TATA CONSULTANCY SERVICES | Discovery EDUCATION

# IGNITE MY FUTURE

THINK SOLVE CREATE CONNECT

LESSON TITLE

# Drone Delivery

*Guiding Question: What will our future look like?*

**SUBJECTS**

Math
Engineering

**COMPUTATIONAL THINKING PRACTICE**

Recognizing and Defining Computational Problems

**COMPUTATIONAL THINKING STRATEGY**

Build Models
Algorithms

**MATERIALS**

Graph paper

Rulers

Pencils

Whiteboard

Drone Comparison student capture sheet

Drone Delivery Challenge prompt

Drone Delivery rubric

Computers with Internet access

## Ignite Curiosity

- If you're good at playing video games, could that lead to a career as a pilot of unmanned air vehicles (UAVs)?
- Could drones help us bring supplies to people in developing countries?
- How can cameras on drones help us to see things differently?

In this lesson, students will utilize the computational thinking strategy of building models to sketch a drone that can deliver pizzas in a busy city. In **THINK**, students act as robotics engineers challenged by the task of efficiently delivering pizzas in a densely populated city. They will research current drone models and learn about different applications for unmanned flight devices. In **SOLVE**, students will learn that humans provide directions to computers through the processes of machine learning, computer vision, and deep learning algorithms. They will "program" their drone to perform a task that would be beneficial to the purpose of delivering pizzas. In **CREATE**, students collaborate in teams to create a technical sketch of the final drone. In **CONNECT**, students explore how drones have become integrated into society and identify how unmanned air vehicle (UAV) technology connects to careers and to problems of tomorrow.

Students will be able to:

- Collect and **analyze** drone data to design improved components,
- **Create** technical sketches of drones that can use algorithms to perform autonomously, and
- **Evaluate** sketch models of drones and provide feedback.

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**Students act as robotics engineers challenged by the task of efficiently delivering pizzas in a densely populated city. They research current drone models and learn about different applications for unmanned air vehicles (UAVs).**

1. **Read** the following scenario to students:
*In a large and busy city, only one pizza place delivers to the most densely populated section. Pizza orders are rolling in very quickly, but there isn't time to drive each delivery due to the congested traffic. Cold pizzas are being delivered, and money is being wasted on gas. As a robotics design team, it is your job to research drones, create a technical sketch that modifies a drone that's currently on the market to suit the purpose of delivering pizzas, and demonstrate the path the drone will take through the city by creating a map algorithm.*

2. **Divide** students into groups.

3. **Distribute** the Drone Comparison student capture sheet and the Drone Delivery Challenge prompt. Students will collect and analyze data about five drones on this list of UAV devices and select one to modify in order to deliver pizza. Explain the categories on the handout:
   - Name should include the full title and model number if possible.
   - Dimensions should be in inches and include Length (L), Width (W), and Height (H). Weight should be in ounces.
   - Flight range is how far the drone can travel before losing the controller signal.
   - Note: The project scenario requires flight range to be 800 meters (3–4 city blocks).
   - Battery life is how long the drone can stay in flight. This might also be expressed as flight time.
   - Charge time is how long it takes one battery to charge to full capacity.
   - Payload capacity is how much additional weight (not including own weight) the drone can hold in flight.
   - Camera presence, quality, size, and weight should be described.
   - Price of all drones should be given in the same currency.
   - Allow students to create their own categories at the bottom of the handout.

4. **Instruct** students to formulate a rating scale for each drone specification. Students will ascribe more points to characteristics that are more important for the task of pizza delivery and fewer points to less important characteristics. For example, the specification of battery life might be the most important to students when considering how long a pizza delivery might take. In this case, students would give the greatest weight of importance to the specification of battery life.

5. **Ask** students to summarize the real-world problem they have been asked to solve (modifying a drone in order to deliver pizzas in a densely populated area). Engage students with the following critical thinking questions:
   - What tasks do humans do now that drones might be able to do in the future?
   - What are the advantages and disadvantages to using unmanned air vehicles (UAVs)?
   - How could drones help us solve humanitarian crises?

## Students will uncover that computers need humans to provide them with directions in the form of algorithms. They will "program" their drone to perform a task that would be beneficial to the purpose of delivering pizzas.

1 **Show** students this video of University of Southern California scientists Flying Drones in Synchronized Flocks. While the video plays, ask students to identify the following three concepts in the work the scientists are doing:

- **Computer vision** – providing computer input based on visual information
- **Machine learning** – algorithms that build knowledge based on previously input data
- **Deep learning algorithm** – a set of computational rules and procedures that work like a neural network similar to the human brain that enable a computer to learn new information more quickly and easily.

