FOR THE WIN ROBOTICS

ORGAN DELIVERY

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials

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
- towers
- writing utensils

Time Allotment

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

Documents

- Package Delivery Slide Deck III
- Package Delivery Student Workbook

Vocabulary

- Radio Frequency – an electromagnetic wave with low energy that is often used in telecommunications

In this Lesson...

Students learn about and discuss the past and the future of drone delivery. Then, they work through a real-life case study using the Engineering Design Process (EDP). During the activity, they code Hopper to fly across a populated city from one hospital to another in order to deliver a pair of lungs to a transplant patient.

Learning Objectives

- Participate in a group discussion working through the Engineering Design Process to envision the possible future of drone delivery.
- Accurately code Hopper to make an organ delivery to a hospital in a 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 Package Delivery 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 drone delivery?" 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 Organ Delivery 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 6 to lead a group discussion with the students. Have them fill out a row in their flight log in their Package Delivery Student Workbook.	45 minutes

ACTIVITY SCENARIO

A hospital that accepts lung transplant patients wants to come up with a code to program Hopper to deliver lungs from another hospital that is located across a densely populated city.

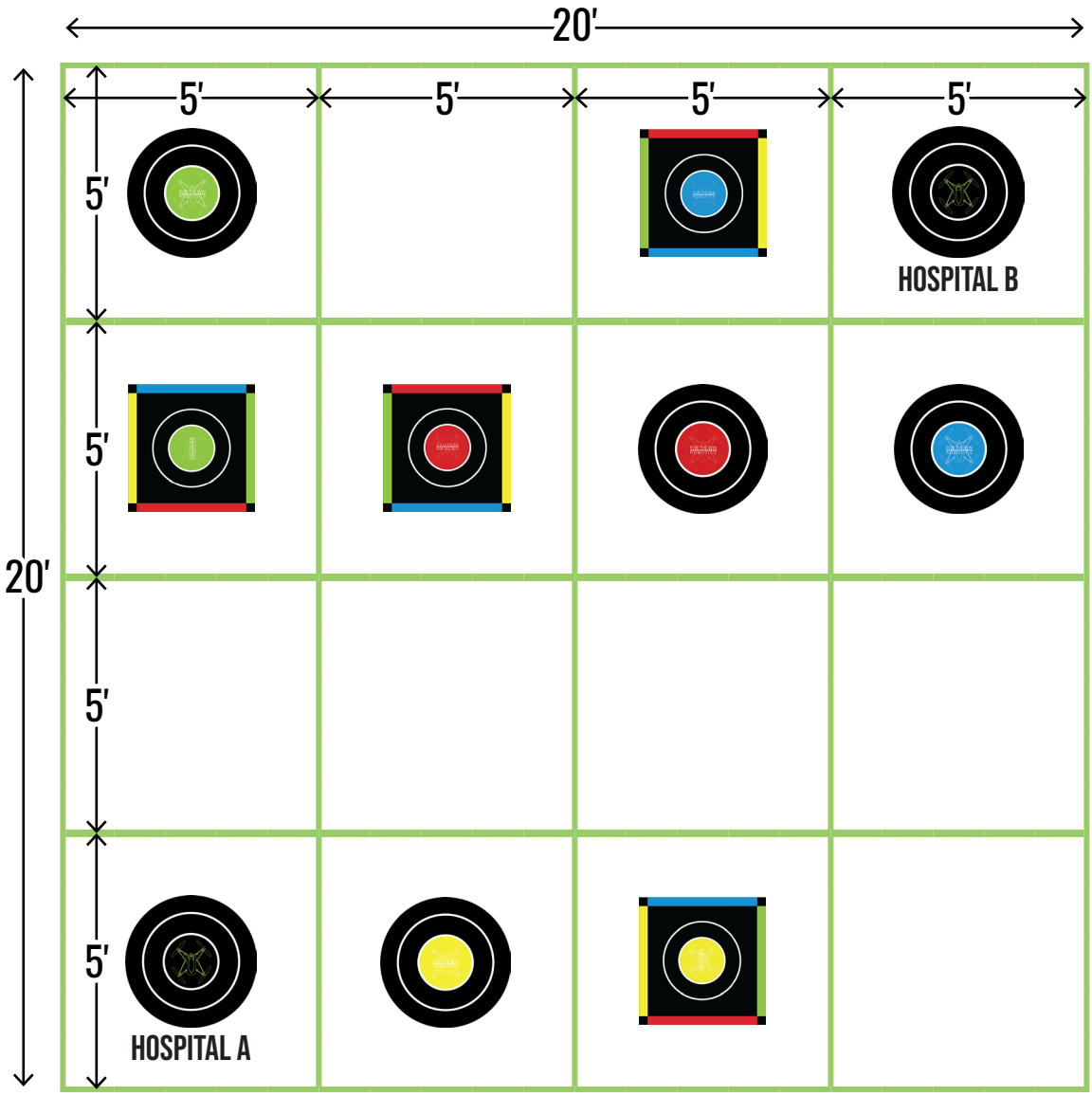
During delivery, Hopper must avoid areas with high chances of radio frequency to avoid signal interference between Hopper and the operator, and high rise buildings that are not allowed to be flown over to comply with local ordinances.

