



Ant Investigation: Field Test Version

The Center to Support Excellence in Teaching
Stanford University

June 11, 2014



Ant Investigation

Overview

The Center to Support Excellence in Teaching (CSET) has developed lessons for teachers to use in elementary, middle, and high school science classes that build on the work of Dr. Deborah Gordon at Stanford University. These lessons are designed to engage students by providing opportunities for them to explore ants and their behavior, ask scientific questions about ants, collect and analyze data and develop explanations about ants and their behaviors to help students better understand concepts such as structure and function, density, information processing, and expandable search networks.

Synopsis of Lessons to be Developed

The approach for the ant investigation is essentially the same for elementary, middle, and high school but takes into account the developmental level of the students. In general, students will engage in the investigation by first thinking about what they already know about ants including their behaviors, structures, and function. Next, students will take time to investigate ant search behaviors in a controlled environment using an ant arena. Students will observe how ants search in a given area and again how they search when that area is doubled in size. During this time, students will record observations and take photographs and videos of ant behavior. Next they will use this evidence to analyze how ants behave in these different environments. Students will share their thinking and develop explanations about ant search behaviors in the different environments.

By this fall, students will have the opportunity to join the ant search behavior community by going to a common website and entering their data onto a spreadsheet. Students will be able to compare their results with others around the world and further their understanding of ant behavior.

The following investigation is a *draft* version of the ant investigation at the high school level. CSET will be piloting the lesson this summer with high school science teachers and will have a final version of the ant investigation for the different grade levels in the fall.

Ant Investigation- DRAFT 6/11/14

Preparation

Collection of Ants

- Students need to collect their own ants the day before the experiment. Each group of 3 students will need to assign 1 person to collect 30 ants.
- Teachers will distribute the following equipment for ant collection. Only students collecting the ants will receive one set of this equipment.
 - Aspirator
 - Vial with lid
 - Cotton ball
 - Small watercolor paint brush
 - Tape
 - Pen or pencil
- Students collecting ants will follow these directions:
 - Place a cotton ball soaked with water at the bottom of the vial.
 - Insert the aspirator onto the top of the vial.
 - Find ants and record as many details about where the ants were found (example: nearest intersection and specific location such as under a log or on the sidewalk). Record this information on a piece of tape and put on the vial.
 - Place tubing on top of ant and suck the ant into the vial.
 - Check to see that the ant has safely been collected into the vial.
 - The paint brush (with moistened bristles) can also be used to help pick up or move ants.
 - Repeat until 30 ants have been collected. Note: do not mix ants from different locations. Start a new vial for each location. Try to collect all 30 ants from the same location.
 - When finished, cap the vial and cover the whole vial with paper or foil so it is protected from light.
- The ants probably don't need food, only water (the cotton ball soaked in water should be sufficient), but it's okay to put a small piece of apple into the vial if you would like to feed the ants.
- When experiment is completed, return ants to their original location. (If they cannot be returned, freeze them for several days and discard in the trash or compost.)

Ant Arena

- Directions for making the arena are shown in Appendix A.

Materials for Students

- 1- Ant arena for each team of 3 students (see Appendix A.)
- 30 - Ants per group
- 1- Camera (or cell phone that has camera)
- 1- Video Camera (or cell phone that has video capability)
- 1- Calculator
- 1- Stop watch (can be on a phone or other device)
- 1- Notebook for each student
- 1- Hand lens for each student
- 1- Student Data Collection Sheet for each student
- 1 - Computer or tablet for viewing photos during Data Analysis
- 1 - Protractor per team

Materials for Teachers

- Sugar solution
- Cotton balls
- Access to a refrigerator

Optional Advance Preparation (to be done by the teacher)

This step can be done if the ants fail to explore the arena in a trial run. To do this optional step, the bottom surface has to be covered with something transparent and waterproof, like a sheet of Mylar, that leaves the grid on the bottom still visible. This step may not be necessary so try it without first.

