Chapter 1

Introduction

This series is an introduction to the basic principles of heating, ventilating, and air conditioning (HVAC). Each represents a systematic attempt to control the various aspects of the environment within an enclosure, whether it is a room, a group of rooms, or a building.

Among those aspects of the immediate environment that people first sought to control were heat and ventilation. Attempts at controlling heat date from prehistoric times and probably first developed in colder climates, where it was necessary to produce temperatures sufficient for both comfort and health. Over the years the technology of heating advanced from simple attempts to keep the body warm to very sophisticated systems of maintaining stabilized environments in order to reduce heat loss from the body or the structural surfaces of the room.

Ventilation also dates back to very early periods in history. Certainly the use of slaves to wave large fans or fanlike devices over the heads of rulers was a crude early attempt to solve a ventilating problem. Situating a room or a building so that it took advantage of prevailing breezes and winds was a more sophisticated attempt. Nevertheless, it was not until the nineteenth century that any really significant advances were made in ventilating. During that period, particularly in the early stages of the Industrial Revolution, ventilating acquired increased importance. Work efficiency and the health of the workers necessitated the creation of ventilation systems to remove contaminants from the air. Eventually, the interrelationship of heating and ventilating became such that it is now regarded as a single subject.

Air conditioning is a comparatively recent development and encompasses all aspects of environmental control. In addition to the control of temperature, both humidity (i.e., the moisture content of the air) and air cleanliness are also regulated by air conditioning. The earliest attempts at air conditioning involved the placing of wet cloths over air passages (window openings, entrances, etc.) to cool the air. Developments in air conditioning technology did not progress much further than this until the nineteenth century. From about 1840 on, several systems were devised for both cooling and humidifying rooms. These were first developed by textile manufacturers in order to reduce

the static electricity in the air. Later, adaptations were made by other industries.

Developments in air conditioning technology increased rapidly in the first four decades of the nineteenth century, but widespread use of air conditioning in buildings is a phenomenon of the post-World War II period (i.e., 1945 to the present). Today, air conditioning is found not only in commercial and industrial buildings but in residential dwellings as well. Unlike early forms of air conditioning, which were designed to cool the air or add moisture to it, modern air conditioning systems can control temperature, air moisture content, air cleanliness, and air movement. That is, modern systems *condition* the air rather than simply cool it.

Heating and Ventilating Systems

Many different methods have been devised for heating buildings. Each has its own characteristics, and most methods have at least one objectionable aspect (e.g., high cost of fuel, expensive equipment, or inefficient heating characteristics). Most of these heating methods can be classified according to one of the following four criteria:

1. The heat-conveying medium
2. The fuel used
3. The nature of the heat
4. The efficiency and desirability of the method

The term *heat-conveying medium* means the substance or combination of substances that carries the heat from its point of origin to the area being heated. There are basically four mediums for conveying heat. These four mediums are:

1. Air
2. Water
3. Steam
4. Electricity

Different types of wood, coal, oil, and gas have been used as fuels for producing heat. You may consider electricity as both a fuel and a heat-conveying medium. Each heating fuel has its own characteristics; the advantage of one type over another depends upon such variables as availability, efficiency of the heating equipment (which, in turn, is dependent upon design, maintenance, and other

factors), and cost. A detailed analysis of the use and effectiveness of the various heating fuels is found in Chapter 5 ("Heating Fuels").

Heating methods can also be classified with respect to the nature of the heat applied. For example, the heat may be of the exhaust steam variety or it may consist of exhaust gases from internal combustion engines. The nature of the heat applied is inherent to the heat system and can be determined by reading the various chapters that deal with each type of heating system (Chapters 6 through 9) or with heat-producing equipment (e.g., Chapter 11, "Gas Furnaces").

The various heating methods differ considerably in efficiency and desirability. This is due to a number of different but often interrelated factors, such as energy cost, conveying medium employed, and type of heating unit. The integration of these interrelated components into a single operating unit is referred to as a *heating system.*

Because of the different conditions met within practice, there is a great variety in heating systems, but most of them fall into one of the following broad classifications:

1. Warm-air heating system (Chapter 6)
2. Hydronic heating systems (Chapter 7)
3. Steam heating systems (Chapter 8)
4. Electric heating systems (Chapter 9)

You will note that these classifications of heating systems are based on the heat-conveying method used. This is a convenient method of classification because it includes the vast majority of heating systems used today.

As mentioned, ventilating is so closely related to heating in its various applications that the two are very frequently approached as a single subject. In this series, specific aspects of ventilating are considered in Chapter 6 ("Ventilation Principles") and Chapter 7 ("Ventilation and Exhaust Fans") of Volume 3.

