ZERO ROBOTICS

Acting out Lost in Space
Instructor's Guide v1.2

Table of Contents

Overview

Students will work in teams to create a strategy for the Astrobee game and then act it out. Each team will compete to see which team's strategy captures the most points in the time allowed. Since the starting position of the game will be randomly selected, it may be ideal to repeat the game more than once to see how strategies hold up at the different starting points.

There are various differences in this version of the game when compared to the actual challenge, but these are made for the sake of simplicity. We were careful to structure this version of the game so that experience with it translates well to when the students begin working on the real thing.

This instructor's guide assumes some familiarity with the Astrobee game (details about the Astrobee game are available in the game overview powerpoint and the game manual).

Notes:

- For this activity, each team should have at least 5 members.
- Team members will take roles, acting out the parts of: *Astrobee Robot, Astrobee Player, Position Judge, Game Tracker, and Score Keeper* as described later.
- Teammates on the sideline can help give directions to their teammates on the grid based on their pre-planned strategy.
- Game duration: This is very variable but we estimate about an hour. Each play of the game may take about 15 minutes.

Student's Mission

The ISS has been damaged and an astronaut needs to be evacuated into a code-locked spacecraft! The student has been tasked by the ISS to use the Astrobee to clear the debris in its way so it may retrieve the code by recognizing the astronaut's hand gestures.

Preparation in Advance

- Review the Astrobee Game Overview with students prior to introducing this activity.
- Read through this guide.
- Gather materials as listed on Page 2
- Print copies of documents found linked beginning on Page 8
- Set up the Game Grid (instructions below, pictured in Game Documents)

Game Format

The game is played on a 8 ft x 8 ft grid sectioned into 1 ft x 1 ft squares. You are welcome to size this up if you have the space! See Game Grid on page 8 for reference on its layout and the suggested starting positions of debris. This can be created using some of the Materials below on the ground/floor. The Game Grid also doubles as representing the Astrobee's Range of Motion, and it cannot travel outside of it. It can, however, place debris down outside of its Range of Motion.

Materials

1. **Tape/Chalk**
    a. Use masking tape to create the grid and blue painter's tape to outline the Imaging Field/Range of Motion. Other tapes could also work.
    b. Alternatively, if the game were played outdoors, different colors of chalk could be used.
2. **Paper Documents**
    a. Print out copies of Strategy Sheet, Game Tracker Sheet, Scoring Sheet for each team - shown at the end of the document.
3. **Writing Utensils**
    a. So that the students may make use of the printed out Game Documents properly when strategizing and fulfilling their team role.
4. **6 Misc. Objects**
    a. The Instructor will need to find 6 objects to serve as the game's debris. Small cardboard boxes are recommended, but just about anything could work so instructors are encouraged to use whatever works. Items such as stuffed animals, balls, or
    b. Write 1 on half of them, 2 on the other half, and also clearly mark the center point on all of the objects if possible. The number 1 or 2 is the mass of that box and is important to the game.
5. **Stopwatch (optional)**
    a. The *Game Tracker* may use the free Google stopwatch for time-keeping purposes if the instructor desires, whether to be mindful or to institute a time limit of some kind. We recommend the one linked above.
6. **Random number generator**
    a. The team's Instructor needs a random number generator to pick a number 1-4,the *Astrobee Robo*t's starting position on the grid. We recommend the one linked above.
7. **Measuring tool**

a. The Instructor will need a measuring tool to make the grid and its squares.

We recommend putting the game grid onto a tarp or employing whatever alternative materials might work best for you. **Feel free to make any adjustments as long as they don't contradict the game's structure!**

Activity Explanation

This game will be divided into two distinct phases: Planning period and Game period.

Planning Period

Before beginning the Game Period, each team will have 10 minutes to determine their strategy, and assign roles to each player. **Teams can not change their strategy once the game has started!**

Located at the end of the document are "Strategy Sheets." These sheets prompt the students to think ahead in regards to how their Astrobee will move, and record what actions their Astrobee is going to take during the Game period. These actions will be expanded in Possible Actions on page 4.

Once a team runs out of predetermined tasks on their strategy sheet, their Astrobee will become idle and the game will end. No new commands can be given during the Game period!

