WHAT'S *the* BEST HEATING SYSTEM?

There's no perfect answer, but running through this checklist can help you sort out the choices.

by WILLIAM LOTZ

Last year, I was asked to lecture on the topic "What is the best heating system?" I refused, as there is no best heating system, at least none that applies to every situation equally well. Every building, owner, location, etc., has a different solution to the problem. After you've gathered the best available information, all you can do is "pays your money and takes your chances."

The best way to come up with a solution is to sort through the following considerations:

- First cost
- Operating cost
- Fuel availability and storage on site
- Comfort and aesthetics
- Space available in the building
- Type of building and its use
- Owner bias and ability

First Cost

First, be aware that many of the initial savings in low-cost systems show up later in higher operating costs. One example is electric (ugh!) which is generally the cheapest heating system to install, but the most expensive to operate. We are designing a lot of retrofits for people with electric who are tired of outrageous heating bills. But looking at first-cost expense alone, electric systems win out, followed by gas, oil, heat pumps, and coal—each increasingly more expensive to install.

In general, air systems are less expensive than hydronic systems. Smaller ducts (for air systems) or smaller pipes (for hydronic systems) will further reduce first costs. However, because they generate increased friction in the system, they make necessary higher horsepower—and more expensive—pumps and blowers. And they usually result in more noise.

The cost of oil tanks or other fuel storage, and chimneys, should also be figured into the first-cost calculations.

Operating Cost.

First consider fuel costs. These vary a great deal depending on your geographic area. For example, electricity costs 2 1/2 cents per kilowatt-hour in much of the Northwest, and 7 to 10 cents in New England. Gas and oil prices also vary.

A commercial coal system that can store 25 tons of coal (not very practical for most residential applications) is the least expensive fuel per Btu. Good quality coal can be obtained in northern New England for $80 to $90 per ton in 25-ton truck deliveries.

If you don't own your own woodlot, wood can be one of the most expensive fuels at current prices. I had one client who wanted wood heat and was ready to buy a woodlot and have her full-time $500-per-week handyman cut the wood. I recommended she use oil heat and she did. She saved a lot of money as a result.

Finally, remember that operating costs include maintenance expenses and the cost of operating fans and pumps.

Fuel Availability and Storage

In some areas you can easily tap into a municipal natural gas line. If that's the case, natural gas is the simple choice. You won't pay much and you won't have to store any fuel. LP gas, however, requires a tank. Depending upon the tank size, the tank must be x feet from the building—never inside the building. I do not recommend burying an LP gas tank as they must be inspected regularly for corrosion.

Where coal is practical, it should be stored in an enclosed bin of adequate structural strength, and located where the coal can feed by gravity or conveyor to the point of use.

Oil requires a tank, and at last, the federal and state governments (in most states) require that any buried fuel tank be either fiberglass, fiberglass-coated steel, double-wall, or cathodic-protected steel. The cathodic-protected steel requires yearly tests to determine if the anode connection is valid and functioning. To me, the only realistic choice is fiberglass if the tank is buried. The other option for homes is a pair of 275-gallon steel tanks in the basement.

Wood requires a lot of space for storage. I don't recommend wood heat to anyone who lives "in-town" or who doesn't own a woodlot. Purchased wood costs too much and the air pollution of several wood stoves in a neighborhood is obnoxious.

System Comfort and Aesthetics

With few exceptions, any heating system can provide comfort as long as it is properly designed. One exception is a building with large areas of roof-mounted glass. But then, roof-mounted glass has other disadvantages, such as high solar gain in the summer and minimal solar gain in the winter.

Another exception is electric radiant heat, which in my experience is seldom comfortable. In a complex for elderly residents, many occupants complained of hot heads and cold feet. Because they were on fixed budgets, they would keep their thermostats set back. They were not comfortable at all, and they still had high electric heat bills. In another case, where the home had a cathedral ceiling with a balcony bedroom, radiant ceiling heat failed the comfort test. Down on the main floor the temperature was 55 degrees, while up in the bedroom, temperatures could reach 80 degrees. As is often the case in this design, there were sliding glass doors on the main level. which caused massive heat losses there. The result was major stratification, poor comfort, and horrendous heating bills. I should say that, regardless of the type of heating system, high ceiling spaces can cause problems and may need a paddle fan to get the warm air down to the people level.

