Office Automation Using the IBM Personal Computer Systems

Including IBM Compatibles

Ross Burgess and Joseph St. John Bate

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Preface

Office automation has been a 'buzz word' for years. Sometimes it is in favour, sometimes not, but it has always seemed to be just on the point of arriving: largely because there was no clear definition of what office automation was, and how it could fit into a corporate computing strategy. Today the position is changing, and it is the personal computer that is bringing about this change.

The IBM Personal Computer has now reached the stage of being a mature product, with a well-structured and developing product line. Competition from the makers of 'compatibles' has added to the variety of machines available, and has provided an incentive to IBM to keep its prices low and its products competitive.

The PC today provides the ideal multi-function office workstation which, together with all the extra facilities and standard software, will help bring the true automated office into existence. A number of developments have helped to bring this about, in particular:

- the good software packages that are now available
- the stabilising of the local area network scene now that IBM have announced their own products
- the availability of a realistic multi-user, multi-tasking PC (the PC-AT) and the software to support it (XENIX)
- the continued drop in prices, to the point where a PC compatible machine can now be bought for less than £1000.

For all these reasons, we believe that the day of the automated office has finally arrived.

In the course of this book we mention many products, hardware and particularly software. There is a vast number of others that we could not mention, many of them no doubt excellent. It is impossible to avoid bias in selecting a few for illustration from so vast a number: we are biased in favour of the products that we know work, and especially the small number of software tools that we have used in our business life and in the writing of this book.

Another point to remember is that the major products are constantly being upgraded. If we list the features of a package, it is quite likely that it will have additional ones by the time you read our list. When selecting a product for your own use, there is no substitute for trying it out, to make sure that it does what it claims to do, and more importantly that it does what you need it to do.

Finally, we would like to express our thanks to Alan Wood, and our past and present colleagues at Digitus, for providing the environment in which we have been able to observe the IBM PC and office automation at close quarters. Special thanks are due to Olivier Saurin and Wasfi Kani: they will recognise their own contributions.

Ross Burgess and Joseph St. John Bate

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Chapter One
What is Office Automation?

The grey box housing the IBM Personal Computer is changing the face of the western world to an extent that most people cannot imagine – even those who have such machines on their desks. The invention of the computer gave us the potential to change completely the way office work is carried out, but it was the *personal* computer which brought this potential within the reach of most organisations. IBM's personal computers have set a standard that is being followed by many other manufacturers, and will therefore spread this influence even further. In the office these changes will be awesome, and will change the way in which fifty per cent of office workers carry out their tasks. The turmoil will be comparable to the first industrial revolution.

Over the years, automation has affected many types of workers, for instance those in factories and on farms, transforming the nature of their work completely, until today we have motorcars 'designed by computers and built by robots'. In the office, automation has brought some changes already, but the changes that will come in the future will be far more significant and affect far more people. Many of these people are as yet quite unprepared for the changes that will come.

As time goes on, computers come to affect more and more aspects of life. In early days of computing, the main applications were for research and scientific purposes; next computers were adopted for commercial data processing. At this time the tasks to be automated were very clearly defined, and were intended to fulfil a specific purpose· producing the company's payroll, printing its invoices, analysing the accounts, and so on. But as computing power has become cheaper, so it has been utilised for new classes application, much more open-ended in nature: tools for optional use, rather than 'systems' to be fitted in with. Amongst these less structured applications, office automation will be one of the major growth areas of the 1980s and 1990s.

Office automation

The term 'office automation' has meant different things at different times. At one time it meant the automation of clerical and administrative tasks by data processing. Office automation in this sense was extremely successful – in most large companies today the computer has taken over many of the tasks which would once have been done by thousands of clerical workers. In all large organisations, and even many smaller ones, the main repetitive tasks – calculating the payroll, typing invoices, posting sales to the sales ledger, keeping track of stock levels – are all carried out by computers.

The tasks that remain in the office, not yet computerised, are those which are not structured and repetitive, those that need decisions to be made. Automation will not

remove the need for the human touch in this sort of area – at least not for some years yet – but it can and will do much to assist the people who make these decisions, and enable them to make better use of their time.

