FOR THE WIN ROBOTICS

SECTOR SEARCH

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials
- Properties of equilateral triangles
- Supplementary angles

Materials Needed

- Hopper(s)
- safety glasses
- FTW CODE device(s) with Bluetooth capabilities (such as iPads or laptops)
- tape (for the floors)
- measuring tape (up to 20')
- landing pads
- writing utensils
- Wifi capable device(s) – **extension only** (such as iPads or laptops)

Time Allotment

Lesson: 1 hour (or 1 – 2 class periods), Setup: 20 minutes

Documents

- Search & Rescue Slide Deck III
- Search & Rescue Student Workbook

Vocabulary

- Equilateral Triangle – a triangle with equivalent sides and angles
- Supplementary Angles – angles whose sum is equal to 180°
- Sector Search Pattern – an aerial search pattern that forms a series of equilateral triangles, useful when the search area is small and the location of a lost individual is accurately known
- Loop – a command that directs the code it covers to repeat until certain conditions are met

In this Lesson...

Students learn about and discuss past and the future of SAR drone technology. Then, they work through a real-life case study using the Engineering Design Process (EDP). During the activity, they code Hopper to fly in a sector search pattern to simulate an aerial search where the location of a lost individual is accurately known.

Learning Objectives

- Participate in a group discussion working through the Engineering Design Process to envision the possible future of SAR drone technology.
- Accurately code Hopper to fly in a sector search pattern in the shape of three equilateral triangles.
- Use the Engineering Design Process (EDP) and STEM practices to redesign Hopper's code as needed.

LESSON STRUCTURE

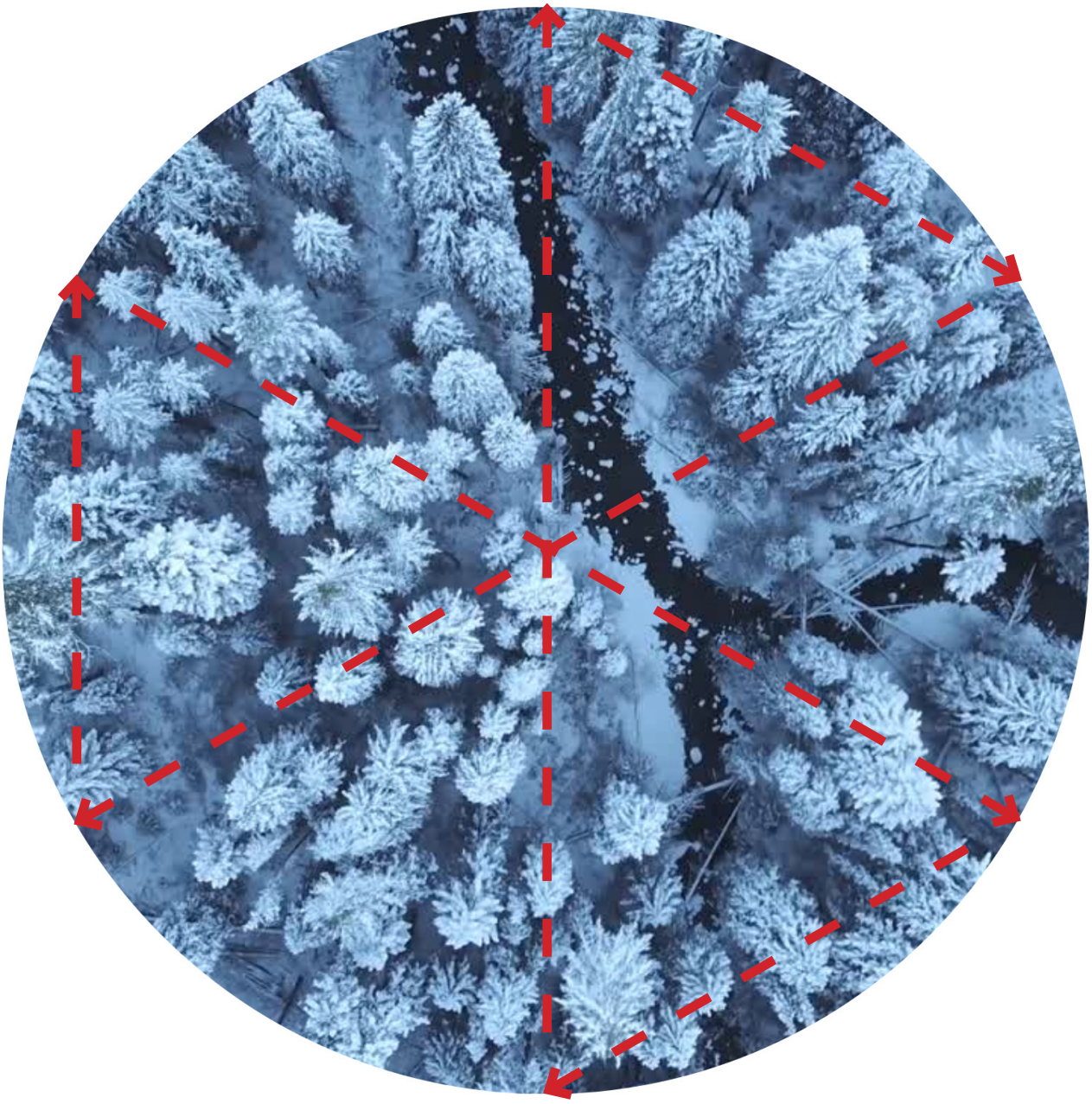
Read through the following table before starting the lesson. Approximate times have been given for each section to help with scheduling and time management.