A common complaint is that a system is too noisy. A noisy heating system is a sign that something needs to be fixed, or that it is poorly designed. If the ducts rattle, it's often because they were not "cross-broken" (where the sheet metal duct is creased to stiffen it). A "whistling grille" usually means that the ducts were sized too small. As a result of higher friction and increased velocity, you hear the air pass through the ducts.

A frequent cause for concern among clients are the compromises made in locating air grilles due to cost and other building construction realities. In an ideal world, we would like to have warm air delivered at the floor level and removed near the ceiling, and the opposite for cool air. In an even more ideal world, we would never mix the two. Perfectly adequate comfort, however, can be attained with all ceiling grilles, or with floor supply and ceiling return, or with other combinations. It is desirable, but not necessary, to have a return-air grille in each space.

One last comment related to comfort. I strongly recommend *against* humidifiers in heating systems as they cause more damage from condensation problems than they are worth. The benefits of a humidifier only exist in museums where old documents or mummies must be kept at a specific humidity level.

Also consider heating-system aesthetics. Good looks need not add a lot to cost—mainly it requires extra planning. Pipes and ducts should be boxed in where necessary. Occasionally, a client will want an exposed duct system that has been designed to look pretty.

Some building owners have strong preconceived ideas of what they want and generally that's what they should have—but not always.

Most baseboard radiators are unattractive but there are some nice-looking ones available—usually at a premium. One client of mine wanted cast-iron radiators because they liked the looks of cast iron. It cost a bundle but they went for it. Some clients are very concerned about grilles being centered in the room and how the grilles line up with lights and such. This should be discussed early in the design.

Some architects object to chimneys. If this is the case, we spec a pulse furnace or boiler, which can vent out of the side of the building with no chimney.

The location of other related items such as outdoor louvers, tanks, a/c compressors, etc., should all be integrated into the building design, and not just stuck in as an afterthought.

Space Availability

Where is the mechanical equipment to be located? Is there adequate room for the equipment *and* adequate space to service it? Where can chases be located for pipes and ducts? These are some of the tricky questions that must be answered when considering the options. The popularity of beamed ceilings and slab-on-grade construction makes it more difficult to locate pipes and ducts for heating systems. The designer has to use kneewalls, closets, boxes, and other devices to hide them. The result is that it takes more time for the designer to put together a system that works, and looks acceptable. Radiant slab floors can be a good solution, but they tend to scare away those unfamiliar with the concept. There are several different piping schemes available for this type of heating system. Space problems can be a real hassle in historical buildings as well. For example, in an old city building we worked with there was no space for an air-conditioning condenser.

Type of Building and Its Use

The way the building is designed and the use of the building must be considered in the design of the heating system. Some examples:

In a Maine airport maintenance building, we designed a gas-fired, ceiling-mounted, radiant-tube system. The ceiling was 22 feet high and there were large doors. The radiant system, combined with passive solar, provided a reasonably priced system with comfort at the people level.

In a CAT-scan room of a Vermont hospital, we specified a high-tech packaged a/c system with precise temperature controls and high performance air filters.

In a Concord, New Hampshire church with a 45-foot ceiling, we designed a radiant floor slab that would provide comfort in the pews and not warm the air in the peak of the beamed ceiling.

Owner Bias and Abilities

The school that can't afford a top-notch maintenance crew probably should not have coal heat. A busy lawyer should not try to heat with wood. The person who is "afraid" of gas should heat with oil.

Some building owners have strong preconceived ideas of what they want and generally that's what they should have—but not always! Recently, a client asked me to design a retirement home with wood heat. I recommended against wood heat as I doubted that a city person in their sixties would want to cut wood for many years. Another client had a home with a great deal of glass, and wanted forced-hot-water heat; I suggested a warm-air system instead, to distribute the solar-heated air from the south-facing glass to the north side for greater comfort and temperature control.