2 **Lead** students in a discussion about how computers make decisions. Explain that humans need to input criteria and constraints into computer programming to provide a reference point for a computer to make a decision. Explain that robots and drones are able to carry out actions based solely on the input that humans provide in the form of computer programming. If drones have a set of rules and commands to carry out those rules, they will be able to fly from point A to B. We call that set of rules and commands an algorithm. Explain that computer vision and machine learning are ways for drones to complete tasks without humans controlling them. Drones get better at performing tasks over time by taking into account problems they have confronted and constructing new responses to solve the problems more efficiently in the future.

3 **Ask** students to think about what input they would provide to a computer when considering the requirements from the previous activity (obstacles, power, carrying, autonomy, navigation). Instruct students to write a list of 5 to 10 rules to help a drone carry out one task such as flying around obstacles, picking up objects, or reacting when the battery is low.

## Students collaborate in teams to create a technical sketch of a modified drone.

**Teacher note:** Consider using steps 1 and 2 to prepare students for the sketching process using a simpler format. For example, students can practice focusing on attention to detail by sketching words in a selected font in 1-inch letters. Allow students to practice using the grid lines on the graph paper as reference points.

1. **Ensure** that students are in their original research groups.

2. **Instruct** students to brainstorm three modifications to a drone they have researched. The goal of the modifications will be to increase the drone's efficiency at delivering pizza from a restaurant to a home. When creating the list of components to modify the drone, students must consider the following:
   - Obstacles along the route
   - Power supply
   - Ability to carry objects of different sizes
   - Autonomous capabilities
   - Navigation instructions

3. **Introduce** students to the term "technical sketch" and explain that engineers use technical sketches to portray dimensions, scale, and components of designs. Lead students through the following definitions:
   - **Technical Sketch** — a sketch drawn to scale that communicates dimensions and labels components of a design. A technical sketch will usually include two or three views that may include front, side, top, bottom, or back.
   - **Dimension** — the length (L), width (W), and height (H) of an object expressed as L × W × H.
   - **Scale** — a measurement used to communicate difference in size of a technical sketch. For example, 2:1 is a technical sketch twice the size of the actual object, 1:1 is a technical sketch the actual size of the actual object, and 1:2 is a technical sketch half the size of the actual object.

4. **Distribute** graph paper and rulers, and instruct students to draw a simple object to three different scales, 1:1, 2:1, and 1:2. Help students choose an object that is about 2 to 4 inches on the longest dimension. For example, students might choose an eraser, cell phone, pencil sharpener, pen cap, crayon box, glue, or other class materials.

5. **Have** students re-read the Drone Delivery Challenge prompt, instructing them to review the criteria and constraints of the Drone Comparison student capture sheet. *Note: students may work individually.*

6. **Require** that students include the following in their technical sketches:
   - Detailed and aligned sketches of all parts and components of the drone
   - Measurements of length, width, and height as applicable for all components
   - Captions that describe functions of modified components
   - Top view, side view, and front view (or other applicable views) of the drone and components
   **Check in:** As students create sketches, float or use small-group instruction to clarify instruction, guide students, and provide feedback.

7. **Provide** an opportunity for students to peer-evaluate technical sketches using the Drone Delivery rubric. Prompt students to determine as a class several examples of work that would be rated "Extensive." After the peer review process, provide time for students to refine their technical sketch after comparing their work with "Extensive" category work.

## Students explore how drones have become integrated into society and the processes and regulations that have changed as a result and identify how drone technology connects to careers and to problems of tomorrow.

**Select one of the strategies listed below to help students answer these questions:**

- **How do this problem and solution connect to me?**
- **How do this problem and solution connect to real-world careers?**
- **How do this problem and solution connect to our world?**

1. **Write** the three questions on PowerPoint or flip chart slides and invite students to share out responses.
2. **Display** pieces of chart paper around the room, each with one question written on it. Ask students to write down their ideas related to the questions on each sheet.
3. **Assign** one of the questions to three different student groups to brainstorm or research, and then share out responses.
4. **Invite** students to write down responses to each question on a sticky note, and collect them to create an affinity diagram of ideas.

### How does this connect to students?

Students likely use remote-like devices such as directional controls and action buttons when using their cell phone or when playing games on a console or in an arcade.

Students have the capacity to build drones in the same way robots are built. They can buy kits and put them together or even 3D print all the parts from scratch to build the drone.

Just like robotics teams in middle and high schools, students will soon be able to compete in competitions using drones to fly around obstacle courses and perform challenging tasks for points.

### How does this connect to careers?

**Aircraft Mechanical Technicians** perform maintenance and inspections on aircraft that have similar parts to drones. They work in air hangars or airfields in repair stations. They study and adhere to the rules and regulations of the Federal Aviation Administration (FAA).

**Aerospace Engineers** design, build, and test unmanned air vehicles (UAVs) that use the same principles of flight as drones. They will build and test prototypes to find problems and develop solutions related to aircraft. Aerospace engineers work in offices, labs, and sometimes in the field.