Lesson Section	Description	Approximate Time
Direct Teaching	Open the slide deck titled Search & Rescue 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 search and rescue (SAR)?" 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 Sector Search 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 20 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, 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 Search & Rescue Student Workbook. An answer key to the student page is provided on page 8.	45 minutes

ACTIVITY SCENARIO

A 911 call was made by a boy who is lost in the snow. Because of his cell phone and the description given over the phone, you accurately know his location.

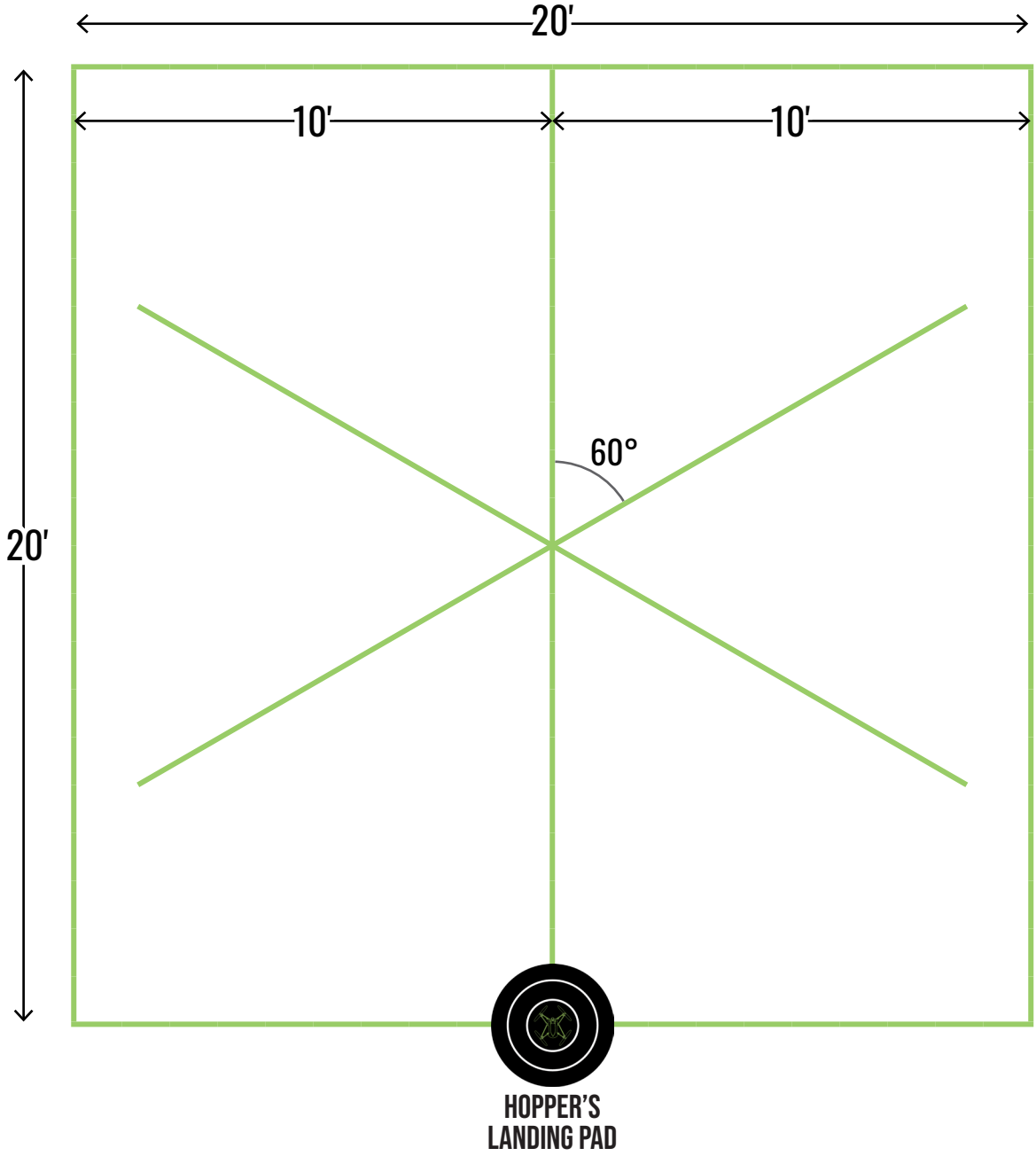
You will code Hopper to fly in a sector search pattern in the shape of three equilateral triangles to identify the exact location of the boy.



