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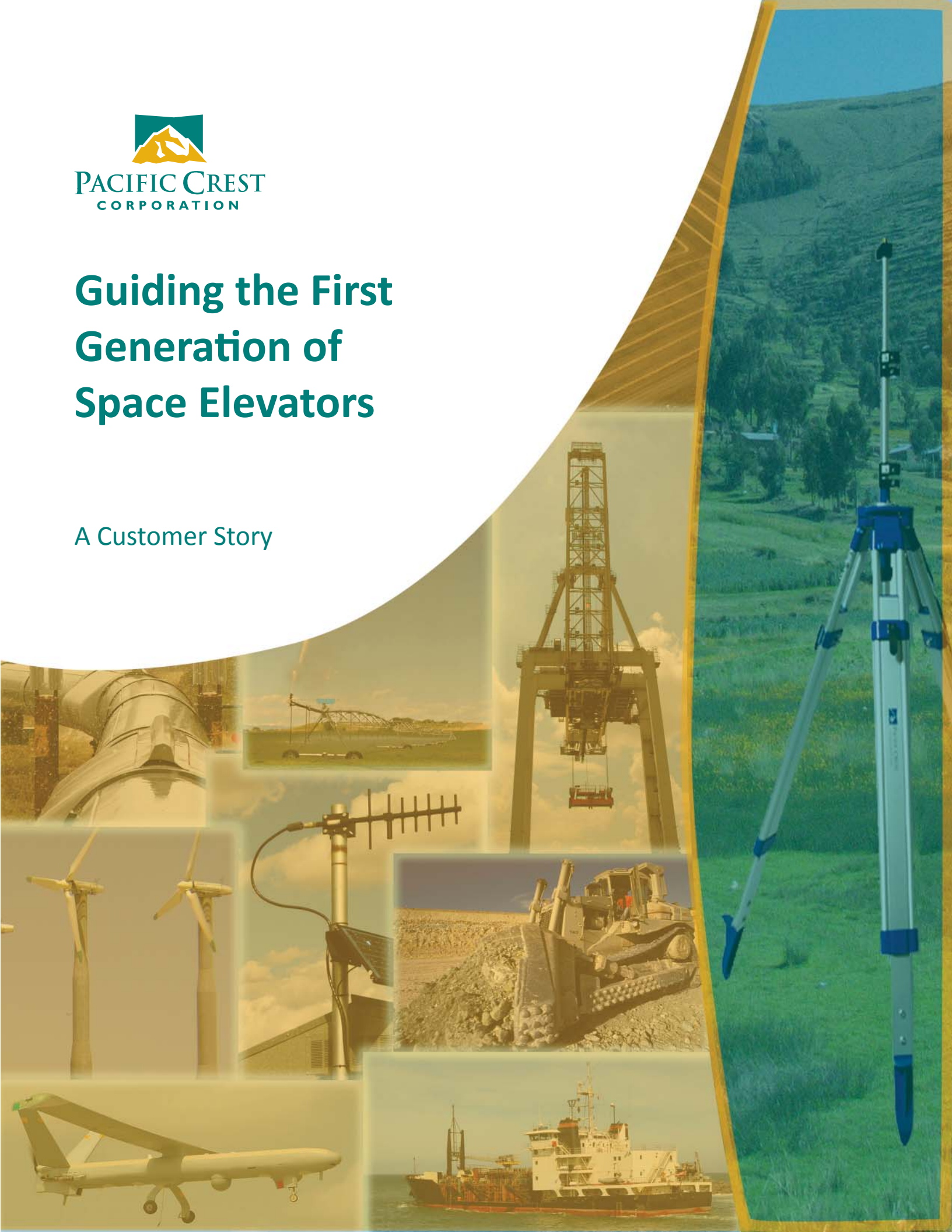
Guiding the First Generation of Space Elevators

A Customer Story



Guiding the First Generation of Space Elevators

Introduction

Imagine stepping in to an elevator that will rise through the Earth's atmosphere, all the way up to a platform suspended in space. The platform is a space terminal where you will depart for destinations within our galaxy or possibly beyond. The Space Elevator will allow people to travel through the atmosphere smoothly without being propelled by rocket into space. The Elevator will ride along a cable that is attached to the space terminal; it will be just like going to the top of a very tall building today.

