FOR THE WIN ROBOTICS

AERIAL SURVEYING

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Cardinal directions
- Finding the area of irregular polygons composed of rectangles, triangles, and/or trapezoids

Materials Needed

- Hopper(s)
- safety glasses
- controller(s) **or** FTW Fly Device(s) with Bluetooth and Wifi capabilities (such as iPads or laptops)
- FTW Fly device(s) with Wifi 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: 25 minutes

Documents

- Construction Slide Deck I
- Construction Student Workbook

Vocabulary

- Remote Pilot in Command (RPIC) – the person flying the drone
- Visual Observer (VO) – the person maintaining visual contact with the drone and in communication with the RPIC
- Navigator – the person responsible for giving the RPIC directions on where to fly
- Irregular Polygon – a 2D shape with straight sides, unequal side lengths, and unequal interior angle measurements

In this Lesson...

Students learn about and discuss some basic aspects of construction. Then, they use their drone flying skills and Hopper's camera to survey a piece of land and calculate the area of part of the land.

Learning Objectives

- Participate in a group discussion using existing knowledge of construction and its current technologies.
- Understand the how land surveying works and how drones can be used instead of manual methods.
- Work as a VO, navigator, or RPIC with teammate(s) to navigate Hopper together and practice drone flying skills.

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 I and have the first slide up as the students walk in. Encourage students to think about the bell ringer questions: "Have you ever seen construction on the side of the road? What does it look like?" 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 Surveying 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 aviation terms such as roll, yaw, pitch, and altitude in the communication between the RPIC, navigator, and VO(s). 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 Construction Student Workbook.	45 minutes

ACTIVITY SCENARIO

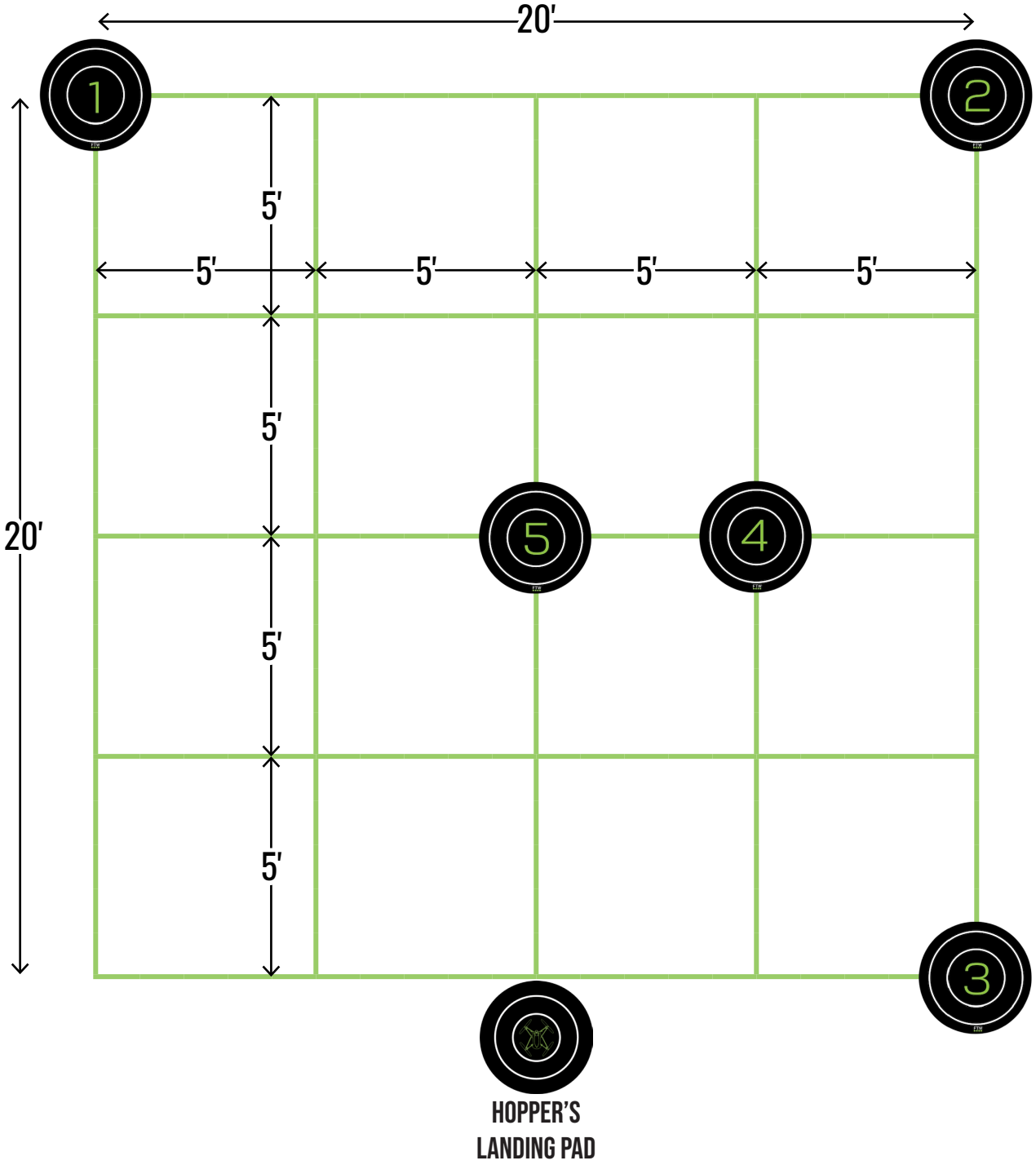
A city that deals with significant flooding is planning on building more flood mitigation infrastructure in a 20 mi × 20 mi square of the city. This part of town is hard to access by foot but the engineers planning this project need data from land surveying in the area to make their designs.

