ADVANCES IN MICROPROCESSING AND MICROPROGRAMMING

B. MYHRHAUG
D. R. WILSON
EDITORS

ADVANCES IN MICROPROCESSING AND MICROPROGRAMMING

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Bjørn Myhrhaug
D. R. Wilson

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INTRODUCTION TO THE PROGRAM

The EUROMICRO 84 symposium is the tenth of its kind. From the first symposium held in Nice in 1975, we have come to the tenth here in Copen-day, hagen.

Microcomputers seem to have been with us forever. But actually, Euromicro with its ten years of symposium activities is almost as old as the microchips themselves.

Few could guess in the mid-seventies how much the chips would affect our daily lives. New applications are invented every day, and authorities in the field have voiced the opinion that only a few percent of the potential application of computers have yet been implemented.

The format for the EUROMICRO 84 symposium follows the traditional pattern with few exceptions. We have this year chosen to have one keynote speaker each day of the conference, rather than having all the keynotes at the beginning.

The keynote speakers will discuss various aspects of computers and microcomputing.

Dr. Peter Naur from Denmark is well known within the computer community. His computing career dates back as far as 1951, and he contributed significantly to the development of the Algol 60 programming language. His keynote speech "Argumentation and Programming" will be presented at the opening of the conference.

Dipl. Math Horst Hünke will in the second keynote present the importan ESPRIT project of the European Community. This project will certainly have a large impact on our field.

On the final day, Prof. Daniel Tabak from Boston University will give us an update on the status in the field of computer architecture. I very much look forward to his presentation of present and future architecture ranging from micro to supercomputers.

The submitted papers come from most European countries, and in addition there are several speakers from overseas: China, Japan and the United States.

The program committee had a difficult choice in selecting the papers for presentation, but with the aid of about 90 persons who agreed to act as referees, we believe that we have achieved a varied and balanced scientific program.

I would like to thank the Programme Committee members and the referees for their good work. I would especially like to thank the deputy programme chairman, Derek R. Wilson, and the Euromicro secretary, Ms Chiquita Snippe-Marlisa, for all their help.

Enjoy the EUROMICRO 84 Symposium.

Bjørn Myhrhaug
Programme Chairman

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PROGRAMMING AS THEORY BUILDING

Peter Naur

Institute of Datalogy,
University of Copenhagen

Summary
The talk will present some views on programming, taken in a wide sense and regarded as a human activity. Accepting that programs will not only have to be designed and produced, but also modified so as to cater for changing demands, it is concluded that the proper, primary aim of programming is, not to produce programs, but to have the programmers build theories of the manner in which the problems at hand are solved by program execution. The implication of such a view of programming on matters such as program documentation, system development methods, and the professional status of programmers, will be discussed.

Session B1:

PERSONAL COMPUTERS, WORKSTATION AND OFFICE AUTOMATION

Chairman: F. Winkelhage
G.M.D. mbH
Bonn (F.R.G.)

Information technology for offices is developing rapidly. In many laboratories great research and development efforts are invested in new hardware and software for the office automation and communication area. At the same time the research labs and many companies run experiments and studies to solve fundamental questions regarding the technical design, the handling of processes and the behavior of men and organizations related to a changing technical environment. This time the EUROMICRO session on office automation is featuring three papers concerning this situation. The paper of J.E. Pettersen presents a study dealing with the IBM-PC as a possible new standard in the personal computing area. The paper of R. Nilsson describes CLERC, a general purpose workstation and compares it with other equipment in that area. The paper of Th. Kreifelts et al. finally presents CoPS, a system for specification and automation of cooperative office processes.

In that way the session combines information about the development on the functional variety of the single workplace with a presentation of an approach to support cooperative office processes.

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THE IBM PERSONAL COMPUTER - EVALUATION AND OBSERVATIONS

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The impact of the IBM Personal Computer on the micro-computer world has been substantial. Use of personal computers in offices, industry and education is growing rapidly, and the IBM Personal Computer itself is expanding beyond the initial system offering. The machine is riding on the crest of a wave still gathering momentum. It will have implications for the whole market range of software. and will influence the design of related products like terminals and workstations. This study looks at the underlaying technology, at the applications software. at the compatibel products - and contains some observations on the trends in the personal computer market.

