NASA's Deep Impact Mission: Decision Making

What Goes Around Comes Around

STUDENT TEXT

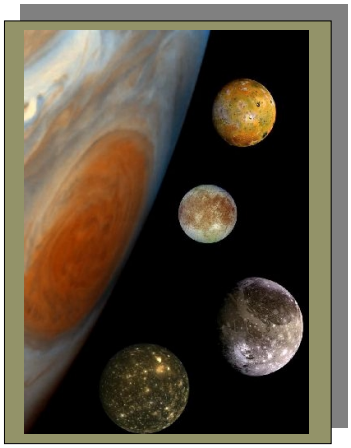
Science pushes technology, as scientists ask questions that demand more advanced instruments. Technology is essential to science. It provides instruments and techniques that offer observations of objects and events that are otherwise unobservable because of their quantity, distance, location, size, or speed.

Fermilab Visual Media Services

Sloan Telescope will map the most comprehensive and fully digital map of the sky.

The above statement, adapted from the National Science Education Standards, describes the reciprocal nature of science and technology. The more technology improves, the more science advances, and vice versa. This is a concept that is not often considered in many science classes. Modern science cannot be completed without the use of technology to enhance the human senses. As you have seen in the last two activities, it is not a matter of IF technology will be used, rather it is to WHAT EXTENT available technology will be used. The remainder of this text is a historical account of the reciprocal nature of science and technology using the telescope as an example. But, as is often the case in history, the question that is often asked is, "Which came first the chicken or the egg?"

In the case of the science of astronomy, it was the science that came first. From the dawn of time, humans have looked up at the sky in wonder. Babylonians around 1600 BC were keen observers of the nighttime sky and often recorded their observations of stars and planets on clay tablets. It was not until 3,000 years later that the telescope was first used to aid celestial observations. Scientists did not invent the telescope; rather, it was the product of craftsmen. For that reason, not much is known about the invention of the telescope since craftsmen were not often historically significant. The telescope was unveiled in the Netherlands. In October 1608, the government had patent applications from both Hans Lippershey and Jacob Metius for "seeing faraway things as though nearby." The devices consisted of convex and concave lenses in a tube, which magnified objects three or four times. Lippershey charged his customers to use his new toy, so the telescope was first used to make money from curious people before it was even considered for science.



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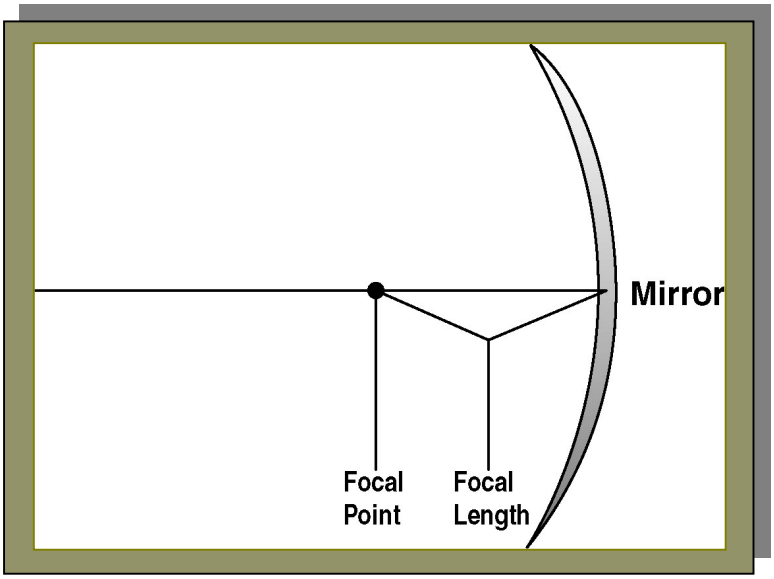
Jupiter, Callisto, Ganymede Europa, and Io. (bottom to top)

Although the telescope was first used for recreation and military use, it was not long before the telescope was applied to science. Galileo in 1610 used his telescope to look at the moon's surface. He saw that it was not smooth and spherical as predicted; rather, it was rough with mountains and craters. Next, Galileo used the telescope to see that the Milky Way was made up of more stars than could be seen with the unaided eye. He also found that Jupiter and its moons resembled a mini solar system, though it was probably Kan Te of China who first saw "a bright red star" attached to Jupiter 2,000 years before Galileo "discovered" these four moons. Though Galileo made some enormous discoveries, it took other scientists several years to verify his findings since their telescopes were not adequate to do so.

It took hundreds of years and a lot of experimentation to get sharp images through telescopes. People were always trying to see farther into space, so the telescope was always being improved and even reinvented. For example Johannes Kepler proposed the use of two convex lenses in order to increase the astronomer's field of vision.