So successful was 'office automation' in the original sense that the phrase itself disappeared from view for a number of years to reappear in a new guise in the 1970s. By this time the idea of automating clerical work had become commonplace, and the need was to assist other classes of office worker – the secretary, the manager, the professional worker. Office automation therefore came back into vogue as a subject for books and seminars, with notions such as 'the paperless office', 'the electronic office', becoming all the rage. But for all the talk, little happened. The technology did not exist at a reasonable price – indeed it has only just begun to exist today. It is the personal computer, the key invention of the 1980s, that has finally begun to make it happen.

Office automation for the typist

One area in which office automation has had some success is word processing. A word processor does not take away the need for typing – at least not yet – but it does make the typist's job much easier. Some typists are hesitant about accepting word processors at first, but we have yet to meet one who has not got used to word processing and would agree to going back to a typewriter!

Word processing is part of office automation, but only a starting point. One of the problems with word processing in the past was the word processing machine, which was big and expensive, difficult to learn how to use, and did nothing else but process words. Word processing's full benefits are realised when it is integrated as part of a total office system so that, for instance, as well as being recorded electronically, a document is filed electronically and distributed by electronic mail to its destination. To achieve this requires the use of machines which are far more flexible than the word processors of the past. Indeed, today's word processor is not a machine as such; it is a software package, and one which will run on a general purpose computer. Among such computers in the office environment, the IBM Personal Computer is by far the most significant.

Office automation for the manager

Word processing benefits the secretary and the typist most directly; but office automation is coming to touch the working lives of managers and executives as well, and it is the personal computer that is bringing this about. For managers, it is not word processing that has provided the starting point, but the electronic spreadsheet and the integrated packages that have grown out of it.

As yet there is little consistency between one organisation and another. A recent survey of managers found that in some companies all the senior management had PCs on their desks, while in others not one of them did. On average, about half the managers surveyed made some use of PCs at work, and half of these in turn used them at home as well. The most widely used application was spreadsheeting, followed by report writing and communication with central computers to obtain data.

Thus we can see that there are three strands that go to make up the automated office:

the processing of text and words; the processing of numbers in spreadsheets; and communication between one person, or one machine, and another. In all of these areas, the personal computer is ideally suited as the user's window onto office automation.

The importance of information

We have mentioned hardware and software, but these are only means to an end. Of course software and equipment are an important and necessary element of the office automation equation, but they should never be considered as the prime elements. It is *information* – the way it flows through an organisation and the form in which it is presented – that is important. The office is the information centre of any organisation. Office automation, therefore, must above all be directed to improving the flow and the effectiveness of information.

What is information?

There are a number of definitions of information. The simplest definition is that information is useful data. The difference between data or inert facts, and information or facts that satisfy a requirement, is not in the data itself; it is in the question that is asked.

A good example is a telephone directory. It contains millions of items of data in the form of names, addresses and telephone numbers. This inert data does not become information until you ask a question: for example what is the telephone number of such and such a company. In providing the answer to the question, the inert data becomes information. But look what happens if you have a telephone number and want to find out the name and address it belongs to: the data certainly is contained in the telephone directory; the question certainly can be asked; but it is almost impossible to obtain the information because of the way in which the data is arranged.

This highlights a major problem in many offices: a lot of data is stored in filing cabinets under the misapprehension that it is information. In reality the data is often filed in such a way that it is impossible to obtain answers to the questions asked. It is inert or useless data. One of the benefits of office automation, if properly organised, is that databases can be constructed using the versatility of the computer system, so that data can be accessed in many different ways and turned into valuable information.

Processes in the office

Another way of looking at the office is to examine the various processes that take place, the ways in which they interrelate, and the skills used by the various office staff to carry out these processes. A number of processes are involved, ranging from the creative powers of thought through to the decision that information should be discarded.

Creation as the starting point

The starting point for information often involves the creation of ideas, the thought process. In many instances, if someone is staring into space when they should have been 'working', they are in fact carrying out the creative task of thinking.

