Unmanned Aircraft Components

Session Time: One, 50-minute session

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

The intended purpose and use of an aircraft drives aircraft design considerations and construction techniques, materials, and components. (EU1)

Innovations in aviation are driven by the desire to make aircraft safer, more capable, and more efficient. (EU3)

A deep understanding of how an aircraft operates enables a pilot to fly the aircraft to its maximum capabilities in both normal and abnormal situations. (EU5)

ESSENTIAL QUESTIONS

Are unmanned aircraft essentially the same as manned aircraft?

LEARNING GOALS

Students Will Know

- Location and function of primary structural components of unmanned aircraft.
- Role of various components in sustaining and controlling flight.
- How multirotor UAS are stabilized and controlled using a single flight system and no moving control surfaces

Students Will Be Able To

- *Identify* and *recognize* the location and function of components that make UAS flight possible. (DOK-1)
- *Explain and analyze* the effects of UAS flight control and stabilization systems. (DOK-L2, L4)

ASSESSMENT EVIDENCE

Warm-up
Students predict what kinds of components are required for UAS flight. They will sketch a UAS and label as many components as they can.

Formative Assessment
Students are asked to conduct research in order to determine how it is possible to control the flight of multirotor drones and how computer software aids the process.

Summative Assessment
Have students write a paragraph describing how the flight control system of a rotor drone works with the propellers to provide control in flight.

LESSON PREPARATION

MATERIALS/RESOURCES

- Unmanned Aircraft Components Presentation
- Unmanned Aircraft Components Student Activity
- Unmanned Aircraft Components Teacher Notes

Drone Flying Activity (one per class)

- Drone options for the classroom
    - Tello Quadcopter Drone- $99 (Amazon)
    - SYMA X5C 2.4G 6 Axis Gyro HD Camera RC Quadcopter with 2.0MP Camera- $36 (Amazon)
    - DROCON Drone For Beginners X708W Wi-Fi FPV Training Quadcopter With HD Camera - $80 (Amazon)

LESSON SUMMARY

Lesson 1: Manned Aircraft Components
Lesson 2: Unmanned Aircraft Components

The lesson begins by having students predict the kind of components found on UAS that are necessary for flight. Students are then asked to make a sketch of a UAS and label the parts. They will be shown photographs of different UAS types and watch a video in which the benefits and limitations of each type are made known.

To introduce students to major components found on a rotor drone, they will participate in a class discussion and watch a video in which these components are briefly described by a drone enthusiast. Students are asked to conduct research in order to determine how it is possible to control the flight of multirotor drones and how computer software aids the process. This will draw their attention to the importance of autopilot and auto-stabilization systems.

If time allows and a drone is available, students can take turns flying it. The students should note the parts of the drone and observe the propellers rotating in different directions. If the drone is equipped with auto-stabilization, have the students fly in this mode first. Switch the stabilization off and note that it is more difficult to control the drone effectively.

Finally, students will write a paragraph describing how the flight control system of a rotor drone works with the propellers to provide control in flight.

BACKGROUND

Students should have some familiarity with UAS given the coverage of the topic in the ninth grade curriculum. This lesson will introduce students to the basic components of UAS and the role of these components in controlling and sustaining flight. Students should be able to differentiate among various types of UAS and compare them to other types of aircraft.

Internal components are especially important in this lesson given the tremendous role that they play in making the control of flight possible. Control and base station functionality will be covered in more detail in Unit 5.

For teachers who are not familiar with some of the concepts covered in this lesson, there are a number of online resources produced by UAS enthusiasts which tend to explain these issues in fairly concrete and accessible language.

DIFFERENTIATION

To promote reflective thinking and guided inquiry in the **ENGAGE** section of the lesson plan, circulate around the classroom and assist students who might have trouble coming up with ideas for the warm-up. Ask questions that provoke their own ideas for possible answers.

LEARNING PLAN

ENGAGE

Teacher Material: Unmanned Aircraft Components Presentation

Slides 1-3: Introduce the topic and learning objectives of the lesson.

Slide 4: Conduct the **Warm-up.**

Warm-Up

Students should consider what they have learned about common structures in various aircraft that are important to flight. Then, ask students to predict what kinds of components would be required for UAS flight. Have them sketch a UAS and label as many components as they can. If time allows, have students share their sketches. [DOK 1; label, DOK 2; predict]

Possible components might include:

Motors, wings (fixed or rotary), landing gear, antenna/receiver, propellers, GPS, camera/sensors, ground proximity sensors, controller, "pilot", etc.

Teaching Tips

You may want to make a list of the components identified by students on the whiteboard and later compare them to the items covered in the presentation. Students will be able to assess how well they predicted the major components of a UAS.

EXPLORE

Teacher Material: Unmanned Aircraft Components Presentation

Slides 5-7: Discuss the features of several different kinds of drones: multirotor, single rotor and fixed wing.

Slide 5: Multirotor drones have more than two rotor systems. There are a variety of configurations: tri-copter (3 rotors), quad-copter (4), hex-copter (6), octo-copter (8) and so on. While there are many low cost units that are easy to operate for short range aerial photography missions, multirotors use a lot of power (batteries) and cannot sustain long flights for missions like aerial surveys of large areas or pipeline patrol.

Most multirotors can only fly for about 20-30 min and use electric motors powered by batteries because gas powered engines do not have the precise throttle response required to control a multirotor aircraft. Future improvements in power sources may lengthen the flight time and capabilities of multirotors.

