Moonshot

We choose to go to the Moon

Draft Version 1.4 – July 26, 2019
There will be an open comment period until 5pm on Tuesday July 30, 2019.
Final rules version will be published by 8:30am on Wednesday July 31, 2019.

Gameplay & Scoring, General:

Each full round of play is two minutes long, and comprises an initial 30s autonomous period that automatically rolls into the 90s "regular" RC period.

No part of the robot can be moving prior to game play.

There are several scoring opportunities in this game:

1. **Flag: Place your Lunar Flag Module in one of four designated rock locations.**
2. **Sample Collection: Collect moon rocks and place them in collection bins or Lunar Module (LM) Starting Box.**
3. **Unobtanium Collection: Collect the single sample of Unobtanium and place it in the collection bins, or Lunar Module (LM) Starting Box**
4. **APS Charging: Spin the charging station to pressurize the Ascent Module aerozine-50 fuel tank.**
5. **Descent Fuel Tank Dump: Remove the extra fuel modules from the LM and Descent Stage to save weight**
6. **Communications Repair (multiplier): Raise the damaged antenna to re-restablish communication with the Command Module Columbia, and to initiate the launch for orbital rendezvous.**
7. **Bonus for returning to the LM prior to launch. (You really don't want to stay on the Moon, do you?)**

NASA Engineers (ROBOON staff) at MIT Space Center (MSC) are empowered to make all scoring judgments and interpretation of rules. Defensive actions are generally allowed to prevent or to make scoring more difficult, but strictly subject to the rules described in detail below. For example, blocking an opponent by pushing or pulling is acceptable. Picking up, flipping, or damaging an opponent's device or the game table is not allowed.

Lunar Flag Module

Description: Place the Lunar Flag Module in one of four specific locations to score points, which also automatically releases the Decent Module Scientific Equipment Package (i.e. the door).

Rock at base of LM ramp	7 points
Lowest Moon boulder shelf	24 points
Middle Moon boulder shelf	48 points
Top Moon boulder shelf	72 points

Notes:

1. The Lunar Flag Module (a.k.a. the flag) will start with your robot within the starting volume of the LM. You are in possession of the flag at the beginning of play.
2. Flag points are scored based on the location of the flag at end of the specific round of play in which it was placed. For instance, during RC period, you may place the flag at the ramp's base rock, but later decide to move the flag to a higher earning boulder shelf. If the flag is successfully moved to the higher scoring location by the end of game play, that higher score will be recorded. However, if the flag is dropped while moving, no points will be awarded since it is not in the specified location at the end of the round.
3. A flag will only be scored once, regardless of the period in which it is placed (autonomous or RC), and will be based on the highest scoring position achieved during a specific period. For instance, if a flag is placed on the base rock autonomously, 14 points are earned (autonomous points are twice the value) as long as the flag remains in that position throughout the remainder of the autonomous period. If, during RC play, the player later chooses to remove this flag and place it on the Top Moon boulder shelf, 72 points are awarded. 72 points will ultimately be awarded since it was the higher of the two achieved scores.
4. No part of your device may be touching a Flag at the end of play to earn points.

Sample Collection (Moon Rocks and Unobtainium)

Description: Points are awarded by placing moon rocks and the single Unobtainium sample in three different collection areas. Ten rocks are on each side of the game board. Ten rocks are in the middle (common) area between the lunar lander legs (between the black and yellow tape).

Lower collection container	Upper collection container	LM Starting Box
5 points per moon rock	15 points per moon rock	10 points per rock
15 for Unobtainium (Uo)	45 for Unobtainium (Uo)	25 for Unobtainium (Uo)

Notes:

1. The upper collection bin is housed within the descent module's Scientific Equipment Package (SEP), located on the second and fourth quadrants of the descent module. The Scientific Equipment Package may ONLY be opened by flag placement. Any actions that cause the SEP to open, other than placing a flag, will preclude a player from acquiring points from the elements associated with the SEP (antenna repair, upper collection access, lower fuel module removal).
2. Samples are scored by their location at the end of the round. For example, a sample that is brought to the starting box and then removed before the end of game play will not score points.
3. Rocks may not score twice. For example, if two rocks are placed in the lower collection container during autonomous, they will be scored ONLY for the autonomous portion of the round. They will not score points again after the teleoperated portion of the round.