No computer system can be a substitute for thinking. However, today's software, available on personal computers, can assist the process in many ways. For instance, a manager may be worried about possible changes in exchange rates, and wonder how these will affect his costs and revenues. A spreadsheet program on a PC can be just the thing for working out the implications of a 'what if' question, taking the raw data and manipulating it until it becomes information which can be put to use in decision making.

The result of this creative process or act of thinking is usually to formulate a response to a situation. It should, however, be borne in mind that barely ten per cent of a manager's time is spent in this process: the bulk of the time is spent communicating the results. It is unfortunate that successful managers, who can both think creatively and also explain and communicate, are so rare.

Many people have difficulty in organising their thoughts in the best form for communication. Maybe they jot down notes on pieces of paper, and keep adding new points until the paper becomes an illegible scrawl and they have to start again. A software package for the PC, such as the 'ideas processor' BrainStorm, can be just what they need to get their thoughts organised, so that they can build up the basis of a speech, a memo, or a report.

Presenting information

The next process is to communicate the information. There is no point capturing information unless you are going to communicate it in one form or another. There are many ways of communicating information, each requiring different skills. Many people involved in these areas have not acquired the skills. Their performance suffers because of this, as does the performance of those to whom they wish to communicate. There is nothing worse than having to sit through an ill-prepared speech by an incompetent speaker. But in terms of the cost to business, in wasted time and missed opportunities, failures in the use of the written word are far more serious. In our own business of computers and new technology we have seen all too often the disastrous consequences of inadequate specifications and missing or out of date documentation.

Again, personal computers can help. No PC at present can make a speech for you, but any talk is helped by well-produced visual aids. A program such as Overhead Express can enable you to produce professional-looking foils for an overhead projector, in a fraction of the time, it would take you to use Letraset and stencils, and at a fraction of the cost of employing a professional to produce artwork. And, of course, if you make a mistake it is simplicity itself to correct it.

Again, no word processor can proofread your text to ensure that what you have to say is well written – but at least it can check for spelling mistakes, which can be very destructive, annoy the reader and distract him from the message you are trying to convey.

Sending the message

Once the document or piece of information has been prepared, the next process in the chain is sending the message. Traditional methods of sending information are by internal or external post in the form of paper, or by the telephone in the form of voice. Both of these methods have built-in inefficiencies, from the slowness of the paper-based system to the inflexibility of the telephone.

The most time-consuming and expensive method of communication is to send the information in someone's head to a meeting or conference. It can be very effective, provided the preparatory processes have been thoroughly carried out, but it is exceptionally expensive. Whether it is cost effective or not, of course, depends on the circumstances: at a certain point in business discussions, there is no substitute for a face to face meeting.

The personal computer offers us new forms of communication, which can get the message across quickly and accurately without the frustrations of the telephone, or the need to rely on the postal service. Such means of communication are in their infancy, but in the remaining years of this century they will become more and more important. Ultimately, the standard means of communication will become electronic, desk to desk. And it is the universality of a desktop electronic workstation, based, we believe, on today's personal computers, that will make this possible.

Information reproduces itself

There has always be a need to reproduce information for distribution. In the past, methods of doing this were rather primitive, ranging from carbon paper, through spirit copiers, to hot metal printing techniques. The restrictive nature of these technologies controlled the extent to which paper-based information could be duplicated.

All this changed dramatically with the development of the photocopier and the computer. The amount of paper swimming around our offices has been doubling every seven years, and this during a time when so-called informed commentators were forecasting the advent of the paperless office. The amount of paper in circulation is threatening to cause a thrombosis in the office. By making use of electronic filing and distribution, sending a message to a person's PC rather than a piece of paper to his desk, we can begin to stem the ever increasing tide of paper.

Search and retrieval

The way information is stored in paper-based files makes information retrieval a highly complex and difficult task. Filing is vital, since information retrieval depends on the accuracy and logic of the way it is stored. It is hard to understand why so little care or thought goes into the filing of information, but the result is that it is difficult or impossible to retrieve. It might as well have been thrown into the waste paper basket if it cannot be found when it is needed.

