On May 7, 1999, NATO military pilots mistakenly bombed the Chinese embassy in Belgrade, Yugoslavia, instead of the intended target, a munitions building known as the Federal Directorate for Supply and Procurement some 218 meters (200 yds) away. The missiles killed three people, injured 20 others, and provoked mass protests in China. Expressing deep regret, intelligence officials explained that the out-of-date U.S. military map from which the pilots were working did not show the embassy compound.

A year earlier, 20 people in a cable car plunged to their deaths when a U.S. military jet on a training mission in Italy severed a ski lift cable near the town of Cavalese. Investigation of the tragedy revealed that the ski lift was not shown on the maps the pilot was using.

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As these examples indicate, accurate maps can literally mean the difference between life and death, and not just in the case of military applications. Government agencies rely on maps of flood-prone areas, of volcanic eruptions, of earthquake hazard zones, and of areas subject to landslides to develop their long-range plans. Epidemiologists map the occurrence of a disease over time and space, helping them to identify the source of the outbreak and to create a plan to halt the spread of the disease. Law enforcement agencies increasingly use maps to identify patterns of specific types of crime and to help predict where they are likely to occur in the future. The value of examining information in a spatial context cannot be overstated.

Maps are as fundamental a means of communication as the printed or spoken word and photographs. In every age, people have produced maps, whether made out of sticks or shells, scratched on clay tablets, drawn on parchment, or printed on paper. The emperor Charlemagne even had maps made on solid plates of silver. The map is the most efficient way to portray parts of the earth's surface, to record political boundaries, and to indicate directions to travelers. In addition to their usefulness to the general populace, maps have a special significance to the geographer. In the process of studying the surface of the earth, geographers depend on maps to record, present, and aid them in analyzing the location of points, lines, or areas.

The art, science, and technology of making maps is called **cartography.** Modern scientific mapping has its roots in the 17th century, although the earth scientists of ancient Greece are justly famous for their contributions. They recognized the spherical form of the earth and developed map projections and the grid system. Unfortunately, much of the cartographic tradition of Greece was lost to Europe during the Middle Ages and essentially had to be rediscovered. Several developments during the Renaissance gave an impetus to accurate cartography. Among these were the development of printing, the rediscovery of the work of Ptolemy and other Greeks, and the great voyages of discovery.

In addition, the rise of nationalism in many European countries made it imperative to determine and accurately portray boundaries and coastlines, as well as to depict the kinds of landforms contained within the borders of a country. During the 17th century, important national surveys were undertaken in France and England. Many conventions in the way data are presented on maps had their origin in these surveys.

Knowledge of the way information is recorded on maps enables us to read and interpret them correctly. To be on guard against drawing inaccurate conclusions or to avoid being swayed by distorted or biased presentations, we must be able to understand and assess the ways in which facts are represented. Of course, all maps are necessarily distorted because of the need to portray the round earth on a flat surface, to use symbols to represent objects, to generalize, and to record features at a different size than they actually are. This distortion of reality is necessary because the map is smaller than the things it depicts and because its effective communication depends upon selective emphasis of only a portion of reality. As long as map readers know the limitations of the commonly used types of maps and understand what relationships are distorted, they can interpret maps correctly.

Locating Points on a Sphere: The Grid System

In order to visualize the basic system for locating points on the earth, think of the world as a sphere with no markings whatsoever on it. There would, of course, be no way of describing the exact location of a particular point on the sphere without establishing some system of reference. We use the **grid system,** which consists of a set of imaginary lines drawn across the face of the earth. The key reference points in that system are the North and South Poles and the equator, which are given in nature, and the prime meridian, which is agreed upon by cartographers.

The North and South Poles are the end points of the axis about which the earth spins. The line that encircles the globe halfway between the poles, perpendicular to the axis, is the *equator.* We can describe the location of a point in terms of its distance north or south of the equator, measured as an angle at the earth's center. Because a circle contains 360 degrees, the distance between the two poles is 180 degrees and between the equator and each pole, 90 degrees. **Latitude** is the angular distance north or south of the equator, measured in degrees ranging from 0° (the equator) to 90° (the