



Beneficial Environmental Impacts of the Space Elevator

Terms of Reference

International Space Elevator Consortium 2020 Study

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Terms of Reference 2020 ISEC Study Topic

Introduction: This is the transportation story of the 21st century. Reliable, routine, safe, and efficient access to space is close at hand. The Space Elevator is the Galactic Harbour, and an essential part of the global and interplanetary transportation infrastructure. In the community of off-planet movement with NASA's newest move to put boots on the Moon by 2024, space elevators must be tossed into the discussions. The key here is that daily, routine, inexpensive, massive movement of payloads to GEO and release from over locations on the Space Elevator will allow high speed launches to other bodies in our solar system. This study will start the discussions about the strengths the space elevator has for supplying activities such as: factories, mining, distribution GEO satellites and other activities that can be done easier in a weightless environment.

The reality is that when humanity decides to do off planet activities, there will be a tremendous need for logistics support, movement of manufactured goods as well as transporting people [especially at low cost and routine/daily]. The question on ISEC's table is: how can the strengths of the space elevator enable missions of all types, while having little or no environmental effect on our planet? We believe that not only can it do this but also allow activities in space that will improve Earth's environment. This study hopes to show what the environmental effects of building and daily use of space elevators will be and what kind of activities can be done to improve the Earth's environment.

Assumptions: The following assumptions will establish the initial conditions of the study. (to be refined over the study)

Growth of Space Elevators: The space elevator expectations between the ISEC and the JSEA have been estimated to have the IOC in 2035 and FOC in 2040. The growth of multiple Galactic Harbours is expected to be supported by other countries (as a launch capability) and by industry (as a center for massive enterprise growth).

Initial Operational Capability (IOC)	First Space Elevator	2035
	First Galactic Harbour (Mid-Pacific)	2036
	Second Galactic Harbour (Indian Ocean)	2037
	Third Galactic Harbour (Mid-Atlantic)	2038
Full Operational Capability (FOC)	First Space Elevator	2040
	First Galactic Harbour (Mid-Pacific)	2041
	Second Galactic Harbour (Indian Ocean)	2041
	Third Galactic Harbour (Mid-Atlantic)	2042



Operational Pace: The assumption has always been that space elevators could liftoff one payload each day. This was assessed by the simulations and expected loading of the tether. Further analysis must be accomplished to go beyond this for normal operations. However, the interplanetary mission support routinely allows the alignment of release location and target orbital characteristics once a day.

Slow down at Rendezvous Location: The assumption is that the payload mass would include the orbital rendezvous rocket motors to slow down and then orbit the target planet with spare fuel to maintain the required mission orbit or land on the surface. This assumption is standard on all interplanetary probes or missions. Of course there are other approaches such as aerobraking or direct landing.

Compatible Infrastructures: The space elevator infrastructures will be compatible with the rocket launch infrastructures and will be complementary in the mission support. One concept circulating is that the rockets would handle people and the Galactic Harbours would handle logistic support.

Baseline Infrastructures: The ISEC baseline for the Space Elevator, and by extension the Galactic Harbour, includes the following characteristics: 100,000 km tether resulting in Apex Anchor at that altitude, IOC payload capability, initial space elevator in mid-Pacific (2035) with Galactic Harbour growing out of that with two tethers (space elevators) by 2036. Each of the major segments (HQ/POC, Apex Anchor, Galactic Harbour, and tether) would be supporting missions of one lift-off a day of 14 MT. The GEO terminus and other points along the tether will have to be prepared for the activities we propose.

Impact of Radiation Doses: Although the one week to GEO and another week to Apex Anchor will ensure that our payloads will be in the radiation belts for considerable time, the time savings in the short duration flights to Mars could be offset. Therefore, a good study of radiation exposure should be started with preliminary results shown. Slow transit through Van Allen Belts vs fast transit through inner solar system radiation environment.

Starting Point: This study has been authorized by ISEC to illustrate the tremendous strengths of the space elevator and what environmental effect both negative and particularly positive it can have.

Background: The envisioned Missions to Mars and the Moon are of incredible size and scope and will require an huge amount of logistical support. This will require a large number of rocket launches with a possible negative impact on the Earth's

environment. The ISEC has always assumed that operational space elevators would have little or no environmental impact and that a number of environmental problems could possibly be solved, if a cheap reliable access to GEO existed. This study will investigate the environmental effects of the construction and operation of a space elevator. It will also consider what possible Earth environmental problems could be alleviated or even solved by the use of space elevators.

The study thrust is:

First to do two Environmental Impact Studies.

The construction of a Space Elevator, considering the construction of the tether, ocean platform, climbers and transporting of materials to the construction site.