Another problem is the form of the information itself. Most people, when writing letters or documents, think only of the immediate need. They forget that other people at

a future date may need to read the document, and may be totally mystified by it. A few additional words to put things in context would make all the difference.

What can office automation do to help? Today there is no need for information to be inaccessible in filing cabinets. Today's database management systems, running on small computers as well as large, can help you to find the sales figures for a particular customer, or the overtime worked by a particular employee, very quickly. If we are talking about information in letters and memos, then using the search facilities that come with advanced office automation systems such as Q-Office or Samna+, it is possible to scan through all the letters on file, looking for the one which dealt with a particular subject.

The purge

In the office a great deal of time is spent gathering information but in the end much of it has to be discarded. However, this is a task that in many cases is not done until death, retirement or some other major event. The result is that acres of expensive office space in some of the prime city sites are cluttered with files of information that are of value to no one. The problem is not only the bulky nature of paper but also the difficulty in knowing which files should be thrown away and which retained. Everyone knows that eighty per cent of all information filed will never be looked at again; the problem is to know which eighty per cent.

Office automation will not solve these problems. What it can do is help provide a framework to speed up and assist the flow and processing of information; provided, of course, that it is carefully introduced. Office automation will only work if the existing information flows within the office have been carefully studied, so that the new system can assist those areas where help is most needed, and where better or faster information will best benefit the aims of the organisation as a whole.

What is remarkable is that the various parts of office automation we have discussed are today available on personal computers. For some applications, of which word processing is a key example, using a personal computer is far preferable to sharing time on one of the big computers of the past. It is personal computers that have brought office automation from an academic theory to a reality in so many organisations already; and it is the standardisation that the IBM Personal Computer has brought that will enable office automation to develop much further in the future.

The workstation

A key concept of today's computing scene, as office automation and networking become more important, is that of the *workstation*. All office workers need a machine on their desk, which can give them a window onto the electronic office and a gateway to communication with other people in their organisation or outside. The telephone does this already for voice communications, and many office workers would find it impossible to cope without one. In the same way in the future, no office worker will be able to cope without an electronic workstation. Such a workstation can do many things – it can replace the typewriter, the pencil and paper, the telephone directory, the calculator, the diary, the in-tray and out-tray, the price lists and reference books, even the telephone itself.

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Of course, not every worker will want the same sort of workstation: some will need voice input and output, some not; some will want a big display screen with colour, others will be satisfied with monochrome; some will want a large-capacity disk for storing data, others will make do with a floppy disk, or a share of a disk on a network; some will want a printer attached to their workstation, others may use a network printer, or have little need for printing at all. Some will want a workstation they can put in the back of the car and take to site visits, or even one they can put in their briefcase and use on the train or aeroplane.

Despite the differences, all the workstations in an office must be fundamentally compatible, able to exchange information with one another, and able to run the same software if need be, so that if the machine on a manager's desk breaks down, or if he is away in a branch office, he can use the workstations where he happens to be to record messages and view his incoming mail. So what we need is a 'family' of workstations, some optimised for managers, others for secretaries, clerks, professional workers, but all following the same underlying standards. Such a family of workstations is now available. The success of the IBM Personal Computer, and the 'IBM-compatible' machines from other manufacturers that follow the standards IBM has laid down, means that a family of different types of workstation, adapted for different purposes and different classes of user, now exists. It is this fact above all that is now bringing the automated office into existence.

But a workstation on its own is only part of the story. The full potential of office automation comes with networking and communication, allowing the various workstations to 'talk' to each other and to the outside world. Some of the office tasks that automation can help with are essentially handled by an individual, such as word processing; others, such as electronic mail, only make sense when shared by several people. A large part of office automation involves a single individual performing his own work on his own data. Only at specific points in his work pattern does he need to interact with other elements in the system (say to receive or transmit a document or data file). Office automation thus has a semi-solitary aspect, which is one of the things that distinguishes personal computing and office automation on the one hand from mainline data processing on the other.

