TECHNICAL ENHANCEMENTS TO THE ASEAM2 PROGRAM

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ABSTRACT - Simplified building energy analysis program requirements of the engineering, programming, and user ccmnunities are reviewed. The ASEAM2 program was written to provide a more advanced public domain energy analysis package for the engineering communities, and also demonstrate user-friendly and programmer-friendly features. These ASEAM2 program enhancements are reviewed from the perspective of each of these three communities. Engineering enhancements include new Algorithms for window shading, daylighting, monthly or annual bin analysis, use of Battelle bin weather data, design heating and cooling load calculations, and the use of existing DOE-2 and ASHRAE algorithm for systems and plant calculations. Programming enhancements demonstrate modularity, linking input and output to other software packages, and incorporate many techniques for code readability. User features include a new input routine with context-sensitive help screens, default values, error checking, etc. ASEAM2 outputs include many summary reports, displaying of intermediate calculations, and the use of external files for supplementary graphing and analysis by spreadsheet programs. Finally, parametric and batch modes of analysis have been incorporated.

INTRODUCTION

In building energy analysis computer programs, there are distinct requirements for the different users. The engineer needs informative output that is easily understood, while providing answers for many complex analysis problems. The person using the computer, however, may be more concerned with user-features such as on-line help messages, documentation, defaults, error checks and messages, and screen appearance. In between these users are the programmers that try to satisfy everyone's needs, but also must develop fast, compact, structured programs which can be easily changed at a future date.

Due to a combination of events in the micro-computer industry, such as the low cost availability of more powerful "personal computers", computer awareness and education, etc., there has been a proliferation of computer programs both in the public domain and private sectors. Unfortunately, public domain programs are not always good examples of coding for the programmers, do not present understandable algorithms and useful output for the engineer, and usually lack some user-friendly features. The commercial sector programs, in order to be competitive, must address these concerns. Clearly, if public domain programs are to be useful, they also should contain these features, but, in addition, be written so that they can be easily understood and modified by others. Some guidelines, therefore, should be developed for public domain programs. The ASEAM2 program is a subtask of such an effort.

Obviously, a program that meets everyone's requirements does not exist, and ASEAM2 certainly does not claim to be in this category. However, in developing ASEAM2, a concentrated effort was made to not only demonstrate many features, but also to make the source code readable and modified easily. The remainder of this paper describes the engineering, programming, and user enhancements incorporated into the ASEAM2 program.

ENGINEERING ENHANCEMENTS

Besides incorporating daylighting and wind shading into the loads analysis, design cooling a heating loads calculations and infiltration loa (crack method and air change method) have also be included. The ASHRAE methodology for estimati design loads has been used. Conduction a infiltration loads that are driven by temperatu difference are calculated separately from t hourly dependent loads such as solar cooling loa (glass and opaque surfaces) and internal loa (lighting, people, and miscellaneous gains). estimate the design loads, the maximum hourly tot is used. Diversified loads are then determined fr the "diversity factors" for lighting, people, et and "averaged" weather conditions such as fractic per cent sunshine for each month.

ASEAM2 is capable of calculating loads c either a monthly bin basis, or the existing annu bin method may be used. Monthly and annual bi weather data may be used from either the DC AF88-29 manual (three 8 hour time blocks) or frc the Battelle bin data (eight 3 hour time blocks).

In general, existing algorithms that have bee developed, published, and documented have bee used. For example, the window shading algorithm i a BASIC translation of an ASHRAE Fortra subroutine. Systems and plant algorithms are take for the most part from the Engineer's Manual to th DOE-2 program. Equation numbers from this manua are used in "comment" statements in the ASEAM source code listing. Daylighting algorithms hav been developed using curve fits equations an interpolations from the tables and figures in th IES Handbook.

Since the added algorithms and monthly analysis required additional time, pre-processor programs were added that pre-calculate and store variables in files that are used by ASEAM2. Examples include the solar altitude and azimuth, as well as the clear sky and direct footcandle illumination on the windows for each exposure. This data file, stored spreadsheet compatible form, is calculated and red on an hourly basis for each month. If the user performs 100 analyses with the same weather data, this pre-processor file will eliminate many repetitive calculations, with an added benefit of using spreadsheet programs for other analyses.