1. INTRODUCTION

The development of the IBM Personal Computer began in July 1980, when a selected team of 12 members were given 12 months to create a competitive personal computer. Almost exactly one year later, on August 12th 1981. the machine was announced.

Most industry insiders knew that the IBM Personal Computer would be important. Nevertheless. almost every observer underestimated the quite dramatic success of the new product. In 1983 more than 400 000 Personal Computers were sold in USA alone, generating revenues in excess of $1 billion.

In many ways the Personal Computer represented a major departure for IBM from its traditional business policy. The company recognized that it was entering a marketplace that had already developed some important standards. There was therefore a need to cooperate with third-party software and hardware vendors.

The result was a micro computer with an open architecture, a philosophy in stark contrast to the tight world of mainframes. IBM has made all the technical specifications available to the user, opening a fountain of compatibel software and hardware for the Personal Computer.

It is on this background that the following study has been undertaken. After a system overview in chapter 2, major hardware and software is described in chapter 3 and 4. Aspects of communication are covered in chapter 5, and some observations on ergonomic features can be found in chapter 6. Finally, the last two chapters are devoted to the central problems of compatibility with the Personal Computer, and with speculations as to its market impact and likely future.

2. THE PC SYSTEM

The IBM Personal Computer is frequently abbreviated the IBM-PC. Sometimes only the letters PC are used, which emphasizes the impact this particular IBM microcomputer has made. In the following chapters both "IBM-PC" and "the PC" are used and should be taken to mean the IBM Personal Computer.

2.1 History

The entire history of the IBM-PC is only just 3 1/2 years from conception to mature product at the end of 83. The introduction of the first machines was only 2 1/2 years ago, but even so the PC-market has been transformed in this short time.

The first machines were very cautiously greeted by the computing community. Question marks were being placed on IBMs timing with the new product, and in particular on the products technical specifications which many saw as 'inadequate'.

These specifications in 1981 described a micro computer based on the Intel 8088 processor, with 1 or 2 floppy discs, a keyboard of the old IBM breed, and a monochrome display without any graphics capabilities. The machine operating system was a version of the relatively unknown MS-DOS from Microsoft, when many had expected CP/M or something 'new' from IBM to be offered. Applications software was however introduced at the same time, and users selected the new product partly because of this, and partly because of the letters I,B,M on the machine front.

The computer was modular in that it had a separat display and a separat keyboard that connected to a systems unit which contained the memory and the processing electronics.

Todays machine has basically the same hardware, but additional machines have been introduced to make up a PC family. The family now consists of:

	Announced
PC	August -81
PC-XT	March -83
3270-PC	October -83
PC-XT/370	October -83
PCjr	November -83
PC portable	February -84

The PC-XT is essentially the PC with a 10M byte built-in harddisc, with bigger on-board memory, and somewhat greater expansion facilities. Further enhancements of the XT have led to the 3270-PC and the XT/370 described in 5.3; these PCs are intended for the IBM mainframe environment. The PCjr and the PC portable are the recent low-end members of the family, and as described in 8.1. Unless otherwise stated the following discussion applies to the standard PC.

The operating system as supported by IBM, has also undergone changes with some enhancements - but upwards compatibility has been maintained from previous versions. The really dramatic change has been in the non-IBM support for the PC. Hardware plug-in boards, operating systems, and applications programs have increased vastly in numbers. Over the last two years, this industry has fed on itself to show enormous growth, and also helped IBM to establish the Personal Computer as the leading market contender.

2.2 System Components

Two components are essential to the IBM-PC: the System Unit and the Keyboard. These two pieces give this particular computer its unique character and identity. The major peripherals are some form of display, and a printer.

Other components extend the PCs capabilities: memory boards, display and printer adapters, disc drives, and communications boards. Most of this equipment is optional.