APS Charging

Scoring:

The Ascent Propulsion System seems to have lost pressure. You need to pressurize the tanks by rotating the pump disk. Points are awarded based on the maximum voltage output of the pump during any period of play. Be forewarned that the APS pump torque increases with speed!

Points = (voltage)^2 / 2 **THIS EQUATION MAY CHANGE DURING RULES REVIEW**

Notes:

1. Spinning the APS charger is limited a maximum of 72 points.

Descent Fuel Tank Dump

Description: Points are awarded by removing the extra Descent Module fuel. Only 20 seconds of fuel remained as the Eagle landed, but even this fuel must be dumped to save weight.

Lowest Fuel Tank removal: 15 points
Upper Fuel Tank removal: 49 points

Notes:

1. Fuel Tank removal will be scored based on which side of the board the Tank resides at the end of game play. If you drop it, try to do so on your side.

Communications Repair Multiplier

Description: Once you have accumulated points, you need to reestablish communications with the orbiting command module. Raise the antenna to communicate and initiate a launch.

Scoring:

The multiplier is determined by the maximum angle achieved during the official timing of the round. A scale is provided to determine the angle (hence multiplier). NASA engineers will determine which multiplier value is obtained

Multipliers:

1.2x
1.5x
2.0x
3.0x

Notes:

1. The multiplier is applied to points obtained at any point during the specific period of play in which the antenna is raised. For instance, if the antenna reaches a 1.5x mark during autonomous play, the multiplier is applied to all points obtained the autonomous period. Similarly, if the antenna reaches a multiplier value during regular play, only points obtained during regular play are multiplied. Note that during autonomous play, points are doubled before the multiplier is applied. The value of the multiplier is the same during autonomous and regular play. In other words, autonomous points are doubled, but not the multiplier.
2. The multiplier may be obtained at any time.
3. The first player to achieve a 3.0x multipier will initiate a launch and be awarded 50 bonus points (not multiplied). An initiated launch will start a 15 second countdown. At the end of the 15 second countdown, the LM will lift-off of the moon surface.
4. Any player to return to the LM prior to lift-off will be awarded an additional 40 bonus points (not multiplied). “Returning” means all components that began in the starting box on the LM, must end within the starting box. No lunar littering!
5. The antennae are mounted on a ratcheting system. Do not force the antenna when practicing or resetting its initial position. Make sure to understand how to use and set the ratchets. During the festivities, NASA engineers will reset the ratchets for you.

Autonomous Period:

To encourage exploration and learning of electronics, the Autonomous Period is 30 seconds. Points scored during this time are double, compared to what they would have earned in the radio control period. If neither competitor wishes to use the autonomous period, they can indicate to the referee and the contest will begin with the 120 second remote control phase.

Scoring Example:

Blue placed the flag in the lowest moon boulder shelf (hence opening their Scientific Equipment Package), and removes the lower fuel tank. Blue then grabs the Unobtainium and two moon rocks and drives back to the LM because Blue notices that Red started a launch.
Blue's score: 24 [flag] + 15 [Fuel tank removal] + 25[Uo in LM] +2*10[rocks to LM] + 50[LM return bonus]= 134 points

Red placed the flag in the rock of the LM ramp base, Charged up the APS to 7 rad/s, and pulled the antenna handle all the way to the 3x multiplier in the final 20s of play!! Then Red grabs a rock and rushes to successfully return to the LM
Red's score: (7[flag in rock] + 1/6*(7)^2 [APS charging] +10 [rock to LM]) *3 + 50 [launch bonus] + 50 [LM return bonus] = 175

What an exciting round!! Red has the higher score and therefore wins.

Rules & Regulations

Excellence in teamwork and collaboration are expected at all times during ROBOCON. All team members should contribute to ideation, fabrication, and testing of the robot(s).

1. **General Principles**
   a. These rules are intended to create opportunities to learn engineering.
   b. Those things not specifically forbidden are allowed.

2. **Timing**
   a. Each round of the contest is 150 seconds long.
   b. For the first 30 seconds, no control signals may be sent to the robot. So that your robot can sense the start of the round, lights will be positioned in the starting box and triggered at the start of the round.
   c. If both players agree to not use the first 30 seconds, then the match will last 120 seconds.
   d. Robots may not be touched by players during game play.

