FOR THE WIN ROBOTICS

3D PRINTER DRONE

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials
- Basic properties of prisms

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
- writing utensils

Time Allotment

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

Documents

- Construction Slide Deck III
- Construction Student Workbook

Vocabulary

- 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 technology in construction. Then, they work through a real-life case study using the Engineering Design Process (EDP). During the activity, they code Hopper to simulate 3D printing a hollow rectangular prism with a square base.

Learning Objectives

- Participate in a group discussion working through the Engineering Design Process to envision the possible future of technology in construction.
- Accurately code Hopper to print a 3D structure in a simulation with the use of a loop.
- Use the Engineering Design Process (EDP) and STEM practices to redesign Hopper's code as needed.

LESSON STRUCTURE

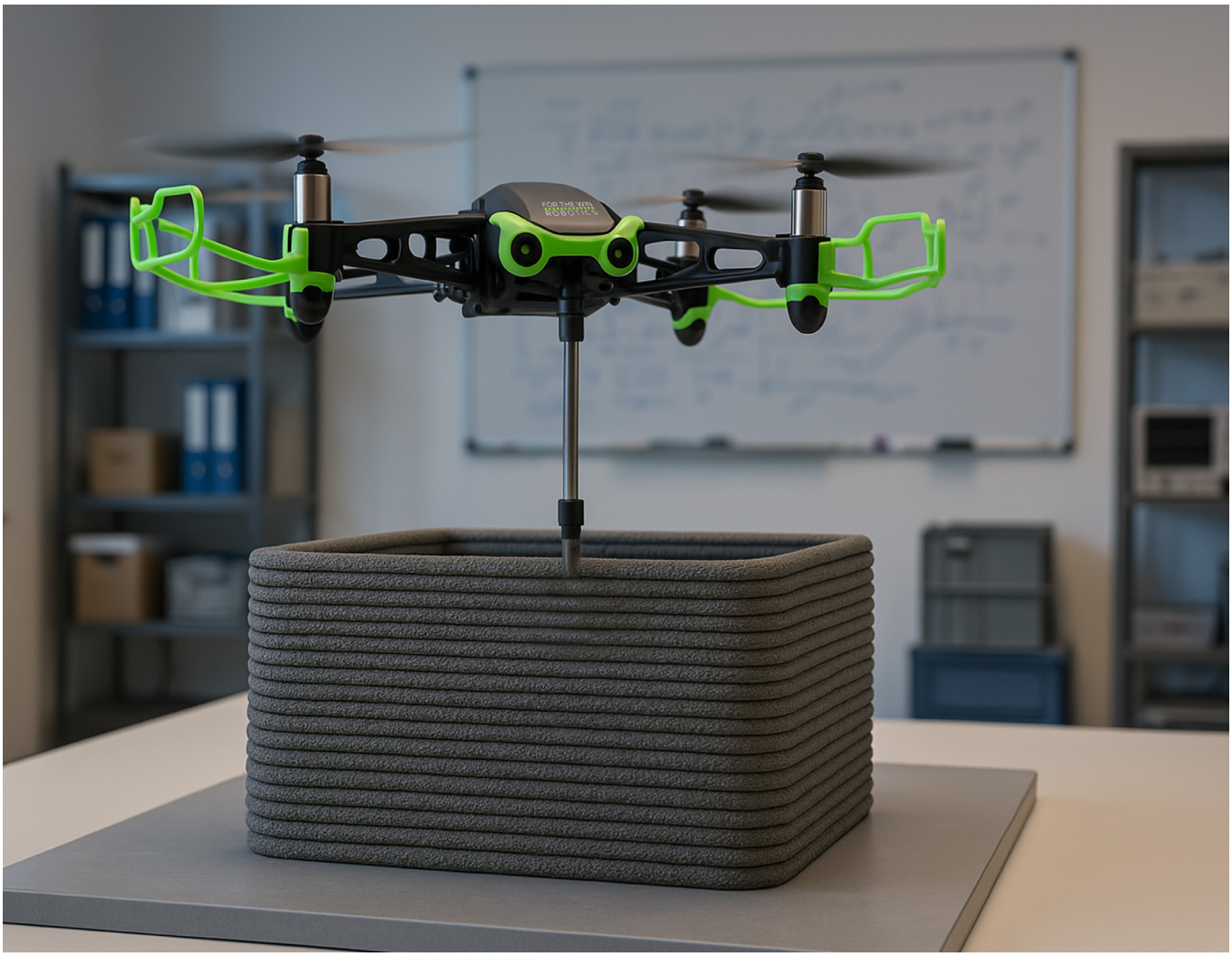
Read through the following table before starting the lesson. Approximate times have been given for each section to help with scheduling and time management.

