Computer Based Energy Management in Buildings

ABBA CONSULTANTS

COMPUTER BASED ENERGY MANAGEMENT IN BUILDINGS

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Abba Consultants are currently preparing a series of monographs upon selected facets of energy management system technology and application. Each subject is covered in greater depth than is possible within the present volume and, further, considers the products and services of individual supply companies.

The following monographs are scheduled for release over a 2 year period. Each is aimed directly at the building automation/energy management field.

Condition monitoring and maintenance management

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The use of power line modems

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Energy conservation is vital to our world economy. Until new, low cost and renewable energy sources become available commercially, we are faced with steadily rising energy prices and uncertainty of supplies; these pressures are complemented by growing demands for improved environmental conditions in many parts of the world.

It has often been claimed - and rightly so - that investment in automation technology as an aid to energy management offers a much higher return than does investment in many other major sectors of energy conservation. The commercial availability of microelectronics, coupled with gradually increasing expertise in applying computer technology to plant automation and control, has led to a wealth of new opportunities for energy efficient operation and management of buildings and service plant.

Energy is no longer seen as a fixed overhead, to be regarded as are rates and rents. It is both a variable cost item and one which, after years of neglect, is highly amenable to improved management, discipline and control. Each pound saved on energy costs becomes one pound extra profit and results, in turn, in increased equity values.

The present plethora of equipment and systems aimed directly at this important but narrow sector of the automation market has opened many new doors for those seeking to use this technology to reduce energy consumption and costs. However, the path is not an easy one for those lacking extensive experience in the energy management field. Whilst the fruits of success are considerable, the consequences of failure are costly and can result in a determination thereafter to avoid other than the simplest steps to reduce energy consumption; the opportunity is then lost for some years to come.

This book, the first major work of its kind, is intended to increase understanding and awareness of building automation systems to stimulate fresh thinking and to raise the prospects of successful, cost effective use of automation techology for energy management purposes. It does ot provide every answer, for the whole field is in a state of transience. However, it should do much to aid the building operator, the energy manager, the professional engineer and the prospective supplier to become conversant with the technology, its application and its practical implementation. It is not a book for the academic and is not based on concepts or theory. It is essentially a text for the practitioner, presenting much of the collective experience of Abba Consultants gained through assignments and investigations in Europe, North America and the Far East.

The text is presented in the form of an overview followed by four Parts plus appendices, any one of which may be read without cross reference to others. However, the four parts combine to present the subject of automated energy management in its entirety and therefore inter-relate closely at both a technical and management level.

PART 1 TECHNOLOGY

Part 1 deals with the essential technology of computers and computer systems of the type employed for building automation purposes, moving on to a detailed discussion of the primary characteristics and features of building automation systems.

PART 2 APPLICATION

Part 2 deals with the techniques and routines available for applying that technology to the problems of energy management in buildings and, in lesser detail, to the monitoring and control of other building services. Modern, soft systems are growing increasingly variable intheir function and a wide variety of special purpose routines may be appropriate in particular cases. For brevity, therefore, Part 2 concentrates upon routines of a standard nature. The content of Part 1 should provide a sufficient base for augmenting the standard routines by special facilities appropriate to individual requirements.

PART 3 IMPLEMENTATION

Part 3 deals with the many tasks, factors and issues which arise in the lengthy process of system implementation. It is in this area that the majority of problems arise, primarily due to neglect by the prospective system user of fundamental rules and requirements.

PART 4 SUPPLY

Part 4 contains a list of the system suppliers now active in the UK and USA. It makes no claim to be comprehensive for the present spectrum of supply is extremely wide and varying day to day.

APPENDICES

Ten appendices on specific technical/commercial items amplify specific areas of the foregoing text. Their contents may be found elsewhere with diligent search but have nonetheless been brought together within this text for the convenience of the reader.

COMPUTER BASED ENERGY MANAGEMENT IN BUILDINGS

PART 1: THE TECHNOLOGY

1 THE COMPUTING SPECTRUM

2 SYSTEM CONFIGURATION

3 SENSORS AND ACTUATORS

4 FIELD EQUIPMENT

5 COMPUTING HARDWARE

6 COMMUNICATIONS

7 SOFTWARE

8 THE TOOLS OF CONTROL

PART 3: IMPLEMENTATION

1 MANAGEMENT ROLE

2 INITIAL INVESTIGATION

3 FUNCTIONAL SPECIFICATION

CHAPTER 1
THE COMPUTING SPECTRUM

1.1.1. INTRODUCTION

Part 1 of this book concerns the technology of building automation systems. It opens with a comment upon computers in general; the purpose of this is to indicate the type of computers applicable to building automation and where these fit into the overall spectrum of computing. It is in no way intended to explain how computers function or what they contain for there are many excellent books on these subjects.

The second chapter outlines some of the considerations and concepts applicable to the architecture of distributed computing systems and, more specifically, to building auotmation systems. Later capters concentrate upon specific aspects of the technology: sensors and actuators (Chapter 3); field equipment (Chapter 4); computing hardware (Chapter 5); communications (Chapter 6); and software (Chapter 7). Chapter 8 is concerned with control methods which are available for tackling the energy management problem. Finally, there is a brief discussion (Chapter 9) of computer based modules which are dedicated to particular, rather than general, energy management tasks.

However, the present chapter is concerned with computers in general. This is a wide subject indeed and one which depends very heavily upon the technology of microelectronics. The term thus features prominently, not only in the present chapter, but throughout this book.

