FOR THE WIN ROBOTICS

AERIAL IGNITION

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials
- Writing basic algebraic equations
- Solving basic algebraic equations

Materials Needed

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

Time Allotment

Lesson: 1 hour (or 1 – 2 class periods), Setup: 10 minutes

Documents

- Firefighting Slide Deck II
- Firefighting Student Workbook

Vocabulary

- Prescribed Fires – fires that are carefully planned and intentionally set by firefighters or land managers
- Aerial Ignition – a method of setting prescribed fires from an aircraft
- Dot Fires – a prescribed fire technique where spots of fire are ignited as opposed to a line of fire
- Control Line – a constructed or natural barrier that contains fires
- 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 benefits of prescribed fires. They write and solve algebraic equations that represent the given scenario. Then, they code Hopper to strategically place equally-spaced dot fires during a prescribed fire simulation with their calculated value.

Learning Objectives

- Participate in a group discussion about the benefits of prescribed fires and how they are set.
- Write and solve algebraic equations based off of the number of dot fires and the distance between each one.
- Accurately code Hopper to fly and hover at each dot fire with the use of loops.
- 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 Firefighting Slide Deck II and have the first slide up as the students walk in. Encourage students to think about the bell ringer question: "What could be some benefits of intentionally setting fires in areas of vegetation?" 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 Aerial Ignition 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 10 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 computer programming terms such as algorithm, command, loop, and bug as they write code. Implement the extension if time permits. Use the questions provided on page 8 to lead a group discussion with the students. Have them fill out a row in their flight log in their Firefighting Student Workbook.	45 minutes

ACTIVITY SCENARIO

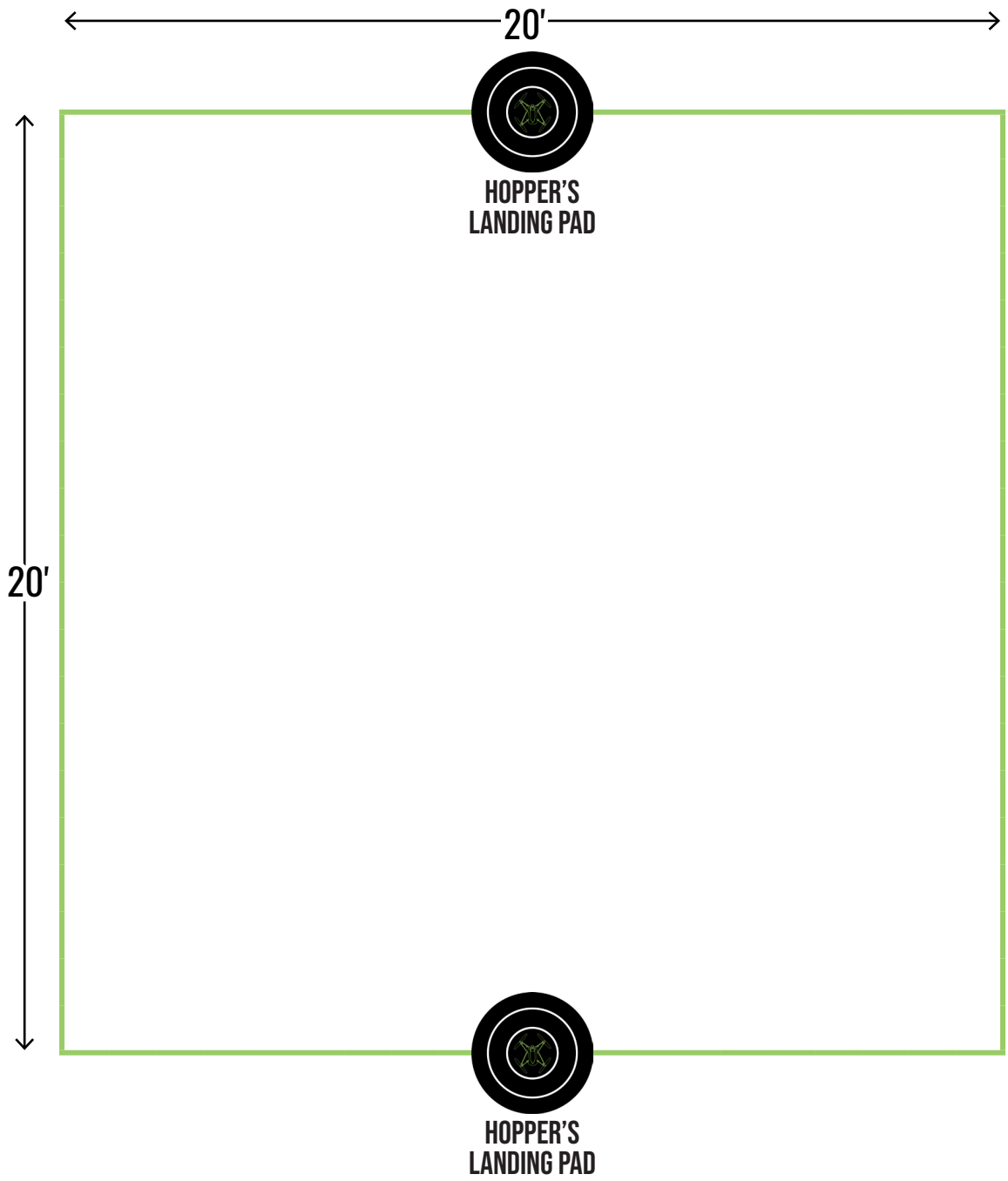
You are using Hopper to ignite 5 equally-spaced dot fires between two streams. The streams are control lines and they are 20 feet apart. The first and last dot fires should be the same distance away from each control line.

