



GIS Career Awareness Learning Module # 1
Version 3.0 November 26, 2007

The Digital Earth --- Virtual Globes and Computerized Maps

- **Estimated Time: 2.5 hours**
- **Learning Goal:** This module will introduce the concept of the Digital Earth. The intended goal of all of the module's learning activities is to demonstrate to students how useful it would be to spatially represent data and imagery on virtual globes and computerized maps (computer/digital cartography). In the course of the learning activities, students will have the opportunity to learn and use engaging software such as Google Earth.
- **Platforms:** PC, Mac, or UNIX.
- **Software Tools Required:** Google Earth, Web browser with high-speed Internet Access. Installation instructions for educators and users are available in the Appendix at the end of this learning module.
- **INSTALLATION:** Educators or Lab Administrators may view step-by-step installation instructions in the Appendix of this learning module.

Note: This Web-based GIS learning module was developed with support from a National Science Foundation – Advanced Technological Education Program Research Grant (NSF-ATE DUE # 0401990): “A Scalable Skills Certification Program in Geographic Information Systems (GIS).”
(<http://geoinfo.sdsu.edu/hightech>)

**ANSWER ALL QUESTIONS ON THE SEPARATE
ANSWER SHEET**

Section 1 – Google Earth

Part I – Google Earth and its Basic User Controls

Google Earth is a friendly 3D, Internet-based Geographic Information System (GIS) application. This application was originally developed by the Keyhole Inc. located in Silicon Valley. In 2004, Keyhole Inc. was acquired by Google. Google re-packaged Keyhole's 3D Virtual globe software and release the new version, call “Google Earth” in

June, 2005. The concept of the Digital Earth was unveiled to the general public by Google Earth; many researchers or governments agencies started to utilize Google Earth for their works. The concept was originally developed for the defense industry for use in reconnaissance (observing, spying, and planning). The software enables you to virtually fly over any place in the world from your computer.

The following exercises will give you hands on experience with using these software applications as learning and research tools.

Begin by starting the Google Earth application.

Start Google Earth, you have two ways:



- Click on the Google Earth icon on your desktop.
- Use the “Start” button in Windows (Start > All Programs > Google Earth > Google Earth).

Learn about Google Earth’s basic features and controls. Please spend no more than 10 minutes completing the following steps.

[1] Toggle on some Points of Interest such as “Roads,” “Terrain,” and “Borders” by clicking on the check boxes next to them (Scroll through and expand the folders in the Layers list of the bottom-left side of Figure 1-1 below). This will enable you to view these features on the virtual globe when you are zoomed in sufficiently close.



Figure 1-1: Google Earth Primary Map Controls and Functions

Go to the “View” pull-down menu and toggle on the “Overview Map” by clicking on the option from the pop-down list. If it is already selected, leave it alone.

[2] Here is a list of some of the basic controls and their functions:



- a) The “Pan and Rotate” control  : Place your mouse cursor at or near the top right-hand corner of the map; try clicking and spinning the outer ring, the four arrows, and the mouse-like button in the center of the ring; try double clicking on the North marker on the outer ring.

NOTE: The “Streaming” indicator on the bottom of your viewing window indicates what percentage of the current scene has been downloaded.



- b) The “Zoom In and Out” control  : To get closer to the ground to see more detail but in a smaller geographic area. Try clicking and dragging the slider toward the plus/minus sign; try double-clicking on any part of the image.

NOTE: You may need to give Google Earth some time to download the “full” image.



- c)  If you have the “Buildings” and “Terrain” features toggled on in the “List of Layers,” you may be able to see 3-D terrain and buildings depending on what geographic areas you are observing.



- d) The Toggle Tools Pane control  : To hide and un-hide the set of tools on the left of the window.



- e) The “Add Placemark” control  : To mark a point of interest.



- f) The “Measure” control  : To measure distances.



- g) The “Add Overlay” controls  : To create and add your own overlay features onto Google Earth. You can draw a polygon, a line, or add a graphic image to the map which Google Earth will “drape” over the terrain.



- h) Email  : To send the current view to a user with Google Earth or an image of the current view to an email recipient.



- i) Print Screen  : To print out an image of the current view displayed on the screen or a list of search results.

- j)  : Quick link to Google map, which is a very useful website of GIS.
- k)  : A switch press between sky and earth. If you click on it, the map will change into sky.

Let's quickly try some of the steps you learned above. Spend about four minutes.

[1] Be sure that Google Earth is running.

[2] Type "San Diego" in the "Fly To" address field and then press the enter key.

[3] Now we are going to introduce an important concept in GIS called, "Map layers." **Map layers are layers of map features, data, or imagery** that can be overlaid or stacked together like layers on a cake or toppings on a burger. Now turn on the "Terrain," "Roads," and "3D Buildings" features in the "List of Layers" (Figure 1-2).