An RPIC and navigator will work together to collect data through Hopper's camera in this piece of land. Then, you will record where each identified manhole is on a scaled diagram and calculate a specific area of the land asked by the engineers planning this project.

ACTIVITY SETUP

Tape a 20' × 20' square on the ground which represents the fly zone. Tape a 5' × 5' grid in this square. Place Hopper's landing pad facing the square, which will be north. Place landing pads 1 − 5 at the intersections of tape as indicated in the diagram below.

An example of the setup is shown below.



ACTIVITY IMPLEMENTATION

Activity Facilitation

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

1. Assign one team member to be the RPIC (remote pilot in command) and another to be the navigator. The remaining team member(s) are the VOs (visual observers).

2. Have the RPIC and navigator place Hopper on the landing pad facing toward the square (north) and have them both turn away from the fly zone. Then, have them connect their controller or FTW Fly device to Hopper through Bluetooth and Wifi in the FTW Fly App. The RPIC will focus on flying Hopper while the navigator will focus on observing the camera feed.

3. Have the VO(s) stand outside the fly zone where they can maintain visual contact with Hopper. They will ensure that Hopper does not go outside of the fly zone for safety. If Hopper goes outside of the fly zone and the RPIC is not able to quickly navigate Hopper back inside the fly zone, have the RPIC land Hopper immediately. The VO(s) can then pick up and place Hopper back into the fly zone before the RPIC takes off again.

4. As the RPIC flies Hopper, the navigator or a VO is going to mark on a scaled diagram of the fly zone each landing pad number in their Construction Student Workbook.

   The rest of the team members can get the data from them after the RPIC has landed Hopper.

5. Have students find the area of the irregular polygon formed by the manholes asked in their Construction Student Workbook.

   Students could use known area formulas for rectangles, triangles, and/or trapezoids to find the area of the irregular polygon. They could also use the 5' × 5' grid to count the number of squares, half-squares, and/or half-rectangles in the irregular polygon to find its area.

ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students by rearranging the landing pads and adding obstacles (such as towers from the activity set) to the setup so that the RPIC must avoid them.

Post-Activity Discussion Questions

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

1. Was flying Hopper while viewing the camera stream easier or harder than flying Hopper while maintaining visual contact?
2. How did the RPIC and navigator in your group communicate with each other? What words did the navigator use to communicate where the RPIC should fly Hopper?
3. How was safety ensured? If Hopper flew out of the fly zone, how did the RPIC respond?
4. Compare how you found the area of the irregular polygon to how other groups found the area. Did they do it differently? If so, how?