You will write and solve an equation that represents this scenario with the unknown d representing the distance between each dot fire. Then, you will code Hopper using a loop to fly across the fire zone and place (by hovering) 5 equally-spaced dot fires.

ACTIVITY SETUP

Tape a 20' × 20' square on the ground which represents the fire zone. The tape represents control lines, such as concrete roads. Place a landing pad for Hopper at one end of the square so that the center of the landing pad lies on the tape. Place another landing pad for Hopper at the opposite end of the square so that the center of the landing pad lies on the tape.

An example of the setup is shown below.

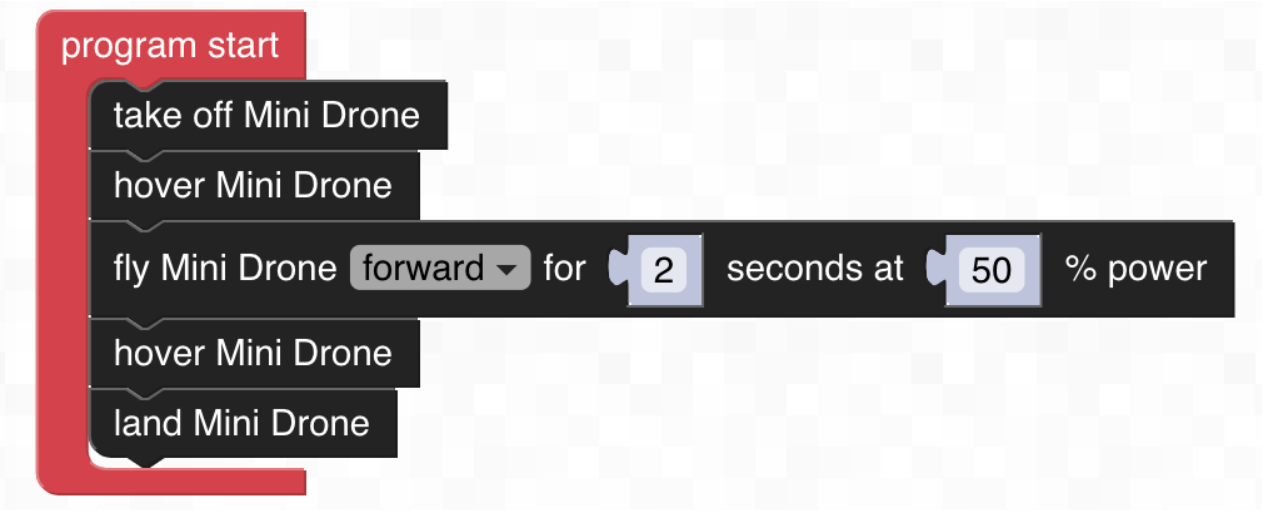


ACTIVITY IMPLEMENTATION

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 = $\frac{\text{distance}}{\text{time}}$ 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:

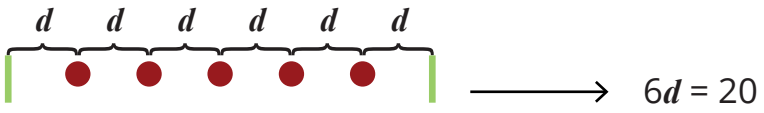
$$\text{distance} = \text{rate} \times \text{time}$$

ACTIVITY IMPLEMENTATION

Activity Facilitation

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

1. Have students write an equation to find the distance between each dot fire using d to represent the unknown distance based on the scenario. Encourage students to create a drawing and label the parts if they get stuck.