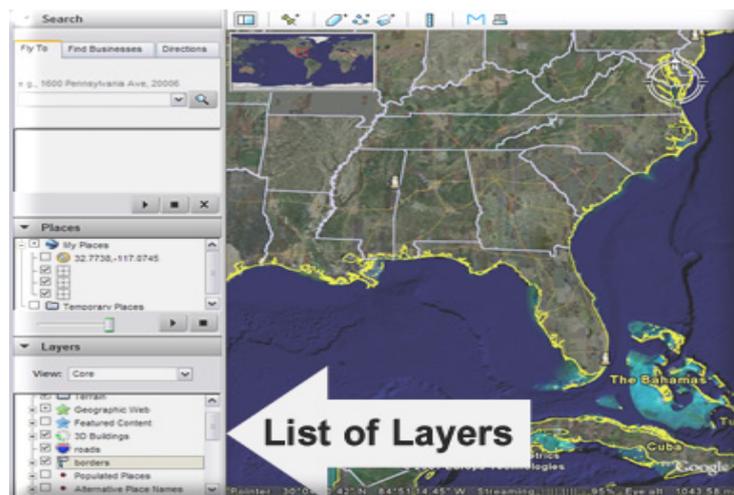


Figure 1-2: List of Layers

Try some examples of 3D View.

- a) The Grand Canyon in Arizona (dramatic terrain):
- Fly to the Grand Canyon by Entering "Grand Canyon" in the "Fly To" Address Field and press enter. (See Figure 1-3)



Figure 1-3 the Grand Canyon in Arizona

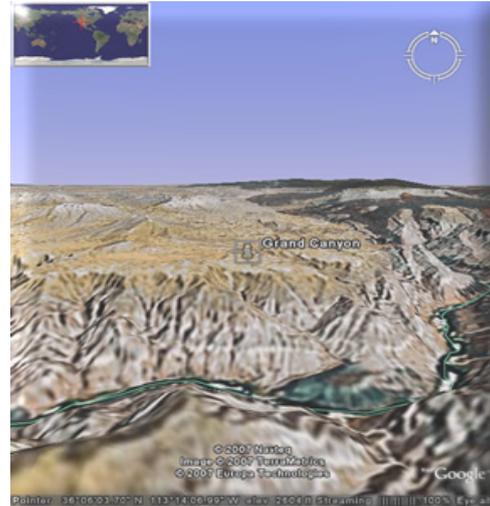


Figure 1-4 a 3D perspective of Grand Canyon in Arizona

- Click on the right button of the “Tilt” control until you see the terrain or building with a 3-D perspective (See Figure 1-4).
- Try exploring the local area by moving around (panning) and zooming in and out.

b) Downtown San Diego:

- Try the same way as above. Choose Roads, 3D buildings, borders, and free to zoom in, zoom out and tilt (Figure 1-5).

You just need to enter “San Diego, CA” in the “Fly to” Address Field. The focus of Google Earth is the downtown San Diego area.

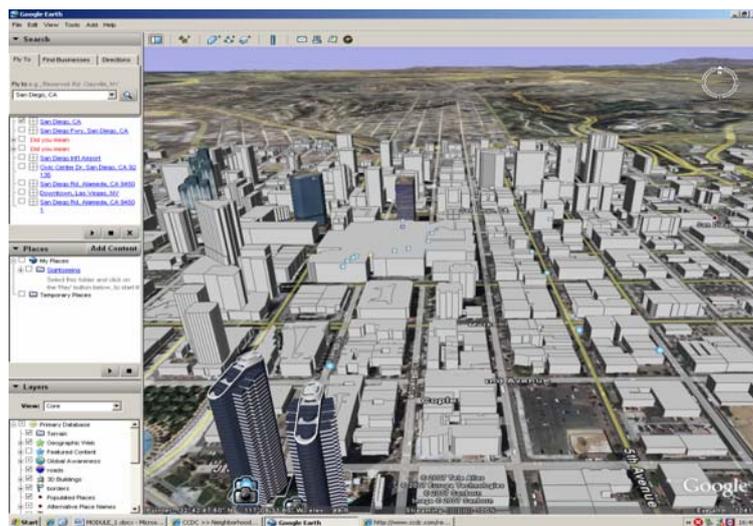


Figure 1-5 Downtown San Diego

[4] Now add more feature layers to Google Earth. You may want to select “Borders,” “Transportation,” “Geographic Features,” etc., and their associated features may not be visible until you sufficiently Zoom In or go to the geographic areas where they occur. This is called “scale-dependent features.”

[5] Now you are free to use the Google Earth navigation tools like “Zoom In,” “Zoom Out,” “Tilt,” etc. to explore the entire globe.

Part II – Please complete the following exercises and answer the following questions. You should try to spend no more than 30 minutes doing these exercises:

To locate a unique point on the earth, a coordinate system must be used. Google Earth and many other applications use the geographic coordinate system of latitude and longitude.

[1] **Latitude:** Latitude describes an imaginary survey line which runs east to west. You can think of these parallels of latitude as forming the rungs on an imaginary ladder. Latitude, when used in a coordinate, is expressed as an angle from 0 to 90 Degrees either north or south of the equator (See Figure 1-6).