The type and design of ventilating system employed depends on a number of different factors, including:

1. Building use or ventilating purpose
2. Size of building
3. Geographical location
4. Heating system used

A residence will have a different ventilating system from a building used for commercial or industrial purposes. Moreover, the

requirements of a ventilating system used to provide fresh air result in fundamental design differences from a ventilating system that must remove noxious gases or other dangerous contaminants from the enclosure.

The size of a building is a factor that also must be considered. For example, a large building presents certain ventilating problems if the internal areas are far from the points where outside air would initially gain access. Giving special attention to the overall design of the ventilating system can usually solve these problems.

Buildings located in the tropics or semitropics present different ventilating problems from those found in temperature zones. The differences are so great that they often result in different architectural forms. At least this was the case *before* the advent of widespread use of air conditioning. The typical southern house of the nineteenth century was constructed with high ceilings (heat tends to rise); large porches that sheltered sections of the house from the hot, direct rays of the sun; and large window areas to admit the maximum amount of air. They were also usually situated so that halls, major doors, and sleeping areas faced the direction of the prevailing winds. Today, with air conditioning so widely used, these considerations are not as important—at least not until the power fails or the equipment breaks down.

Air Conditioning

Although the major emphasis in this series has been placed on the various aspects of heating and ventilating, some attention has also been given to air conditioning. The reason for this, of course, is the increasing use of year-round air conditioning systems that provide heating, ventilating, and cooling. These systems *condition* the air by controlling its temperature (warming or cooling it), cleanliness, moisture content, and movement. This is the true meaning of the term *air conditioning*. Unfortunately, it has become almost synonymous with the idea of cooling, which is becoming less and less representative of the true function of an air conditioning system. Air conditioning, particularly the year-round air conditioning systems, is examined in detail in Chapters 8, 9, and 10 of Volume 3.

Selecting a Suitable Heating, Ventilating, or Air Conditioning System

There are a number of different types of heating, ventilating, and air conditioning equipment and systems available for installation in the home. The problem is choosing the most efficient one in terms

of the installation and operating costs. These factors, in turn, are directly related to one's particular heating and cooling requirements. The system must be the correct size for the home. Any reputable building contractor or heating and air conditioning firm should be able to advise you in this matter.

If you are having a heating and ventilating or air conditioning system installed in an older house, be sure to check the construction. Weather stripping is the easiest place to start. All doors and windows should be weather-stripped to prevent heat loss. Adequate weather stripping can cut heating costs by as much as 15 to 20 percent. If the windows provide suitable protection (they should be double- or triple-glazed) from the winter cold, check the caulking around the edge of the glass. If it is cracking or crumbling, replace it with fresh caulking. You may even want to go to the expense of insulating the ceilings and outside walls. This is where a great deal of heat loss and air leakage occurs.

You have several advantages when you are building your own house. For example, you may be able to determine the location of your house on the lot. This should enable you to establish the direction in which the main rooms and largest windows face. If you position your house so that these rooms and windows face south, you will gain maximum sunlight and heat from the sun during the cold winter months. This will reduce the heat requirement and heating costs. The quality of construction depends on how much you wish to spend and the reliability of the contractor. It is advisable to purchase the best insulation you can afford. Your reduced heating costs will eventually pay for the added cost of the insulation. If you suspect that your building contractor cannot be trusted, you can reduce opportunities for cheating and careless work by making frequent and unexpected visits to the construction site.

Career Opportunities

Many career opportunities are available in heating, ventilating, and air conditioning fields, and they extend over several levels of education and training. Accordingly, the career opportunities open to an individual seeking employment in these fields can be divided roughly into four categories, each dependent upon a different type or degree of education and/or training. This relationship is shown in Table 1-1.

Among workers in these fields, engineers receive the highest pay, but they also undergo the longest periods of education and training. Engineers are usually employed by laboratories, universities, and colleges or, frequently, by the manufacturers of materials and

Table 1-1 Relationships between Career Category and Type of Work or Education and/or Training Required

Career Category	*Type of Work*	*Education/Training*
Engineer	Design and development	4 years or more of college
Technician	Practical application	Technical training school and/or college
Skilled worker	Installation, maintenance, and repair	Apprentice program or on-the-job training (OJT)
Apprentice or OJT worker	Training for skilled-worker position	High school degree or equivalency

equipment used in heating, ventilating, air conditioning, and related industries. Their primary responsibility is designing, developing, and testing the equipment and materials used in these fields. In some cases, particularly when large buildings or district heating to several buildings is employed, they also supervise the installation of the entire system. Moreover, industry codes and standards are usually the results of research conducted by engineers.

