traveling from Earth to the moon, it would not be practical to do so using a spacecraft released from the top station because such a spacecraft would have a high initial speed relative to the moon, requiring it to use a considerable amount of rocket fuel in order to slow down before it could safely land on the moon. Instead, the journey to the moon could be made using compact spacecraft the size of conveyor cars that could, like the latter, hook onto the conveyor belt and be carried aloft. However, instead of unhooking at the top station, these small spacecraft would detach from the conveyor belt at a height some distance above the height of geostationary orbit but below the height of the top station, designed to put the spacecraft in a long elliptical orbit around Earth, calculated to rendezvous with the moon at a relatively low speed. On the trip back to Earth, the spacecraft could hook onto an unoccupied attachment site on the downward-moving portion of the conveyor belt, a difficult but doable maneuver.

The reader may be wondering why the illustration of the space conveyor shows two rollers for each of the two stations. Why not a single roller for each station? The reason is that with two rollers, the conveyor car has an opportunity to hook onto an attachment site while the latter is on the horizontal section of the conveyor belt between the two rollers. If a single roller were used, the coupling would have to occur when the attachment site was at the bottom of the roller, a maneuver requiring extremely precise timing. Whereas failing to attach would be an inconvenience to the passengers, as they would have to wait until the next unoccupied attachment site came by, failing to unhook could be catastrophic, as the people on board would be stuck in the conveyor car for the several additional days required to reach the top station or ground station, as the case may be, and likely run out of the life support essentials, particularly oxygen. An additional benefit of having two rollers at the top station is that it prevents the top station from swinging about the axle of the roller, which could occur if a single roller were used.

Since there may be hundreds if not thousands of conveyor cars simultaneously moving up and down the conveyor belt, the carrying capacity of the space conveyor is vastly greater than that of the space elevator. Furthermore, whereas the space elevator must expend energy in order to lift the climber from the ground up to the height of GEO (it could coast the rest of the way upward to the top station), if the height of the space conveyor is chosen so that the force of gravity acting on the conveyor belt with the attached conveyor cars is exactly balanced by the centrifugal force resulting from Earth's rotation, the only energy required to operate the space conveyor would be that which is necessary to offset the small losses due to friction on the bearings supporting the rollers as well as air resistance on the tiny fraction of the conveyor belt lying within Earth's atmosphere.

If the space conveyor is constructed so as to be at this height of energy-neutral operation, which, as shown below, turns out to be 144 thousand kilometers (89 thousand miles), the balance between gravity and centrifugal force would hold even if the mass of the upward-moving traffic exceeds that of the downward-moving traffic, as is likely to be the case for several centuries after the space conveyor begins operation, as humanity leaves Earth to explore and colonize the rest of the solar system.

So how is it possible to sustain a net upward flow of mass from a state of lower gravitational potential to one of higher gravitational potential using only the energy necessary to overcome friction and air resistance? The first thing to recognize is that the space conveyor lies in a rotating frame of reference, namely, rotating Earth. Newton's laws of motion can be applied in a uniformly rotating frame of reference provided we introduce what physicists refer to as fictitious forces, one of which is centrifugal force, which we have already considered. The second so-called fictitious force is the Coriolis force.

The Coriolis force is interesting in the way that it operates. It doesn't affect any object at rest with respect to the rotating frame. An object in motion relative to the rotating frame will experience a Coriolis force perpendicular to both its direction of motion and the axis of rotation of that frame, in this case, Earth's axis of rotation. Thus, the upward-moving (west) side of the conveyor belt will experience a Coriolis force in the westward direction, whereas the downward-moving (east) side of the conveyor belt will experience a Coriolis force in the eastward direction. The result is that the moving conveyor belt will bulge slightly outward.

If the mass of the upward-moving traffic exceeds the mass of the downward-moving traffic, as is likely to be the case for some time after the space conveyor begins operation, the Coriolis effect will result in a net westward force being exerted on the space conveyor. This westward force will exert a torque about Earth's axis of rotation, causing a decrease in Earth's rate of rotation. We have thus identified the source of energy responsible for lifting the conveyor cars: the energy of Earth's rotation!

Since the mass of the conveyor cars is only a tiny fraction of Earth's mass, the resulting slowing down of Earth's rotation is likely to be too small to measure, except, perhaps, with the most accurate atomic clocks. Furthermore, even this tiny effect should vanish after several centuries, when the solar system has been colonized to the point where the flow of traffic leaving Earth is essentially equal to the flow of traffic arriving at Earth. In any case, Earth's rotation is already slowing down due to the tidal drag caused by the moon and to a lesser extent by the sun; scientists correct for this effect by adding a second to the day every so often in order to keep the atomic clocks in sync with Earth's period of rotation. The tiny addition to this rate of slowing down caused by the operation of the space conveyor could be accommodated by adding a second to the day slightly sooner than would otherwise be necessary.

