**Dynamic Design:
A Collection Process**

Continuous Collecting

DATA COLLECTION

Data are the facts and figures from which conclusions may be drawn. There are different types of data that can be collected. One type is **continuous data** or a measurement that involves **quantitative** (how much) observations. An example of continuous data would be measuring the temperature in a parking lot over time. Another type is **categorical data** or data that is obtained through **qualitative** (what it is) observations. An example of categorical data would be the types of cars found in a parking lot.

When conducting scientific investigations, scientists need to collect data to prove or disprove their **hypotheses**. There are many ways to collect data, ranging from surveys of people on the street to observations of organisms in the field. It is important to consider the purpose of the experiment when deciding how to collect the data. In most circumstances, the collection process involves **variables** that need to be controlled.

Why is it important to control variables in any scientific experiment? One also needs to consider potential sources of **bias** when collecting data. What is bias and how might it affect the data that is collected?

INSECT COLLECTION

Entomologists (scientists who study insects) have developed various techniques to collect insects. They use different capture techniques based on the type of insect they want to trap. There are different traps for flying insects, crawling insects, and those found mixed with ground cover. Scientists at the Lloyd Center South conduct surveys on moths in Massachusetts. Center director Mark Mello collects moths at night using four different methods, including mercury vapor light traps, portable blacklight traps, portable ultraviolet traps, and baiting trees. The first three methods use different types of light, whereas in the last method Mello paints a mixture of rotten bananas, beer, molasses, brown sugar, grape jelly, and rum onto tree leaves. The mixture mimics the odor of fermenting fruit, which attracts moths.
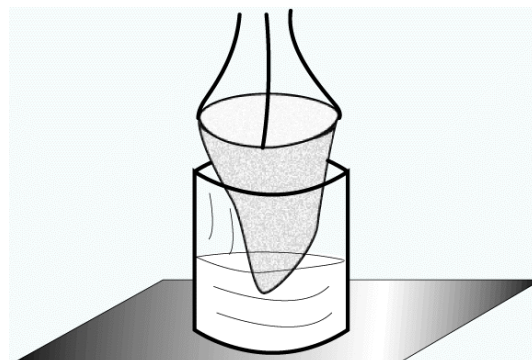

Insect trap

A barrier trap is another device for catching flying insects. The windowpane is a barrier trap that consists of a piece of clear glass or plastic with a shallow trough filled with ethanol attached at the bottom. When the trap is hung across a path, in a flyway, or at the edge of the woods, flying insects crash into it. Those that drop after hitting the glass fall into the trough and are killed. Insects that crawl about on the ground can be captured in a pitfall trap. This can be constructed by placing a plastic cup partially filled with alcohol in the ground. Modifications can be made by adding bait such as rotting food or dry cereal to attract the crawler. Insects found in ground cover can be extracted by using devices that sift or separate the insect from the soil. Examples include a Berlese funnel, a separator box, or a kitchen sifter.

SOLAR WIND COLLECTION

Just as there are different types of traps for collecting insects, there are different methods to collect solar wind. You have already read about the aluminum foil experiments that were used during the Apollo missions. This method was very good for collecting the noble gases. Another method of analyzing solar wind was used on Apollo 12 and 15. A solar wind spectrometer was used to compare the solar wind properties at the lunar surface with those measured
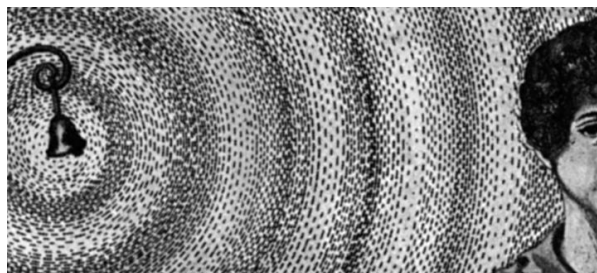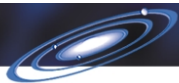
in space near the moon. The Genesis spacecraft will have ultrapure wafers to collect bulk solar wind and an electrostatic concentrator that will reflect and focus a 1000 cm^2 cross section of solar wind particles onto a small target.

AN ANALOGY OF SOUND

Animals collect data constantly through their senses. Animals differ in the types of senses they have and the extent to which they are used. For instance, dogs have a good sense of hearing, yet other species are completely deaf. The Noctuid moth can detect the sound made by bats, but only as the presence or absence of sound. (They are tone deaf.)

