

**Robo Climb 2017**  
**Robotic Space Elevator Competition**  
Saturday, August 26, 2017  
Museum of Flight, Seattle, WA

**Purpose:**

A challenge for middle- and high-school students to build robots that simulate carrying satellites into orbit. *Fun!* STEM. Innovation of space elevator climbing mechanisms.

**Short Description:**

We are back to the 'original' rules and setup this year. Autonomous robots will have 5 minutes to carry as many 'satellites' as possible up a ribbon, leaving them at the top.

**Registering:**

Teams must preregister to participate. Registrations must be received no later than August 12<sup>th</sup>. There is a maximum of 10 teams in each class. Send your registrations by email to: [SpaceElevator@robot-city.org](mailto:SpaceElevator@robot-city.org). Include your team name, team captain, team member names, the robot class you are participating in; please ask if you need a piece of sample ribbon, and include a physical address in your registration. Late registrations may be allowed as space permits, but won't receive a sample ribbon.

After the maximum number of teams is reached, we will keep a wait list for the first few backup teams. There are two checkpoints to show that they have a viable robot. If these checkpoints are not met, one of the backup teams may be given your spot.

This competition is meant for kids. Adult coaches are required for all teams, but the adults should remain hands-off in the actual building and programming of their team's robots; the robots should be entirely student built.

**The Field:**

The field will consist of six ribbons beside each other at 2-foot intervals. Up to six robots will run at the same time. The ribbon is a 3-1/16" wide nylon "Caution" tape.

The taut space elevator ribbon will be about 22 feet long, and just over 3" wide. The bottom will be weighted down with about 20 pounds of tension, the top will go through the center of a 1 foot diameter steel disk perpendicular to the ribbon. Note that because the ribbon is woven nylon, there may be frayed edges on the ribbon. Also, over time the ribbon will become worn. Robots will need to deal with this.

The actual ribbon material used is "500' Heavy Duty Reinforced Caution Tape", Empire manufacturer, Home Depot SKU 719-282, under \$20; often in tool aisle.

The satellites will be small weights (3" high aluminum bar stock of various diameters) with a magnetic clip at the top. The satellites will magnetically attach to the steel plate at the top of

the ribbon, representing that they have been left in orbit. Weights are approximate. There will be ten  $\frac{1}{4}$ -pound satellites, ten  $\frac{1}{2}$ -pound satellites, and five 1-pound satellites available for each robot.

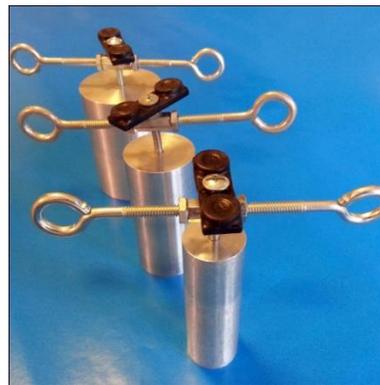
The floor will have mats to help cushion the fall of robots or satellites, but probably not enough to prevent damage should your robot disengage from the ribbon.

Once robots have been attached to the ribbons, all humans must leave the field, and stay behind the erected barriers before the round is started. No one is to enter the arena until the "all clear" signal has been given at the end of a run.

For details about the satellites, see the separate scale drawing pdf.



$\frac{1}{4}$  pound satellite



$\frac{1}{4}$ ,  $\frac{1}{2}$  and 1 pound satellites

#### Classes:

There are two classes of robots: *LEGO Only*, and *(Almost) Anything Goes*. Each class will be judged separately. Robots may be brought by individuals or teams. For a team, you may have up to three people on the team be in the pits. Your build team at home may be larger than this, and extra members are welcome to watch in the audience.

*LEGO Only* are robots built completely from LEGO, using standard LEGO building techniques (no gluing, cutting, melting, etc.). Use as many EV3s, NXTs, motors or sensors as you need. HiTechnic or MindSensor sensors are allowed. Any programming language may be used.