ACTIVITY SETUP

Tape a 20' × 20' square on the ground which represents the fly zone. Tape a 5' × 5' grid in this square. Place two landing pads for Hopper that represent Hospital A and Hospital B in the center of the lower left and upper right 5' × 5' squares.

Place four landing pads and four activity towers in the centers of the indicated 5' × 5' squares as shown in the example setup below.

An example of the setup is shown below. Activity towers are set at the 6' height setting.



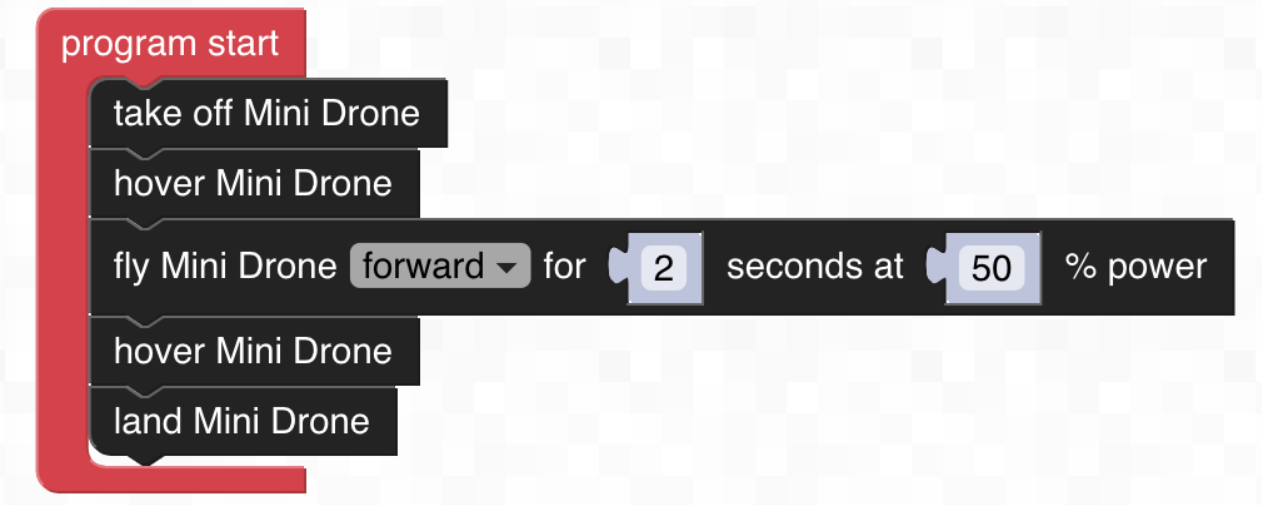
ACTIVITY IMPLEMENTATION

If the groups and Hoppers are staying the same as in the Rural Delivery 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.

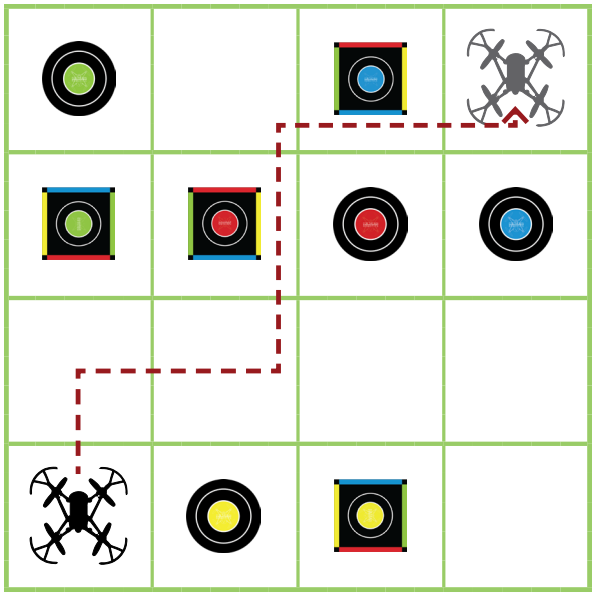
1. Place Hopper on Hopper's landing pad that represents Hospital A. Make sure Hopper's eyes are facing forward according to the setup orientation.
2. In this simulation, Hopper must delivery a pair of lungs from Hospital A to Hospital B while abiding by the following rules:
   - Hopper must fly below 6 feet (the height of the towers) at all times due to local law.
   - The 5′ × 5' squares with landing pads represent areas where Hopper cannot fly because of too much radio interference.
   - The activity towers represent buildings that Hopper cannot fly over because of a local ordinance.
3. Have each team code Hopper to fly from the starting landing pad (Hospital A), to the ending landing pad (Hospital B) while staying in the 20' × 20' fly zone and abiding by the rules previously listed.

   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.

