FOR THE WIN ROBOTICS

VERTICAL FARM INSPECTION

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials

Materials Needed

- Hopper(s)
- safety glasses
- FTW CODE device with Bluetooth capabilities (such as iPads or laptops)
- tape (for the floor)
- measuring tape (up to 20')
- landing pads
- towers
- writing utensils

Time Allotment

Lesson: 1 hour (or 1 − 2 class periods), Setup: 25 minutes

Documents

- Agriculture Slide Deck III
- Agriculture Student Workbook

Vocabulary

- Vertical Farming – a modern form of agriculture where crops are grown in stacked layers, usually indoors
- Loop – a command that directs the code it covers to repeat until certain conditions are met

In this Lesson...

Students learn about and discuss the past and the future of agriculture. Then, they work through a real-life case study using the Engineering Design Process (EDP). During the activity, they code Hopper to inspect rows of crops in a vertical farm.

Learning Objectives

- Participate in a group discussion working through the Engineering Design Process to envision the possible future of agriculture.
- Accurately code Hopper to fly up and across to inspect rows of crops in a vertical farm simulation.
- Use the Engineering Design Process (EDP) and STEM practices to redesign Hopper's code as needed.

LESSON STRUCTURE

Read through the following table before starting the lesson. Approximate times have been given for each section to help with scheduling and time management.

Lesson Section	Description	Approximate Time
Direct Teaching	Open the slide deck titled Agriculture Slide Deck III and have the first slide up as the students walk in. Encourage students to think about the bell ringer question: "What kinds of new technologies could be created in the future of agriculture?" Go through the rest of the slides of the slide deck with the students. Play any videos directly from the slides if possible (as opposed to going to the external website). Reference any presenter's notes as needed for each slide. The last slide presents the scenario of the Vertical Farm Inspection activity to the students.	15 minutes
Discussion & Activity	Ensure the activity is set up prior to the beginning of the lesson. Allow for up to 25 minutes to set up. Separate students into small teams. Choose team sizes based on how many students there are and how many drones are available. Ideally, there would be no more than 3 – 4 students per team. Encourage the use of the steps of the Engineering Design Process, and computer programming terms such as algorithm, command, bug, function, and loop as students write code. Implement the extension if time permits. Use the questions provided on page 7 to lead a group discussion with the students. Have them fill out a row in their flight log in their Agriculture Student Workbook. See page 8 for examples of the activity. Students' codes may vary but should be as efficient and concise as possible.	45 minutes

ACTIVITY SCENARIO

You are using Hopper to inspect three equally-spaced, vertically stacked rows of your vertical farm. Each row is 10 feet long, and each row is 2 feet apart from each other.

