Abstracting from concrete characteristics of individual systems and isolating the common (for some set of systems) regularities describing the change of their state under various influences, we arrive at the concept of an *abstract system*. This system is distinguished by the fact that its components are described not in terms of designations of objects, but in terms of some abstract collection of elements characterized (taken singly or as a whole) by specific properties that are common for a wide class of objects. In this scheme, Ackoff's definition of an abstract system is of interest: "An abstract system is a system all of whose elements are concepts" (Ackoff, 1962).

Connections of an abstract system with the environment are also defined in the form of quantitative characteristics independent of the qualitative nature of the concrete connections. The transition from consideration of concrete systems to consideration of an abstract system carries the same character as the transition from the study of operations on concrete numbers in arithmetic to the study of operations on abstract numbers in algebra.

Figure 1.1 shows schematically a system in the form of the part of space in which all its elements are concentrated and it also shows how the system is connected to the surrounding environment. The arrows indicate the directions in which the actions are transmitted. X designates actions of the system on the environment, and Y designates the actions of the environment on the system under consideration. These connections can convey actions concentrated at specific points of the system, for example, in the form of a force applied to an element of the system; they can have distributed character as well, acting on the surface or on each point of the whole system or some part of it. As distributed actions one can consider the actions of temperature or pressure on the surface of a system, the actions of gravitational or magnetic fields, and so forth.

In the systems approach, the concept "system" is closely associated with several other concepts: "information," "motion," "structure," "control," "model," and "function," to name a few. This extension of the original conceptual basis gives the systems approach a certain advantage over a nonsystems investigation, because it permits construction of a more multifaceted representation of the nature of a system as well as of the methods for its study. We will now illustrate some of these concepts in more detail.

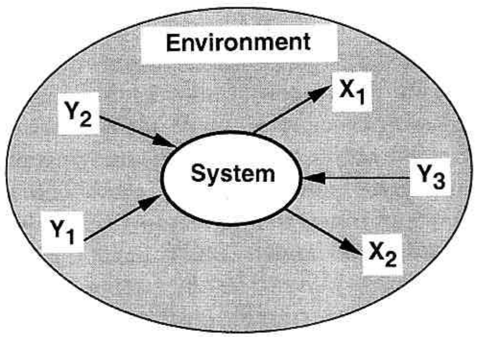

Figure 1.1
A system and its environment; Y refers to input actions, X refers to output actions.

1.4 Motion

In mechanics the term "motion" is used narrowly to denote the change in position of some object in space over the course of time. In the systems approach, motion has a more general meaning, that is, any change in an object over time. For example, a change in body temperature and a change in a bank account balance can be called motions.

Because the regularities of motion of the most varied objects have much in common, it is useful to consider the laws of motion not of concrete systems (of which there are many) but of abstract systems. In the systems approach, one of the most important concepts connected with motion is the concept of the "state of a system." Ackoff gives the following definition: "The state of a system at some moment of time is the set of values of the essential properties which the system has at that moment."

The number of properties of any system is undoubtedly large. For each concrete investigation, only some of them are significant. Consequently, the significance of specific properties can change with a change in the purpose of the investigation. Thus the state of any system can be characterized with specific precision by the collection of values of the essential properties. This collection of values permits one to compare the state of the same system at various moments in time in order to detect its motion. For example, in some cases we may be interested in only two possible states (such as inclusive or exclusive, or yes or no). In other cases we may be interested in a large number of possible states (such as the velocity or temperature of the system).

Various forms for describing the state of a system exist. It is possible, for example, to list values of all properties $X_1, X_2, \ldots X_n$, determining the state of the system at a specific moment of time and to list their values for fixed moments. However, we consider a more convenient method of representation of states and the motion of systems to be the method based on the concept of the state space.

We will designate by n the number of properties determining the state of the system under consideration. For $n = 1$, $n = 2$, and $n = 3$, the state of the system can be illustrated graphically in space with the number of dimensions equal to n. If $n > 3$, then we lose the possibility of graphic representation of the