Slide 6: Single rotor drones are similar in appearance to traditional helicopters. They are capable of greater speeds and are more efficient than multirotors, but are less stable. Single rotor drones also require a tail rotor.

Slide 7: A fixed wing drone is most similar to traditional fixed wing aircraft because of its flight controls (including ailerons, elevators and rudders.) Fixed wing drones are able to fly long distances and cover wider areas than rotor drones. They are able to use gasoline powered engines which allows them to stay in the air for hours - some can stay in the air for more than one day at a time. The main disadvantage of a fixed wing drone is their inability to hover. Launching a fixed wing drone requires a runway or a catapult. Fixed wing drones are commonly used for military applications like reconnaissance and weapons delivery.

Slide 8: Show students a video that describes the different types of drones and their individual advantages and disadvantages. Stop the video at 4:30.

- "Differences Between Drone Types and Their Features-BAA Training" (Length: 6:13, stop at 4:30) http://video.link/w/4APd

EXPLAIN

Teacher Material: Unmanned Aircraft Components Presentation

Slide 9: Discuss the main components of a typical multirotor drone.

- Propeller - Propellers provide lift. Most drone propellers are made out of plastic or carbon fiber.
- Motor - The motor drives the propeller, which provides lift.
- Landing Gear - Drones require high ground clearance and can have fixed or retractable landing gear.
- Main Drone Body -The drone body houses the battery, circuit boards, avionics, camera, and sensors.
- Antenna - Antennas facilitate communications with ground units to transmit video and sensor signals and receive control signals.
- Gimbal with Camera -The drone gimbal is a pivoting mount that provides stabilization for the camera and sensors.

Teaching Tips

If you have a drone in the classroom, show it to students during this discussion so they can see the actual parts and components on a real device.

Slide 10: Show a video that explains the major components of a typical rotor drone.

- "Parts of a Drone" (Length 1:29)

  http://video.link/w/7oPd

EXTEND

Teacher Materials: Unmanned Aircraft Components Presentation, Unmanned Aircraft Components Teacher Notes

Student Material: Unmanned Aircraft Components Student Activity

Slide 11: Conduct the **Formative Assessment.** Provide each student with a copy of **Unmanned Aircraft Components Student Activity.**

Formative Assessment

In groups of two or three, students will read how multirotor drones fly and maneuver. Have them answer the questions on **Unmanned Aircraft Components Student Activity.** There are suggested online articles to assist in their research.

They will be describing the basic aerodynamics of how multirotor drones create lift, climb, descend, move horizontally, and rotate (yaw). They will also describe how computer software is used to make operating multirotor systems much easier and more accessible. Once they are finished, have students share their answers in a class discussion where the teacher can clarify any areas of misunderstanding or confusion. This activity should demonstrate their understanding of multirotor aerodynamics and stabilization systems. [DOK 3; cite evidence; draw conclusions]

Answers are included in **Unmanned Aircraft Components Teacher Notes.**

Slide 12: In groups of three to four, have students take turns flying a drone. Before flying, reference the "Know Before You Fly" website for safety information. Take proper precautions as to flying venue, location of obstacles, and positioning of students and observers.

The students should note the parts of the drone such as the propellers, motors, and body. Referencing the controller, students should be briefed on how the controls affect the drone's direction of flight. Have the students move the controls slightly so as not to take flight, but enough to see which propellers spin with different control deflections. Students should observe the propellers rotating in different directions. Have the students take flight to maneuver the drone off the ground, move it up and down, forwards and backwards, left and right.

If the drone is equipped with auto-stabilization, have the students fly in this mode first. Switch the stabilization off and note that it is more difficult to control the drone effectively. If time allows and students are proficient enough, attempt landing on a precise spot or navigate a simple course, such as a rectangle.

EVALUATE

Teacher Material: Unmanned Aircraft Components Presentation

Slide 13: Conduct the **Summative Assessment.**

Summative Assessment

Have students write a paragraph describing how the flight control system of a rotor drone works with the propellers to provide control in flight. [DOK 3; assess; revise]

A good answer would indicate the hand controller sends signals to the flight control system on the drone. Processors in the flight control system combine signals from the controller with information from the gyro stabilization unit to tell the motors how fast to turn the propellers.

Summative Assessment Scoring Rubric

Follows assignment instructions
Writing shows evidence of the following:

- An understanding a drone flight control and stabilization systems
- An assessment of how the flight control system works with the propellers

Student work shows overall understanding of the concepts covered in the lesson

Points	Performance Levels
9-10	Consistently demonstrates criteria
7-8	Usually demonstrates criteria
5-6	Sometimes demonstrates criteria
0-4	Rarely to never demonstrates criteria

GOING FURTHER

Ask students if any of them are involved in drone building/racing, and have them share their experiences.

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Connections to Engineering, Technology, and Applications of Science
        - Influence of Science, Engineering, and Technology on Society and the Natural World: New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology (HS-ETS1-1, HS-ETS1-3)

COMMON CORE STATE STANDARDS

- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

https://www.auav.com.au/articles/drone-types/

http://flight-evolved.com/buyers-guide/how-drones-work/
http://flight-evolved.com/buyers-guide/how-drones-work/

https://www.rchelicopterfun.com/quadrocopter.html

https://www.wired.com/2017/05/the-physics-of-drones/

http://knowbeforeyoufly.org/