The operation of a Space Elevator along with its logistical support. Second and the most important part of the study will be to consider all the ways a space elevator could be used to solve environmental problems that now plague the earth.

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It has been considered for some time that any sizable space colonies main purpose would be to construct large solar panels to capture the suns rays and beam the energy to earth using microwaves. It was thought that this would solve the problems created by burning fossil fuels and thus give Earth an alternate power source as fossil fuels become depleted. Gerald O'Neal proposed this in his book "2081".

Could nuclear waste be disposed of economically and in mass in outer space? This will also be considered along with how it should be done, projection into the sun, Jupiter or in some other way.

Manufacturing that is polluting or dangerous on the Earth could possibly be done at GEO, with minimal expense for movement of materials to GEO and finished products returned to earth or sent on to Lunar or Mars colonies.

The breakout of the study could follow the following preliminary outline.

Part A: Summary of the findings

Part B: Environmental Impact Study of SE Construction

1. Ocean Platform for Earth Port
2. Material manufacture of tethers
3. Construction of platform
4. Rocket launches needed to GEO during construction



5. Shippment of supplies materials to construction site
6. Others to be determined

Part C: Environmental Impact Study of SE during Operation

1. Traffic to and from Earth Port
 - a. Air
 - b. Sea
2. Platform
3. Tether
 - a. Atmosphere
 - b. Space
4. Space Port at GEO
5. Activities Beyond GEO

Part D: Positive effects to make the Earth greener

1. Manufacture of graphene tethers will remove CO₂ from the atmosphere
2. Space based Solar Power, what would it take to completely power the Earth by space based solar?
3. Space based polluting industries using materials from other bodies in space instead of the earth.
4. Interplanetary travel with minimal chemical based propulsion
5. Remove space junk and limit additional debris
6. Nuclear Waste
7. Recycle and repair old satellites
8. Will require fewer rocket launches while increasing our presence in space
9. Allows the less expensive and practical release of nuclear waste to Jupiter or other space locations
10. Practical logistical support for Mars or Moon colonies
11. Will limit the need for high velocity re-entries

Part E: Conclusions (this is where we can do some comparison for doing some of the same things entirely by rocket launches)

Each of the Areas in Part B and C would have to consider each of the items normally addressed in an environmental impact study, which are the following:

1. Properties
2. Noise
3. Visual Resources and Light Emissions
4. Historical, Architectural, Archaeological, and Cultural Resources
5. Air Quality
6. Water Resources (Including Surface Waters, Groundwater, Wetlands, Floodplains, and Wild and Scenic Rivers)
7. Biological Resources (Including Fish, Wildlife, and Plants)
8. Hazardous Materials, Pollution Prevention, and Solid Waste
9. Socioeconomics, Environmental Justice, and Children's Environmental Health Risks and Safety Risks
10. Natural Resources and Energy Supply
11. Secondary (Induced) Impacts

I believe we should add SPACE to this list as we are suggesting a permanent infrastructure in space. Obviously, a number of these will not apply but some will need to be discussed at length and well documented.

Specific Topics to be Researched:

Impact studies; JE

Graphene Manufacture; ?

Polluting Industries: ?

Space Based Solar Power;

Space Junk; PS?

Nuclear waste; ?

Burning fuel effects, Bert Molloy

Others ?

Study Lead: Jerry Eddy Study Members: Peter Swan, Bert Molloy, Bob Greene, Paul Phister, Joshua Bernard-cooper, Nelson?

Our schedule for this study is as follows:

- August 2019 — Study authorized at Board of Directors meeting
- Aug-Sept 2019 — Topic announced at the yearly conference with mini-workshop for brainstorming - initial team formed



- Sept 2019-Jan 2020 — Final team formed and outline of study topics - with Jerry Eddy announced as lead
- Jan- June 2020 — Specific items assigned, analyzed and studied - chapters written - topics submitted to ISEC yearly conference
- May 2020 — Preliminary presentations given at space elevator session at ISDC on topics - mini workshop to discuss proposed concepts from within individual chapters
- Sep-Dec 2020 — Draft of Final Document.
- Oct 2020 - presentation and papers at IAC Dubai
- Jan-Feb 2021 — Review of final report within team
- Feb-Apr 2021 — ISEC Review of Final Document (red team and internal acceptance)
- May 2021 — Publish Study Report

Specific Items to be Researched:

Goal for ISEC: We need to insert “positive environmental impact” in all aspects of space elevator discussions. This will become increasingly important as global warming becomes accepted as fact in the public mind.

Remember: This is the transportation story of the 21st century. Reliable, routine, safe, positive environmental impact and efficient access to space is close at hand. The Space Elevator is the Galactic Harbour, and an essential part of the global and interplanetary transportation infrastructure.