NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

A BIRD'S EYE VIEW / REMOTE SENSING—Part 1

Students will learn what remote sensing is and how it was developed, from the early years of 'pigeon photography' to the latest in satellite imagery. They will also develop an awareness of how things are interpreted within the realm of aerial photography!

*Please note: Some of the ideas contained within this lesson plan were derived from information obtained from an animated NASA lesson plan entitled "The Adventures of Amelia the Pigeon" (*https://science.nasa.gov/adventures-amelia-pigeon).

LESSON PLAN – PART 1

Learning Objectives

The students will

- Learn about the development of remote sensing with respect to the five senses, focusing on sight
- Learn how to change their thought processes about how objects look from far above
- Learn how to sketch familiar objects—not how they look from the typical 'side/personal view,' but from a perspective which is high above the object in question
- Understand how and why we changed our mindset from the normal vision of the world (eye level) to that of an aircraft flying in the sky
- Develop an understanding of how to interpret photographs taken from birds, kites, rockets, hot air balloons, aircraft, satellites and spacecraft—and how to interpret textures, colors, geometric shapes, shading and shadows

Introduction/Background

Remote sensing was initially introduced in the late 1950s, and prior to that aerial photography was used and more apropos. Simply stated, remote sensing is the science and acquisition of information about a particular object (identifying, measuring or observing) without making direct, physical contact with that object. Although several of our five senses may be amplified and/or reconfigured to be used in a remote sensing role, for the purposes of this lesson plan, the focus will be on the sense of sight. The history of remote sensing (from the "bird's eye view" perspective) began with the invention of photography. The very first aerial photo was taken in 1858 from a hot air balloon that was floating about 1,200 feet above Paris. During the Civil War, observations were done from balloons for military purposes, and it is also possible that photographs were taken as well. In 1903, the Bavarian Pigeon Corps used pigeons to take aerial photos over Europe. The cameras which were strapped to them were activated by timing mechanisms. Cameras were affixed to kites to photograph the San Francisco earthquake of 1906. During World War I, aerial photography was accomplished from airplanes, as it was during World War II (although, more sophisticated techniques existed).

Grade Level: 2—4

Ohio Learning Standards/Science (2018)

Expectations for Learning

Nature of Science

Earth and Space Science

4.ESS.1: Earth's surface has specific characteristics and landforms that can be identified.

Ohio Learning Standards/Fine Arts (2012)

Fine Arts: Grade 3:

3PR: Find and solve problems of personal relevance and interest when developing art making ideas

4PR: Create artworks that demonstrate awareness of two- and three-dimensional space.

Ohio Learning Standards/Social Studies (2019)

Grades 2 through 4:

History: Historical Thinking and Skills

Geography: Spatial Thinking and Skills

Ohio Learning Standards/Mathematics (2017)

Geometry:

2.G: Reason with shapes and their attributes

3.G: Reason with shapes and their attributes

Materials Required:

- Board and markers
- Laptop, monitor, digital projector
- Paper and pencils for each student
- Helium-filled balloon tied to long string
- Two-liter bottle with lid

And the first photographs of Earth from space were made by a camera riding aboard an American-launched V-2 rocket in 1946. After World War II ended, a climate of distrust and political unrest existed between the Soviet Union and the United States—the Cold War. The very first overflight of the Soviet Union by a U-2 spy plane was in 1956, and this aircraft did an adequate job taking secret, aerial reconnaissance photos for the Central Intelligence Agency (CIA) for several years. However, on May 1, 1960, Francis Gary Powers was shot down by surface-to-air (SAM) missiles while flying over the Soviet Union, and our secret reconnaissance missions were exposed. President Eisenhower was forced to admit to our aerial spying.