Lesson Section	Description	Approximate Time
Direct Teaching	Open the slide deck titled Construction 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 construction?" 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 3D Printer Drone 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 Construction Student Workbook.	45 minutes

ACTIVITY SCENARIO

Hopper is 3D printing a storage structure that is shaped as a hollow rectangular prism with a square base. The square base needs to be 10' × 10'. With the building material that Hopper is using, there needs to be five layers of the building material for the structure to reach 5' tall.

You will write a code to command Hopper to print five layers in a square pattern to create the storage structure. Use a loop to make your code more efficient.

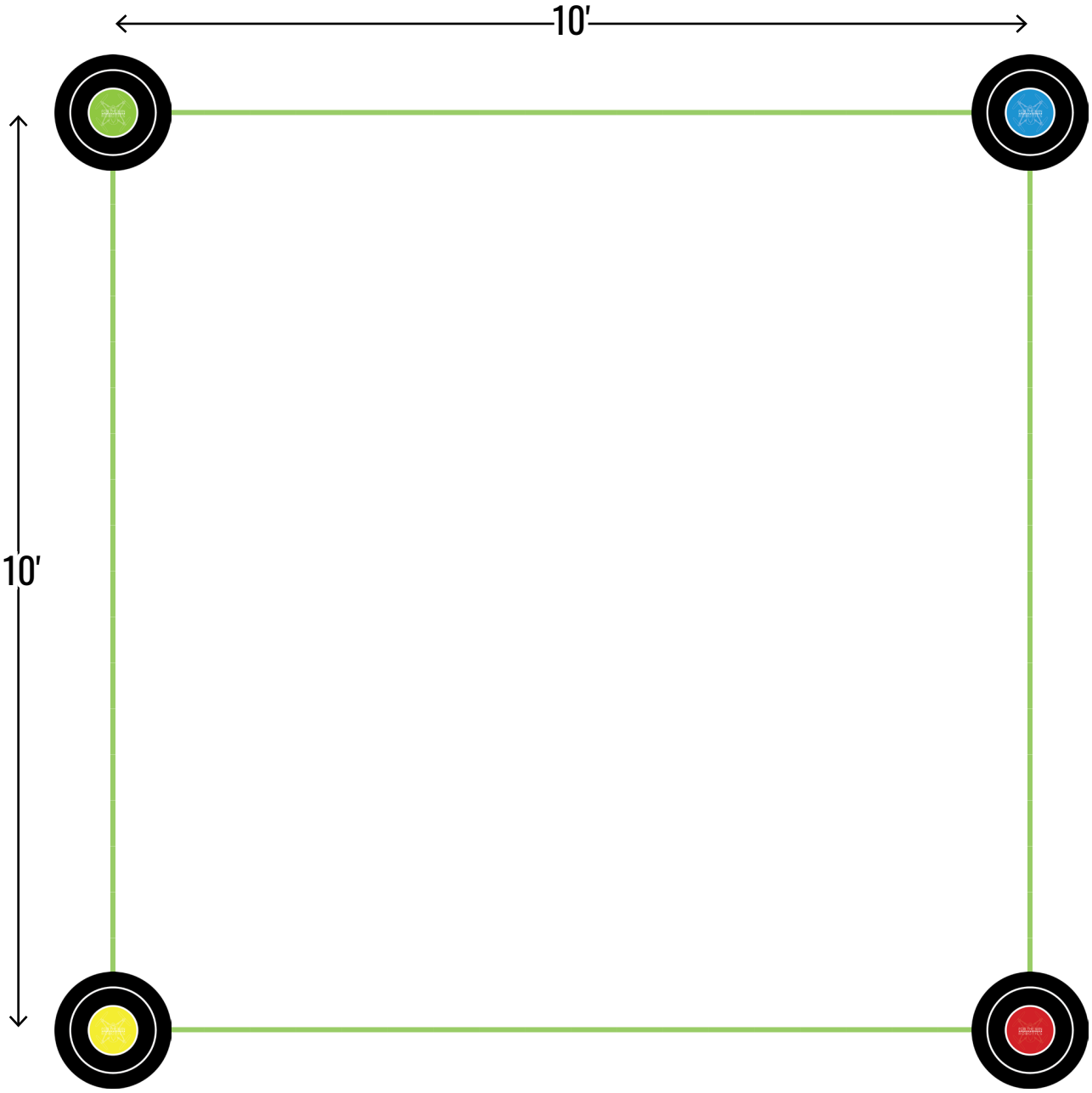


ACTIVITY SETUP

Tape a 10' × 10' square on the ground which represents Hopper's flight path. Place a landing pad at each of the four corners of the 10' × 10' square.

*The size of the square can be smaller or larger depending on the space available. Adjust the implementation of the activity to the size of the square.

An example of the setup is shown below.



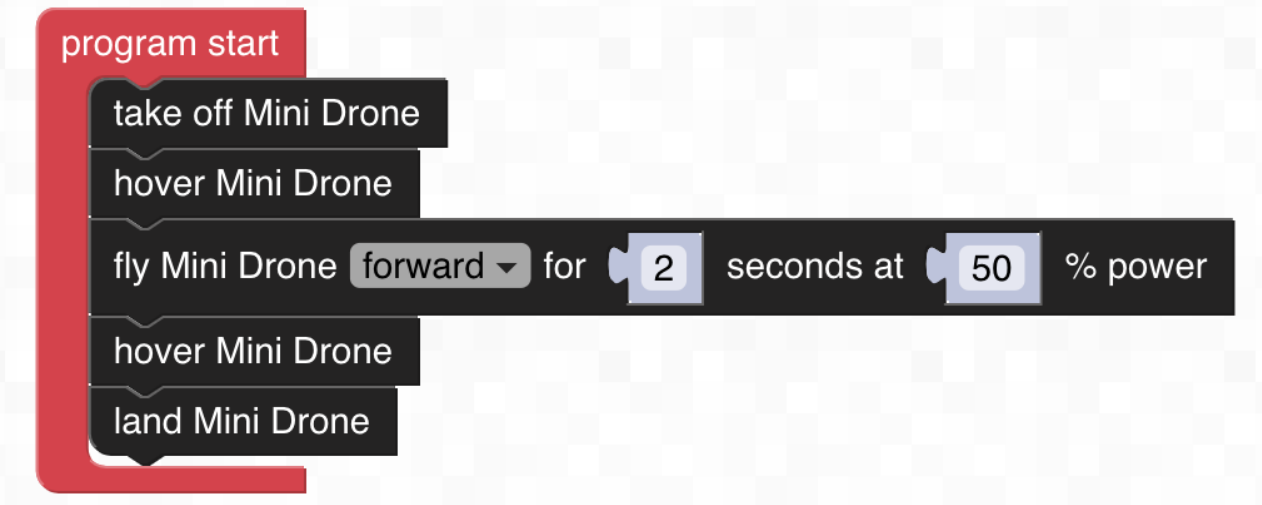
ACTIVITY IMPLEMENTATION

If the groups and Hoppers are staying the same as in the Bridge Inspection 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.