Strategy Brainstorming

Before the game period begins, instruct students to brainstorm a strategy. Encourage students to create a sequential list of tasks they intend to accomplish and to deconstruct these overarching tasks into smaller, actionable steps. While a Strategy Sheet is available in the game documents section for reference, brainstorming can be facilitated using any medium such as a whiteboard or blank paper. Students should document each step the Astrobee is expected to take along with the corresponding actions that are expected to achieve them.

Here are a list of questions that can be used to prompt the brainstorming session:

1. How can you break down this challenge into a series of goals to achieve?
2. How many pieces of debris and which ones do you want to move?
    a. What paths will you take to reach the debris?
    b. How will you move it?

    c. Do these paths risk collision while moving your debris?
3. How will you manage battery power?
4. What paths will you take to avoid colliding with debris while you're trying to move debris?

Increments & Actions

Time is an important part of the game again, so students should be mindful of how their strategies would apply in that context, especially in terms of efficiency. Therefore, to encourage awareness of a strategies' relative runtimes, the game is split up into a max of 15 increments. An increment is an interval of 5 individual actions. We only include an option for time-keeping because we believe AOtG should be a fun and relaxed opportunity for the students to build ways to approach the challenge. The *Game Tracker* is responsible for documenting a summary of every increment.

The list of possible actions is as follows:

- Moving the Astrobee
    a. Move the astrobee in units of squares in the forward, backward, left, right, and directions. Every change in direction makes a new action.
        i. For example, moving 2 squares to the right and then moving 2 squares backwards are considered two separate actions.
    b. The movement is invalid if the final position is outside of the marked boundaries of the *Astrobee Robot*'s range of motion(the Game Grid).
- Grab Debris
    a. When within a grid that a piece of debris at least partially occupies, the *Astrobee Robot* may pick it up by using this action.
    b. Once you have grabbed a piece of debris, you may not at all interact with other debris until you have dropped it.
- Move Debris
    a. Functionally identical to moving the Astrobee, except now the movement may also be invalid if it involves coming into contact with another piece of debris.
- Drop Debris
    a. The *Astrobee Robot* may set the debris down from the grid it's standing within. The debris may not be tossed/thrown.
    b. The debris can only be set down to one of the adjacent squares of the grid.
    c. If at the edge of the *Astrobee Robot*'s Range of Motion, the piece of debris may be set down outside of the Range of Motion.
- End the Game

a. Ends the game, meaning that the team will not move the astrobee or debris anymore.
b. The score will be calculated by the *Score Keeper* using the score sheet so that the team may evaluate how things went.
c. To avoid a point penalty, one should first return the Astrobee's starting position before ending the game.
d. Fill out the score sheet, reset the grid and grab fresh Game Documents if you plan to play again.

For example, for one 5-action increment, a team may have the Astrobee move forward one square (toward a piece of debris), pick up that debris, move two squares to the right, move one square forward, and then drop that debris.

Game Period

During the game period, teams one at a time will have their *Astrobee Robot* stand in one of the four possible starting positions (denoted on the Game Grid) selected by randomly generating a number from 1 to 4. The *Astrobee Player* will begin giving out actions as per their **Strategy Sheet**. The Game Tracker will summarize what occurs as the game progresses on the **Game Tracker Sheet**. The *Position Judge* will keep an eye on how things move around the grid and the *Score Keeper* will keep track of Battery Power as the game progresses as well. Once the game ends, the *Score Keeper* will fully compile the points and penalties and present their team's points.

Student Roles

Each student within the team will be taking on a specific role to ensure their Astrobee earns the most points possible.

1. **Astrobee Robot**
    a. You are the actual Astrobee!
        i. Only move or interact with debris when the *Astrobee Player* gives you the instruction to! Follow their instructions as best as you can.
        ii. Call out your actions aloud as you do them so you don't take an action too fast or when you aren't supposed to!
        iii. Be prepared to return to your previous position in the case you're told by the position judge that a move you've executed is invalid.
        iv. In case the others forget, make sure you don't interact with or run into debris while already carrying other debris, as that makes an

invalid move. Exiting the range of motion also makes an invalid move.