One hour before student investigation begins, use a cotton ball soaked in sugar water to wipe all over the floor of the two testing chambers (but not the nest area). The barriers should be removed for this step. Wipe the chamber areas dry with a dry cotton ball. The residue of the sugar should be enough to attract the ants to the chambers once the chambers have been open to them. However, do not place any food into the chambers. In this experiment, the ants are not foraging. They are searching a novel area. Be sure the barriers are back in place before giving the arena to the students.

Investigation

1. Student roles:
 - a. Timer and recorder: will call out times and record observations in writing for the group
 - b. Arena manager: responsible for removing chamber separators and handling arena and taking pictures at timed intervals
 - c. Videographer: will make a continuous record
2. Open the nest area access, and place 30 ants into the nest area of the arena. Make sure that the ants have access to water by placing a small piece of cotton ball soaked in water into the nest area. NOTE: ants may need to be placed in a cold,

refrigerated area (not the freezer) for a few minutes to slow them down before placing them into the nest area.

3. Close the nest area access to prevent ants from crawling out of the nest area.
4. Do not shake or jostle ants in the arena at any time. This includes tapping on the cover of the arena and banging or jostling the lab table.
5. Slide the first barrier out to allow ants to freely enter into the first chamber (=Area 1). The ants must walk freely into the chamber. If not, the ants will be alarmed and will not search. All of the ants might not come out, or they might not come out all at once. Start the timer when some of the ants have moved out of the nest area. Then, when the number of ants seems to be more or less steady for at least 5 minutes, open the 2nd barrier. Continue timing for at least 5 minutes.
6. Observe the ants for at least 5 minutes. During this time, start taking photographs every 15 seconds. Also, take a video from the beginning to the end of the observation period to record the ants' searching behavior. Try to take the photographs and video from a fixed location, and make sure the entire search area is included in the photos. It may help to mount the camera and video recorder on a stand or tripod. Write down initial observations of what the ants seem to be doing and record notes on the Student Data Collection Sheet.
7. When the number of ants searching Area 1 seem to be more or less steady for at least 5 minutes, slide out the barrier between the first chamber and the second chamber. Record the time when the barrier is removed. The ants are now free to explore Area 2, a space that is twice the size of Area 1.
8. Again, observe the ants for at least 5 minutes after you remove the second barrier. During this time, take a series of photographs every 15 seconds, and take a video of the ants' searching behavior. Write down initial observations of what the ants seem to be doing and record notes on the Student Data Collection Sheet. At the end of your observation period, stop your timer and record the time.

Data Analysis

Analysis Part One:

1. Count the number of ants in Area 1 over time by counting the number of ants in each of the photos at 15 seconds, 30 seconds, 45 seconds, etc. Record on the Student Data Collection Sheet.
2. In the same manner, count the number of ants in Area 2 over time. Record on the Student Data Collection Sheet.
3. Plot the data.
4. Use your data to answer the questions on the Student Data Collection Sheet.

Analysis Part Two:

1. For Area 1, count how many grid squares are occupied by ants in each photo over time. Repeat for Area 2.
2. Plot the proportion of grid squares that are occupied by ants over time.
3. Use your data to answer the questions on the Student Data Collection Sheet.

Analysis Part Three:

1. Watch the video closely so you become familiar with the paths that the ants walk.
2. At fixed intervals, stop the video and find all of the ants.
3. For each ant visible, measure how long it stays in the larger grid square (group of 4 grid squares) where you found it.
4. Use your data and calculations to answer the questions on the Student Data Collection Sheet.

Analysis Part Four:

1. Use the photos taken over time for Area 1. Count the number of interactions of ants in each photo. Count the number of ants in each photo. Record the data on the Student Data Collection Sheet.
2. Use the photos taken over time for Area 2. Count the number of interactions of ants in each photo. Count the number of ants in each photo. Record the data on the Student Data Collection Sheet.
3. Use your data to answer the questions on the Student Data Collection Sheet.