Robots in the *(Almost) Anything Goes* class may be built with anything else, including other building systems, including VEX or Tetrix. Homebrew robots are definitely welcome. You can use any processor, and any materials you wish. Restrictions are that your power source needs to be electric batteries, and all processing must be done on the robot.

Whichever class you choose to enter, your robot will need to pass an inspection to be allowed onto the space elevator ribbons.

Due to the popularity of the *LEGO Only* class, and the limited number of *(Almost) Anything Goes* robots, it is possible that the *(Almost) Anything Goes* class will may either be dropped in the future, or be limited in the number of teams.

## Venue:

Each team will have a small pit area for their use. The space will be very limited – enough for a laptop, your robot and perhaps a few small tools – power is available. No cutting, grinding or soldering will be allowed on the premises. Because space is limited, please restrict yourselves to three people total in the pit area at any one time.

## Robots:

Size limit: 16" diameter, centered around the ribbon, 20" maximum height; 12 pound weight limit. Robots may not extend beyond this size at any time.

Robots may not damage the field or ribbon. They may only use friction on the ribbon to lift themselves. No sticky substances, and nothing may penetrate the ribbon when climbing. Any robot damaging a ribbon will be disqualified. Any robot that looks to the judges like it might damage the ribbon will be stopped from further runs until the issue is resolved to the judges' satisfaction.

Robots must be remotely started from 8 to 10 feet away. At the judge's signal you will give your robot the signal to go. You may use whatever remote starting mechanism you desire, but other than signaling the robot, it may not provide any extra push or energy to your robot. Also, your signaling device may not interfere with other robots. That being said, make your robot as robust against extraneous signals as you can. Some example signaling devices: visible light, IR or RF signals, or very commonly a pin being pulled out by a string. If you use a string, you must use one that is highly visible, and not just a thread. False starts will be penalized, but be allowed to continue.

Robots must be able to be fastened onto an existing ribbon without access to the ends of the ribbon. That is, you will need to attach your robot to the ribbon by clamping onto it from the side, not by feeding the ribbon through it. The ribbon has very little play, and as a result is unable to be seriously deformed by wrapping it around wheels, etc.

Robots must be completely autonomous, carrying a maximum of 4 satellites at a time up the ribbon. Satellites will remain attached to the steel plate until the end of the round. You are encouraged to build a satellite dispenser that holds or even feeds the satellites to your robot each time it comes to the bottom. The dispenser may not be higher than 20", or wider than 18" centered on the ribbon in the direction that the ribbon is wide. Its length may be up to 30", in the direction perpendicular to the ribbon. The dispenser may not expand in size beyond these limits. It may be as automated as you like, but must as with the climbing robot, be completely autonomous. Before the round starts, you may put as many of the satellites provided for your robot into your dispenser as you desire. But you may not interact with the dispenser after the round starts. Note that the ground around the ribbon may be uneven or unstable. Your dispenser will need to deal with this.

Robots should keep track of the time since the start signal, and make every effort to be on or near the ground level at the end of the 5-minute round.

Satellites may not be modified, unscrewed or taken apart. The eyebolt cross piece must remain vertical and at the top near the magnets. If you have a holding bracket for the satellites, it must be designed so that the satellites may be easily removed. The brackets may remain behind, 'in space'.

#### Checkpoints:

There are two checkpoints for robot entries. First, robot teams are required to provide a video of their robot on or before August 12th showing that it can climb a ribbon and descend again.

The second checkpoint is due on August 15th. You must show that you can attach your robot to the ribbon in under a minute, and remove it again, also in under a minute. If you have a satellite dispenser, you must also show that it can be set up and loaded with the satellites in under two minutes. If you wish, you may include this video with the first checkpoint on the 12th of August.

If either checkpoint is not met, another team may be given your spot.

#### Scoring:

Each successful trip up the elevator to the top will score 10 points. A successful trip up will be one in which the robot gets within 2 inches of the top of the ribbon. Each successful trip back down will be worth 5 points. A successful trip down is one that ends at the floor, or at a height where your dispenser is able to pass it a satellite, where the robot has descended in a controlled fashion.