ACTIVITY SETUP

Tape a 20' × 20' square on the ground which represents the fly zone. Place a 20' piece of tape down the center of the square. Two additional 20' pieces of tape should be placed at the center of the square so that approximate 60° angles are created at the center of the fly zone. Place Hopper's landing pad at the bottom center of the square.

An example of the setup is shown below.



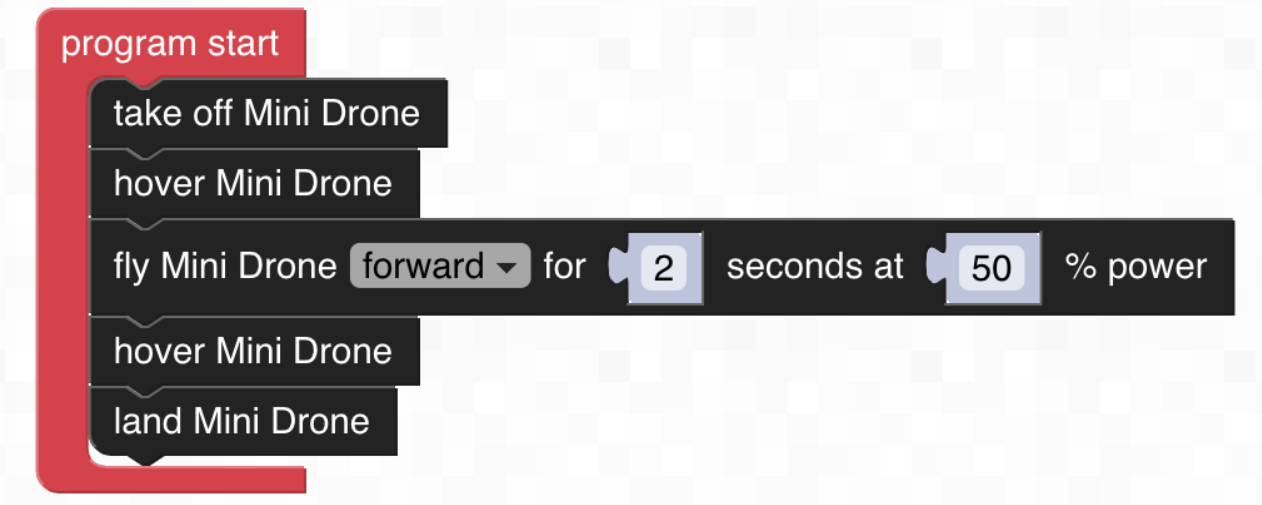
ACTIVITY IMPLEMENTATION

If the groups and Hoppers are staying the same as in the Expanding Square Search activity, finding the speed again is not necessary and this part of the activity can be skipped.

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.