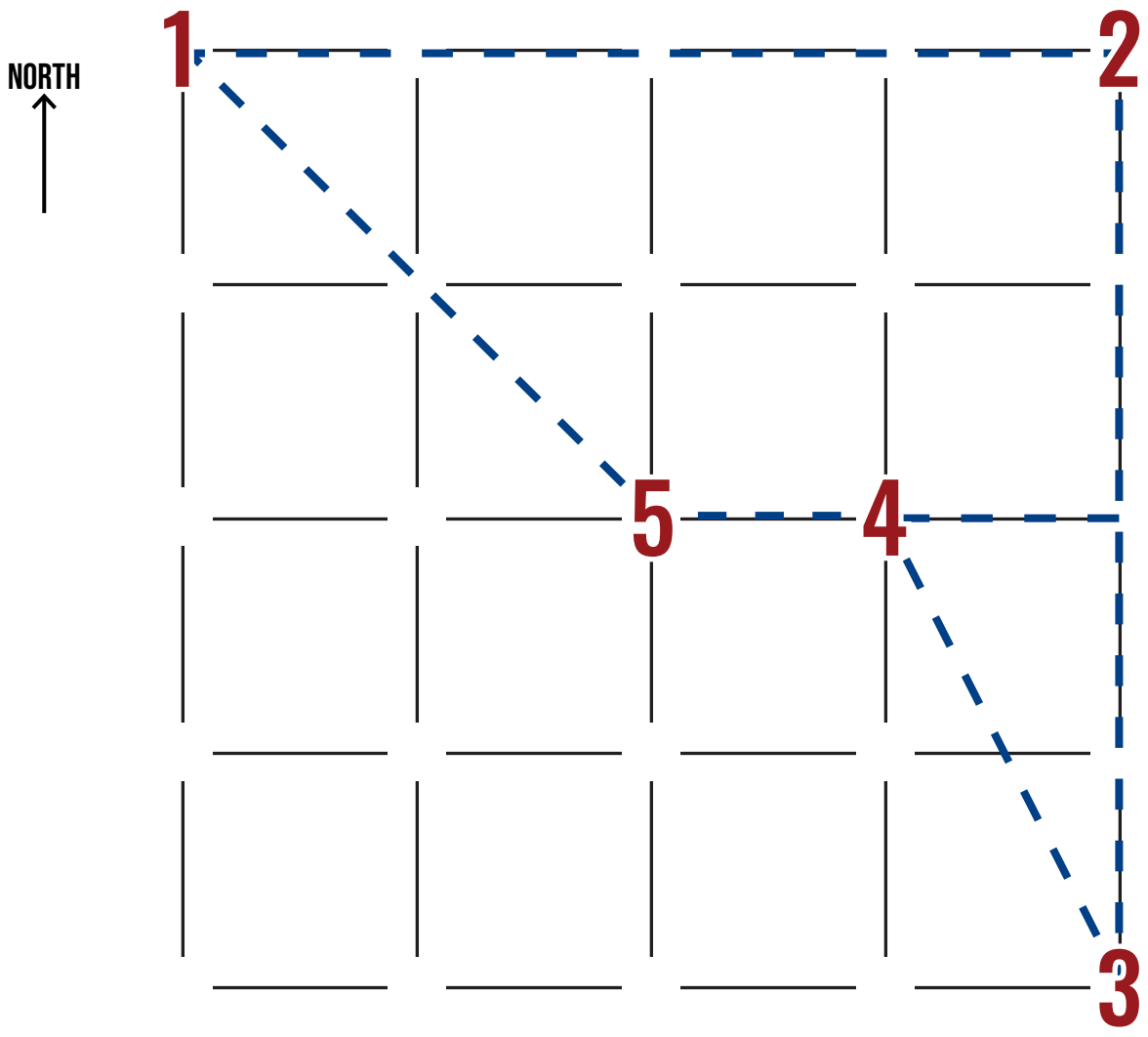
Flight Log

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
04/01/2025	Hopper	Burbank High School Gymnasium	20 minutes	My partner Bob and I flew Hopper over an area of a city prone to flooding to conduct a survey. We collected data on where manholes were located on a map. Then, we calculated the area of the irregular polygon formed by the manholes.

STUDENT PAGE

1. Write the number of each manhole identified through Hopper's camera on the scaled diagram below. Each square below represents 5 square miles. (1 foot = 1 mile)



2. Draw an irregular polygon in your diagram above connecting all the manholes in numerical order. The engineers designing the flooding infrastructure need the area of land formed by this irregular polygon to determine how many materials to order.

   Deconstruct the irregular polygon into more familiar shapes such as rectangles, triangles, or trapezoids. Then, find the area of the irregular polygon.

175 square miles

$$\frac{base_1 + base_2}{2} \times height = \frac{10 + 20}{2} \times 10 = 150$$

$$\frac{1}{2} \times base \times height = \frac{1}{2} \times 5 \times 10 = 25$$