Some owners have a taste for fancy components. They may want programmable thermostats, for example. Others will be happier with a simple, less complicated model. When designing the heating system, the designer should make certain of the homeowner's lifestyle needs and make a variety of suggestions whenever possible.

A Few Words on Renovation

The first principle of reworking an old building is: If it ain't broke don't fix it. Some old boilers seem to last forever. Frequently, in an older building, there is enough heating capacity to heat two buildings. Tapping into a heating system to add a room or wing can be fairly straightforward.

In most retrofits, we find that the building needs exhaust fans in the bathrooms and kitchens. Most pipes and ducts need to be insulated and the old asbestos removed in a safe manner.

Some clients with warm-air heat assume it would be a simple matter to convert to an air-conditioning system. It is not. Air conditioning requires larger ducts, larger grilles, and larger blowers than are usually used in heating systems. We recently saw a condo that had been converted to a/c and it just didn't work. The system was too small, plus the ducts were full of holes and uninsulated.

The Best System

It should be obvious by now that even using the checklist above, finding the best system isn't straightforward. A lot of the factors interact, and in a renovation, the decisions can be even tougher. Sometimes the best heating system for a particular situation hasn't been made yet. So the answer you get to "What's the best heating system?" won't be perfect, but running through this sort of checklist should help you find a satisfactory solution for your situation. ■

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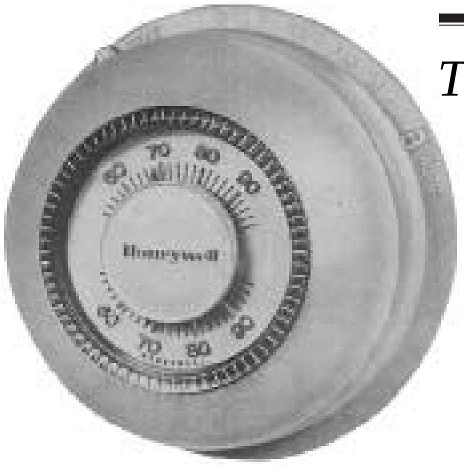
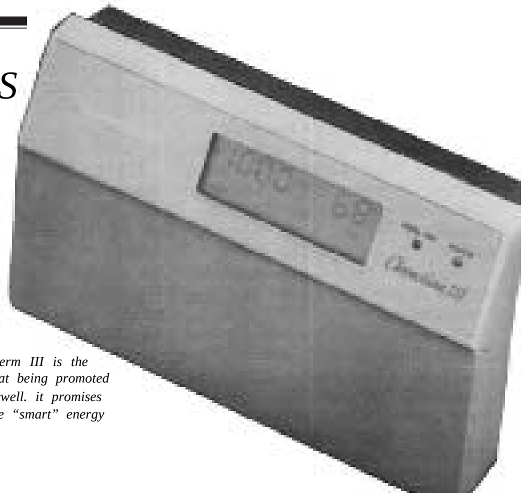
THERMOSTATS I HAVE KNOWN



Honeywell's T87 "round" thermostat has been around for 34 years, despite the prediction in 1952 that the round design wouldn't sell because it was "too different."



Chromotherm III is the newest stat being promoted by Honeywell. it promises to provide "smart" energy savings.

You can buy a cheap thermostat for under $15 that does not even have temperature settings—just "low - comfort - high," or numbers 1 through 5. (I avoid recommending these as I wouldn't want one in my home or office.) Or you can spend lots more for sophisticated, computerized thermostats that anticipate your every need.

When selecting a thermostat consider these major factors:

- Voltage
- Compatibility with system.
- Simple vs. complex (cost)

Some thermostats are powered by 24-volt current, some by 120 volts or even 240 volts (for electric heat). In large buildings they are frequently powered by compressed air. Low-voltage thermostats require a transformer. The computerized models usually have battery backup for operation during power outages.

When choosing a thermostat you must take into account what you are controlling—pump, zone valve, damper, oil burner, fan, etc. Is the thermostat compatible with the controlled equipment? Heat pumps require thermostats designed specifically for heat pumps—and check whether the heat pump is single-stage or two-stage before you buy the thermostat. Some heating/cooling manufacturers supply a thermostat with their equipment so you will have a proper match between the controller and the controlled.

