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The potential for the computer in the design of building environmental systems

Energy and computers are probably the two most currently discussed topics in the HVAC field. Although building systems have been utilizing energy for centuries, it was not until the increased use in recent years resulting from product and system advances that did not consider energy economics as a design parameter, and the recent awareness of energy source limitations by the public that the energy parameter has come forward.

The digital computer, on the other hand, is a relatively recent development, which can handle, process, and store vast amounts of information in microseconds. It found an almost instant market in processing readily quantified variables, such as cost accounting, bookkeeping, etc. Properly programmed, it can "solve" complex problems in a small fraction of the time it would take to do so manually. In many cases, the time required for a manual calculation would be so prohibitive that an exact solution would be impossible.

Design engineers in the HVAC discipline were not quick to utilize these advantages for several reasons, thus the 15- to 20-year delay. Some reasons for this time gap are:

- Designers lacked training and skill to author or use programs.
- The need was not evident. "Successful" systems had been designed for years utilizing manual calculations.
- Fee structures discouraged improved de-

signs utilizing computer techniques at added design cost.

- Catalog data on components and subsystems in tabular or graphic form were accepted as accurate.
- Most design firms were relatively small and could not financially afford the necessary hardware.

Computer use now recognized

Numerous changes, however, have occurred in the past five to ten years that have created a vital interest in computerized techniques. They are:

- Recent engineering graduates were educated in computer programming and use techniques.
- Shared-time networks availed even the smallest firm of large-capacity computers for a relatively small terminal lease charge.
- First cost pressures accompanied by significant advances in systems concepts initiated an element of need.
- Energy awareness by the nonengineering public has opened a market for energy calculations (calculations so complex and extensive that manual solutions would be prohibitively expensive).

Enormous sums of capital were invested throughout the decade of the seventies in seeking methods to use the computer advan-

tageously in this field; many efforts failed. However, at this time a plateau has been reached from which computer technology will doubtless move into a lasting and functional pattern.

Differences are cited

One lesson learned was that there are significant differences between engineering computer programs and so-called data processing. Data processing programs are based on a well-defined set of equations, numerical relationships, or algorithms, and can be effectively written by professional computer programmers. Most programs related to HVAC however, are so complex that the *most valid programs* are written *by skilled systems engineers*, for whom computer programming is a secondary skill. Programs thus developed are a bit more cumbersome but generally valid.

Another significant difference is twofold. First, hardware capacity limitations are most detrimental. And second, logistics are such that the scheduling of the computer for performing a calculation cannot be predetermined. When used as a design tool, computerized techniques are most cumbersome if access to the hardware is not readily available. The reason for this is that a good design program does not provide the *answer; it provides valid information based on the input*. Thus, when the output is obtained, it is often necessary to study it, and then change the input as dictated thereby until the output reflects the most desirable design. (This concept has been challenged by some, but the majority concur.)

Computer improves accuracy

Another lesson learned is that HVAC system design and system analysis have been less than exact sciences. For example:

- Load calculations formerly used provided an "adequate" answer. However, when the computer was employed to quantify many judgments and approximations of the manual techniques, it was found that considerable basic research in building load phenomena was required.

- Elementary energy calculation techniques previously used, such as the degree-day and simplified bin calculations, were quickly seen to relate poorly with actual energy usage in commercial and institutional buildings because of the consumption of auxiliary systems, control techniques, and ventilation and occupancy schedules. Again, considerable research efforts to identify the algorithms were dictated.

- Fluid systems designs, classically based on standardized constants applied to the Darcy Weisbach equation and Moody's friction factors, were found to be useful only for sizing piping systems on the basis of full design flow in all branches. Again, extensive research into the dynamics of the system under varying operating conditions was dictated.

In summary, the computer is not only coming into focus as an important design tool, but efforts at its application have opened many doors indicating a need for development of the science.