B. Technological Challenges

Before a space conveyor can be constructed, the space surrounding Earth would have to be cleared of all satellites and debris that could possibly hit the space conveyor. The only satellites that could safely coexist with the space conveyor would be those in GEO; even those satellites would have to be carefully monitored to ensure that they didn't drift into the space conveyor. A similar requirement applies to a space elevator.

A second requirement is that the conveyor belt of the space conveyor, as well as the tether of the space elevator, have sufficient tensile strength to support its own weight plus the weight of any attached vehicles from the ground to the height of GEO. In calculating the minimum required tensile strength, we will assume that the tether has a uniform cross-section. Whereas the required tensile strength can be reduced by using a tapered tether (no comparable option exists for a conveyor belt), such a reduction occurs at the expense of an exponential increase in the taper ratio, defined as the area of the cross-section at the height of GEO divided by the area of the cross-section at Earth's surface, so anything more than a modest reduction in the required tensile strength would require a taper ratio that is prohibitively large. Furthermore, a tapered tether precludes the possibility of fabricating the tether with continuous strands, potentially reducing the tensile strength of the tether.

To compute a lower bound on the required tensile strength, consider a cable of uniform cross-section anchored to the ground at one end and attached to a counterweight at the other end some distance above the height of GEO. The maximum tension on the cable occurs at the height of GEO and is at least equal to the net weight of the cable from the ground up to the height of GEO.

To compute the height of GEO, we use the fact that at that height, the gravitational pull of Earth is exactly balanced by the centrifugal force due to Earth's rotation. The gravitational acceleration at height h above the equator, denoted by g_h, is given by

$$g_h = g\frac{R^2}{(R+h)^2}, \tag{1}$$

where g is force due to gravity alone at the equator, and R is the radius of Earth at the equator, which is equal to 6,378.137 km[1].

The apparent (measured) force of gravity, denoted by g_a, is equal to the force due to gravity alone, g, offset, to some extent, by the centrifugal force due to Earth's rotation, so that

$$g = g_a + \omega^2 R, \tag{2}$$

where g_a = 9.78033 m/s^2 (Ref. 2), and ω is Earth's angular rotation speed.

$$\omega = \frac{2\pi}{T}, \tag{3}$$

where T is the length of Earth's sidereal day, which is equal to 86,164 s (Ref. 3).

At the height of GEO, denoted by h_G, the force of gravity is exactly balanced by the centrifugal force due to Earth's rotation, so that

$$g\frac{R^2}{(R+h_G)^2} = \omega^2(R+h_G). \tag{4}$$

Solving Eq. (4) for h_G results in

$$h_G = \left(\frac{gR^2}{\omega^2}\right)^{\frac{1}{3}} - R. \tag{5}$$

Substituting the numbers for the variables in Eq. (5) and performing the calculations (I used an Excel spreadsheet) results in h_G = 35,809 km, which is very close to the generally accepted value for the height of GEO of 35,786 km[4]. One possible reason for the slight discrepancy between these two values is that in calculating the gravitational attraction of Earth as a function of height, we assumed that all of Earth's mass was concentrated at its center. This is valid for a perfect sphere with a radially symmetric density distribution but only approximately true for an oblate spheroid such as Earth. In any case, this discrepancy is far too small to be of consequence for our purposes.

A lower bound on the required tensile strength of the cable is that which is necessary to support the net weight of the cable from the ground to the height of GEO. This is given by

$$\sigma = \rho\int_0^{h_\mathrm{G}}\left[g\frac{R^2}{(R+x)^2} - \omega^2(R+x)\right]dx, \tag{6}$$

where ρ is the density of the material out of which the cable is fabricated, and σ is a lower bound on the required tensile strength of the cable.

Performing the integration in Eq. (6) results in

$$\sigma/\rho = h_\mathrm{G}\left[\frac{gR}{R+h_\mathrm{G}} - \omega^2\left(R+\frac{h_\mathrm{G}}{2}\right)\right]. \tag{7}$$

σ/ρ is a lower bound on the required tensile strength to density ratio of the material used for the conveyor belt. Since the weight of the conveyor belt is proportional to its density, the relevant variable is the tensile strength divided by the density, which is known as the specific strength.