Any satellite autonomously loaded from your satellite dispenser will get an extra 25 bonus points when they are carried up the ribbon. Preloaded satellites (for the first run up the ribbon) are allowed, but won't score this bonus.

Each ¼-pound satellite carried up is worth 2 points, with a 48 point bonus for successfully attaching it (via the magnet on the satellite) to the steel disk at the top of the ribbon.

Carrying up a ½-pound satellite is worth 5 points, with a 95 point bonus for successfully attaching it to the steel disk.

Carrying a 1-pound satellite up is worth 10 points, with a 190 point bonus for successfully attaching it to the steel disk.

Only satellites remaining attached to the steel disk at the end of the round count for the bonuses.

Any robot starting before the judge's signal will be penalized by 100 points, and any points scored prior to the actual start will also be forfeit.

Robots will get up to three scored runs. The best run will be your official qualifying score. The final run of robots (at 4pm) will be between the five highest scoring robots of each class. This final round will determine the first, second and third place winners.

In the unlikely case of a tie, the lightest robot will be given preference. Judges' decision is final in this matter. Any question that arises in the interpretation of the rules will be decided by the head judge, guided by the spirit of the contest. The decisions of the head judge are final.

#### Competition Timing:

The arena will be available starting at 9am for test fitting. Teams will be assigned time slots for their robots to run. Starting at 10am, and every half hour thereafter robot runs alternating between classes will take place. Robots must be ready to be set up at the ribbon 5 minutes prior to their scheduled time. The first run will be for the (Almost) Anything Goes class. The second run for the LEGO Only Prebuilt. From 12 to 1 there will be a lunch break.

There will be three qualifying runs for each team. Timeslots for your runs will be assigned, and spaced out over the day. This gives you a chance to fix or modify your robot if needed.

If there are any extra ribbons available, they will be given on a first-come first-served basis for others to test out their robots (in any class). These will not be scored by the judges.

At 4pm we will start the Final rounds. These will consist of the five highest scoring robots in each class. Robots must be set to go at the appointed time, or another competitor's robot will be chosen. At 4:00 the (Almost) Anything Goes robots will run. At 4:20 the LEGO Only Prebuilt robots will run.

Finally, at 4:45 prizes will be awarded.

#### Recommendations:

Build something that works reliably before building something that works fast. Build something simple that works before attempting something complicated. A robot that reliably ascends and descends the ribbon without carrying a satellite is better than one that attempts to carry multiple 1-pound satellites, but stalls or jams on the ribbon partway up. Build as light as you can. Keep in mind your mechanism for attaching and removing your robot from the beginning. Your robot should be able to tolerate motion in the ribbon. There will likely be both shaking and twisting. *Bring a few sets of fresh batteries!*

#### Prizes:

There will be one robot chosen as the Engineering Award winner. The team captain (or builder, in the case of a single person team) will be awarded a prize. The person awarded the prize will have sole discretion as to what to do with it or how to share it with the team.

The team captains for the first, second and third place of each class will also be awarded a prize.

Sample Registration Email:

**To:** SpaceElevator@robot-city.org  
**Subject:** Registration for *AWESOME\_TEAM\_NAME*

Team Name: *AWESOME\_TEAM\_NAME*

Robot Class: LEGO ONLY / ALMOST ANYTHING GOES

Team Coach: *First & Last Name of adult coach(s)*

Team members:

*team member* (Captain)

*team member*

*team member*

*team member*

If you wish, you may include an address or phone number, but they are not required.

I will use the supplied spelling of the names for name badges, so please check to make sure you spell them correctly. If there are any updates, please let me know as soon as you have them.

Please include your *AWESOME\_TEAM\_NAME* in all email correspondence. Use your preferred contact email to send the registration email. I will send a couple of reminders to this address for video checkpoints, as well as last minute details about the competition itself. Make sure you check it as the competition deadlines approach.