The types of computing system are many and varied. So also are their applications. However, diffuse as it may be, there is a pattern which relates the two and it is this which should now be explored. The whole computing spectrum may be partitioned into several categories, each of which is self-contained and well established. It is important to list these categories, for only then can the equipment which relates to each be considered within a proper framework.

Firstly, there is the traditional area of batch data processing. Jobs, i.e. programs together with data to be processed by those programs, are entered via some form of peripheral device when the computer is free to begin the processing or when it releases a peripheral to commence the input function. All input is on punched cards or similar media or it may already be available on some form of backing store such as a tape or disc. When a job is

completed, the results are printed or sent to backing store for later access. Batch processing is used extensively for many forms of commercial operations and for technical/scientific computations. Programming is generally in a high level language, typically Fortran for technically oriented jobs and Cobol for commercial purposes, and supported by a wide range of standard software. The machines used in this way vary enormously in power and cost and it should be noted that the simple pocket calculator is itself a batch processor.

This approach is extended by placing input/output terminals remote from the computer such that jobs can be run from those terminals via fixed cables or telephone lines. The use of these remote job entry (RJE) terminals removes the need to take the job to the computer for processing. However, processing is still performed in a batch mode, even though in this case, as in that above, the machine may well be able to accommodate more than one concurrent job stream.

The use of RJE terminals is only one step away from using a small data processing system to meet local requirements e.g. at a branch office, and calling on a head office large computer for extra processing power and for integration and coordination of the functions of the smaller systems. The latter act exactly as RJE terminals as seen from the central machine or mainframe and may be anything from intelligent terminals to small to medium mainframes systems in their own right. The term 'mainframe' is used here to distinguish these computers from the mini or microcomputers noted later. This approach is one of distributed processing, a technique which is rapidly gaining ground in many organizations which, having established monolithic data processing empires in a move towards centralization some years ago, are now changing course and giving local centres as much autonomy as possible. The universities for example, although for rather different reasons, have moved well away from the use of a single large centralized computer; they now prefer in-house medium power minicomputer systems linked to a downgraded but nevertheless still large mainframe.

One may then move to a time sharing system in which a number of low speed terminals communicate directly with the mainframe and operate under a time sharing executive. The executive software services each

terminal according to a given priority structure so that the processor tackles a small portion of a job before temporarily dumping the interim results to backing store and moving to the next job in line. These systems are usually, but not necessarily, associated with the use of interactive or conversational languages by means of which the user can develop his program on the terminal; the consequent saving in elapsed time is considerable. The input at the terminal is usually from a VDU/keyboard, paper tape or cassette tape and the output arrives similarly. Time sharing systems are generally applied to technical and scientific data processing rather than repetitive commercial functions. Facilities are available from a number of major computer bureaux, perhaps the best known being that operated by Honeywell in which processing is performed within a massive computing network spread across the globe. In this and similar cases, the user has effective access to nearly unlimited computing power and storage areas, albeit at a high cost. Also, many medium sized in-house mainframe systems now offer internal time sharing facilities. With teleprocessing, one returns to the commercial field. A number of enquiry terminals are linked to a mainframe computer, often via some intermediate computing stage. These are usually simple keyboard/VDU stations which are used for interrogating a data base located on the central machine or for accessing a program which is located centrally. Examples include an airline reservation system; a stock exchange enquiry system; and stock control systems now used in many large production organizations. The terminals are serviced by the computer to which they are attached under the control of a program called a teleprocessing monitor. This program allocates priorities to the servicing of each terminal in order to minimise the response time. It is this response time i.e. the elapsed time from making a request to receiving a reply, which determines the success or otherwise of a teleprocessing system. The central computer operates in much the same manner as in the previous case of time sharing applications, both being multi-access or multi-user situations. However, as noted, it is only in the teleprocessing case in which speed of response, as distinct from job turn around time, is vital.

So far, mention has been made only of those situations in which data is fed to the computer from a simple peripheral or from another computer. One now turns to the use of a computer for monitoring and controlling

equipment such as process plant. Here, the input data is of three types: analog signals from sensors which indicate the plant status; digital signals which do likewise; and instructions or commands from the process operator. The analog data is converted to digital signals by the computer; the various input channels are scanned sequentially; and the incoming data is stored in memory ready for access by the programs which determine how it is to be processed. On output, the converse applies, the computer sending either digital or analog signals to the plant where they drive actuators, contractors and so forth. In these applications, the monitoring of input data and the generation of output signals is often the major task with the actual data processing programs being relatively simple. In some situations, however, these programs can be extremely complex, especially when the control method to be applied depends on some complex algorithm. In very many cases, the computer has to be linked to a time base which is synchronized with that of the plant - i.e. it is driven by a 'real time clock'. This enables it to access plant data at regular or predefined times and to respond to time dependent instructions from the operator.

The type of computer used for these applications is very different to those used for the purposes outlined previously. The various forms which it may take when built into a working system are discussed later and it is necessary to note here only that they are today based almost entirely around mini and micro computers, even though those devices are not used exclusively for control applications. One may also note that the present category of computing may include a simple electronic washing machine controller; a large system operating a petrochemical plant with the aid of perhaps a single operator; or a computer controlling a radar scanning system on board an aircraft.

Finally, a meaningful distinction can now be made between the terms 'off-line', 'on-line' and 'real time'. A batch data processing system (and its several variants) operates off-line in that it is a stand-alone system with no external input other than the customary range of peripherals. Time sharing and teleprocessing systems communicate with terminals which require to be serviced within a short time from that at which a request or other input is made. They are said to be on-line terminals. The RJE facility is often termed on-line also but this is incorrect. Real time, i.e. an ability to operate within an actual time framework, is a term confined