Joining the Ant Search Behavior Community

Enter your data on the spreadsheet on the website: URL will be available in Fall 2014.

Field Test Version

June 11, 2014

Student Data Collection Sheet

Observations for Area 1

What do you notice about the way the ants are searching?

What do you notice about the way the ants are interacting?

Observations for Area 2

What do you notice about the way the ants are searching?

What do you notice about the way the ants are interacting?

Analysis Part 1

Area 1

Time																			
# of ants in arena																			

Area 2

Time																			
# of ants in arena																			

Plot:

Field Test Version

June 11, 2014

Answer the following questions:

1. What pattern do you notice from your plotted data?
2. How long did it take the ants to adjust to searching in Area 1? In Area 2?
3. What does this tell you about how the ants adjust their paths when their search area and density is changed?

Analysis Part Two

Area 1

Time																			
# of grid squares with ants																			

Area 2

Time																			
# of grid squares with ants																			

Plot:

Answer the following questions:

1. What do these data tell you about how thoroughly the ants searched in Area 1?
2. How thoroughly did the ants search when they were exposed to the larger Area 2?

Analysis Part Three

Drawing of Area 1

Show how much time ants spent in each square.

Drawing of Area 2

Show how much time ants spent in each square.

Field Test Version

June 11, 2014

Calculations

Area 1

Find the average time an ant spent in one of the larger grid squares. Make a frequency distribution of times in a square in Area 1.

Area 2

Find the average time an ant spent in one of the larger grid squares. Make a frequency distribution of times in a square in Area 2.

NOTE: An Excel spreadsheet can be used to perform calculations for the frequency distribution.

Field Test Version

June 11, 2014

Answer the following questions:

1. Did the ants search more or less thoroughly when they were more crowded?
How do you know? What did the ant search patterns look like?
2. In Area 1, was density high or low compared to Area 2? Explain.
3. Use your drawing to compare the paths in Area 1 and Area 2. Were there differences in how ants searched in Area 1 versus how they searched when they were able to search in a larger Area 2?
4. What do you notice about the relationship between how long ants tended to spend searching in a square, and the search pattern of the ants?

Analysis Part Four

Area 1

Time																			
# of interactions																			
# of ants																			

Area 2

Time																			
# of interactions																			
# of ants																			

Answer the following questions:

1. How does the interaction rate scale with number of ants?

2. What can you infer from this data?

DRAFT

APPENDIX A

Directions for Making Ant Arena

Materials:

1. Foam sheets
2. Plexiglass to cover the arena
3. Grid with square cells, drawn on paper (you will make this)
4. Glue
5. Scissors
6. Ruler
7. Mylar, or other transparent, waterproof sheet material (optional)

Directions:

STEP 1

Cut out **two** large pieces of foam, measurement: 4.5 inches (11.5 cm) x 5.0 inches (13 cm). This size is appropriate for small ants, less than 5 mm. For larger ants, a larger arena would be better.

STEP 2

Measure the length of one of the ants that you will use in this experiment. Using that measurement, draw on a piece of paper a grid with squares that measure about 10% longer than the length of your ant, and group those squares into sets of 4 (see example). Glue grid onto one of the foam pieces. Set aside.

Take the other piece of foam and cut using dimensions shown. There will be 3 separate pieces.

Glue the 3 pieces onto the first foam board on top of the grid according to the picture.

STEP 3

Make 2 chamber separators out of foam (use scraps from the first sheet; see dimensions shown).

Make an appropriately sized square nest insert from the foam.

Cut a piece of plexiglass that fits over the top of the entire ant arena, measurement (for small ants): 4.5 inches (11.5 cm) x 5.0 inches (13 cm).