So the ability to share data and communicate is important, but it is still more important that the workstation on a person's desk should have its own intelligence, and be able to work in isolation if necessary. Thus for office automation, the traditional data processing solution of a large mainframe or minicomputer is just not satisfactory or cost effective. Office automation needs a combination of two types of machine: individual workstations with the power to provide a good response in screen intensive applications; and file servers with multi-user facilities for centralised filing, mail, and communications.

The future of office automation

The automated office has so far been slow in arriving. The need has been apparent for a long time, but the costs of equipment, and the incompatibilities which prevented one machine from talking to another, have slowed the introduction of office systems. Another problem has been the lack of understanding of office systems and what can be achieved. Who would have thought, ten years ago, that the electronic spreadsheet would today be

one of the most import desktop tools?

Today the pattern is changing, as machines become cheaper and more standardised. Several years ago we surveyed the office scene, and were told by a major organisation that they would like to put a workstation on every desk, but only when the cost fell below £1000. Today a personal computer costs less than this magic figure, and it can take advantage of the enormous amount of software developed for the IBM PC. It is from now on that the growth of office automation will really start. Our own work as office automation consultants bears this out, while IBM's own predictions show the growth they expect in this respect:

Industry sector	*Employees per workstation*	
	1985	*1990*
Asset management	40:1	10:1
Administrative and clerical	5:1	2:1
Business outlets	20:1	4:1
Professional staff	4:1	1:1
Data processing staff	2:1	1:1
Engineering and science	7:1	1.5:1
Text handling (including secretaries)	4:1	1:1

So we see the number of workstations set to increase dramatically in the next few years. Moreover, the IBM PC will account for an enormously large proportion of these workstations. Various sources have calculated that in 1985 IBM had 40 to 50 per cent of the personal computer market, and the figure was expected to rise to 65 per cent by the end of 1986. In large corporations the figure is even more striking: a survey has concluded that 72 per cent of PC purchases in this market in 1985 were from IBM.

On the basis of these figures, there is clearly an enormous future for information technology. Of one thing we can be sure – that IBM, and the IBM Personal Computer, together with the IBM compatibles, will continue to account for a very large share of this market.

Chapter Two
The Importance of the IBM PC

Over the last few years there has been much talk of office automation, the 'office of the future', the 'paperless office', and so on. In practice, little has really happened as yet in most organisations. Recently a new factor has emerged. The IBM Personal Computer, which has made the very concept of personal computing respectable in business circles, now has the capability to play a part in promoting true office automation in the same way.

The world will never be the same since the introduction of the microcomputer. At first it it was games that were affected; now it is the way in which we carry out our day to day work in the office.

The world of the microchip

The computer and the microprocessor are the basis of many aspects of office automation. Electronic computers are only forty years old, and they have been in widespread use for only twenty years. For most of this period a computer was a big and expensive piece of equipment. Moreover, the tasks it was designed for were not at all typical of most office work. It was suitable for batch processing, in other words for being fed with a very large number of transactions of the same type – sales, overtime hours worked by employees, and so on – and then being left to process the data and produce printed output for someone to pick up later. The image that is still so often projected in films and television of the computer at work features a magnetic tape drive whirring away, as one transaction after another is processed in turn. This approach never really fitted office work: clerical functions had to be fitted in with the batch computer processing, but this meant that much of the flexibility of the traditional office was lost. Secretaries and managers were more or less unaffected, except when they received the masses of computer output and wondered what to do with it.

Today's computer systems are very different. Magnetic tape still has its place, as a means of taking backup copies of data in case it is lost, but the main storage medium is disks of various types, which can allow access immediately to *any* customer's record, not just the next one on the file. In place of punched cards for input and masses of paper for output, we have the keyboard and the visual display screen. In many cases the computer itself is now on your desk, rather than locked away in a 'holy of holies' that you are not allowed to enter. The new computer technology allows the computer to work at the user's pace, not the other way round.