Sound will be used in an analogy between the way animals hear and how the solar collectors on the Genesis spacecraft will collect solar wind. In vertebrates, hearing involves vibration of hair cells and fluid in the inner ear of mammals, birds, reptiles and amphibians and lateral line in fish. Mammals have the most advanced hearing sense of the vertebrates. Over 23 species including bats can hear high, ultrasonic pitches. Chimpanzees can hear up to 30 kHz while smaller animals like bats, mice, and shrews hear up to the range of 90 to 120 kHz. "Porpoises and seals may produce and hear underwater sounds up to around 180 kHz," (Mohl 1968). Sound travels about five times faster in water than in the air. This is due to the water molecules being closer together than molecules in the air. Elephants can hear frequencies that are lower than humans (infrasonic). "The baleen whales can hear very low frequency sounds but have no echolocation. This enables the baleen whales to communicate over long distances, as the low-frequency sound has better propagation and wider scatter underwater," (Luo, 1999).

In this analogy, all sound that exists in an environment will represent the solar wind. The animals that hear the sounds will represent the materials in the collectors on the Genesis Sample Return Capsule. Animals vary in their ability to hear the sound, just like materials vary in their ability to collect elements of solar wind. The materials used in the collector wafers will capture and hold the solar wind samples. This material will vary depending on the element or elements to be captured. How is the sound analogy an effective way to relate to solar wind collection on the Genesis spacecraft? In what ways does this analogy fall short of an accurate portrayal of Genesis solar wind collection?

The materials used in the collector wafers must be pure enough so that the ratio of solar wind particles to impurities is greater than 100 to 1 (less than 1%). The materials must also be clean enough so that for any given element, the surface contamination will be less than would be expected for the two-year collection period. The materials used must also allow scientists to analyze the results with the desired technique. Finally, the correct materials must be used for different elements. For instance, if the scientists are trying to analyze carbon, they would want a wafer material to be something other than carbon. Based on extensive testing, specific materials will be used in constructing the collector wafers. Silicon wafers will be used to collect most elements and isotopes. Aluminum will be used for the noble gases. Chemical vapor deposit (CVD) diamond will be used for oxygen, nitrogen, and other light elements. Diamond, gold/platinum, germanium, and other substances will be used for alkali elements, radioactive elements, and as alternates for all measurements. Materials such as sapphire, and combinations such as diamond on silicon, silicon on sapphire, aluminum on sapphire, and gold on sapphire will also be used.
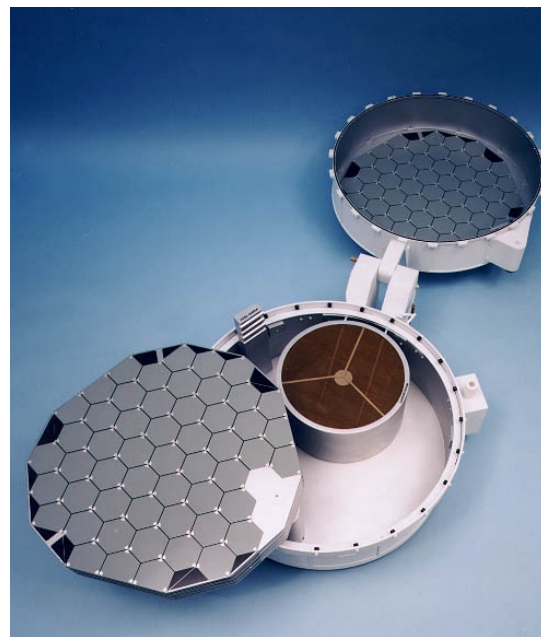
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Collector Array

Data collection is important in all areas of science. From entomology to cosmic chemistry, scientists use various collection techniques in order to have the data necessary to answer their research questions. Data collection is just one step in the process. According to the National Science Education Standards students of science should, "Design and conduct a scientific investigation (e.g., formulate questions, design and execute investigations, interpret data, synthesize evidence into explanations, propose alternative explanations for observations, critique explanations and procedures)." Once the isotopic data has been returned from the Genesis mission scientists will spend years interpreting this data and using this evidence to have a clearer picture of the solar system in which we live.