Lesson 5: Making Custom Wings

In this lesson, students will be able to get creative and design their own drone wings. One of the coolest features of the Circuit scribe drone is the ability to make custom wings out of cardboard. Students will be introduced to engineering drawings and will create an engineering drawing for the wings they design.

Key Concepts:

- Resistance
- Technical Drawings
- How to use a Multimeter
- Art and Design

Objectives:

- Cadets will create custom cardboard wings for their drone and make an engineering, or technical, drawing of them.
- Cadets will measure the resistance of their wings and calculate the current supplied to the motors.

Instructor Background:

Engineering Drawings

An engineering drawing is a type of technical drawing used to define the requirements for engineering products or components. It's similar to a blueprint for architects. In general, an engineering drawing has an outline of the product or part, dimensions, dimension lines and arrows. An engineering drawing, also called a technical drawing, helps facilitate communication between engineers and manufacturers as the drawing clearly shows all parts and dimensions.

Activity 1: Making Cardboard Wings

Materials:

- Cardboard
- X-acto knife (optional)
- Scissors
- Pen/pencil
- Ruler
- Paper
- Silver ink pen

Time: 20-30 minutes

Description: In this activity, each cadet will have the opportunity to design and construct a set of custom drone wings.

Plan Ahead: Although there is a cardboard sheet for every drone kit, you should collect extra cardboard to use for making wings. Any corrugated cardboard will work as wings, as long as it is not bent.

Safety: An x-acto knife is great for cutting out cardboard, but can also be dangerous. Decide whether you feel that your students can safely use an x-acto knife in the classroom or not. If you decide your cadets can safely use xacto knives, establish safety rules like only walk with a x-acto that has a lid on, cut away from yourself, and don't play with the knives.

Step-by-step:

1. Describe the activity and introduce technical drawings.
2. Have cadets sketch out their wings on the cardboard. They should make sure to include a small cut out on the top of one wing and on the bottom of the other wing. These small cutouts will interlock the wing. Students can look at the cardboard fill-in wings for an example.
3. In the cadets' portfolio, have each cadet create a technical drawing for their wings. They should use a ruler to find the dimensions of their wings including the height of the tallest part of the wing, the height at the shortest part of the wing, the width of the wings and any other important parts.
4. After finishing their technical drawing, instruct cadets to carefully use a x-acto knife or scissors to cut out each wing.
5. Cadets can now use the Circuit Scribe pen to fill in the wing where the traces should go. Each trace should be about ¼ inch wide. Remind cadets to fill in the traces on both sides of both wings.

Activity 2: Measuring Resistance and Calculating Current to Motors

Materials:

- Cardboard wings
- Multimeter
- Toaster oven
- Oven mitts
- Timer

Time: 15-20 minutes

Description: In this activity, students will measure the resistance of their wings, use heat to lower the resistance if needed, and calculate the current going to each motor using Ohm's law.

Plan Ahead: Heating Circuit Scribe ink makes other components in the ink evaporate and leaves behind the silver. This can make the ink more conductive. If your classroom doesn't have access to an oven, you may consider finding a toaster oven for your class to use for the day.

Safety: Toaster ovens become hot to the touch after being turned on. Have an aid or student helper be in charge of putting the wings in and out of the oven with safety mitts on.

Step-by-step:

1. Have students measure the resistance of each of their traces with the multimeter. They should measure all of the 8 traces, left and right on the front and left and right on the back for each wing.
2. Write down the measured resistance in their portfolio. If a trace has a resistance higher than 2 ohms, tell students to look for any blank or thin spots of ink and fill them in again.
3. If the resistance is still higher than 2 ohms, the wings can be heated up to decrease resistance. Have the cadet put on oven mitts and place their wings in the oven. Wings should be put in an oven on its lowest setting for 10-15 minutes.
4. Now pass out the Lesson 5 worksheet, a multimeter and a drone kit to each group, and have students calculate the current going to each of the motors.

Discussion Questions:

- Which do you think will fly better, the PCB wings or the wings you made?
- What strategy did you use to design your wings?