NASA Challenge

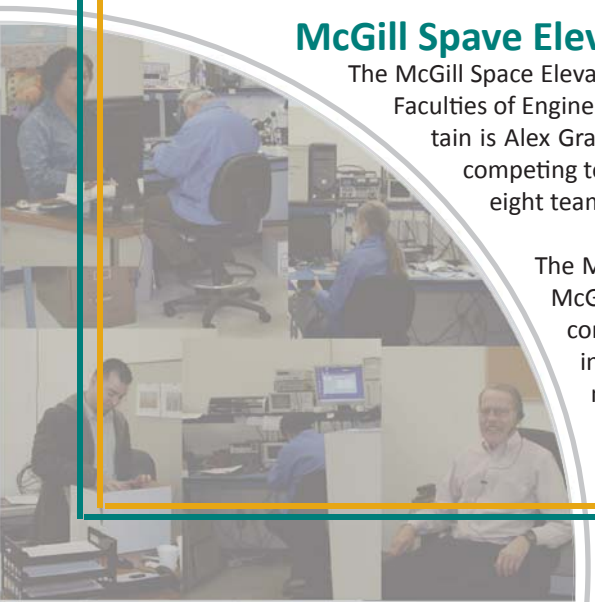
NASA created the Centennial Challenge in 2003 to honor the spirit of the Wright Brothers and other pioneers in space and aviation on the 100th anniversary of the Wright Brother's historic flight. It also noted that much of the progress made during the 20th Century could be attributed to contests that offered prizes to the winners. NASA designed a contest that would monetarily reward those competitors who enabled solutions to the tasks outlined in the Centennial Challenge.

The Centennial Challenges seek to:

- Drive progress in aerospace technology of value to NASA's missions
- Encourage the participation of independent teams, individual inventors, student groups and private companies of all sizes in aerospace research and development
- Find the most innovative solutions to technical challenges through competition and cooperation

The Centennial Challenge is made up of seven challenges, with a total purse of US$10,000,000. One of the challenges is the Power Beaming and Tether competition managed by the Spaceward Foundation. The Power Beaming "challenge is a practical demonstration of wireless power transmission. Teams build mechanical devices that can propel themselves up a vertical cable. The power supply for the device is not self-contained but remains on the ground. The technical challenge is to receive the transmitted power and transform it to mechanical motion, efficiently and reliably."

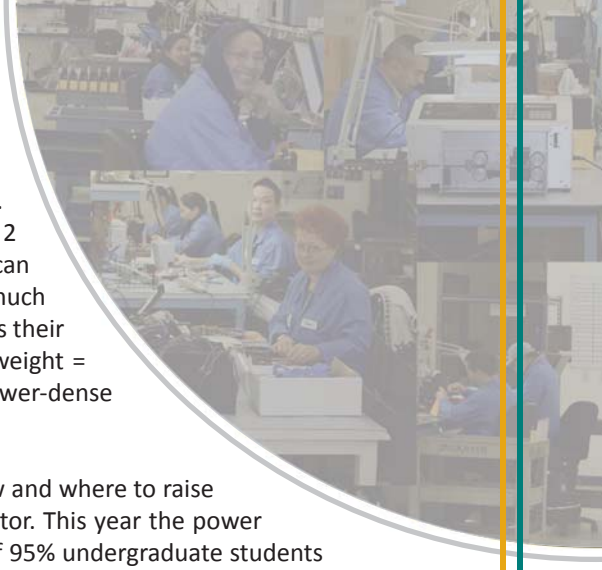
The Spaceward Foundation has created the Elevator:2010 challenge with a goal "to generate enough interest in the project, so that within five years the Space Elevator basic building blocks can be demonstrated as feasible, and full-scale design and construction can begin." Elevator:2010 is divided into the Power Beaming and Tether Strength competitions. The competition is tentatively set for November 7, 2008 at Meteor Crater, AZ. There are eleven teams competing in the Power Beaming competition from the US, Canada and Japan. One of the teams is McGill University located in Montreal, Canada.



McGill Spave Elevator Team

The McGill Space Elevator Team (MSET) is composed of 50 talented undergraduate students representing the Faculties of Engineering, Arts and Science at McGill University in Montreal, Canada. Its current Team Captain is Alex Gravenstein, a third year Mechanical Engineering student. The team is in its second year competing to complete a working solution to NASA's Beam Power Challenge after being one of only eight teams to qualify for the finals in 2007.