Modern computers could not exist without solid-state technology. The solid state revolution started with the transistor, invented by Bell Laboratories and available from about 1956; it continued with integrated circuits and then large-scale integration (LSI), combining many transistors or other devices on a single piece of silicon; finally leading to

the microprocessor, the computer on a chip.

The microprocessor is, of course, not just an office device; it is one of those few inventions, like the wheel or the alphabet, which is truly a general purpose device. Microprocessors are more and more coming to be embedded in factory equipment for control purposes; they are appearing in the home as part of washing machines and other appliances; they are even being used in motor vehicles: anywhere there is a need for a process to be controlled in response to varying circumstances. But the most obvious use is as part of a computer of one sort or another. Generally, the microprocessor is the central 'brain' of the computer. It takes a chunk of data at a time from memory, processes it according to the instructions in its program, and writes the result back to memory. It is the size of this chunk of data which prompts the classification of micros as 8-bit, 16-bit, and so on.

The advent of the microprocessor has revolutionised computer design: computers can now be made much smaller, much cheaper, and much more reliable, and thus the personal computer has been made possible.

The first microprocessor was the Intel 4004, which came out in 1971, followed next year by the first 8-bit microprocessor, the 8008, and in 1974 by the 8080. Since then there have been remarkable increases in speed and power, and other manufacturers (Motorola, Zilog, and others) have produced other microprocessors. But it is Intel (now partly owned by IBM) who produced the 8088 and its relatives, the basis of the IBM Personal Computer.

The micro has come of age

The term 'personal computer', or 'microcomputer', can give a misleading impression to many people, suggesting a machine used for playing space invader games, rather than today's business micros. In fact, microcomputers now come in many types.

We can define a *microcomputer*, or rather a *micro-based computer* as a computer whose central processing unit is a single-chip microprocessor. This covers a very wide range of machines, single-user and multi-user, 8-bit, 16-bit, and 32-bit.

The original generation of micros used 8-bit processors, such as the 8080, and were limited in their capabilities. Even so, many organisations used them very successfully for solving business problems – for stock control, accounting, word processing, and so on. Using micros meant a drastic reduction in the cost of hardware; moreover the market for software became so large that it was worthwhile for manufacturers to expend a lot of effort to produce a package that would sell cheaply in large numbers.

Another factor in the early days of micros was the existence of an 'industry standard' operating system, in the shape of CP/M (control program for microcomputers), which was available on all computers using the 8080 or Zilog Z80. CP/M opened a wide market on a number of machines, and provoked software suppliers to produce a wide range of software packages. Indeed the 'industry standard' is a key concept in microcomputing. In order to be accepted, a software package must be priced low – the price is falling all the time – and this means that the suppliers can only recoup their development costs if they can sell a very large number of units. If all the machines are totally incompatible, and need software to be developed specially for each, this mass market cannot develop, and a wide range of good software can never appear.

So it was CP/M, in the first place, available on so many different machines, that promoted the the growth of so much 'generic' software such as word processors, data managers, and spreadsheets.

There is still a place for 8-bit micros in business – a CP/M-based micro with screen, keyboard, disk drive and printer can now be bought for a price which would have bought a home machine with no screen or disks a few years ago – but 8-bit machines are now definitely a backwater of computing, useful only for the very small business not needing any more power or capacity. The mainstream of the business micro market has changed fundamentally since the heyday of CP/M.

Recent developments in microcomputing

Four developments have changed the face of microcomputing over the last few years: 16-bit processors; networking; multi-user systems; and finally the entry of IBM into the personal computer market.

Networking dramatically extends the power of the micro. In the office automation area, it allows multiple users to share files, share data, and exchange messages. More generally it allows the equivalent of mainframe computer power to be built up from smaller units.

Multi-user micros are now available for many of the situations where a minicomputer would previously have been required. Again the low cost of the micro is making a whole area of computing available to a new class of users.

The *IBM Personal Computer* has had a dramatic effect, particularly in making the concept of microcomputing respectable. It has set an 'industry standard' in the 16-bit single-user area; it has led to new developments in networking; and the PC-AT, with XENIX, will give effective multi-user capabilities at last to the very small business.