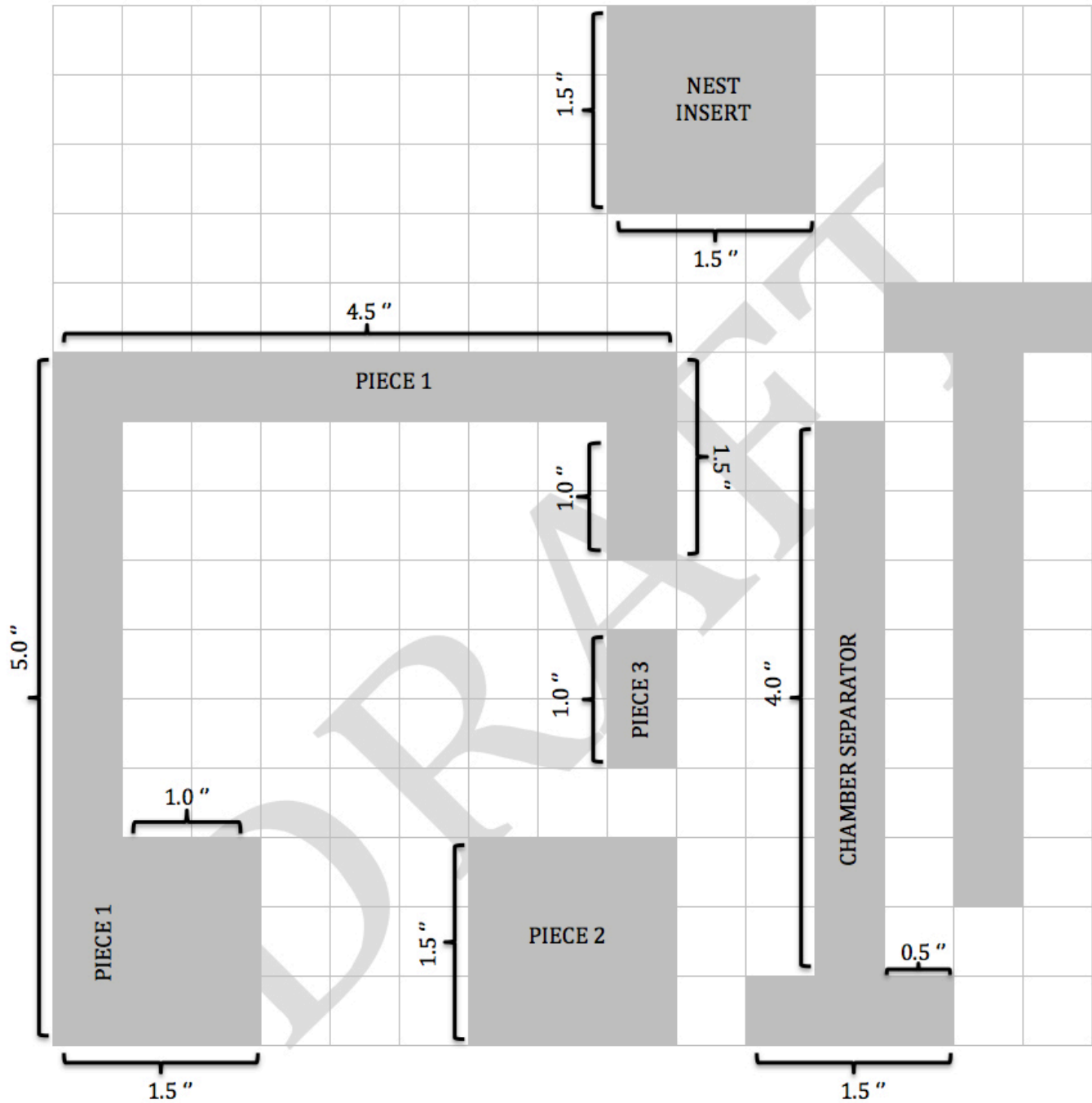
STEP 4

Assemble the Ant Arena, making sure that the barriers can be opened and closed, and that the parts fit closely enough to prevent ants from escaping. If the arena is not clipped together securely, ants can escape over the barriers and edges as well as through the barriers.