CORONA Program satellites, first launched in 1960, contained the first American high-resolution space reconnaissance system (the American public didn't know of the program's existence until 1995 when it was finally declassified – it was known to the public at the time as the Discoverer XIV research program). The first satellites in this program took photographs of wide swaths of land to identify items such as airfields and missile sites of foreign military and nuclear powers. But we still needed an aircraft to replace the U-2 that would help us see if the Soviet Union, as well as other countries, was developing the types of weapons that could be used against us. It would have to be a long-range, supersonic, photo-reconnaissance aircraft. It would have to be able to fly faster than Mach 3 (more than three times the speed of sound) for hours at a time. It would have to reach an altitude in excess of 85,000 feet (over 16 statute miles). It would have to be able to photograph up to 100,000 square miles of the Earth's surface per hour. Such an aircraft could fly high enough and fast enough to avoid SAM missiles, and it could also fly higher and faster than any enemy fighters or interceptors.

The CIA turned to the makers of the U-2, Lockheed Martin's "Skunk Works" in Burbank, California, to design and build this aircraft. The first of these very special aircraft were designated A-12s, and they were three decades ahead of any other jet airplanes. These "Blackbirds" first flew at the secretive Area 51 in Nevada, in April of 1962. In July of 1964, President Johnson announced the SR-71 Blackbird Program to the world—and every aforementioned requirement was met or exceeded by the SR-71. In the 1960s and early 1970s, Gemini and Apollo astronauts took hundreds of photographs of the Earth, the moon and space from their spacecraft and from the moon! And between 1971 and 1986, HEXAGON KH-9 reconnaissance satellites were the largest (and last) U.S. intelligence satellites to return photographic film to earth. During the Cold War, 19 HEXAGON missions imaged 877 million square miles of the Earth's surface. In 1972, the first Earth Resources Technology Satellite (ERTS-1) was launched by the National Aeronautics and Space Administration (NASA). It was later renamed Landsat-1, and its primary objective was to obtain information on agricultural and forestry resources, land cover, land use, geology and mineral resources, hydrology and water resources, environmental pollution and marine resources! In the late 1990s, the USAF started flying the unmanned Predator vehicle which used satellite data links to gather information which could be shared instantaneously with commanders around the world. About the same time, the US first flew another unmanned aerial vehicle, the Global Hawk, with its powerful digital camera and infrared sensor that can gather imagery in any weather condition, day or night. Through satellite links and ground relay stations, that information is transmitted immediately anywhere in the world. Its "Synthetic-Aperture Radar/Moving Target Indicator" lets ground crews track even small, moving objects on the ground. In 2001, Google Earth was released – a computer program that provides a 3-D representation of our planet based primarily on satellite imagery and aerial photography!

Procedures:

NOTE: Teachers may use as much of the information contained within the "Intro/Background" section as they deem appropriate for their students; similarly, teachers may wish to pick and choose items within this section.

- Write (on board) the things that will be covered in class, including: our five senses, the historical aspects and details surrounding the development of present-day remote sensing, why remote sensing is important to the defense of our country, student drawings, demonstrations, 'clues' to help students interpret what a particular aerial image is depicting (such as geometric shapes, textures, shading, colors and shadows) and a PowerPoint presentation (as part of the interactive lesson plans). Before beginning the 'Hook' segment below, ensure that students have several sheets of drawing white paper and a pencil.

- Hook: Release a helium-filled balloon and allow it to go to the classroom ceiling (tethered with a long string). Tell the class this is a model/representation of a hot air balloon, and they should imagine that they are inside a basket beneath it. Show the students a 2-liter bottle with the cap affixed to the top but only show them the side view of the bottle. Ask them to imagine that they are floating up in the balloon, and they are looking down at the bottle (making certain that students can only see the side of the bottle). Ask the class to draw what they think the bottle might look like as they look straight down at it.