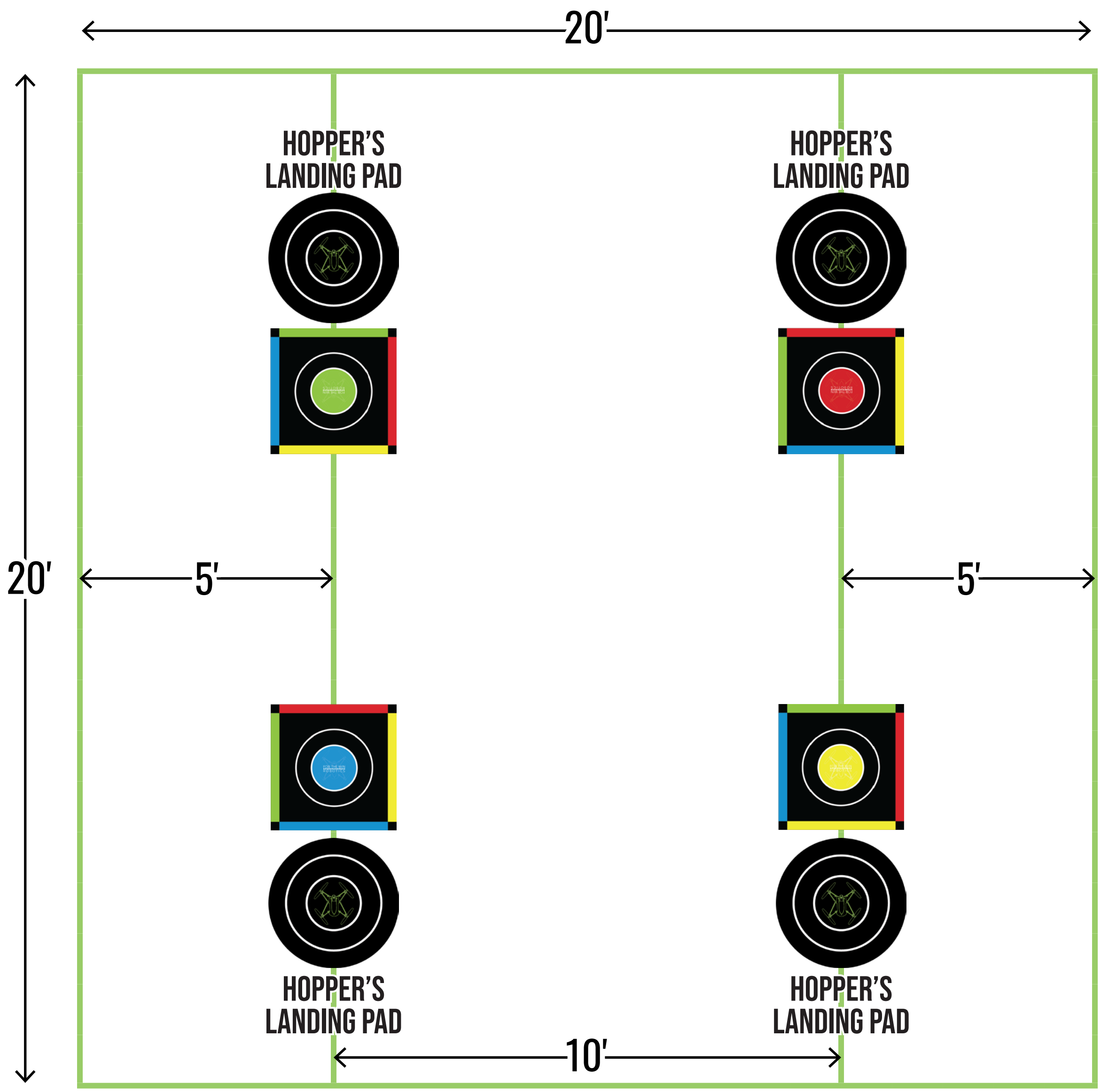
You will write a code to command Hopper to take off, fly across each row, and then fly down to land. Hopper's eyes must be facing toward the rows of crops while flying horizontally to inspect.

ACTIVITY SETUP

Tape a 20' × 20' square on the ground which is the fly zone. Tape two lines of tape parallel to each other each 5 feet from the sides of the square. These two lines of tape should be 10 feet apart. Place a tower on each of these parallel lines, and then place a landing pad for Hopper right in front of each tower.

It can be helpful to mark 2-foot intervals on the towers with tape so represent the heights of the first and second rows of crops.

An example of the setup is shown below. This setup allows for two groups to fly Hopper at once. Activity towers are set at the 6' height setting.

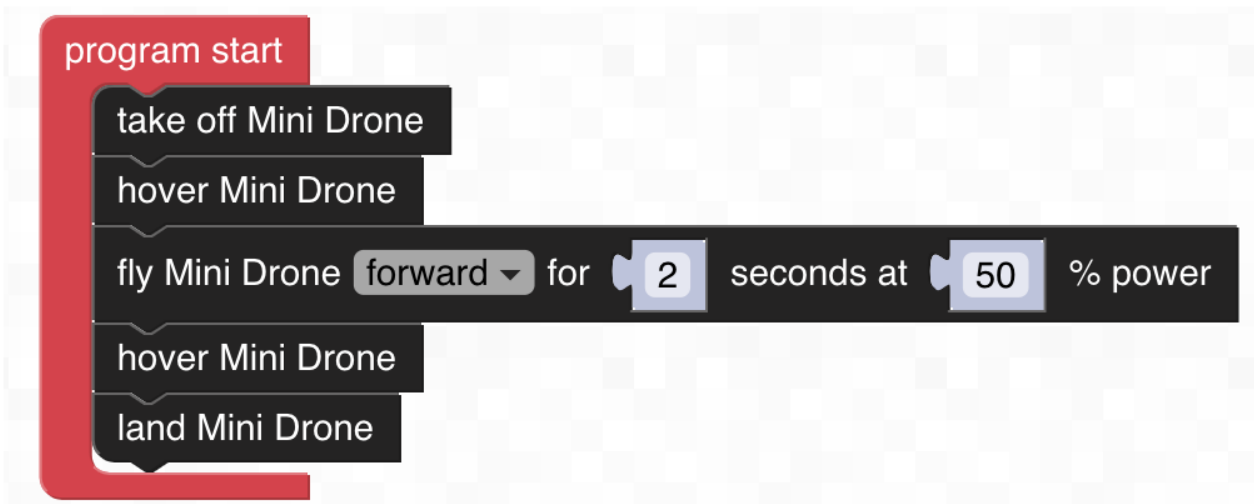


ACTIVITY IMPLEMENTATION

Have each team find Hopper's approximate speed when coded to fly at a certain power percentage and for a certain number of seconds. It is recommended to stay at 50% power or below.