The Personal Computer XT is different in that it has some of the above extensions as standard equipment. The XT comes with one (double sided, double density) floppy disc drive, a 10M byte hard disc, adapter board for both drives, and the Asynchronous Communications Adapter in its basis version.

All IBM-PCs come with PC-DOS as the operating system, if the machine is bought with mass storage. This Disc Operating System is a tailored version of Microsofts MS-DOS. It is however, possible to use the PC in its stripped-down version without mass storage. The machine is then run under a special ROM-based BASIC which acts as a combined operating system and programming language interpreter.

PC-DOS is fitted with a special printer driver, in order to make full use of the IBM-PC printer. This printer is not an original IBM product, but the EPSON FX-80 dot-matrix printer. It is a graphics dot-by-dot controllable type of printer, and has a parallel Centronics standard interface.

A casette interface was included with the PC, to make the first machines attractive to the home user as well as the business user. Little interest was ever shown for casettes as mass-storage, and the interface was dropped with the introduction of the PC-XT. Neither casette storage nor printers are discussed in the following.

3 HARDWARE

The basic hardware consists of Display, Keyboard and Systems Unit. Of these the Systems Unit integrates the main computer components on the System Board, and contains mass storage, peripheral connections, a small loadspeaker, and the power supply.

3.1 System Board

The System Board is a multilayer board with dimensions of approximately 28cm * 22cm , located horisontally at the bottom of the systems unit. Fig.1 shows the board lay-out, with the following main components:

1. 8088 CPU
2. Processor support
3. 8087 coprocessor socket
4. ROMs (for system firmware)
5. RAM
6. Expansion slots
7. Configuration switches

3.1.1 8088 CPU

The CPU is a standard Intel 8088 clocked at 4.77Mhz. This is a 16-bit processor capable of addressing 1Mb, but with an 8-bit data bus - functionally compatible with the 8086. At 4.77Mhz the clock cycle is 210ns, resulting in a bus cycle of 4 clock cycles = 840ns.

3.1.2 Processor support

This consists of a set of five chips - the Intel 8255 PPI, Intel 8237 DMA Contrcller, Intel 8259 Interrupt Controller, Intel 8253 Timer, and Intel 8288 Bus Controller.

The 8255 Programmable Peripheral Interface is partly used to connect the keyboard to the processor. An interrupt is generated to the processor when a scan code is received from the keyboard. The PPI is also used to exercise program control over the casette motor.

The 8237 DMA Controller provides four independent DMA channels. Channel 4 is reserved to refresh dynamic RAM, the other 3 are generally available on the system I/O bus.

The 8259 Interrupt Controller has 8 levels of interrupts with priority. Six levels are supplied to the expansion slots for use by add-on cards. The other two are used on the System Board - one for a timer interrupt (level 0), and one for the keyboard (level 1).

The 8253 Timer has three channels. Channel 0 is dedicated to the timer interrupt, and channel 1 for the DMA controller.

The 8288 Bus Controller is designed to work with the 8088 or 8086 processor. Together they control the internal bus, as well as specify the external interface conditions for the PC add-on cards.

3.1.3 8087

The coprocessor which may be employed together with the 8088 is the 8087 numeric coprocessor. The coprocessor has been designed as part the PC - but it is not supplied on purchase. Rather, room has been reserved on the System Board in the form of an empty socket.

As yet little S/W exists to take advantage of the enhanced number crunching availability with the 8088/8087 combination. From a programmers viewpoint, the 8087 adds extra instructions to the 8088s repertoir and makes available additional processor registers. The increase in processing speed obviously depends upon the amount of number-crunching in a task; it can be highly significant.

3.1.4 ROM

There are two programs kept in the system ROM - Casette Basic and the PC BIOS (Basic-Input-Output-System). On the System Board are 6 sockets, five of which are occupied by 8k*8 ROM chips. One contains the BIOS, and 4 contain the Casette Basic. (The fift socket was thought needed by Microsoft, but they squeezed their Basic into 32k bytes.)

Additional ROMs may be added up to a maximum ROM space of 256k bytes. The ROM space is located at the top of the memory map from C0000 (hex) onwards.