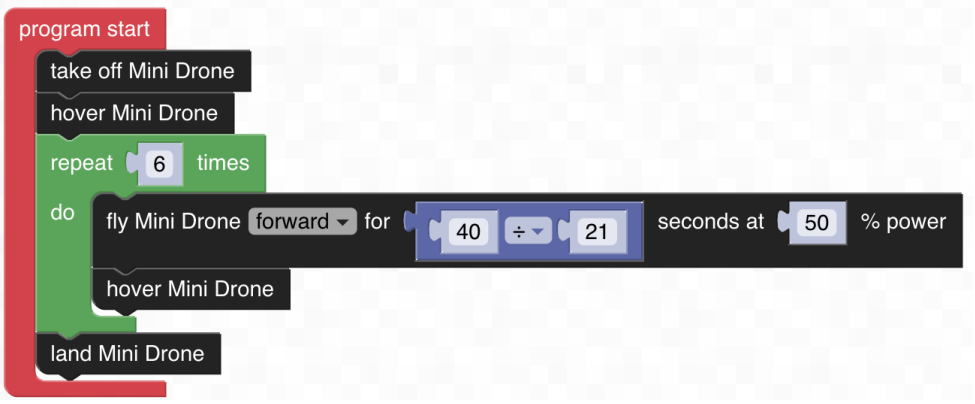
2. Have the students solve their equation and write their answer as a simplified, improper fraction for accuracy and friendlier calculations.

3. Once students have calculated that $d = \frac{10}{3}$ feet, have them use the formula

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

to calculate the time that they should code Hopper so that Hopper flies $\frac{10}{3}$ feet in between each dot fire. Again, have students write their answers as simplified, improper fractions for accuracy and friendlier calculations.

4. Once each team knows the time that they want Hopper to fly between each dot fire placement, have them code Hopper using a loop to fly across the fire zone and place (by hovering) 5 equally-spaced dot fires. They can use the operation command in the Math tab for an improper fraction or convert to a decimal. Encourage students to write down what they want Hopper to do in words before coding as needed.



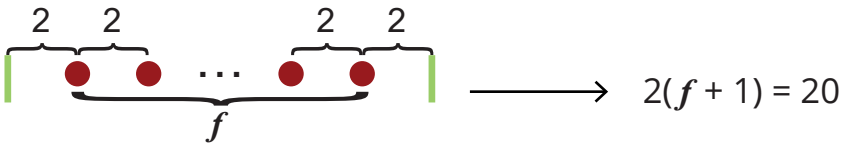
5. If a team was not successful in the number of times Hopper places dot fires or their accuracy (e.g. doesn't reach the other side all the way), have them adjust their code and try again. If Hopper ever flies outside of the square, the student should click on the red Emergency Land button.