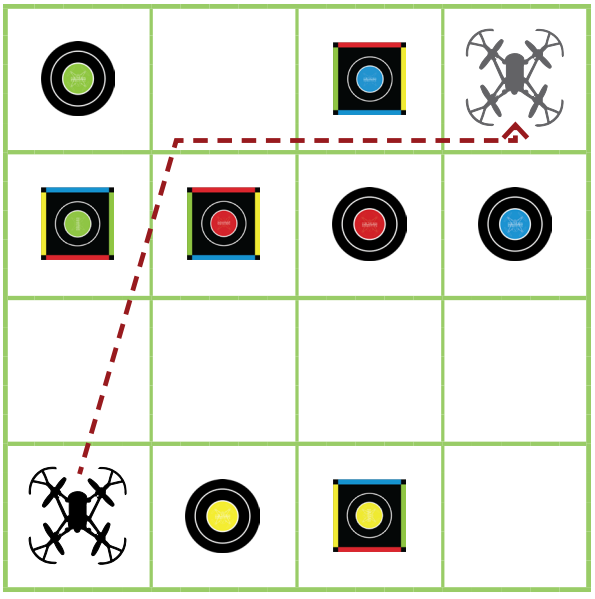
   Students can use the 5' × 5' grid to approximate distances when writing their code.

Delivery Route Examples

Delivery Route 1



Delivery Route 2



ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students to try to shorten the time it takes Hopper to deliver the lungs by modifying their code. If students increase Hopper's power percentage to achieve this, be sure they do this incrementally and pay extra attention to ensure safety.

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?

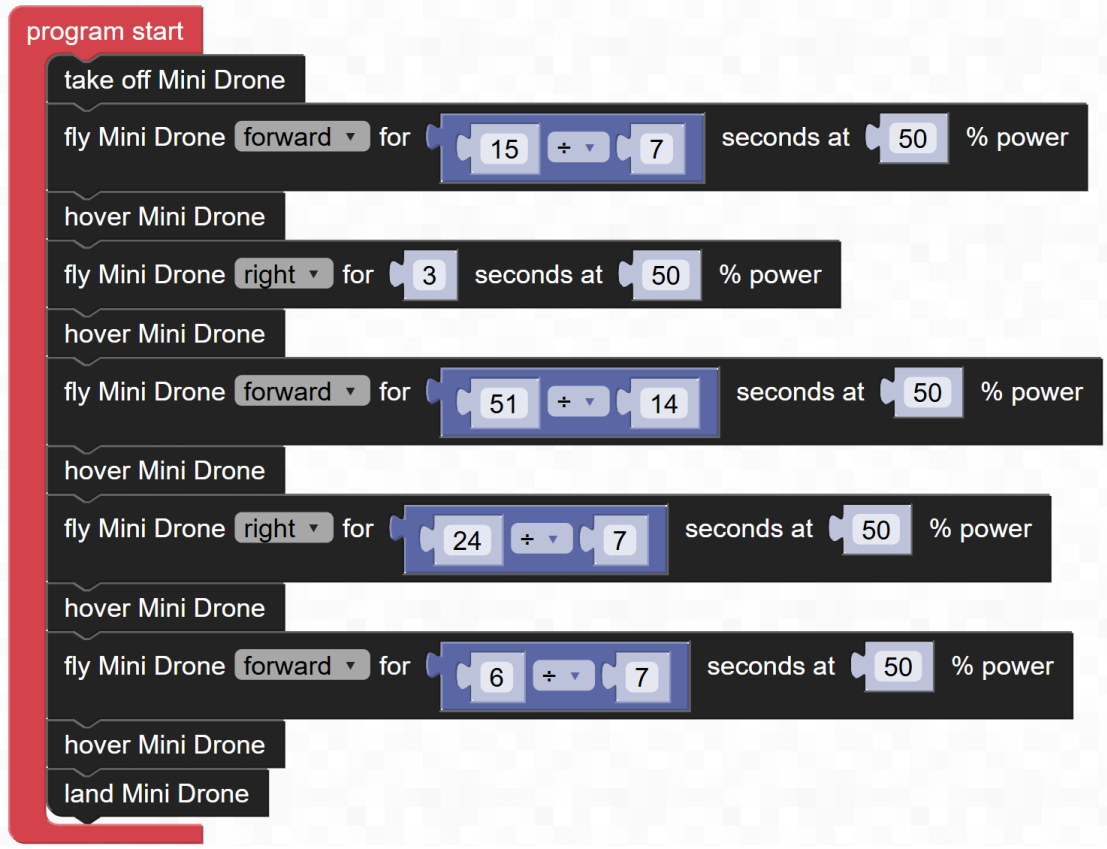
Flight Log

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

Date	Drone Model	Location	Flight Time	Notes
04/03/2025	Hopper	Granada Hills Charter High School Auditorium	20 minutes	My partners Ava, Kai, and I coded Hopper to deliver a pair of lungs to a transplant patient across a busy city. We avoided buildings and areas with high radio frequency.

CODING EXAMPLES

Sample Code for Delivery Route 1



Sample Code for Delivery Route 1