The most important parallel of latitude is the equator. It surrounds the middle of the earth like a belt and can be described as 0 Degrees latitude.

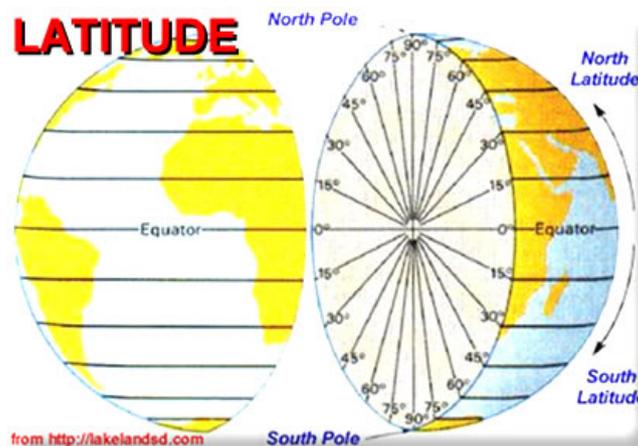


Figure 1-6: Latitude

In the “Decimal Degrees” system, it is important to note that when you are going north of the equator the values range from 0 to 90 Degrees and you are going in the “positive” direction. Think of this as going “up” on the imaginary ladder starting from the equator. You go south of the equator; the values range from 0 to -90 Degrees. Think of this as going “down” the imaginary ladder from the equator.

As an example, Sydney, Australia, which is in the Southern Hemisphere, lies at approximately -33.87 Degrees Latitude (note the negative sign).

Anchorage, Alaska which lies in the Northern Hemisphere lies at approximately 61.22 Degrees Latitude (note that it's a positive value).

When used on a map, a single latitude value is sort of like the equivalent of a y-coordinate in the Cartesian coordinate system.

[2] **Longitude:** Longitude describes an imaginary survey line running south to north. There are 360 Degrees of longitude and they all converge at the North and South Poles. Longitude, when used in a coordinate, is expressed as an angle from 0 to 180 Degrees either west or east of the Prime Meridian (See Figure 1-7).

The most important meridian of longitude is the Prime Meridian. This imaginary line extends from the South Pole to the North Pole and passes through Greenwich, England. It can be described as 0 Degrees longitude.

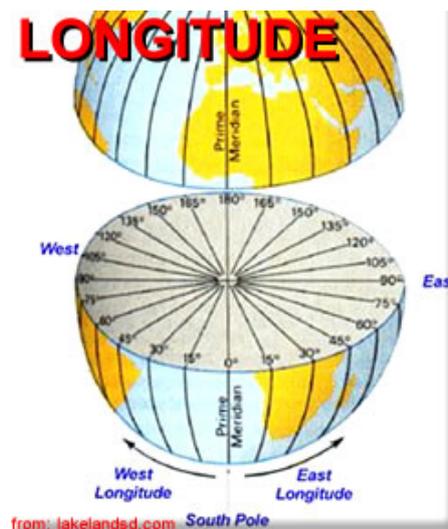


Figure 1-7: Longitude

In the “Decimal Degrees” system, it is important to note that when you are going west of the Prime Meridian, the values range from 0 to -180 Degrees and you are going in the “negative” direction. You go east of the Prime Meridian; the values range from 0 to 180 Degrees. At positive OR negative 180 Degrees longitude, you reach the International Date Line. This imaginary line runs from the South Pole to the North Pole in the middle of the Pacific Ocean and is on the opposite side of the earth from the Prime Meridian.

As an example, Sydney, Australia, which is in the Eastern Hemisphere, lies at approximately 151.21 Degrees Longitude (note that it's a positive value).

Anchorage, Alaska, which is in the Western Hemisphere, lies at approximately - 149.89 Degrees Longitude (note the negative sign).

When used on a map, a single longitude value is sort of like the equivalent of an x-coordinate in the Cartesian coordinate system.

[3] **Decimal Degrees:** Latitude and longitude are most commonly expressed in “Degrees, Minutes, and Seconds” or “Decimal Degrees.” Both are equivalent. However, for the sake of simplicity, you are going to use “Decimal Degrees.” In order to view map coordinates in decimal degrees, you will have to make a change. First, select the “Tools” pull-down menu and click on “Options...”

The Google Earth Options menu should appear (Figure 1-8). In the Google Earth Options menu, be sure the “3D View” tab is selected and change the “Show Lat/Lon” option to “Degrees” (Figure 1-8). In this case, the latitude (y-coordinate) and longitude (x-coordinate) will be represented in decimal degrees. This is how most GIS and related software applications represent latitude and longitude. Save the settings by clicking on the “OK” button.

