3 Design parameters

Whether it be in operating a business, creating an artistic work, working at a skilled trade, or practicing engineering, there is an inherent tendency to filter out many of the seemingly insignificant bits of basic knowledge upon which our expertise was structured and base our daily functioning and decisions on selected conglomerations of these basics. This developmental process comes with experience and is a prerequisite to effective production.

From time to time, however, with changing technology, social structures, monetary economic conditions, etc., every practitioner should reevaluate the parameters upon which he is basing his daily decisions. The reevaluation of parameters, if applied to engineering designs, would produce vastly different results from those we have seen in the past two decades.

To develop this concept, consider that as any new field or engineering technology is born, there is essentially only one design parameter—performance. Examples: that the machine convert thermal energy to shaft work; that the generator convert shaft work to usable electric energy; or that the bridge span the river and support the weight required. Then, as each field of engineering technology matures, other design parameters inevitably are required. Take, for example, the heat engine, for which the original parameter was simply to convert energy from a thermal to a mechanical form. Subsequent parameters that evolved included improving the heat rate (or energy efficiency), decreasing the weight-to-horsepower ratio, reducing the maintenance requirements, refining or improving the automation and safety systems, and decreasing the production or manufacturing cost per unit of power produced.

As the practicing engineer embarks upon any phase of design, he is well advised to stop for a moment and compile a list of the design parameters that he will attempt to satisfy. In the field of building systems design, as in any discipline of systems engineering, such an examination of relevant parameters must be undertaken at numerous phases throughout the design development. A typical listing of such phases relating to building environmental systems would be:

- Establishment of indoor conditions.
- Calculation of the loads and load profiles.
- Selection and design of terminal control systems.
- Selection and design of terminal distribution systems and methods.
- Selection of type(s) of thermal distribution systems and subsequent design.
- Selection and design of ranges, rates, and thermal levels of thermal distribution systems.
- Selection and design of high-level (heating) primary conversion system.
- Selection and design of low-level (cooling) primary conversion system.
- Selection of high-level (heating) energy source or sources.
- Selection of low-level (cooling) energy source or sources.

Consider, for example, the first phase listed above—establishment of indoor conditions. If this question were addressed hastily regarding air conditioning for human comfort, one might state a specific dry bulb temperature and relative humidity (such as 75 F DB and 50 percent RH). But upon reflection, we all realize that the basic parameter is human comfort. Thermal comfort, in turn, is a physiological phenomenon achieved by a balance between metabolic heat rate (input), work produced (output), and heat dissipated (re-

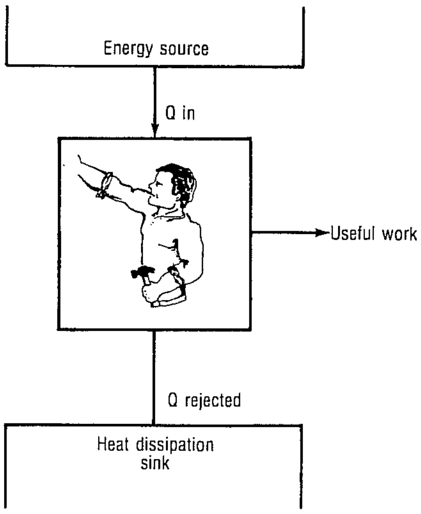

Fig. 3-1.

jected). In oversimplification, the human machine can be described thermally by the classical block diagram used in elementary thermodynamics to illustrate the second law (see Fig. 3-1). The designer of the thermal environment is concerned chiefly with the heat dissipation. Consideration of the heat transfer phenomena affecting this exchange—radiation, convection, evaporation, and conduction—establishes the following comfort parameters:

- Dry bulb temperature.
- Relative humidity.
- Mean radiant temperatures (enclosed and "exposed" surfaces).
- External radiant effects (solar, direct and reflected.)
- Contact surface temperatures (chairs, desks, etc.).
- Air velocity.

Obviously, this is quite an expansion from simply dry bulb temperature and relative humidity. However, thousands of buildings enclosing millions of square feet have been constructed without the ability to provide for thermal comfort because of a failure to recognize one or more of these as relevant parameters. This chapter does not include a discussion of some of these typical failures, but every practicing engineer can provide his own.

Another interesting aspect: It becomes immediately evident that the thermal environmental system is not *added* to the building; rather, it is an integral part thereof. The design engineer, therefore, cannot avoid involvement in the basic building design, or at least in the aspects related to heat exchange.

Other chapters will deal with parameters relating to the other phases of design. In the meantime, compile your own listings; in addition to improving the wisdom of design decisions, this will make it increasingly evident why the engineer must participate in the architectural aspects of building design decisions.