A team's power percentage should stay *roughly* the same throughout this activity.

To stabilize Hopper after takeoff and before landing, it is recommended to command Hopper to hover. An example of a code students could write is shown below.



The takeoff and landing spots of Hopper should be measured.

Then, have each team use the formula rate $= \dfrac{\text{distance}}{\text{time}}$ to find the rate (speed) in feet per second of Hopper at the power percentage they chose.

Review with students that the formula for finding the rate is derived from the well-known formula:

$$\text{distance} = \text{rate} \times \text{time}$$

ACTIVITY IMPLEMENTATION

Activity Facilitation

Go through the following steps with the students to facilitate the activity.

1. Place Hopper on Hopper's landing pad in front of the tower on the left. Make sure Hopper's eyes are facing forward, toward the tower.

2. In this simulation, the top of the towers represent the third, uppermost row of crops. Since there are no markers for the first and second rows, the overall accuracy of the students' code will be determined by the accuracy shown by the third row of crops. **There can be a small margin of error when it comes to Hopper flying up to the top of the towers when flying across the third row of crops.**

3. Have each team code Hopper to fly up and across three equally-spaced rows while staying in the 20' × 20' fly zone. This can be in any pattern that they choose so long as Hopper flies up the same distance each time, and Hopper flies across the 10 foot space three times. This can be done with or without a loop. After flying across three times, command Hopper to fly down and land on one of the landing pads to end the code.

   Encourage students to draw and label where they want Hopper to go, and to write down what they want Hopper to do in words before coding as needed. They can keep the answers to any calculations they do in exact form for coding. They can use the operation command in the Math tab for improper fractions, or they can convert to decimals.

4. If a team was not successful in the accuracy of coding Hopper, have them adjust their code and try again. If Hopper ever flies outside of the 20' × 20' square, the student should click on the red Emergency Land button.

Pattern Examples

Pattern 1: "backtrack pattern"

Pattern 2: "snake pattern"

ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students to adapt their code from the activity to program Hopper to inspect four rows of crops using the same 6' towers as a guide for the uppermost row.

Post-Activity Discussion Questions

Use the following questions to lead a group discussion after implementing the activity.

1. Was your initial calculation of Hopper's speed accurate? Or did you have to adjust it while coding the scenario?
2. Did you keep your calculated values as simplified, improper fractions? Why or why not?
3. Did you write down or draw your code before creating it in FTW CODE? If so, what did you create and how was it helpful?
4. Compare the code from your group to the codes that other groups wrote. Are they different? If so, how?
5. After comparing codes, would you make any changes to yours? If so, how would you make improvements to your code to make it more efficient?

Flight Log

Have students fill out a row in their flight log in their Agriculture Student Workbook. An example of what it could look like is shown below.

Date	Drone Model	Location	Flight Time	Notes
04/01/2025	Hopper	El Camino Real High School Gymnasium	10 minutes	My partner Alison and I coded Hopper to inspect three 10' rows of crops in a vertical farm. We used a loop in our code to achieve this.

CODING EXAMPLES

Sample Code for Pattern 1

```
program start
  take off Mini Drone
  repeat 3 times
  do
    fly Mini Drone up for 1 seconds at 25 % power
    hover Mini Drone
    fly Mini Drone right for 40 ÷ 7 seconds at 50 % power
    hover Mini Drone
    fly Mini Drone left for 40 ÷ 7 seconds at 50 % power
    hover Mini Drone
  fly Mini Drone down for 3 seconds at 25 % power
  land Mini Drone
```

Sample Code for Pattern 2

```
program start
  take off Mini Drone
  fly Mini Drone up for 1 seconds at 25 % power
  hover Mini Drone
  fly Mini Drone right for 40 ÷ 7 seconds at 50 % power
  hover Mini Drone
  fly Mini Drone up for 1 seconds at 25 % power
  hover Mini Drone
  fly Mini Drone left for 40 ÷ 7 seconds at 50 % power
  hover Mini Drone
  fly Mini Drone up for 1 seconds at 25 % power
  hover Mini Drone
  fly Mini Drone right for 40 ÷ 7 seconds at 50 % power
  hover Mini Drone
  fly Mini Drone down for 3 seconds at 25 % power
  land Mini Drone
```