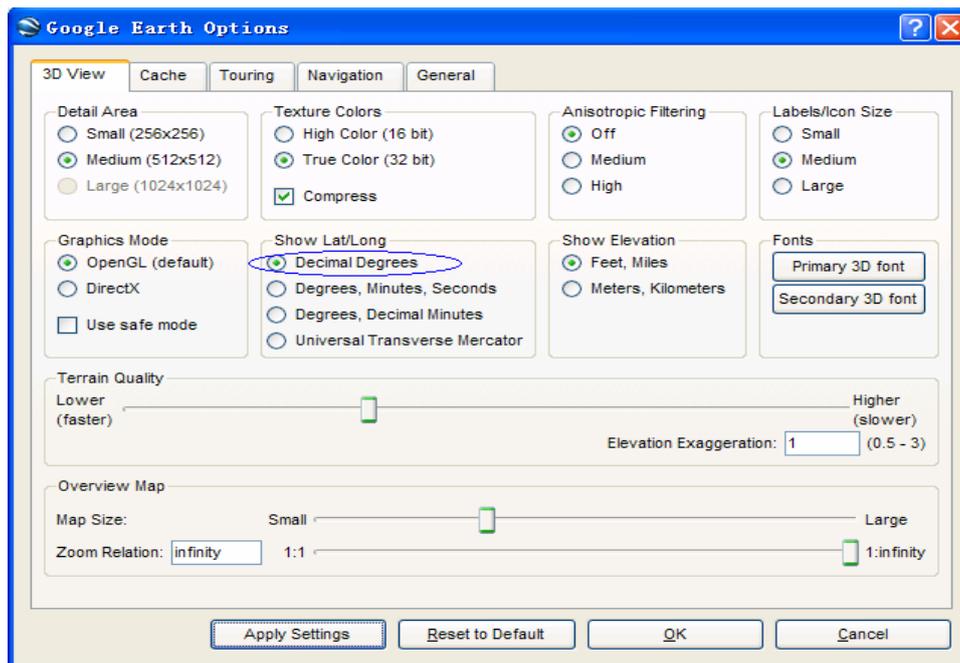


Figure 1-8: Google Earth Options Menu with Degrees Selected for Latitude and Longitude in the 3D View Tab

Now you are going to determine what the Latitude and Longitude coordinates of your school are?

Hint:

- Be sure the “borders” and “roads” features are selected in the List of Layers.
- Locate your school.
- Find out the latitude and longitude coordinate values by moving your mouse cursor over the center of your school in the view window.

Coordinates will appear in the bottom-left corner (See Figure 1-9 below).

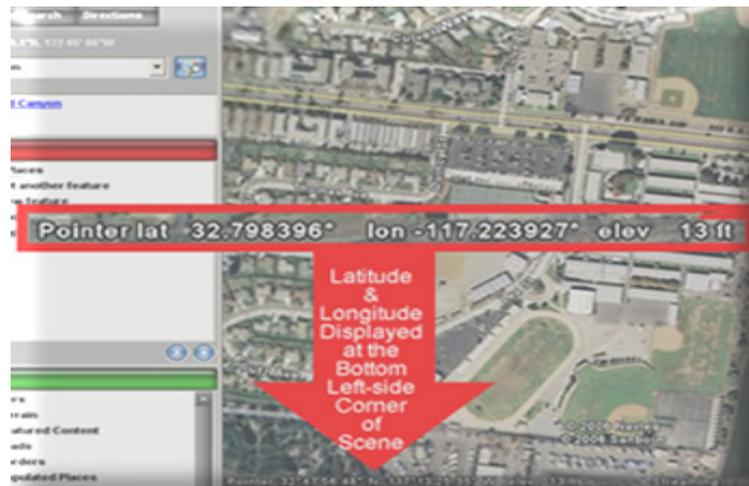


Figure 1-9: Latitude and Longitude Coordinates of Mission Bay High School (San Diego, CA)

Alternatively, you can enter the full address of your school in the “Fly To” address field.

On the separate answer sheet, fill in the following:

A-1: Your School Name:

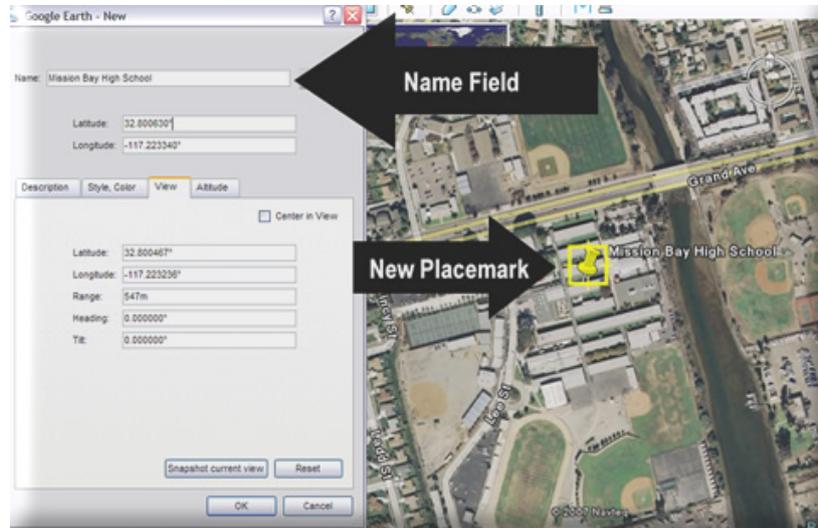
A-2: School Latitude (the map Y-coordinate in degrees):

A-3: School Longitude (the map X-coordinate in degrees):

[4] After you determine where your school is located, create a Placemark that marks it. To do this you need to follow a few easy steps and spend no more than 8 minutes:

- Make sure your school is displayed near the center of your screen.
- Click the “Add Placemark” control. It looks like a pushpin and is located near the top of your Google Earth window.