Note: if the floor of the arena will be wiped with sugar water, there should be a waterproof layer, e.g. of clear plastic, over the grid on the bottom surface.

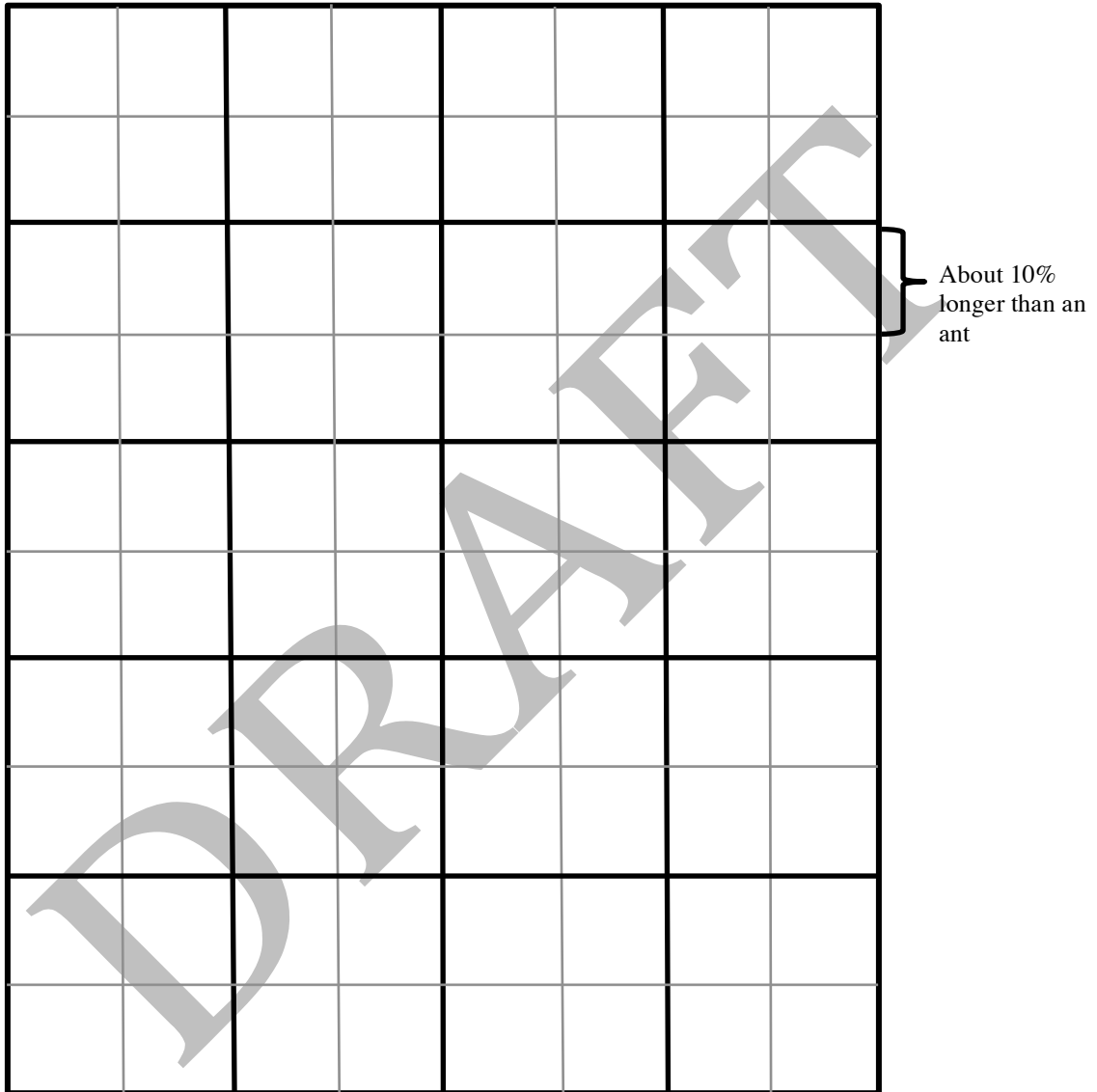
DRAFT

Ant Arena - Schematic

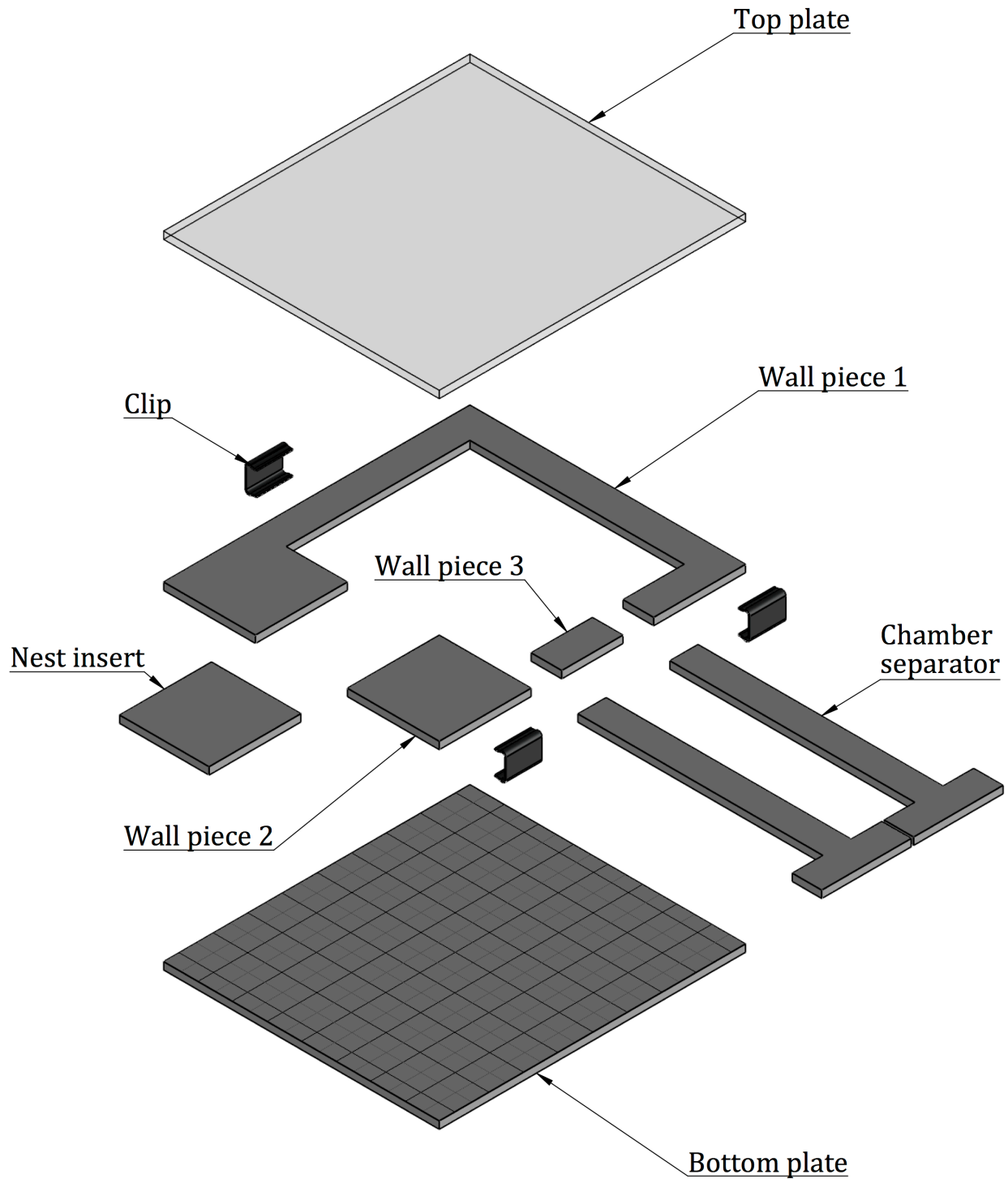


Example grid to make and glue to the Ant Arena.