2. **Astrobee Player***
    a. You're responsible for giving the instructions to the *Astrobee Robot* according to your Strategy Sheet!
        i. Be specific about where your *Astrobee Robot* should move. Instead of vague or general statements like "go to that debris", you may say something more like "turn left and move 2 steps forward."
        ii. The *Astrobee Robot* should not move or interact with debris without you specifically instructing it to! It also should not come into direct contact with debris(as in literally touch it) while carrying debris.
        iii. Help ensure that the *Astrobee Robot* returns to its previous position after an invalid instruction **AND** that it proceeds to the next valid command from there.
        iv. Do not change the strategy sheet during the Game Period, even if the *Astrobee Robot* is not going where you want it to go! You can always fix it in the next Planning Period, so please stick to the process.
3. **Position Judge***
    a. You monitor the position of debris and the *Astrobee Robot*.
        i. The *Astrobee Robot* is in range of a piece of debris if it's in a grid square the debris occupies even partially. Only then can the *Astrobee Robot* pick up that debris.
        ii. Make sure the *Astrobee Robot* only interacts with debris when it is in range of it and that they don't touch another debris while already carrying debris. If they do, let them know that move is invalid and they need to go back to the end of their previous action.
        iii. If the *Astrobee Robot* moves a piece of debris so that its marked center point is outside the Imaging Field, let them know they can stop and alert the *Score Keeper* so they can award the appropriate amount of points at the end of the game.
4. **Game Tracker**
    a. You will keep track of the actions being taken and document every increment on their *Game Tracker* sheet.
        i. Every five actions in a run of the game is an increment, for which the *Game Tracker* must record whether the game has ended and a brief summary of what occurred.
        ii. The *Game Tracker* may ask the others to slow down/stop to ensure they don't get behind.

iii. **(optional)** The *Game Tracker* will start a timer at the beginning of every game, employing this as & why the Instructor sees fit.

5. **Score Keeper***
    a. You will calculate how many points your team earns.
        i. During the game, keep track of the *Astrobee Robot*'s Battery Power. You start with a full battery that decreases for every move the *Astrobee Robot* makes. If Battery Power reaches 0, the game ends immediately. No actions may be taken besides dropping any piece of debris where the *Astrobee Robot* stands.
        ii. At the end of the game, award your team points on the Scoring Sheet for every box whose <u>center</u> is outside the Imaging Field.
        iii. The details of the calculations can be found in Possible Points/Penalties and the Scoring Sheet, as with everything else related to the score.
        iv. If they need help, feel free to assist them with the math or encourage them to use a calculator.

*More than one student may participate in this role. We would recommend prioritizing an extra student for the *Position Judge* role before the others.

Possible Points/Penalties

Teams start the game with 0 points. The main way to earn points through this year's game is by picking up, moving, and dropping pieces of debris relative to the Imaging Field. If the center of a piece of debris is moved outside the marked boundaries of the Imaging Field, they receive points for it. Every 2-mass debris is 50 points and every 1-mass debris is 30 points.

Additionally, students must keep track of Battery Power(**BP**) as the game progresses, as they can earn more points by moving less while dispersing debris, encouraging efficiency! You start with 100 BP, and lose BP equivalent to **<u>(1 + box mass)*squares traveled</u>** every time the *Astrobee Robot* moves. Any BP remaining at the end of the game is rewarded as points.

The team can also, however, lose points via deductions. If the center of a piece of debris is still within the marked boundaries of the Imaging Field, the team will lose 10 points if it is 1-mass or 15 points if it is 2-mass. Similarly, there's a deduction for if the game ends without the robot returning to its starting position, such as if BP runs out before the End Game action is made. In this case, 40 points are lost.

Game Documents

Below are the required documents for Acting out the Game. Students may need multiple copies of some documents if you plan to run the game more than once. You just need to click through the links to take you to the documents, at which point they should be easy to print!