A New Placemark control panel should pop-up and a Placemark will appear near the center of the screen (Indicated by the black arrow in Figure 1-10 below).



**Figure 1-10: Creating a Placemark in Google Earth
(Mission Bay High School, San Diego, CA)**

- Click and drag the Placemark on the map to the center of your school campus.
- Type in the name of your school in the Name field of the New Placemark control panel (Figure 1-10). The Placemark will then, automatically display your school's name.

Before you press the OK button to finish creating the Placemark, fill in the following information from the New Placemark control panel on the separate answer sheet:

A-4: Name Which You Entered for the School:

- Click on the "View" tab in the New Placemark control panel. You will see the Latitude and Longitude that is associated with your Placemark.

Based on the information that you read from the New Placemark menu, fill in the following on the separate answer sheet:

A-5: Latitude as Shown in the New Placemark control panel:

A-6: Longitude as Shown in the New Placemark control panel:

- Click on the OK button to save the new Placemark of your school on the map. When you Zoom Out, the new Placemark of your school will remain visible.

Now you will determine what is the direct straight line distance between your school and San Diego State University (SDSU)?

- Type the address of SDSU in the “Fly To” address field. The address is near **5398 Campanile Dr., San Diego, CA.**
- Create a new Placemark for SDSU.
- Zoom out enough so you can see both Placemarkers (your school and SDSU). You should be able to do this even if your school is located in another country!
- Open the Measure Tool control, which is located in the Tools pull-down menu. It might also be called Ruler depending on which version of Google Earth you are using. Use Miles as your measuring unit and click on your school and then click on SDSU while the Measure Tool is open. (Figure 1-11)

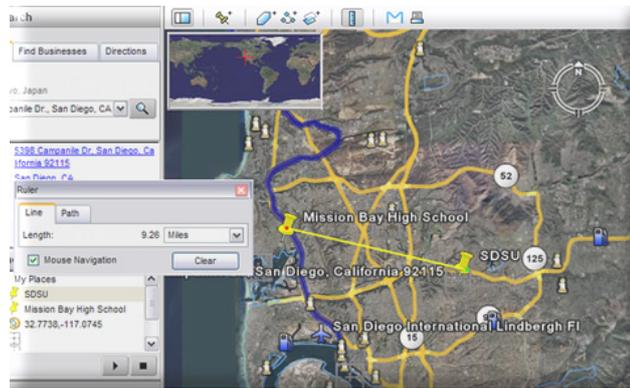


Figure 1-11: Determining the Distance between Two Places

Answer the following on the separate answer sheet:

A-7: Distance between Your School and SDSU (miles):

Now close the Measure Tool by clicking on the X on the top right-hand corner of the Measure Tool menu.

In this next step, you will create street map directions between your school and SDSU.

- The “From”: Click right mouse (or Mac users, hold down the Control button and mouse Click) on your newly-created high school Placemark. A pop-up menu should appear. Select the “Direction from here” option.
- The “To”: Right mouse click (or Mac users, hold down the Control button and mouse click) on the SDSU Placemark which you created. Select the “Direction to here” option.

Now, Google Earth should automatically create the street navigation direction between your school and SDSU (Figure 1-12)!

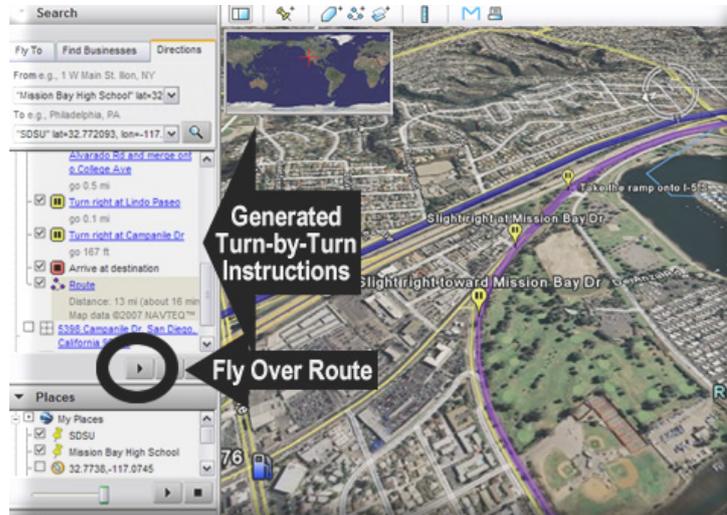


Figure 1-12: Generating Turn-by-Turn Navigation Instructions

If you zoom into your school, you will see street by street instructions all the way to SDSU!