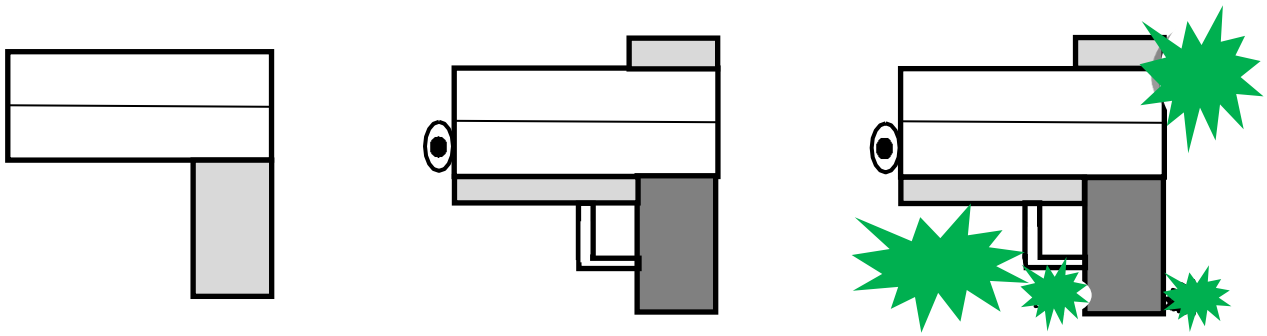
- Show the class what the overhead view of a 2-liter bottle looks like on the board: a large circle, with a much smaller circle in the center (representing the cap). You may also wish to show the students how it looks by pointing the cap end of the bottle at them.

Side view

Top view

Procedures (continued)

- Tell the students to imagine that their hot air balloon has floated outside and it is now far above their own house—or they may wish to pretend that they are inside a helicopter hovering above their home.
- Get the class started by drawing a few simple objects on the board. A large rectangle with a horizontal line bisecting it could represent the roof of the house, and another rectangle sticking out from it might show where the driveway is:
- Features may be added: Texture for landscaping:



- While students are trying to visualize and draw a bird's eye view of their home, do not show them the house with the features added (deck, front porch, sidewalk and chimney) or the drawing with trees and shrubbery. Walk around the classroom; only give assistance to those students who are having difficulty getting started. Give them ample time and tell them that they don't have to create a 'masterpiece'—a basic drawing will do quite nicely! When most of the students have finished their works of art, show them your detailed drawings with features and landscaping. Ask students how their drawings differ from yours (they may have added a mailbox on the street, a garden in the back yard, a sidewalk close to the road, etc.). Ensure that students can recognize 'clues' to help them understand overhead drawings (shapes, textures, shading, shadows and color)!
- Pass out a piece of 8.5 x 11-inch cardstock (any color) to every student and have them fold about an inch of the sheet over (along the 11-inch dimension). You may wish to demonstrate this from the front of the classroom and they may wish to use the edge of their desk or table to facilitate the folding—but it should result in an "L" shape with a 90-degree angle. Tell the class that this could be the side (person's) view of a building, such as a warehouse or an office complex. Ask the class what the 'bird's eye view' of this folded sheet of cardstock looks like, and have them draw both the 'side view' and 'bird's eye view' perspectives. Students should have drawn a long, thin rectangle for a 'side view' and a wider rectangle for the 'bird's eye view,' as depicted here:

('Side View')

('Bird's Eye View')

This concludes Part One of this lesson.

Resources:

NASA's Amelia the Pigeon website: https://science.nasa.gov/adventures-amelia-pigeon

Another lesson plan using Amelia the Pigeon:
https://www.univie.ac.at/geographie/fachdidaktik/FD/site/external_htmls/imagers.gsfc.nasa.gov/amelia/index.html
And the teacher guide:
https://www.univie.ac.at/geographie/fachdidaktik/FD/site/external_htmls/imagers.gsfc.nasa.gov/amelia/teachersguide/lessonsK_2/K-2Lesson1.html

ERTS: https://landsat.gsfc.nasa.gov/landsat-1/

Google Earth: https://www.google.com/earth/

Background resources from the National Museum of the USAF (https://www.nationalmuseum.af.mil/):

- Homing Pigeon: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/197423/USAFmuseum/
- U-2: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195974/lockheed-u-2a/
- SR-71: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198054/lockheed-sr-71a/
- Reconnaissance Satellites:
    - https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198108/discoverer-xiv/
    - https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195920/gambit-1-kh-7-reconnaissance-satellite/
    - https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195922/gambit-3-kh-8-reconnaissance-satellite/
    - https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195921/hexagon-kh-9-reconnaissance-satellite/
    - https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/589823/teal-ruby/