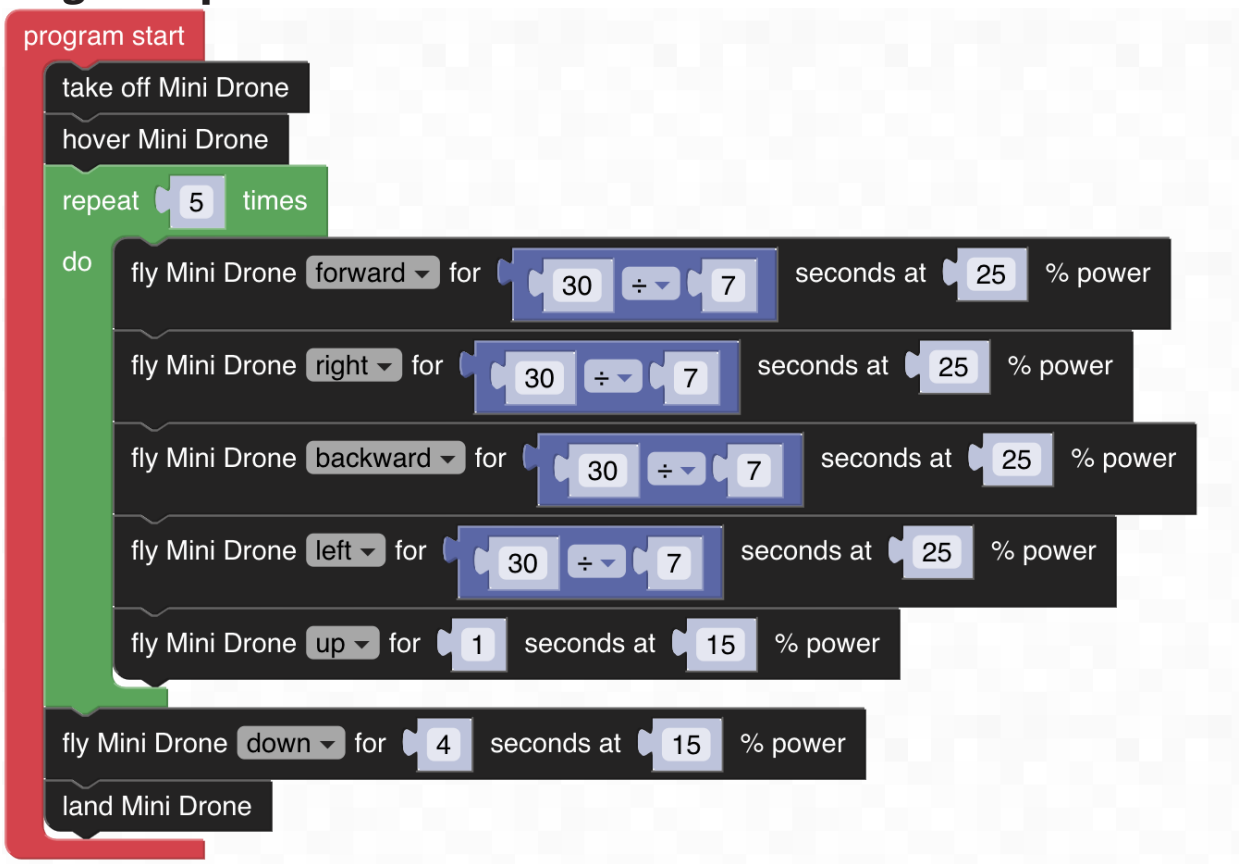
1. Have each team place Hopper on the landing pad of their choosing. Then, have each team write a code to command Hopper to take off, fly in a 10' × 10' square and fly up about a foot five times, and then land on the same landing pad where Hopper took off.

   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.

   The height that Hopper is coded to fly up can be as accurate as the measuring tools available. The height of a tower at the 5' setting can be used as a guide.

2. 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 10' × 10' square, the student should click on the red Emergency Land button.

Coding Example



ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students to simulate 3D printing a storage unit in the shape of a prism with any base shape as long as the loop starts and stops at the same location.

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. Compare the code from your group to the codes that other groups wrote. Are they different? If so, how?
4. Was using a loop helpful while completing this activity? Why or why not?

Flight Log

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

Date	Drone Model	Location	Flight Time	Notes
04/03/2025	Hopper	Redwood Middle School Blacktop	20 minutes	My partner Stephen and I coded Hopper to 3D print a square storage container with a loop. Then, we altered our code to command Hopper to print a storage container with a base shaped like a regular hexagon.