A-8: Copy down the first driving instruction that Google Earth lists FROM your school (Just copy down the first one!) on the separate answer sheet:

Now, let's try something really cool.

- Press the “play” button under your list (Figure 1-12) and watch the route fly over animation. (Some versions of Google Earth may not have this feature enabled.)

[5] Other questions with Google Earth.

- “Area 51” is a Top Secret U.S. Military site in the Nevada desert that many in the government claim does NOT exist! The coordinates are 37.249361,-115.812339.

Now briefly answer the following question based on what you find. What is Area 51? (Hint: Copy these coordinates into the “Fly To” address field. Be sure the “Fly To” address field tab is selected!)

A-9: Briefly describe “Area 51” on the separate answer sheet:

- What is the name of the nearest Pizza restaurant to your school? (Hint: Make sure your school is near the center of the screen then; Select the “Find Businesses” tab

located next to the “Fly To” tab (Figure 1-13) and enter Pizza in the “What” field then press enter.)

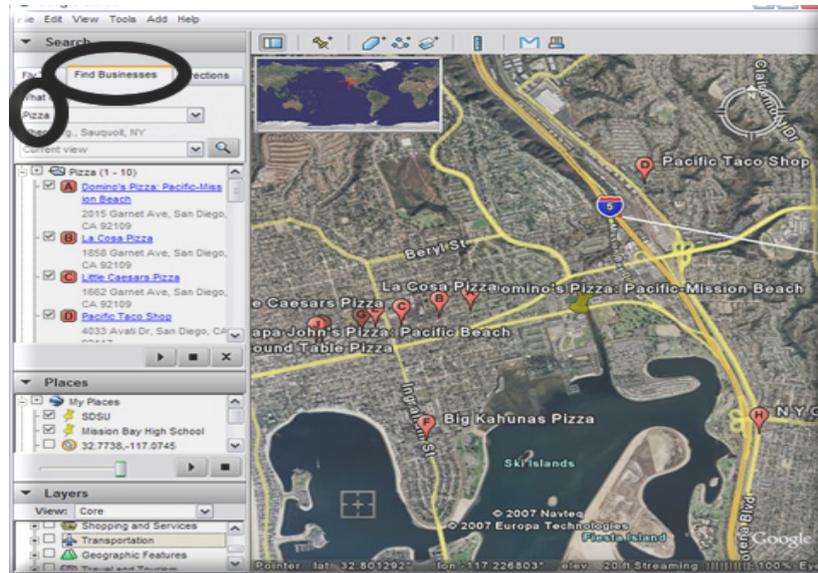


Figure 1-13: A Local Search of Pizza Restaurants

A-10: *What is the name of the nearest Pizza Restaurant to your school? (Answer on the separate answer sheet.):*

Measure how far it is from your school with the Measure Tool.

A-11: *How far is the Pizza Restaurant from your school? (Give the distance in feet.) (Answer on the separate answer sheet.):*

- c) Alcatraz Island, near San Francisco, California, used to be used as an “inescapable” high-security prison where the worst and most notorious criminals were kept. The island known as “The Rock” is surrounded by dangerous currents and freezing-cold water. It was supposed to be nearly impossible to escape!
- Determine which direction the city of San Francisco is from Alcatraz Island and how far apart they are. (Hint: Use the Fly To field and type Alcatraz.)
 - The idea is to determine how far someone needs to swim in the ice-cold water to escape the prison island (If you need to know the city names on the viewer, simply toggle on the layer called, “Populated Places” in the “List of Layers.”)
 - Determine what direction the Golden Gate Bridge is from Alcatraz Island.

A-12: Which direction must you go (North, South, East, West) from Alcatraz Island to the shores of the city of San Francisco? (Answer on the separate answer sheet.):

A-13: How far apart is Alcatraz Island from the nearest point along the shoreline of the city of San Francisco (in feet)? (Answer on the separate answer sheet.):

A-14: Which direction (North, South, East, West) is the Golden Gate Bridge from Alcatraz Island? (Answer on the separate answer sheet. (Make sure the 3D Buildings layer is toggled on.)

Part III – Google Earth Applications

[1] The Bird Flu Example. You should spend no more than 10 minutes to finish this part.

Bird flu is a contagious viral infection that can affect all species of birds. The contagious virus lives primarily in the respiratory system in the infected birds, and human infection occurs when people come into contact with infected birds or contaminated surfaces. There are thought to be millions of migratory ducks and wildfowl which carry the disease. Worldwide, according to the World Health Organization, more than 135 humans' infections of the virus have been recorded.

On November 16, 2005, Nature Magazine's Senior Reporter Declan Butler has thoroughly researched the Avian Flu outbreak information and has published the confirmed cases of Avian Flu in a Google Earth file. His avian outbreak map includes Human cases, and a time series of placemarks showing the progression of the flu over the last 18 months.

- a) Click the link <http://www.nature.com/nature/googleearth/avianflu1.kml> to open the KML file. Then Google Earth will be automatically launched (Figure 1-14). If you see alert message window, click “continue”.