**Surveying and Mapping Technicians** conduct land surveys and collect data that can be analyzed for planning airfields for drones. Drones can also be used to survey the land and collect data for surveying and mapping technicians.

**Photographers** are using drones to capture images from perspectives that have never been seen before, such as aerial photographs larger aircraft are unable to take. For example, drones can take close-proximity photos and video of fireworks. They can also fly close to tall buildings to capture photos and video of problems that need to be fixed.

### How does this connect to our world?

Drones are beginning to take over transportation tasks such as delivery of goods. The military has also used drones for tactical operations.

Business applications that incorporate drones include farming irrigation, 3D rendering for building construction, surveying for engineering design, monitoring environmental conditions, and media coverage via aerial shots.

Find more easy-to-implement resources to integrate computational thinking practices into your classroom by visiting **ignitemyfutureinschool.org**

# National Standards

## NEXT GENERATION SCIENCE STANDARDS

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Engaging in Argument from Evidence**<br>▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) | **ETS1.B: Developing Possible Solutions**<br>▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) | **Influence of Science, Engineering, and Technology on Society and the Natural World**<br>▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1) |

## COMMON CORE STATE STANDARDS CONNECTIONS

**Mathematics**

- **MP.2** Reason abstractly and quantitatively.
- **CCSS.MATH.CONTENT.6.RP.A.1**
  Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

## K-12 COMPUTER SCIENCE FRAMEWORK

**Practice 3. Recognizing and Defining Computational Problems**

The ability to recognize appropriate and worthwhile opportunities to apply computation is a skill that develops over time and is central to computing. Solving a problem with a computational approach requires defining the problem, breaking it down into parts, and evaluating each part to determine whether a computational solution is appropriate.

# Drone Comparison

| | Drone #1 | Drone #2 | Drone #3 | Drone #4 | Drone #5 |
|---|---|---|---|---|---|
| Name | | | | | |
| Dimensions: L × W × H (inches) | | | | | |
| Weight (ounces) | | | | | |
| Flight Range | | | | | |
| Battery Life | | | | | |
| Charge Time | | | | | |
| Payload Capacity | | | | | |
| Camera | | | | | |
| Price | | | | | |
| Other | | | | | |

# Drone Delivery Challenge

In a large and busy city, only one pizza place delivers to the most densely populated section. Pizza orders are rolling in very quickly, but there isn't time to drive each delivery due to the congested traffic. Cold pizzas are being delivered, and money is being wasted on gas. As a robotics design team, it is your job to research and analyze drone models, brainstorm and implement a modified drone design for pizza delivery, and create sketches that demonstrate the new drone's capabilities.

## Criteria/Constraints:

Drone must be able to carry two specified sizes of pizza boxes and be capable of carrying other sizes in the future. The pizza box sizes are:

- 10 ⅛″ × 10 ⅛″ × 1 ¾″ (L × W × H)
- 14 ⅛″ × 14 ⅛″ × 1 ¾″ (L × W × H)

Flight time (battery life) of the drone must realistically match a pizza delivery time. If the battery life is shorter than 10 to 15 minutes, consider alternate designs or options to compensate.

The pizza must be delivered safely. The drone must avoid obstacles, handle the box carefully, and move gracefully.

## Directions:

- Select a drone from the current market. Price and performance will be a factor in assessment.
- Create a technical sketch of the drone.
- Include additional sketches of modified components that allow the drone to deliver pizza according to the criteria and constraints listed above.
- Use the Drone Delivery Rubric to guide drone selection and modification.

## Drone Delivery Rubric

| Category | Inadequate | Adequate | Extensive |
|---|---|---|---|
| Price | The drone is too expensive when compared with performance capabilities. | Price is moderate, and the drone still meets all other criteria and constraints. | Price is very reasonable, and the drone still meets all other criteria and constraints. |
| Carries both pizza box sizes:<br>10 ⅛″ × 10 ⅛″ × 1 ¾″<br>14 ⅛″ × 14 ⅛″ × 1 ¾″ | Is not able to hold both size boxes. | Is able to hold each size of box. | Is able to hold each size of box and easily switches between box sizes. |
| Adaptable to carry cargo of additional sizes | Is not able to hold objects of additional sizes. | Is able to hold other sizes in addition to both pizza boxes. | Easily adapts to fit objects of many sizes and even different shapes. |
| Delivers pizza on one charge or is adapted accordingly | Is unable to deliver pizza before battery dies. | Delivers pizza without a need to charge. | Delivers pizza without a need to charge. Adapted to switch power sources. |
| Safely picks up, transports, and releases pizza | Pizza is deformed. | Pizza is delivered in edible condition. | Pizza is delivered fresh, hot, and in perfect condition. |