Technicians obtain their skills through technical training schools, some college, or both. Many assist engineers in the practical application of what the latter have designed. Technicians are particularly necessary during the developmental stages. Other technicians are found in the field working for contractors in the larger companies. Their pay often approximates that of engineers, depending on the size of the company for which they work.

Skilled workers are involved in the installation, maintenance, and repair of heating, ventilating, and air conditioning equipment. Apprentices and OJT (on-the-job training) workers are in training for the skilled positions and are generally expected to complete at least a 2- to 5-year training program. Local firms that install or repair equipment in residential, commercial, and industrial buildings employ most skilled workers and trainees. Some also work on the assembly lines of factories that manufacture such equipment. Their pay varies, depending on the area, their seniority, and the nature of the work. Most employers require that both skilled workers and trainees have at least a high school diploma or its equivalent (e.g., the GED). The requirement for a high school diploma may be waived if the individual has already acquired the necessary skills on a previous job. The pay for skilled workers and trainees is lower than that earned by engineers

and technicians but compares favorably to salaries received by skilled workers or equivalent trainees in other occupations.

Pipe fitters, plumbers, steam fitters, and sheet-metal workers may occasionally do some work with heating, ventilating, and air conditioning equipment. Both pipe fitters and plumbers (especially the former) are frequently called upon to assemble and install pipes and pipe systems that carry the heating or cooling conveying medium from the source. Both are also involved in repair work, and some pipe fitters can install heating and air conditioning units.

Steam fitters can assemble and install hot-water or steam heating systems. Many steam fitters can also do the installation of boilers, stokers, oil and gas burners, radiators, radiant heating systems, and air conditioning systems.

Sheet-metal workers can also assemble and install heating, ventilating, and air conditioning systems. Their skills are particularly necessary in assembling sheet-metal ducts and duct systems.

Some special occupations, such as those performed by air conditioning and refrigeration mechanics or stationary engineers, are limited to certain functions in the heating, ventilating, and air conditioning fields. Mechanics are primarily involved with assembling, installing, and maintaining both air conditioning and refrigeration equipment. Stationary engineers maintain and operate heating, ventilating, and air conditioning equipment in large buildings and factories. Workers in both occupations require greater skills and longer training periods than most skilled workers.

It should be readily apparent by now that the heating, ventilating, and air conditioning fields offer a variety of career opportunities. The pay is generally good, and the nature of the work provides considerable job security. Both the type of work an individual does and the level at which it is done depend solely on the amount and type of education and training acquired by the individual.

Professional Organizations

A number of professional organizations have been established for those who work in the heating, ventilating, and air conditioning industries or who handle their products. These organizations (frequently referred to as *associations, societies,* or *institutes*) provide a number of different services to members and nonmembers.

Some professional and trade organizations have established permanent libraries as resource centers for those seeking to improve their skills or wishing to keep abreast of current developments in their fields. In many instances, research programs are conducted in cooperation with laboratories, colleges, and universities.

Many of these organizations address themselves to the problems and interests of specific groups. For example, there are professional organizations for manufacturers, wholesalers, jobbers, distributors, and journeymen. Some organizations represent an entire industry, while others restrict their scope to only a segment of it. Every aspect of heating, ventilating, and air conditioning is covered by one or more of these professional organizations.

Anyone, member or not, can write to these professional organizations for information or assistance. Most seem very willing to comply with any reasonable request. The only difficulty that may be encountered is determining the current name of the particular organization and obtaining its address. Unfortunately, these professional organizations have shown a strong proclivity toward mergers over the years, with resulting changes of names and addresses.

The best and most current guide to the names and addresses of professional organizations is *The Encyclopedia of Associations,* which can be found in the reference departments of most public libraries. It is published in three volumes, but everything you will need can be found in the first one. At the back of this volume is a section called the "Alphabetical & Key Word Index." By looking up the key word (e.g., *heating* or *ventilating*) of the subject that interests you, you can find the page number and full name of the professional organization (or organizations) concerned with the particular area. See Appendix A in this volume for a partial listing of these professional and trade associations.

Some professional organizations of long standing have been merged with others or have been disbanded. For example, the Steel Boiler Institute (formerly the Steel Heating Boiler Institute), which maintained standards in the heating industry with its SBI Rating Code, is now defunct. The Institute of Boiler and Radiator Manufacturers (source of the old IBR Code) merged with the Better Heating-Cooling Council to form the Hydronics Institute. A recent attempt to contact the Steam Heating Equipment Manufacturers Association has resulted in the return of a letter marked "no forwarding address." It seems very likely that it, too, has joined the list of defunct professional organizations.

Appendix A (Professional and Trade Associations) at the end of this book gives a listing of professional organizations. It also contains their present addresses, the names of some of their publications, and a brief synopsis of their backgrounds and whom they represent.