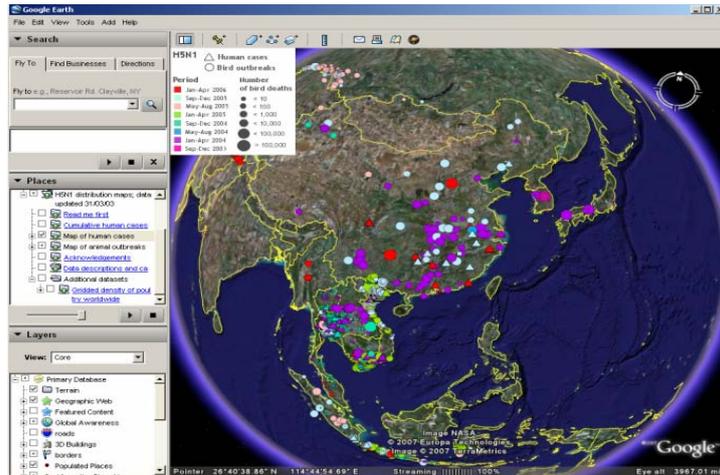


Figure 1-14: Bird Flu Outbreak map of Google Earth

- b) In the “Place Panel”, select the layer of “Additional datasets.” If you see the alert message window such as “Unsupported image format, go_Russia.png”, click “ok” and remove the Russia layer (“Additional Datasets -> Gridded density of poultry worldwide->Russia”)

This way you can view the poultry density for any continent you are interested in. You can focus on the human cases or animal breaks by selecting the respective layers.

For example, you may notice that there were quite a few human cases happened in the first several months of 2006 in the Middle East (Figure 1-15). For each case, you can make an inquiry by directly clicking on the symbol. Please keep track of the spread of the flu virus based on the maps.

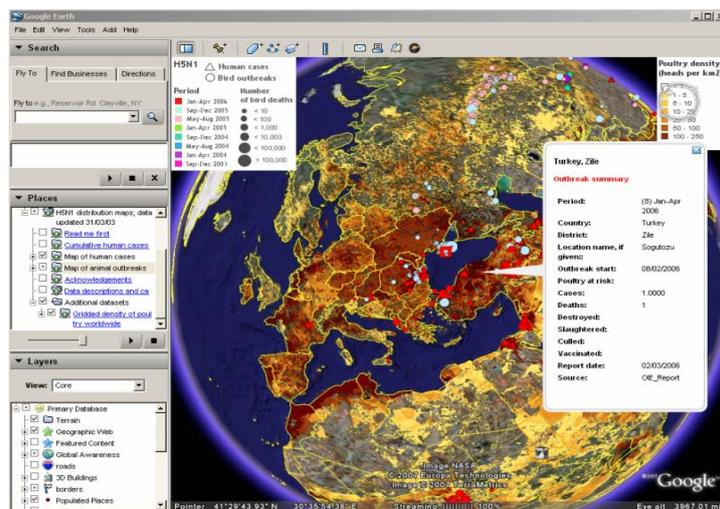


Figure 1-15: Bird Flu Outbreak map of Google Earth Focused in the Middle East

A-15: Describe the patterns of the bird flu for both bird and human cases in the Middle East (geographic distribution, spread patterns and seasonal patterns) by viewing the bird flu maps.

A-16: Try to identify how many human cases happened in Turkey and report their Latitudes and Longitudes (Hint: in the place panel, only select the “Map of human cases”).

A-17: According to the maps, could you predict the potential areas that can be impacted by the bird flu (Hint: Use poultry density map and if possible try to search for bird migration information)?

[2] The Flight Info Example. You should spend no more than 10 minutes to finish this part.

[Fboweb.com](http://www.fboweb.com) is an aviation solution website. This website provides flight tracking services which are visualized by Google Earth. It allows users to obtain detailed information on airports, their runways, frequencies and services available, nav aids, airways, intersections, and other parts of the US National Airspace System.

- a) This website provides real-time information of the flight tracking. Go to <http://www.fboweb.com/antest/ge/intro.aspx?old=1>.
- b) Click the link “hourly snapshot” on the webpage. This will display all active flights in the last hour. The website will update the flight information every hour and provide a new Google Earth layer.



Figure 1-16: The One-hour Newly Flight Information

A-18: Click the link “hourly snapshot” and open the real-time flight tracking. Zoom to San Diego Airport and report the flight numbers of the planes which are about to take off or land.

fboweb.com has developed an interface to integrate our flight-tracking data with this "3D Earth Browser" so that you can now see flights in real-time and in 3D. Zooming in to particular flights, rotating around them, seeing them from all angles

- c) Take a look at inbound flight traffics for Los Angeles International Airport (LAX). Click on the “Track it!” button (See Figure 1-17), you can see the inbound traffics toward LAX in Google Earth (See Figure 1-18) by using the tools we introduce before.