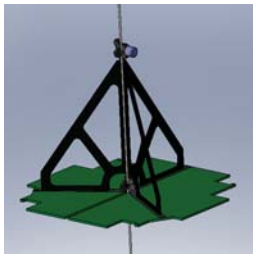
The MSET first learned of the challenge when Professor Higgins, Mechanical Engineering, at McGill University came across an article about the 2005 Space Elevator competition. The competition was very innovative and allowed students to be extremely creative in designing a space elevator beaming system. He showed the article to Cyrus Foster who recognized the competition as "a great learning experience." Based on this, Cyrus founded the McGill Space Elevator Team in the fall of 2006 and became the first Team Captain.



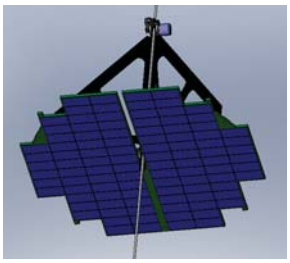
The Spaceward Foundation provides the tether which is a 3/16" diameter 7x19 stainless steel aircraft cable that is 1 km in length and is suspended in place by a helicopter. Each of the teams will provide a climber that must ascend the tether at a minimum of 2 m/s (6.6 feet per second). There is also a high-performance prize for the climber that can move at 5 m/s. The climber must not exceed 50 kg in total weight, but can carry as much payload as possible up to this limit. Climbers are scored according to a formula that uses their speed, amount of payload and their net weight (payload x average speed / climber weight = score). Power to the climber is unlimited. Each team is tasked with creating the most power-dense climber for this competition.

There are many challenges that faced the team from the outset. The largest one is how and where to raise the money to purchase the necessary equipment to design and make the space elevator. This year the power source chosen cost over $31,000. Then take into consideration the team is made up of 95% undergraduate students from different disciplines. There are organizational and communication issues to deal with, not to mention the space elevator work has to coexist with regular college work.

The McGill Space Elevator Team (MSET) has developed a robotic climber, weighing less than 2 kg, to ascend the 1 km tether at speeds between 2-6 m/s as required by the competition rules. The climber cannot have any stored energy (batteries) as specified by the Spaceward Foundation. Batteries are only allowed to power computing electronics, brakes, etc. This will ensure the climbers are powered by a light source which is necessary to keep the space elevator light enough to climb the tether. They must beam all the power to the climber required to fight gravity and ascend the tether. The beam will be a 2.5kW infrared laser on the ground, aimed at the bottom of the climber. The bottom of the climber is a photovoltaic array (solar panel) that converts the laser beam to electricity that drives the climber's motors. The greatest technical challenge is how to aim the laser to track the ascending climber with arcsecond precision to ensure the climber receives energy from the ground at all times.



Top View



Bottom View

Since the tether is attached to a hovering helicopter, it is not completely vertical or straight and it can move with the wind. MSET will use two Trimble BD960 receiver modules from Pacific Crest to keep the power beaming continuously to the climber. One BD960 is in a base unit and the other BD960 is in the climber. They are set to RTK low-latency mode and will determine the x, y, z position of the climber with a precision of 2-3cm. A computer takes information from both BD960s and then adjusts the motors controlling the laser, so it is continuously pointing at the climber.

The MSET chose the Trimble BD960 after extensive research. They needed to find the GPS system with the highest amount of accuracy. After searching online, the team decided the BD960 fit their requirements perfectly. The BD960 provides centimeter level positioning accuracy in an easy-to-integrate form. The BD960 in the base unit is working effortlessly with the LAN interface. The Electrical Team, led by Puneet Mulchandani, is finishing off the differential GPS mode.

There is still more work to be done by the MSET. The lightweight frame is being finalized while the electrical team is working on the bugs in the climber-base communications. There are multiple different types of hardware being employed and they must all function with the same code. By end of September the initial climber will be ready. Full testing will begin in earnest by mid October when the laser arrives.

NASAs Centennial Challenge is driving the evolution of space exploration and travel. By harnessing the collective genius of individuals and teams around the world, the realization of elevators that will carry people to terminals outside of the Earth's atmosphere is in the not too distant future. Aided by the Spaceward Foundation's Elevator:2010 and the team from McGill University, the BD960 will be guiding people to points beyond our world very soon.

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