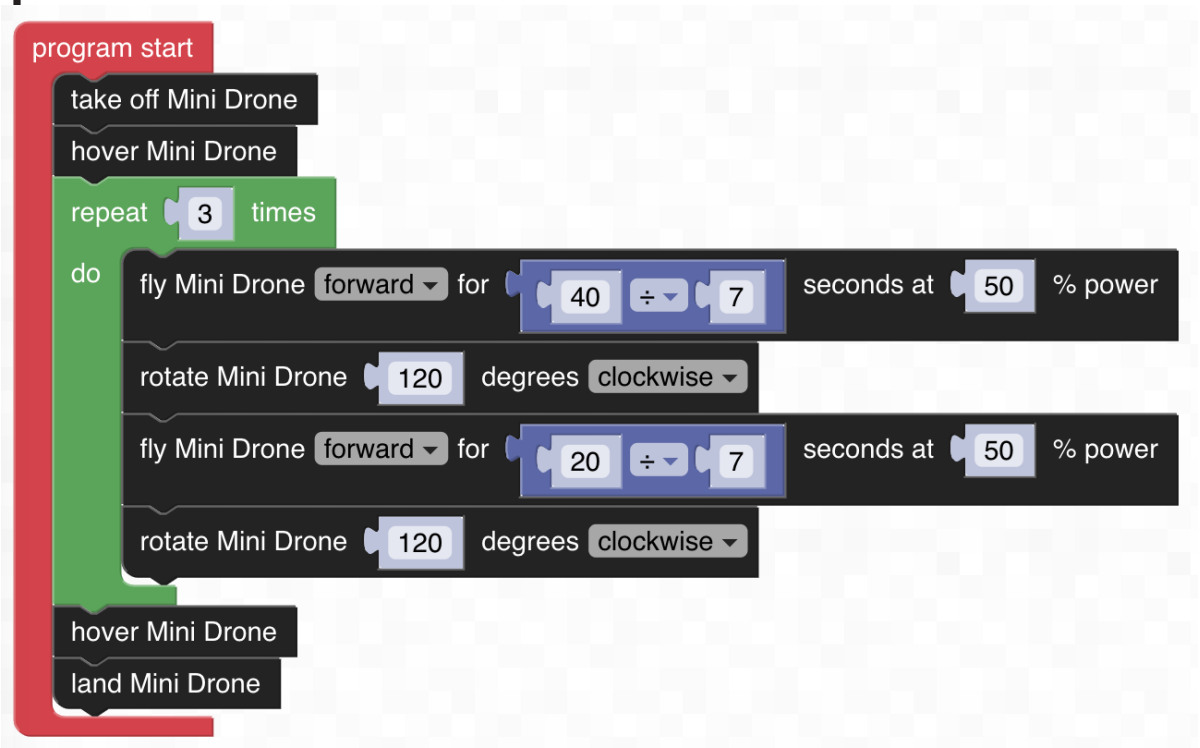
1. Place Hopper on Hopper's starting landing pad with Hopper's eyes facing forward toward the fly zone.
2. Have each team code Hopper to fly in a sector pattern. They should use the pieces of tape as a guide when writing and testing their code. Hopper should take off and land at the same location.

   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.

   Encourage the use of a loop in their code.

   Remind students of the properties of equilateral triangles and to find supplementary angles as needed.
3. If a team was not successful in the accuracy of coding Hopper, have them adjust their code and try again. If Hopper ever flies too far outside of the 20' × 20' square, the student should click on the red Emergency Land button.

Sample Code



ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students to simulate finding a lost individual using their code and Hopper's camera. Place another landing pad in the search area while the team has their back turned to the search area and have them identify the location of the landing pad while viewing Hopper's camera feed while they run their code.

Additionally, students can extend their code to include another flightpath of the sector search pattern with a 30° shift as discussed on slide 5 in the Search & Rescue Slide Deck III.

Post-Activity Discussion Questions

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

1. Did you keep your calculated values as simplified, improper fractions? Why or why not?
2. 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?
3. What properties of equilateral triangles did you use when finding your distances to travel? How did you use your knowledge of supplementary angles to find the angles to rotate Hopper in your code?
4. Compare the code from your group to the codes that other groups wrote. Are they different? If so, how?

Flight Log

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

Date	Drone Model	Location	Flight Time	Notes
04/03/2025	Hopper	Northridge Middle School Gymnasium	20 minutes	My partner Kristen and I coded Hopper to fly in a sector search pattern to simulate locating a missing boy in the snow. We used our knowledge of equilateral triangles and supplementary angles to find our measurements.

STUDENT PAGE

1. In an equilateral triangle, each angle is equal to 60°.

2. The sum of supplementary angles is equal to 180°.

3. Write the measurement of each marked angle on the diagram below of the sector search pattern.