Strategy Sheet

(https://drive.google.com/file/d/1vyik5kQqpVgR4cfuBhmBxqcRChVVxNDL/view?usp=sharing)

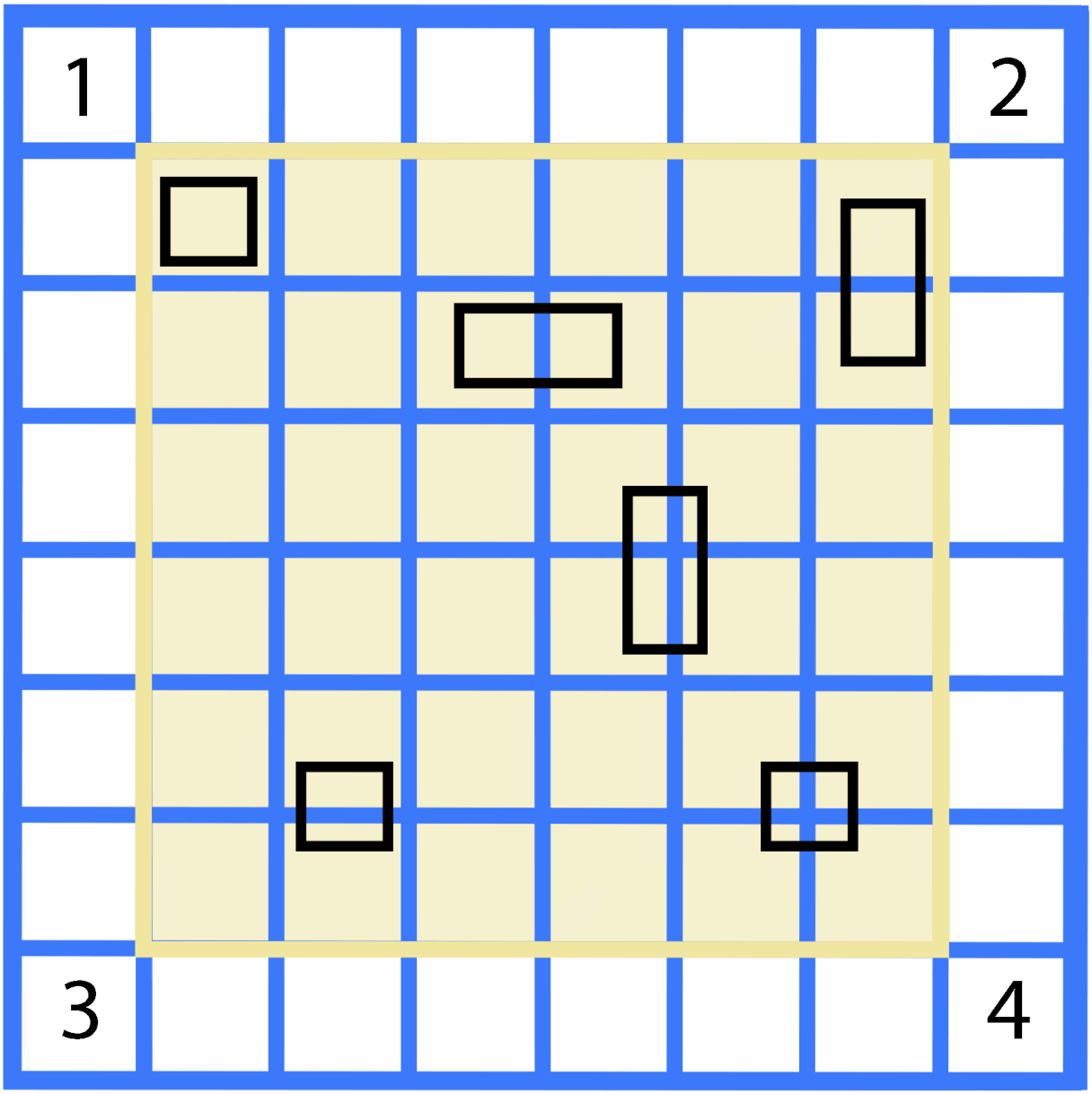
Game Tracker Sheet

(https://drive.google.com/file/d/1BAQNhOJjeVIXCDuHVAc1jYv8zb05_-H5/view?usp=sharing)

Scoring Sheet

(https://drive.google.com/file/d/1XbWJGPKfgK4YIOh4UPjQgnU7KL8oYUIO/view?usp=sharing)

Game Grid



Alternative Game Grid Provided Here

The numbers are the potential starting positions, the blue lines are painter's tape that mark the grid/Range of Motion, the beige lines are the masking tape that mark the Imaging Field, and the Imaging Field has been shaded in on this diagram for ease of understanding. The black boxes represent the 1-mass and 2-mass pieces of debris laid out in recommended starting positions.