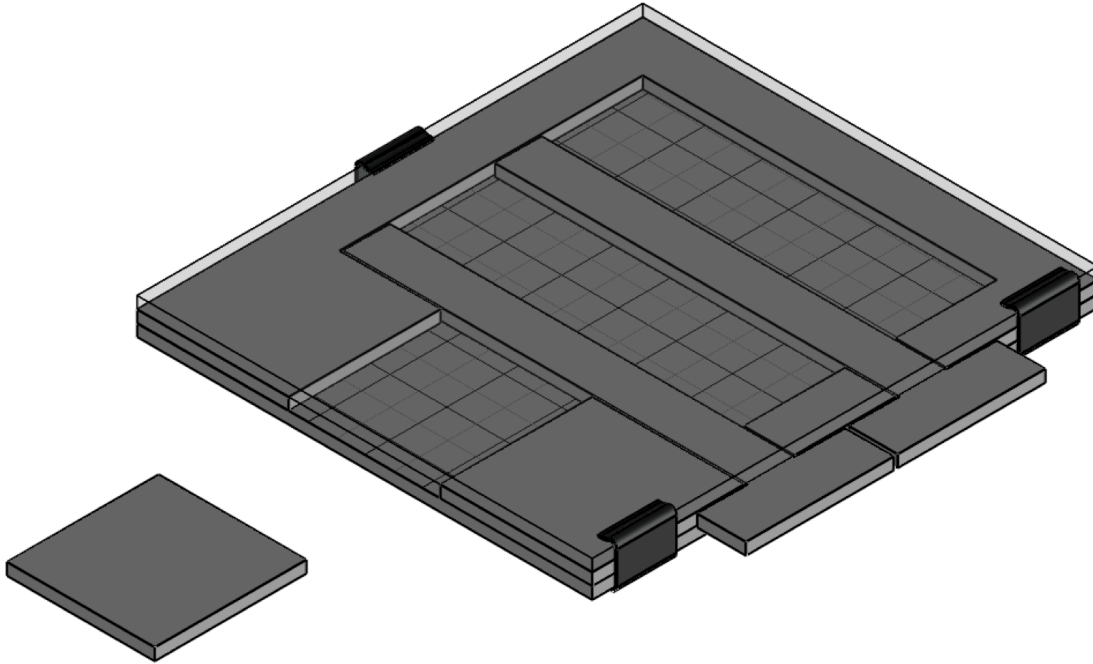
Measurements and number of squares will vary with ant size.