Substituting the numbers for the variables in Eq. (7) and performing the calculations results in

$$\sigma/\rho = 57{,}756{,}545\ \mathrm{m^2/s^2} = 58\ \mathrm{GPa/(g/cm^3)}. \tag{8}$$

Carbon nanotubes has been considered as a possible material for the tether of a space elevator, so it is likewise a possibility for the conveyor belt of the space conveyor. The maximum tensile strength of carbon nanotubes that have been produced in the laboratory is 63 GPa[5]. Taking the density of carbon nanotubes as 1.34 g/cm^3 (Ref. 5) results in a specific strength of 47 GPa/(g/cm^3), which falls short of the minimum requirement. However, the theoretical limit of the tensile strength of carbon nanotubes is 300 GPa[5], corresponding to a specific strength of 224 GPa/(g/cm^3), so the possibility of fabricating the conveyor belt of a space conveyor from carbon nanotubes cannot be ruled out.

A promising alternative to carbon nanotubes is graphene, which has a tensile strength of 130 GPa[5] and a density of 1.0 g/cm^3 (Ref. 5), resulting in a specific strength of 130 GPa/(g/cm^3), which is over twice the minimum requirement.

We choose the height of the top station so that if the upward-moving part of the conveyor belt is uniformly loaded along its length, the total downward force acting on it due to gravity is exactly balanced by the upward centrifugal force. At this same height, the forces acting on the downward-moving part of the conveyor belt will likewise balance, provided it too is uniformly loaded along its length, although the loadings on the two sides need not be the same. Thus, we have that

$$\int_0^{h_{\mathrm{t}}} g\frac{R^2}{(R+x)^2}dx = \int_0^{h_{\mathrm{t}}} \omega^2\,(R+x)dx, \tag{9}$$

where h_{t} is the height of the top station for energy-neutral operation.

Integrating both sides of Eq. (9) and solving for h_{t} results in

$$h_{\mathrm{t}} = \frac{1}{2}\left(R^2 + \frac{8gR}{\omega^2}\right)^{\frac{1}{2}} - \frac{3}{2}R. \tag{10}$$

Substituting the numbers for the variables in Eq. (10) and performing the calculations results in h_{t} = 143,905 km.

The "gravity" experienced by those residing in the top station, denoted by g_{t}, (actually due to centrifugal force) is given by

$$g_{\mathrm{t}} = \omega^2(R+h_{\mathrm{t}}) - g\left(\frac{R}{R+h_{\mathrm{t}}}\right)^2, \tag{11}$$

which results in $g_{\mathrm{t}} = 0.78$ m/s^2, which is about 8% of Earth's surface gravity.

The speed of the top station relative to the center of Earth, denoted by v_{t}, is given by

$$v_{\mathrm{t}} = \omega(R+h_{\mathrm{t}}), \tag{12}$$

which results in v_{t} = 11 km/s.

C. Construction

The space conveyor could be constructed by first placing a space station in geostationary orbit by conventional means (i.e., rockets). A cable having the required specific strength would be wound around a pulley, which would be lowered to Earth directly above the location where the ground station is to be constructed. The cable would be unwound from a spool or spools at the space station. The pulley would need to be given an initial boost to get it going on its downward journey. After the pulley was some distance from the space station, Earth's gravity would pull it down the rest of the way. When the pulley reached the ground, it would be hooked onto an anchor point. The space station would then move into a higher orbit in order to put some tension on the cable at ground level. The two ends of the cable would then be spliced at the space station to form a continuous loop of cable and wrapped around a second pulley. The pulley at ground level would then be attached to a motor, and the moving cable would be used to transport supplies from the ground to the space station in order to construct the space conveyor.

The conveyor belt is envisioned to be approximately ten meters wide and ten centimeters thick. Construction of the space conveyor could be hastened by fabricating a conveyor belt of lesser cross-section, say, around one meter wide and one centimeter thick as an intermediate step in order to increase the rate at which material could be transported to the top station. The conveyor belts would be fabricated at the top station and wrapped around a roller that would be lowered to Earth as material is continuously added to the conveyor belt.

III. Lunar Alternative

Due to the long sidereal period of the moon, about 27 days[6], a space conveyor constructed on the moon to the height of energy-neutral operation would be so long that it would be impractical. On the moon, rocket fuel would be scarce whereas energy in the form of solar energy is abundant, so an alternative to using rockets to vertically take off from and land on the moon would be to accelerate the spacecraft along a track on the moon's surface using magnetic levitation until the spacecraft reached the speed necessary to escape the moon's gravity. The power would be supplied by banks of solar panels lining either side of the track, along with rechargeable batteries to store the surplus energy for operation during the lunar night. On landing, the same track could be used, with the spacecraft slowed down using regenerative magnetic braking in order to recover some of the kinetic energy of the incoming spacecraft.

