Shoebox Satellites

(adapted from Shoe Boxes to Satellites by Bonnie Briggs of Creswell High School, in *The Oregon Mathematics Teacher, Dec, 1996*)

This activity will help club members understand how satellites take discrete data measurements to create continuous images. Different satellites measure different properties; but they all create continuous images from a set of data points. This activity mimics an altimetry-type satellite that measures the height of a landscape or of the ocean surface.

There are two types of satellite sensors – active and passive. This is an active satellite – it sends out a signal and measures the distance the signal has traveled before it bounces back and is received by the satellite (usually by measuring the time). Other satellite sensors are passive – they do not send out their own signal, they just record the energy radiating off of the land, water, or surface of another planet. The satellite images from the web-based activity last year, and the other satellite activities this year, are from a passive satellite sensor. There are many satellite images that are in the public domain from NASA and NOAA that you and your club members can look at. Google maps http://maps.google.com even has aerial photography of most places. You can look up your area and see what is visible.

NOTE: This activity will take 2 club periods, one to make the landscapes, and one to do the 'satellite' measuring.

Materials:

- Boxes with lids (4 plastic boxes with holes in the lid are included)
- Newspaper torn into strips
- Papier-mâché paste
- Newspaper crumpled into balls or other objects to create an interesting landscape
- Paint Brushes
- Bamboo skewer with a centimeter scale
- Black plastic bags
- Latex gloves
- Permanent marker
- Graph paper

Procedure:

What is a topographic (topo) map?

A topo map is a way to represent a 3-D world on a 2-D piece of paper. The contour lines on a topo map represent lines of equal elevation. The closer the lines are together the steeper the elevation. These are similar to the contour lines used in weather maps. The contours just mean something different. The following mini-exercise is adapted from the *Streamkeeper's Field Guide*, pg. 20.

The SMILE Program
August Teacher's Workshop, 2005
Shoebox Satellites

Your hand is a perfect tool for understanding topographic representations. Put a latex glove the hand you don't write with (don't do this if you're allergic to latex). Have club members make a fist with their gloved hand and hold it in position with your knuckles up. Using the permanent marker (non-permanent ones won't stick to the latex and will make a big mess) draw contour lines of constant elevation on the glove – one under your middle finger knuckle, one around your index and ring finger knuckles and the lowest one encompassing your pinky knuckle. Have club members unclench their fist and lay their hand flat. The rings on your flat hand are like the contour lines on a map.

Included is a topo map of the Mary's Peak area near Corvallis, and the highest point in the Coast Range. Notice how closely spaced the contour lines are near Mary's Peak, and how widely spaced they are in other areas. You can find free topo maps of your area on the web. I found this one at http://mapserver.maptech.com.

Building the Landscapes

In teams, club members will construct landscapes in their boxes using papier-mâché and selected objects to support the landscape. The landscapes will need to dry so they should be made in one club session and then used in the next one. Once the landscapes are dry put the lids on them and groups should switch boxes. Club members should remotely sense the landscape using a stick and mark the distance between the top of the box and the landscape below. Have the club members record the heights they record on the graph paper. Have them draw contour lines on their graph to construct a 'best-guess' of what the landscape in the box looks like. Discuss how accurate they think they are, then open the lid of the box and have them check their reconstruction. What types of mistakes did they make? How different is the landscape they sensed from their graphed interpretation?

Making the landscapes:

- Line the clear plastic boxes with black plastic. This will help with clean-up (so you can reuse the boxes) and the club members won't be able to see the other landscapes later.
- Have club members design a landscape in their shoebox using the crumpled newspaper or other objects selected to make create the form of the landscape.
- Rip up the newspaper used for the papier-mâché.
- Make up the paste solution.
    - 1 : 3 flour : water
    - mix until there are no lumps
    - thin with water or thicken with flour as necessary.
- Paint the torn-up pieces of newspaper on both sides with the paste and start placing them on the landscape, smoothing out the air bubbles as they put the strips down.
- Coat the landscape entirely with one layer of papier-mâché.
- Put down a second layer of papier-mâché on the landscape.

- Leave the boxes in a well-ventilated area (with the lids off) to dry till the next club meeting. Make sure that the boxes are labeled, so club members don't get their own box back next time.

Remote sensing:

- Put the lids with pre-drilled holes onto the boxes and distribute them to the student making sure that no group gets its own box.
- Make the measuring sticks with the bamboo skewers. Mark the skewers every centimeter or half centimeter.
- Help club members set up an appropriate grid system so they can record their results on the charts given.
- Have the club members draw contour lines on their graphs to construct the landscape.
- Have club members compare the different contour maps.
- Take the lids off and let the club members compare the landscape in the box with the reconstructed landscape on the graph paper.
    - Did they miss any major features even with the finer sampling scheme?
    - How could they have made their reconstructions better?

~~~~~~

Altimeters

(from **http://inventors.about.com/library/inventors/blaltimeter.htm**)

The altimeter is an instrument which measures vertical distance with respect to a reference level, for example, the altitude of the land surface or any object such as an airplane. Louis Paul Cailletet was the French physicist who invented the altimeter and the high-pressure manometer.

Louis Paul Cailletet (1832-1913)
French physicist and inventor who in 1877-78 was the first to liquefy oxygen, hydrogen, nitrogen, and air.

Barometric Altimeter
In 1928, German inventor Paul Kollsman changed the world of aviation with the invention of the world's first accurate Barometric Altimeter also called the "Kollsman Window".

Radio Altimeter
Lloyd Espenschied invented the first radio altimeter in 1924. In 1938, the FM radio altimeter was first demonstrated in New York by Bell Labs. In the first public display of the device, radio signals were bounced off the ground, showing pilots the altitude of an aircraft.
~~~~~~