The ASEAM2 systems calculation will allow the user to specify different systems in each zone, while combining perimeter baseboard with other systems. That is, an interior zone VAV system and an exterior zone multizone system with baseboard may be specified in the same analysis.

New algorithms have also been included in the plant algorithms for domestic hot water energy usage as well as extensions for estimating annual operating costs.

PROGRAMMING ENHANCEMENTS

The ASEAM2 source code has been designed with readability as its primary objective. This goal obviously conflicts with other desireable program features such as compact code and speed. For example, the window variables "UFACTOR", "AREA", "SHDCOEF" are assigned to elements in the input array to make the source code calculations more derstandable. This is an unnecessary step since array variables could be used in the calculations directly. Similiarly, statements within calculation loops are indented, and subroutines are easily distinquished and numbered.

In "commenting" the program internally, extensive use of in-line documentation also conflicts directly with other desireable goals. To achieve the goals of "documented" source code that can be easily modified, and program speed and compactness, multiple versions of the ASEAM2 program will be issued: an ASCII source listing of the BASIC programs, complete with in-line comments, and a compiled program. The ASCII code listing for some subprograms, due primarily to the extra comments statements and readability features, cannot directly be used by the BASIC interpreter due to the memory restriction of BASIC. However, with compression utilities, these subprograms will execute with the interpreter, but will not be very readable.

The ASEAM2 data files also are created to be readable and useable by other programs. Standard ASCII sequential files are used throughout and the contents of the file are identified within the file. Most data files, both input and output, can be edited by text editors or word processors, and many output files can be "imported" into spreadsheet programs for graphing or further lysis.

Another programming feature of ASEAM2 includes demonstrating how one program can link to other programs for either input or output. As a demonstration, ASEAM2 can read the text output file from the Controlite daylighting program and extract information useful for the ASEAM2 analysis. Output files generated by ASEAM2 could be written to be "input" files for graphic, spreadsheet, life cycle cost, word processing, and many other programs.

USER ENHANCEMENTS

Perhaps the most important "visible" features of programs are the user enhancements: the ease of getting input data into the program, the usefulness and variety of output reports, and, especially for building energy analysis, the effort required to analyze several alternatives.

The input routine for ASEAM2 includes many "user-friendly" features: context-sensitive help messages, error and range checking of data entries, movement between questions and screens through the cursor direction keys (up arrow, page down, etc.), and the use of default values. From a programming aspect, external text files are used for creating input screens. The appearance, defaults values, hi/low limits, input question wording, etc., can therefore be changed without having to recompile the program.

The outputs from the ASEAM2 program can be divided into three types: summary, calculation, and analysis. In the summary type outputs, calculation results are stored in external files and later recalled and printed by a "reports" program. In many cases, these reports will appear similar to the DOE-2 program outputs. The calculation outputs are printed to the screen or printer only and will contain abbreviated intermediate calculation details as they are performed during the calculation loops. The analysis outputs are typically calculation results that are written to files in a spreadsheet compatible format. These files are later retrieved by a spreadsheet or user-written programs.

ASEAM2 can perform analyses in both an immediate execution, single run mode, and also in a multiple run, deferred mode. For multiple runs, the user can specify several uniques analyses to be run (batch mode), or specify parametric analyses on selected input variables. The batch mode permits the user to investigate and compare changes in several variables, such as correlating energy consumption with changes in building shape, HVAC system or plant equipment types, etc. The parametric processor, on the other hand, allows the user to quickly change selected input variables for additional analyses. Examples of input variables that could be changed by the parametric processor include: building rotation, changes in wall or window U-Factors, infiltration air-change rate, minimum percent outside air for systems, etc.

SUMMARY

The primary objective in developing the ASEAM2 program was to provide well documented source code for building energy analysis that would demonstrate good programming techniques, utilize many user-friendly features, and incorporate new and better calculation algorithms. In the process of writing the source code, several "trade-off" decisions had to be made. For example, instead of writing code that is more compact and faster, source code that was readable and understandable was stressed, and floppy diskettes and limited help screens were chosen over the hard disk and expanded help screen alternative.

Although ASEAM2 can be thought of solely as another software product, it has additional usefulness since its code was designed to be inspected, changed, and re-used by the public.