WHAT IS ENTROPY ?

Entropy is a well-defined, but somewhat peculiar and seemingly artificial, function arising from the second law of thermodynamics. Although there are many important consequences deriving from it, the second law is quite mundane and essentially states that heat cannot be completely converted into work. In order to arrive at the entropy function from the second law, it is necessary to postulate the existence of a reversible process. This is a process in which all inefficiencies such as friction and unbalanced potentials are absent; it is clearly an idealization that can be approached but never attained. A change in entropy, ΔS, is defined as being equal to a quantity of heat transferred in a reversible process, Q, divided by the absolute temperature, T

$$\Delta S = Q/T$$

Because reversible heat transfer is an idealization that can only be approached, entropy seems awkward and contrived in comparison to other functions or variables used in science. It is an extremely useful tool for making engineering and scientific calculations, but its significance outside this narrow application has been greatly exaggerated−it has acquired a mystique.

For certain simple systems such as an ideal gas, the methods of quantum statistical mechanics (QSM) can be applied to obtain an expression of the entropy in terms of a parameter, omega , which is a measure of the number of spatial and energetic arrangements accessible to the assemblage of molecules. This has led to the putative view that omega measures disorder and therefore entropy is itself a measure of disorder. While this interpretation works some of the time, it is not always reliable. In any event, the concept of disorder is nebulous and difficult to define, especially on the molecular level where disorder might be the term used to describe the normal state of a bunch of molecules that are continually colliding.

Because the (QSM) expression of entropy has the same form as an equation arising from communication theory (CT), some have argued that entropy is a measure of information about the assemblage of molecules. However, CT does not lead to an entropy expressed in terms of a heat effect(see above definition) as does QSM and thus entropy as a measure of information is not a valid concept.

The only unambiguous physical interpretation of entropy derives from the function's origin in the study of engines that convert heat into work. *The entropy increase in a process is a measure of the work lost because of our inability to carry out the process in a reversible manner.* It is a measure of how close we have come to an idealization-- the reversible process. As an example consider a cubic foot of natural gas that we use to heat our homes in wintertime. The combustion of gas in our furnace is an irreversible process (with a large increase in entropy) but we can devise a reversible process (no change in entropy) where gas is oxidized in a fuel cell and the electrical energy produced is used to drive a heat pump. Detailed calculations, using the condition of zero entropy change, show that the reversible process would deliver over 13 times as much heat to the house as the irreversible combustion. Entropy is a valuable tool for the engineer for it shows that in this example there is much room for improvement.

If all processes could be carried out reversibly, then no ability to do work would ever be lost and the entropy of our world would never change. Because the reversible process can only be approached, all actual processes are irreversible and the entropy of the world continually increases.