3. **Winning & Advancing**
   a. There will be a series of round-robin play, three groups of 4 teams will all play each other. The top team from each group will advance, along with the next-highest rated team from all combined groups. These 4 teams will compete in a single-elimination to determine the overall winner.
   b. In the tournament, the highest scoring team in each match advances to the next round. In general, only one team may advance. If there is a tie, it will be broken by weighing the two systems. The lighter machine(s) prevails.

4. **Control**
   a. When possible, contestants must participate in controlling their own machines.
   b. All control must be accomplished without physically contacting the robot.
   c. Control may be achieved via radios and, in addition, any another wireless device approved by the instructors (e.g. a TV remote control, laser pointer, a cell phone, Xbee, Bluetooth, etc).
   d. A contestant may use a single lab standard four channel radio controller. However, contestants may add more degrees of control by using additional controllers such as a TV remote control, laser pointer, or playstation controller.
   e. Outside Controllers are permitted, but only to supplant the existing 4-channel controllers, and may not exceed four channels.
   f. A contestant may not deliberately interfere with the radio or other remote control of the opposing player.
   g. "Assistant drivers" may be used, though only one standard lab RC may be used for the player.
   h. Contestants must wear safety glasses when in the vicinity of the table. Some prescription glasses are acceptable.

5. **Robot Configuration**
   a. Your entire robot must fit in a *Starting Volume* at the beginning of each match when set up on the table. The primary starting volume is 16" square and 16" tall located inside the Lander. The box is "virtual" and has no ceiling or door. This virtual starting box may be placed anywhere within the colored starting zone at the front edge of the tables at the beginning of play. There is an additional starting volume at the base of the moon lander, with a volume of 10" by 10" by 10" tall. All parts of your robot(s) must start in these locations.
   b. Your entire robot must be made from the kit materials and components, fasteners and items in the stock bins, approved batteries, and electronic components authorized by the ROBOCON staff. Items that primarily serve to make robots look cool generally will be allowed including LEDs, seven-segment displays, and such items.
   c. Your "kit" includes up to 6 cubic inches of 3D printed parts. You are also limited to consuming up to 4 cubic inches of support material.
   d. Machine weight is limited to 12lbs. You should generally still attend to the weight of your machine as excess weight may lead to poor performance. Also, weight of your system will be used as a tie breaker.
   e. Energy may be stored in batteries, elastic strain, and gravitational potential energy. Total stored energy may not exceed 30kJ. This limit will be enforced by the ROBOCON staff based on calculations in the lab notebooks. Mechanisms using large amounts of rubber or springs must have adequate safety locks to reduce the chance of accidents. These locks may be removed once all contestants and onlookers are safely away from the device. Safety of all forms of energy storage will be at the discretion of the instructors and judges.

f. No boost converters are allowed. Voltage is limited to the 7.4V LiPO batteries. If 7.4 V is to be supplied to any electronics, it must be approved and checked by an instructor AND must be fused.
g. The rechargeable AA -four packs that are typically used with the lab radio controllers are considered 500 mA-hr devices, regardless of the actual labeling on the batteries.
h. Contestants will be responsible for charging their own batteries, springs, rubber bands, etc.
i. Your machine may be reconfigured between rounds. One reason to reconfigure is to accommodate the differences between the right and left sides of the field. You will know at least 5 minutes before you compete which side your machine will be assigned.
j. You will have access to set up your machine(s) within the starting box prior to each round. You should be able to complete your set-up fully in fewer than three minutes.

6. Sporting Conduct & Safety

a. An area in front of the central landing gear is considered common space and useable by both players.
b. Driving your robot across into the other player's side of the table is not permitted.
c. Damaging the contest table and or control equipment is strictly forbidden.
d. In the case of destruction deemed by the judges to be accidental, the judges may permit repairs and a rematch.
e. Contestants and spectators (i.e. any human beings) may not directly affect the motion of the machines or anything else on the table.
f. It is permissible for a robot to reach outside the boundaries of the table during a round.
g. Nets or entanglement devices are not permitted, but other defensive devices generally are permitted.
h. NO DANGEROUS MACHINES. THE JUDGES' DECISIONS ON SAFETY MUST BE RESPECTED AND OBEYED PROMPTLY.

General questions may be asked of UA's, TA's, and Instructors, however, all officially sanctioned rule interpretations will be made by NASA engineers. Answers from the MIT Space Center represent the official position of the ROBOCON team. "Go flight"