On My Wavelength
Engineers Design Antennas to Suit Specific Purposes

Dayton, OH (Wright-Patterson Air Force Research Lab)—Engineers develop all kinds of antennas for various needs. They apply research from math and science and put it to practical use. Antennas are integral to radios, broadcast televisions, cell phones, and other communication systems. The engineers are making smaller and better antennas to be used on land, in the air, and out in space.

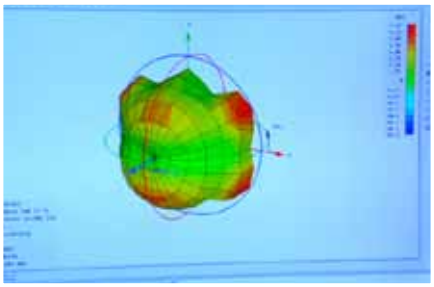
"Antennas are the eyes and ears of everything we do." **Ray Febo, electrical engineer**

Framework	Standards
Middle School	NSES - B.iii.1 ➤ Energy is transferred in many ways. STL - 2.S ➤ Trade-off is a decision process. STL - 17.H ➤ Communications systems transmit information from machine to machine. STL - 17.I ➤ Communications systems transmit and receive.

Content Illustrated

- Animation of encoding and decoding for communication.

Content



Physical Science

- Antennas send and receive energy using radio waves.
- Radio waves are the longest waves of the electromagnetic spectrum.
- Wavelengths are measured from peak to peak of the wave and range from 100 km to 1 mm.
- The speed of light is 186,000 miles per second or 300 million meters per second.

Technology

- Antennas communicate with all kinds of systems (TV, radio, cell phones). They create a wave through the air to transmit information (including pictures and sound) to another antenna located up to several miles away, where the information is decoded.
- Each antenna is designed to resonate at a specific frequency.
- Big antennas are used for big waves, small antennas for small waves.
- Individual radio stations and cell phone networks are systems that operate on their own specific wavelengths. They need the correct corresponding antennas, which are typically half the size of the wave.

Engineering

- Different antennas are needed for different purposes. One engineering challenge is to create the smallest antenna with the best performance.
- Another is to create a phased array of antennas that can be electronically controlled to send beams in different directions without needing to physically move any single antenna.

Math

- Wavelength and antenna size are directly proportional.
- Frequency (measured in hertz) is equal to the number of wave cycles per second or the number of wave tips (peaks) that pass through a point every second.
- Frequency and wavelength are inversely proportional.
- Frequency x wavelength = speed of light.
- A radio station broadcasts at 98.1 FM. Its frequency is 98,100,000 Hz (98.1 MHz).
- Therefore wavelength = 300,000,000 / 98,100,000 = 3.05 meters.

Guiding Questions

To think about as you watch:

- What is the relationship between wavelengths and antenna sizes?

Suggested Activities

- Determine the range of wavelengths received by an AM radio, a cell phone, and a cordless phone.

- *On My Wavelength* can be found online at www.ndep.us/On-My-Wavelength. Visit www.ndep.us/LabTV for a list of process skills modeled in webisodes.

Keywords

antenna
array
electromagnetic
spectrum
encode
energy
frequency
hertz
radio waves
wavelength