

# Fountains of Paradise

## Mobile Earth Base Design for the Space Elevator

### Robotic Architectural Environments: Winter 2009

Department of Architecture

California State Polytechnic University

Units: 3.0: Lecture / Location: MWF 2-6pm, IDC

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<http://www.robotecture.com/spaceelevatorbase>

#### COURSE OUTLINE

The focus of this design studio is to allow architecture students to make contributions to the conceptual design for an Earth base of the Space Elevator.\* A space elevator is essentially a long cable extending from our planet's surface into space with its center of mass at geostationary Earth orbit (GEO), 35,786 km in altitude. Electromagnetic vehicles traveling along the cable could serve as a mass transportation system for moving people, payloads, and power between Earth and space.

The Space Elevator is a very real proposal which has already seen quite a bit of development from an engineering standpoint in terms of the cable design and propulsion requirements. The project has however seen little development from an architectural standpoint in terms how to build the base for the elevator, how to design it and where to set up the operation.

The designs in this studio will primarily focus on a base tower approximately 50 km tall with the cable(s) tethered to the top. **The tower will also be supported by numerous support structures including research labs, housing, infrastructural and tourist facilities.** The base will be a mobile seagoing anchor station would incidentally act as a deep-water seaport. The mobility of such a base will have the advantage of being able to maneuver to avoid high winds, storms, and space debris.

An equatorial location is ideal for the tower because the area is practically devoid of hurricanes and tornadoes and most importantly, because it aligns properly with geostationary orbits. To keep the outer end of the cable structure from tumbling to Earth, it would be attached to a large counterbalance mass beyond geostationary orbit. Each design will propose and develop a counterweight strategy.

On an architectural level, designs will explore and demonstrate efficient planning issues that include the development of transportation, utility and facility infrastructures to support space construction and industrial development from Earth out to geostationary orbit (GEO). The high cost of constructing a space elevator can only be justified by high usage, by passengers and payload, tourists and space dwellers. Students will work in teams of two to produce complete building designs including the detailed development and construction concept for the base. Students will develop scaled prototypes of the system that can successfully demonstrate the robotic aspects of the project that will be integrated into the designs to optimize the performative aspects of the designs in terms of energy, mobility and robustness. Physical models will demonstrate actual robotics, structure and materials.

*\*A **space elevator** is a proposed structure designed to transport material from a celestial body's surface into space. The concept most often refers to a structure that reaches from the surface of the Earth to geostationary orbit (GSO) and a counter-mass beyond. The concept of a space elevator dates back to 1895, when Konstantin Tsiolkovsky, proposed a compression structure, (that is, a free-standing tower), or "Tsiolkovsky tower" reaching from the surface of Earth to geostationary orbit. Most recent discussions focus on tensile structures (tethers) reaching from geostationary orbit to the ground. (A tensile structure would be held in tension between Earth and the counterweight in space, like a guitar string held taut.) Space elevators have also sometimes been referred to as **beanstalks, space bridges, space lifts, space ladders, skyhooks, orbital towers, or orbital elevators.***

## **COURSE REQUIREMENTS:**

The course is project based and centers on a series of several design exercises successively building upon each other and culminating in the design of a mobile seagoing anchor base to the Space Elevator.

A short criticism of each of the required readings will be expected. Students will post all assignments on the web. Ability to create 3D CAD models is required. No prior programming experience is required. Incomplete projects on the due dates will affect your grade.

## **GRADING (Please also see justification breakdown below):**

(5%) Attendance and class participation

(5%) Reading and criticism of assigned texts

### **Problem Exercises:**

(10%) 01/PowerPoints of Readings (Linked to Blogs)

(10%) 02/Schematic Organization

(10%) 03/Energy Options

(10%) 04/Tower Design

(10%) 05/ Final Presentation

## **Grading and Attendance**

All students are required to attend all classes and complete all assignments on time. Any student who has more than three unexcused absences may be failed in the class. Whenever possible, discuss any necessary absences with your instructor before you are absent or very shortly thereafter.

A. All of the exercises are graded in the same manner. Projects must be complete. I always prioritize complete and working over aesthetics.

The grade is based on:

### **1. Process of design: 50%**

You will be graded on the principle issues that the class was focused on:

+ Ability to design a small project in a short period of design, identifying both critical design and construction issues: originality, formal consistency, functional issues, site sensitivity and material and construction issues are all factors to be considered

+ Ability to understand and apply robotic, behavioral, structural and construction issues to your design project and to integrate materials and structural systems into your design process in a meaningful and consistent manner

+ Demonstration of a sufficient mastery of the design and material issues in your project as shown by the study models and process drawings

+ Ability to make independent decisions and to make progress on your project between meetings with the faculty

+ Attendance and participation in class discussions

### **2. Final Products: 50%**

The final products will be assessed based on the craft, precision, accuracy and completeness of final prototypes as well as the quality of the design they illustrate: they need to demonstrate both your understanding and integration of robotic, behavioral, structural and construction issue issues and your ability to execute and present your integration of them in your work.

Everything will be documented on the WWW. I am concerned with clear, navigatable websites. Creative web presentations have no bearing on your grade, difficult to navigate websites will.

### Academic Integrity

Students are expected to be familiar with university standards of academic integrity published in the university catalogue and to conduct themselves in accordance with these standards.

### IDC Regulations

The College and Department have a number of rules that must be followed by students working in the IDC:

1. All items brought by students into the IDC during the course of the academic year must be removed by the end of Spring

quarter. If the studios are not cleaned out at the end of the academic year, grade holds will be instituted.

2. Any power equipment found being operated inside the building will be confiscated. Students must use power tools only outside and only in groups of three, for safety reasons.

3. All students are encouraged to bring their computers to studio, however the University takes no responsibility for their security.