NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

A BIRD'S EYE VIEW / REMOTE SENSING-Part 3

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!

LESSON PLAN—Part 3

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 (not very easily done)
- 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 (there are many advantages)
- Develop an understanding of how to interpret photo- graphs 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
- Clean, empty pop can for each student
- Two sheets of 3X3 sticky notes per student
- One 18-inch piece string per student
- Four small round stickers per student

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!

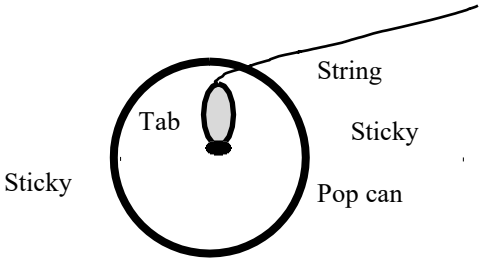
Procedures for Lesson Plan-Part 3

- Start with Slide 13 from the available slide presentation. Tell the class that in 2011, the National Reconnaissance Office declassified several top secret spy satellites, and they became exhibits at the National Museum of the United States Air Force! Show slide 13, and tell them the photo is of the largest U. S. spy satellite, the KH-9, also known as 'Big Bird!' 'Big Bird' was sixty feet long (about the length of a school bus) and had a ten-foot diameter! It took pictures as it orbited from 80 to 370 miles above the Earth, and the film itself was sixty MILES long! In orbit, it used solar arrays/solar panels to generate power from sunlight. "Big Bird' did spying for us (aerial reconnaissance) while flying over other countries. Ask the students how they think we were able to retrieve the film-return capsules (and the important film) after they parachuted close enough to the Earth. With air planes and a parachute-snagging hook system!
- Show the class slide 26 and tell them this is a satellite image of a famous large city (New York City and its environs.) Ask them what they see (answers may include rivers, a large body of water at the bottom of the photo, green and brown areas, etc.). The next slide shows a lot more detail of the same area, and the smallest of the three islands in the center of the photograph is Liberty Island, home of the Statue of Liberty! Ask students if they can see the boats moving around within New York Harbor!
- Show the students the next slide and tell them that this is a satellite image of another famous, large city (don't tell them that it is Washington, D.C. quite yet). Ask them what they see (answers may include a river, bridges, trees, buildings, etc.). Tell them to concentrate on the island in the upper left corner of the satellite photo, and then move directly to the right almost to the center of the photo—have them look for a dark, circular shape. Show the next slide and tell them that this is the same city shown much closer. They should be able to see that the circular shape is now in the upper right-hand corner of this photo (don't tell the class yet, but the circle is the White House South Lawn). There is a large building shown just above the circle and this building is right at the top edge of the image. Ask students what they think the famous building might be (the White House). Have the class analyze what they see across the bottom of the satellite photo (from left to right: the Lincoln Memorial, the Reflecting Pool, the World War II Memorial and the Washington Monument)! Skip the last slide.

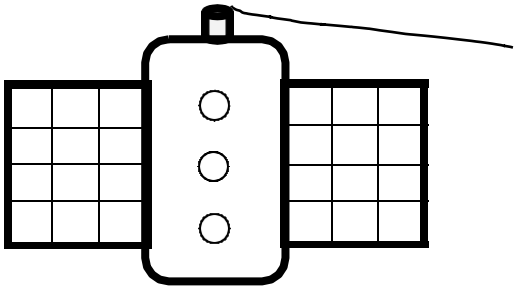
Tell the class that it is now time to build their spy satellites!

- Pass out the materials for this fun activity. Each student should have two 3" x3" sticky notes (preferably the extra sticky kind), one clean empty pop can with the tab still attached, one 18" length of string, a pencil and three or four white or multi-colored sticky back circles. Be prepared to show students each and every step with your own model in front of the classroom.
- **Step one**: have the students carefully bend the tab on their pop can up so that it is nearly perpendicular with their desk or table surface.
- **Step two**: students should tie one end of their string to the top of the tab and use three knots for security (this will allow students to hang their 'satellites' in your classroom or in their room at home).
- **Step three**: ask the students to use a pencil to draw 'tic-tac-toe' crossing lines on each side of both of their sticky notes—tell them that these represent the satellite's solar panels (which create electrical power from sunlight).
- **Step four**: students should bend the sticky notes just below the sticky part so that they form an 'L' shape.
- **Step five**: have students attach the sticky notes to their pop can so that they are on the opposite sides of the can (the shorter portion of the sticky note 'L' shape has the adhesive on it, and that is what adheres to the surface of the 'satellite'). Each sticky note should be pointing outward to replicate actual solar panels.
- **Step six**: students may wish to place their three or four white sticky back dots (which represent the cameras on their 'satellite') on one side of their pop can, or they may wish to affix them in a completely different pattern—it is totally up to them! The following illustrations show a 'satellite' from both a bird's eye view and a side view.

Birds Eye View



"Side View"



Assessment/Evaluation
The students should be evaluated on their class participation and contributions, listening skills and ability to follow verbal instructions (especially during the satellite building portion of Lesson Plan –Part 3).

Extension
Ask students (either individually or in small, designated teams) to research satellites and remote sensing (both past and present). Allow time for them to share what they have discovered at a later date.

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/