All components

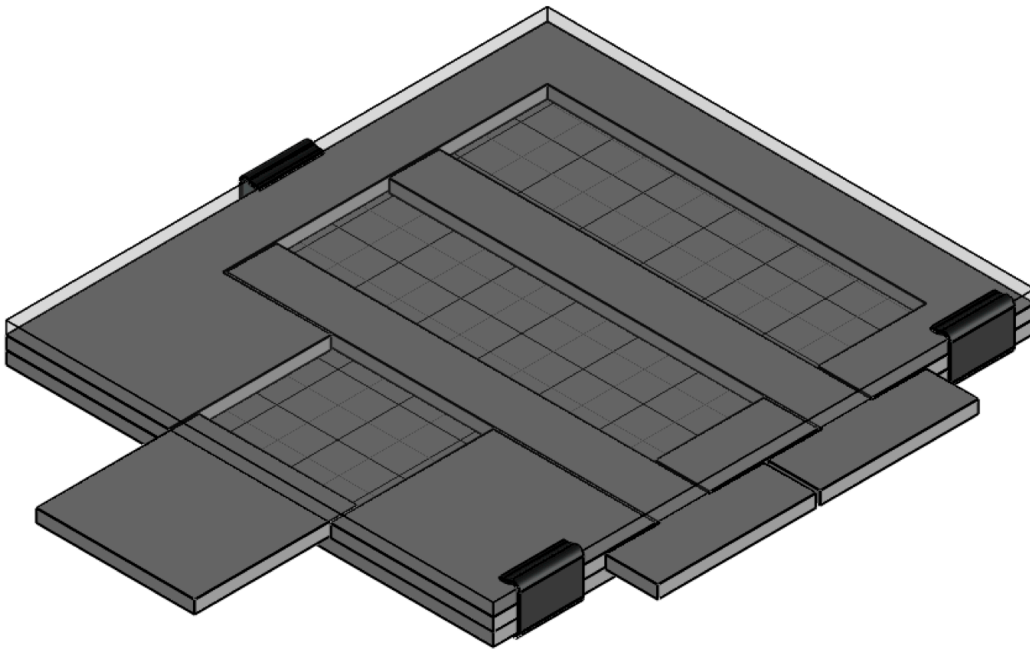


Loading

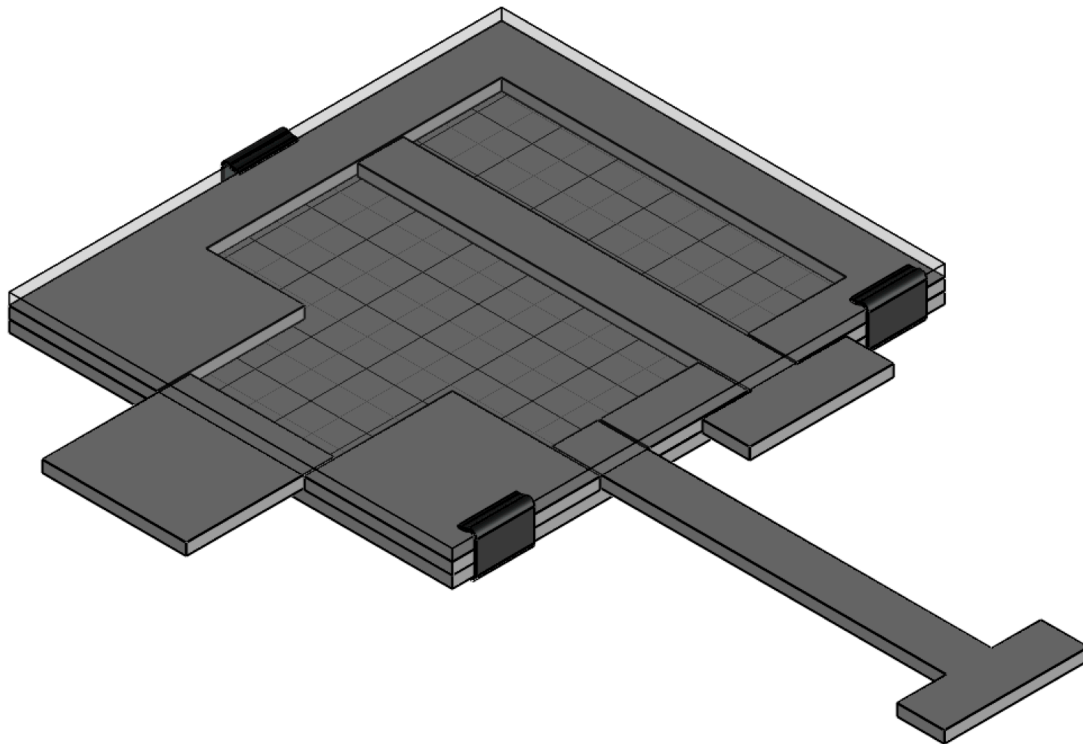


DK

Loaded



Gate 1 Open



Gates 1 and 2 Open