Do the clients want a simple thermostat or do they want a seven-day programmable thermostat with automatic night setback? Night setback is very cost-effective with almost all heating and cooling systems. The seven-day programmable night-setback thermostat is a good investment in energy savings. In a heating system, the lower you set the thermostat at night, the more energy you will save. Just how much energy you save depends on the heating system, and what your setback schedule is, but in general a 10-degree setback will save you about 15 percent on your fuel bill. However, the heating system must have the Btu capacity to reheat the space in the morning. Some air-source heat pumps cannot recover temperature quickly in the morning and a set-back might bring on the resistance electric heat. This will cost more than you saved by the nighttime setback.

My Choices

The "workhorse" is the *Honeywell* T87. This well-known round stat is reasonably simple and sold everywhere. The T87 is available in centigrade or fahrenheit, in various ranges: 40° to 90°, 50° to 90°, 45° to 75°, and 35° to 65° fahrenheit. It is 24-volt, and is available for heating, cooling, and combined heating and cooling. With a Q539 subbase you can add other functions such as controlling Fan-On-Auto or Cool-Off-Heat, or gas air conditioning, summer fan, heat pump with electric backup, or a variety of other specialized applications. When you buy a T87, be sure to get the proper one for your application!

The big name thermostats include Barber-Coleman, Johnson/Penn and

The Digistat HP 2000 made by American Stabilis features two-stage heating and two-stage cooling controls.

The Clark stat employs automatic vacancy setback and changes to occupancy setting when you touch its "spot."

Powers. There are a zillion lesser-known brands. One of my favorite thermostats is the *Digistat* made by American Stabilis (Lewiston, Maine). They make a series of seven-day programmable thermostats—some of which are made for the "biggies" named above. The *Digistat Simplestat* sells for only $99. It has a clock, uses 24-volt power plus backup AA batteries, can be programmed for two automatic setbacks per day, and is designed for single-stage heating and cooling. It does most everything except shine your shoes. The *Simplestat* has several more complex siblings including: *Digistat* HP-1000 (heat/cool, seven-day auto switchover); *Digistat* HP-1500 (heat pump, two-stage heating); *Digistat* HP-2000 (two-stage heat, two-stage cooling).

There is also a *Superstat* that is so complex that I don't understand all it does and it costs $300 to $400 per unit.

Clark & Co. Inc. (Underhill, Vermont) makes an interesting thermostat that responds to human touch. The *Clark* can run on line voltage and it changes to occupancy setting when you touch its "spot." This is an advantage in school classrooms or public meeting rooms. It can be set to heat or cool a room for a specific number of hours after it is touched. Then it returns to the vacancy setting.

Where it Goes

Another important consideration is where the thermostat will be installed. Remember, the thermostat is a temperature-sensing device and it can only sense the temperature where it is installed—unless there is a remote bulb. Generally, we prefer an inside partition wall (not an exterior wall), out of the sunlight, and away from the direct influence of radiators, woodstoves, or fireplaces. A classic problem is when sun shines in a window and turns off the heating system while the rest of the building is cold.

Most people like to have the thermostat where it can easily be seen and used (if a manual type). For the person on the go, thermostats can be connected to modems where you can dial your phone number to reset the thermostats. We have designed these systems for expensive vacation homes.

In a multi-zone building where the client wants each room or area controlled separately, the various zone thermostats can tie into a single hot-water boiler with zone valves or zone pumps to provide individual comfort control.

The same is true for air systems. Trol-A-Temp (Elmwood Park, New Jersey) makes a good control panel/thermostat/zone-damper system for forced-air heating.

Keeping it Up

Thermostats wear out and get out of calibration. Also they need to be dusted (carefully) inside occasionally. They should be checked every few years by a technician to assure proper operation. The lonely thermostat is a vital component in any temperature-comfort system and should not be ignored. Support your local thermostat! ■

—William A. Lotz