ACTIVITY IMPLEMENTATION

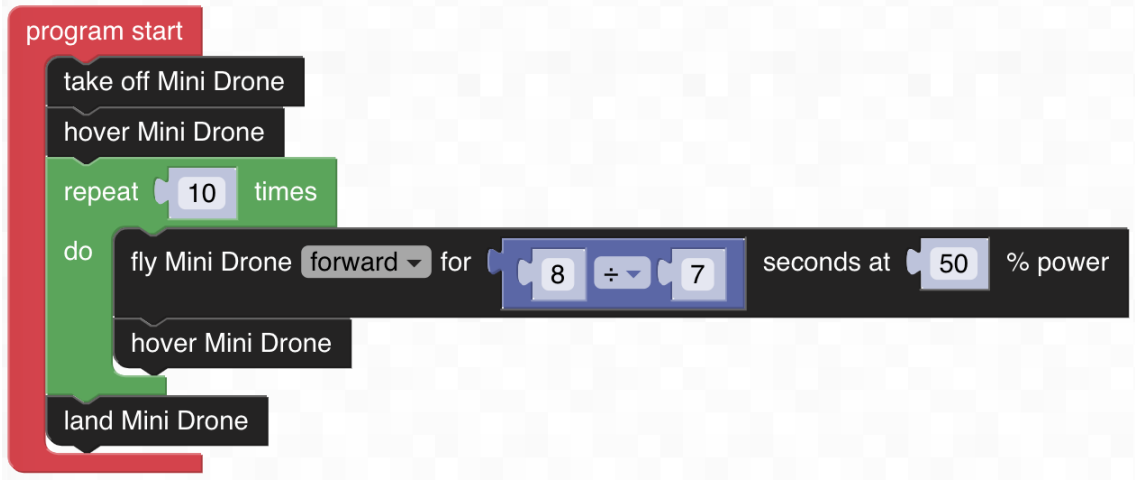
Extension

If time permits, challenge the students work through this new scenario.

1. Give students the following scenario: Hopper needs to ignite dot fires that are 2 feet apart between two streams. The streams are control lines and they are 20 feet apart. The first and last dot fires should also be 2 feet away from each control line.
2. Have students write an equation to find the number of dot fires using f to represent the unknown number of dot fires. Encourage students to create a drawing and label the parts if they get stuck.



3. Have students solve their equation to calculate that $f = 9$ dot fires.
4. Have students calculate the time that they should code Hopper so that Hopper flies 2 feet in between each dot fire. Have students write their answers as simplified, improper fractions for accuracy and friendlier calculations.
5. Once each team knows the time that they want Hopper to fly between each dot fire placement, have them code Hopper using a loop to fly across the fire zone and place (by hovering) 9 dot fires that are 2 feet apart. They can use the operation command in the Math tab for an improper fraction or convert to a decimal. Encourage students to write down what they want Hopper to do in words before coding as needed.



6. If a team was not successful in the number of times Hopper places dot fires or their accuracy (e.g. doesn't reach the other side all the way), have them adjust their code and try again. If Hopper ever flies outside of the square, the student should click on the red Emergency Land button.

ACTIVITY IMPLEMENTATION

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 struggle while writing equations that modeled the scenario? How did your drawings help you visualize?

3. Did you keep your calculated values as simplified, improper fractions? Why or why not?

4. 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?

Flight Log

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

Date	Drone Model	Location	Flight Time	Notes
04/02/2025	Hopper	Redwood Middle School Gymnasium	15 minutes	My partner Jimmy and I wrote and solved an equation to find the distance between spot fires we needed to ignite. Then, we coded Hopper to fly over a space between two streams and hover over the areas of ignition .