Not all improvements are from experimentation; sometimes technology advances by accident. "William Gascoigne, an amateur astronomer in England, was using a Kepler-style telescope when part of a spider's web found its way inside the telescope. One small web line happened to fall right at the focus point, so both the thin line and the image Gascoigne was viewing were magnified together. Gascoigne realized that he could more accurately point the telescope using the line as a guide, and he went on to invent the telescopic sight by purposefully placing wires at the focus point. This helped astronomers make more accurate observations and measurements of objects in space, using the thin wires as a reference point." (JPL, 1998)



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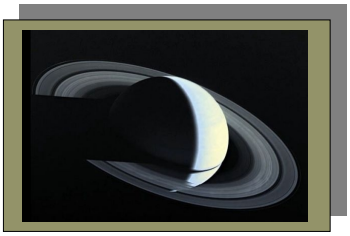
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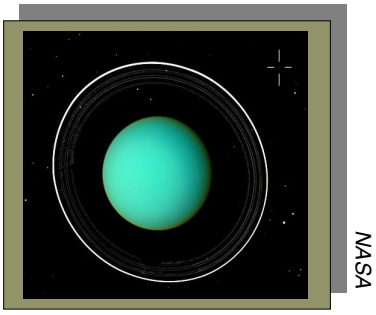
Christiaan Huygens discovered the rings of Saturn.

At the start of the 1600's it was realized that increased magnification was achieved by increasing the focal length of the objective. The focal length is the distance from a lens or mirror to its focal point. The focal point is the place where parallel light rays converge after being reflected or refracted.

Beginning in the 1640s, the length of telescopes rose to lengths of 15 or 20 feet. A typical astronomical telescope of this era was the one made by Christiaan Huygens in 1656. His telescope was 23 feet long, magnified about 100 times, and was used to discover the rings of Saturn. Jean Dominique Cassini discovered many of the moons of Saturn. He used telescopes as long as 135 feet. It seemed that every time Cassini made a longer telescope, he discovered another moon! On March 13, 1781, William Herschel used a seven-foot telescope to discover a new planet, later called Uranus. As time passed, the reports of more discoveries thrilled people, who then wanted the latest telescope so they could see these new discoveries for themselves.

As mirror making and lens grinding began to improve, larger telescopes were made that needed to be housed in permanent buildings. At first, these observatories were built near large cities since that was where many scientists lived. However, it was discovered that the location of the telescope is as important as how big it is. Because of the lack of light pollution and factors such as clear skies and a thin atmosphere, many of the new observatories were built on mountaintops away from cities so that the best seeing could take place. The 200-inch Hale telescope located at Mount Palomar was completed in 1949. It revealed such wonders as the first quasars: star-like radio sources moving at incredible speeds at the edge of the visible universe. Once observatories on mountains became commonplace, scientists were interested in eliminating the effects of the atmosphere altogether.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William Herschel discovered the planet Uranus in 1781. The rings were discovered accidentally in 1977.

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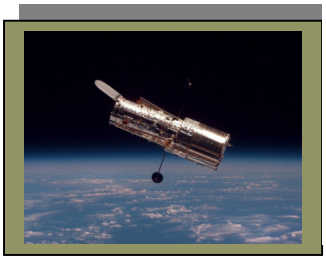
The Kuiper Airborne Observatory was retired in 1995.

The Gerard P. Kuiper Airborne Observatory (KAO) was a national facility operated by the National Aeronautics and Space Administration to support research in infrared astronomy since 1974. For over twenty years, the KAO was the world's only airborne telescope devoted exclusively to astronomical research. The plane was a converted C-141 military cargo plane that carried a 36-inch reflecting telescope. The KAO was the scene of many major discoveries, including the first sightings of the rings of Uranus and a definitive identification of an atmosphere on Pluto.

After the success of airborne observatories, the plan was to build an orbiting telescope that could be remotely controlled from Earth. The Hubble Space Telescope took eight years to build and was launched into orbit in 1990 by the space shuttle Atlantis. By observing 14,000 astronomical targets, Hubble has contributed significantly to our understanding of the universe from our solar system to the most distant galaxies. The Hubble Space Telescope has already outlasted its projected "life" and will retire by the end of 2010. The Next Generation Space Telescope scheduled to launch in 2009, will continue our quest to peer deeper into the far reaches of the universe.



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By orbiting above the Earth's atmosphere, the Hubble can get clearer images.

As you can see from these examples, as the telescopes got bigger and better, the types of information that was learned increased causing the need for larger and more sophisticated instruments located at some exotic places. Science and technology are indeed reciprocal.

Web site

http://www-isds.jpl.nasa.gov/cwo/cwo_54ga/html/cd/telescop.htm
History of the telescope (JPL,1998)