Spacecraft arriving from Earth via the space conveyor thereon would, on their return trip to Earth, be accelerated along the lunar launching and landing track in the direction opposite to that of the moon's orbit around Earth in order to fall toward Earth in a long elliptical orbit, calculated to rendezvous with the space conveyor and hook onto the downward-moving portion of the latter.

IV. Martian Challenge

In some respects, Mars provides a more favorable environment for constructing a space conveyor than Earth does. First, the space around Mars is currently pristine, free of the plethora of satellites and debris that surrounds Earth. Second, due to the smaller size, lesser gravity, and similar rotation period of Mars as compared to Earth, the minimum specific strength required for the conveyor belt of a space conveyor built on Mars is only about one-fifth of that required for one on Earth. (See Table 1.)

Table 1. Earth and Mars Compared

Descriptor	Earth	Mars	Ratio
Equatorial radius (km)	6,378.1[1]	3,396.2[7]	0.5325
Apparent (measured) gravity at the equator (m/s^2)	9.7803[2]	3.7207[7]	0.3804
Length of the sidereal day (s)	86,164[3]	88,643[8]	1.0288
Height of geostationary/areostationary orbit (km)	35,786[4]	17,032[9]	0.4769
Minimum specific strength required for a conveyor belt ($GPa/(g/cm^3)$)	57.757*	11.612*	0.2011
Height of a space conveyor for energy-neutral operation (km)	143,905*	66,012*	0.4587
"Gravity" experienced at the top station (actually due to centrifugal force) (m/s^2)	0.78145*	0.33978*	0.4348
Speed of the top station relative to the center of the planet (km/s)	10.959*	4.9198*	0.4489

Unfortunately, there are obstacles in the way of constructing a space conveyor on Mars in the form of the two Martian moons, Phobos and Deimos. Phobos has a diameter of 22.2 km[10] and orbits Mars at an altitude of 5,989 km[11]; Deimos has a diameter of 12.6 km[10] and orbits 23,460 km[12] above the surface of Mars. Both moons lie in equatorial orbits below the height of a space conveyor for energy-neutral operation, so a space conveyor anchored at the equator would lie directly in the path of these orbiting moons. Fortunately, the Martian moons are relatively small compared to Earth's moon, so a workaround is possible.

To construct a space conveyor on Mars, begin by placing a space station in areostationary orbit (the Martian equivalent of geostationary orbit). However, instead of having the ground station directly below the space station, locate the ground station on either side of the equator at a sufficient distance from the equator so that the cable attached to the pulley used to anchor the space station is not in the path of Phobos, whose orbit lies below the height of areostationary orbit. When completed, the space conveyor will lean toward the equator but not cross it, so it will not lie in the path of either of the moons. The slight inclination of the space conveyor from the vertical will cause a corresponding tilt in the axes of the rollers of the ground station. To compensate for this, the attachment sites could be constructed so that the bar supporting the conveyor car can rotate so that the attached conveyor car is kept level.

As an alternative to or in addition to the space conveyor described above, the Martian moons could be converted to top stations for space conveyors. The space conveyor described previously could be used to transport material and personnel between the Martian surface and the moons in order to facilitate the construction of these space conveyors. The moons could be hollowed out to create habitable spaces within. From the excavated rock, metals used for construction as well as other minerals of value, such as carbon used for making the carbon nanotubes or graphene for the conveyor belt, could be extracted. Solar energy collectors could provide power for the construction. Arrays of mirrors could focus sunlight on vessels into which the waste products from the mineral extraction operations would be fed. The contents of these vessels would be vaporized by the concentrated sunlight, that gas being expelled at high speed through a nozzle to provide thrust to slowly move the moons into areostationary orbits, positioned so that the space conveyors, when constructed, are equally spaced around the Martian equator. The relatively large masses of the top stations constructed out of the moons could support conveyor belts of sufficient width and thickness to carry full-sized spacecraft aloft.

After the space conveyors using the Martian moons have been constructed, the ground station of the original space conveyor could be moved to the equator to eliminate the leaning of that space conveyor, if desired.

* Calculated

V. Conclusion

Since the minimum specific strength required for the conveyor belt of the space conveyor is the same as that for the tether of the space elevator, it follows that if the technology exists for constructing a space elevator, it likewise exists for constructing a space conveyor. Therefore, given the substantial advantages of the space conveyor as compared to the space elevator, namely, vastly increased carrying capacity as well as greatly reduced energy required per unit payload carried aloft, it makes sense to devote our resources to designing and building a space conveyor rather than a space elevator.

If and when the space conveyor becomes operational, it could reduce the cost of space travel to the point where it is affordable to the general public and becomes as common as air travel is today.

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