Today, therefore, the micro-based computer needs to be taken seriously. It is no longer a toy; it is a key part of information processing in many companies, and increasingly the starting point for office automation.

Sixteen-bit micros came and won

We have talked about 8-bit and 16-bit computers, but this needs a little further explanation. Microprocessors are generally classified as 8-bit or 16-bit, but this is an over-simplification: we really need to look at several different aspects to get the full picture. The 8-bit/16-bit distinction refers to the size of the data bus, that is, whether the basic chunk of data that the microprocessor deals with at a time is one byte (8 bits) or two bytes (16 bits). On this basis, the 8080 is an 8-bit microprocessor, the 8086 is 16-bit.

By the time the IBM PC appeared, it was clear that a 16-bit microprocessor would be at the heart of any new personal computer system. IBM had used the 8086 in the Displaywriter word processing machines, and this chip might have seemed an obvious choice. In fact the PC, when it appeared, was based on a lower-powered version of the 8086, the 8088, which has an 8-bit external data bus. The 8088 provided a bridge to the previous generation of micros, and made it possible to use some of the many 8-bit auxiliary chips that were available. It is a moot point whether the 8088 should be regarded as an 8-bit or 16-bit processor, but internally it is identical to the 8086, which is a full 16-bit processor.

The 8088 is by no means the last word in microprocessors – in some ways it already seems a little old fashioned – but the most powerful member of the PC range, the PC-AT, uses the next generation of the same family of microprocessors, the 80286, which is substantially more powerful.

More important than the data bus size, in most cases, is the size of the memory that the microprocessor is capable of addressing. This is determined by the size of the address bus. 'Eight-bit' microprocessors normally have a 16-bit address bus, allowing them to address any one of $2^{16} = 65536$ memory locations (referred to as 64K), each location being one byte. Sixteen-bit micros, on the other hand, have various sizes of address bus, or have other ways of increasing the memory they can address. For instance, the 8088 has a basic address bus of 16 bits like the 8080, but in addition has 4 more bits available, so that it effectively has 20-bit addressing, allowing it a theoretical memory space of 1024K, or one megabyte. In practice, a rather smaller amount – up to 640K – can be installed as main memory in the PC. Because of the way the chip is constructed, however, memory has to be treated, for some purposes, as ten chunks of 64K, rather than a continuous address space of 640K.

Some computers, of course, have still larger address spaces than this: for instance the IBM mainframes, in their XA (extended architecture) mode, use 31-bit addressing, while the IBM System/38 is designed to support a 64-bit addressing scheme, which would allow the machine to address every byte of all the disk space ever manufactured.

Of course, the theoretical address size for a microprocessor is not the same as the actual memory size of a particular microcomputer, but that is not the point. The difference between 64K and, say, 256K is enormous in terms of the power of the software that can be supported. Even on home micros, suppliers are finding 64K (ROM plus RAM) too restrictive, and are devising ways of bypassing this restriction. For business use, and particularly for office automation, a large memory is essential. Larger memory makes possible the use of far more powerful software than was previously available. This extra power can be used to give increased speed, but more significantly it opens up new possibilities, such as providing a more user-friendly appearance, linking multiple applications together, and allowing multiple users to use a single machine simultaneously.

A key advantage of the IBM PC in the early days was that its main operating system, DOS (also called MS-DOS or PC-DOS – we will discuss the complications of the terminology later) was, in its first version, very similar to CP/M. It was not difficult for software houses to convert their existing CP/M software, so that there was a ready made source of software packages – the word processor WordStar, used to type a large proportion of this book, is a prime example. Later, of course, these packages were much improved, and new ones were written to take advantage of the extra features of the PC, so that now it has an enormous range of its own software, far superior to anything on CP/M. Indeed, the influence of the PC has meant that in some ways (disk formats for example) DOS is far more of a standard than CP/M ever was.

IBM and the importance of the IBM PC

To anyone who has any exposure to computers and office automation, the name IBM (International Business Machines) needs little introduction. IBM is very important as the dominant influence in computing, and increasingly in other aspects of technology. It is

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