Reentry of Space Capsules[3]

During the early days of the space program, it was recognized that upon reentry into the earth's atmosphere and due to frictional heating, the outside of a space capsule would rise to a temperature much higher than any known material could withstand. Thus, a research directive (i.e., a problem statement) was issued: *Develop a material that is able to withstand the extremely high temperatures of reentry.*

When the *Apollo* moon landings occurred during the late 1960s and early 1970s, such heat-resistant materials had still not been developed. Yet our astronauts returned safely to earth! How could this be?

The answer is that the problem formulation eventually had been redirected toward the *true* objective, which was to protect the astronauts, not to develop a heat-resistant material.

This reformulation of the problem statement was the breakthrough step that led to the final solution. Researchers noted that some meteors reach the earth's surface without completely disintegrating. These meteors are not completely destroyed because their surfaces vaporize when they become molten, so that only some of their material is lost. Vaporization acts to cool a surface: This process is known as *ablative cooling.* Space capsules were then protected with heat-shielding material that vaporizes at high temperatures. The heat due to friction is thereby dissipated in the form of vapors.