boundaries

interacting parts

emergent properties

complexity

9-12

Understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis. In defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other

Troubleshoot common mechanical and electrical systems, check for possible causes of malfunction, and decide on that basis whether to fix it themselves or get help from an expert.

A system usually has some properties that are different from those of its parts, but appear because of the interaction of those parts.

Most systems above the molecular level involve so many parts that it is not practical to determine the existing conditions, and thus the precise behavior of every part of the system cannot be predicted.

Systems may be so closely related that there is no way to draw boundaries that separate all parts of one from all parts of the other.

Even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

As the number of parts in a system grows in size, the number of possible internal interactions increases much more rapidly, roughly with the square of the number of parts.

6-8

The output from one part of a system (which can include material, energy, or information) can become the input to other parts.

Analyze simple mechanical devices and describe what the various parts are for; estimate what the effect of making a change in one part of a device would have on the device as a whole.

As the complexity of any system increases, gaining an understanding of it depends increasingly on summaries, such as averages and ranges, and on descriptions of typical examples of that system.

Any system is usually connected to other systems, both internally and externally. Thus a system may be thought of as containing subsystems and as being a sub-system of a larger system.

Thinking about things as systems means looking for how every part relates to others.

3-5

In something that consists of many parts, the parts usually influence one another.

Collections of pieces (powders, marbles, sugar cubes, or wooden blocks) may have properties that the individual pieces do not.

Something may not work as well (or at all) if a part of it is missing, broken, worn out, mismatched, or misconnected.

K-2

Make something out of paper, cardboard, cloth, wood, plastic, metal, or existing objects that can actually be used to perform a task.

Sometimes people aren't sure what will happen because they don't know everything that might be having an effect.

Something may not work if some of its parts are missing.

When parts are put together, they can do things that they couldn't do by themselves.

Most things are made of parts.