Figure 1-17

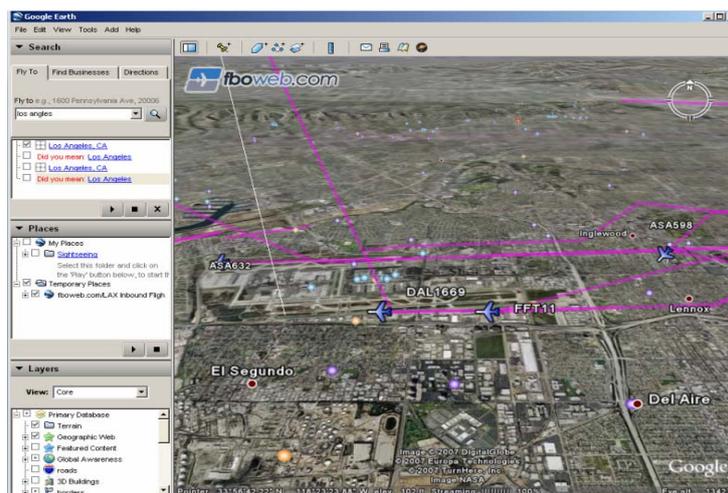


Figure 1-18: The Inbound Traffics Toward LAX in Google Earth

One of the first things you might like to try is finding a flight to track. Even non-subscribers can use the free “QuickTrack” option to track any commercial flight.

The main flight is shown with its flight path in yellow and "extruded" to show its height above the ground and previous tracks (See Figure 1-19). In addition, when tracking individual flights, the aircraft's surrounding traffic is also displayed - all IFR aircraft within a 30 nautical mile radius.



Figure 1-19: An Example of Flight Tracking

A-19: Track one of the flights which fly off from San Diego International Airport and record the information of the flight.

A-20: For LAX inbound flight traffics at the time you are viewing the map, how many planes are below the altitude of 1,000 feet? List their flight numbers and their altitudes (Hint: use the “Tilt” tool to have a better perspective).

Section 2 – Written Assignment

Now that you have seen and worked with examples of digital globes and computerized maps, we would like you to answer some questions about them. We want you to combine all of your answers into a 250-word paragraph (approximately one typed page) by including the following information on the separate answer sheet:

B-1: *In your paragraph, quickly describe (in two sentences or less) the GIS applications that you used (Google Earth).*

B-2: *In your paragraph, also answer if you think that the GIS applications (Google Earth) can help people? In what ways can they help people? In what kinds of occupations/industries would they be useful?*

B-3: *In your paragraph, based on your experience with GIS applications (Google Earth), please discuss which application you liked the best and tell us WHY? Please also discuss what the best or “coolest” feature of your favorite application was.*

Student Survey

This learning module was developed specifically for you---the students---in order to expose you to GIS and related geospatial technologies.

GIS and related geospatial technologies, similar to what you worked with in this learning module, are major components of one of the most important new industries for career growth. Businesses, organizations, and governments are increasingly seeking skilled talent in this industry.

Now, to benefit other students and the authors of this learning module, you are required to finish this Student Survey and please send it back to the San Diego State University NSF-ATE team. We would greatly appreciate your input. Please take time to answer these questions as openly and honestly as possible. **They will not affect your grade or score.** You can provide your feedback to your teacher/educator along with the learning module answers on the separate answer sheet.

Thank you for helping us improves our modules!

- S-1:** What did you like best about this learning module one? Why?
- S-2:** What did you like least about this learning module one? Why?
- S-3:** Was there anything that was really hard to understand or difficult to complete in this module one? What was it? Why?
- S-4:** Is there anything in this learning module one that we can add, exclude, or change to make it better? What is it? Why?

STUDENTS MAY STOP HERE!

Appendix: Installation Instructions for Google Earth

These simple instructions have been written using screen shots and instructions for the Windows Operating System. Installation instructions for the Mac and Linux Operating Systems are similar.

Be sure to have “administrative” privileges on the computer you are installing the software on. Accounts on computers in a lab setting usually limit installation to users with administrative privileges only.

1. Open your Web browser and navigate to URL: <http://earth.google.com/download-earth.html> and click “agree and download”
2. On the next Web page, click on the “Download Google Earth” button.

After you have clicked on the “Download Google Earth” button, specify where you want to save the installation file on your computer and keep the original file name.



Figure A: Part of What is Displayed on the Web Page after Pressing the “Download Google Earth” Button

NOTE: Web browsers with pop-up or download blocking may get an error message. If this is the case, click on the “click here to start it” link displayed on the download page to manually initiate a download (Figure A).

3. After saving the installation file to your computer, close your Web browser and run the installation file by clicking on it.
4. Follow the Google Earth installation instructions that follow and accept the licensing agreement and any other installation messages that appear. The default “Complete” installation is sufficient for the learning module.

WINDOWS USERS NOTE: If you are given an option to “switch to ‘DirectX’ mode,” we recommend that you respond by clicking “No” and keep Google Earth in ‘OpenGL Software Emulation’ mode since it is compatible with a greater number of computer graphics cards.

Answers to some of the most popular Google Earth-related installation questions are also available at <http://earth.google.com/faq.html>.