3.1.5 RAM

The system RAM consists of 4116, 16k*1 dynamic RAMs, with up to 64k bytes on the system board. Memory chips are placed in 4 rows of 9 chips in each - where the first 8 are socketed and the last is soldered into place. This last chip performs parity checking for its row. Refresh circuitry is located on the system board.

As the PC was introduced at a time when 64K*1 chips where not generally available at the 'right' price, IBM choose not to use these in the first PC. In a slightly modified version put on the market in spring 83, 64k chips have been used and the ROM BIOS been modified to support them. This means that the total RAM space on the system board has been increased to 256k bytes - thus greatly increasing the usable RAM area without needing add-on memory boards. In this case the total amount of RAM space available is 640k bytes.

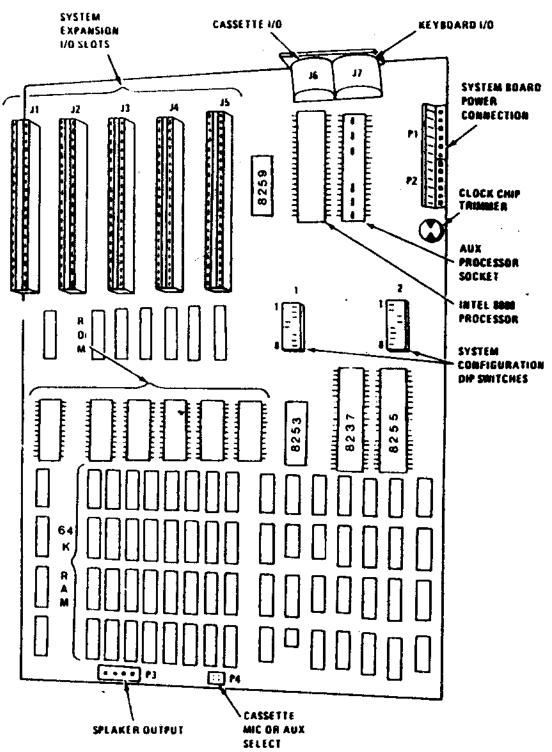

Fig.1 System Board

3.1.6 Expansion Slots

The Expansion Slots on the System Board are the PCs I/O-channels. There are 5 such channels on the PC, and 8 on the PC-XT.

An I/O channel is an extension of the 8088 processor bus. It is demultiplexed, repowered, and enhanced by the addition of interrupts and DMA facilities.

The I/O channel contains an 8-bit bidirectional data bus, 20 address lines, 6 levels of interrupts, control lines for memory and I/O read or write, clock and timing lines, 3 channels of DMA control lines, memory refresh line, channel check line, and power. These signals are available in a 62-pin connector.

All devices not part of the System Board, excluding the keyboard and casette recorder, are considered peripherals to the PC and require an expansion slot to become part of the system. Devices are addressed using I/O mapped address space. A total of 512 devices addresses are available to plug-in cards.

With only 5 slots available on the PC. limitations to the number of facilities available may be encountered. A typical PC will have:

- a display and adapter
- a printer and adapter
- two floppy drives and adapter
- a memory expansion board

If the Monochrome Display and the IBM printer are selected, this combination takes up three expansion slots - the Monochrome Display/Printer Adapter being integrated on one board. If the Colour Display is chosen four slots are needed. as the Colour Display Adapter has no printer interface. Should either of the communications adapters be added to this, then all the 5 slots are occupied. This leaves no room for further expansion to add a harddisc, A/D & D/A boards, etc.

The cramped expansion capabilities has been one of the major criticisms of the PC. IBM responded to this criticism with 8 expansion slots in the PC-XT, and with the introduction of a special Expansion Unit for the standard PC.

The **Expansion Unit** has the same dimensions as the System Unit. and may be placed beneath this unit. It has 8 expansion slots to take additional adapters and/or add-on boards. Some restriction is put on the location of certain adapters (e.g. Monochrome Display Adapter and Floppy Disc Adapter <u>must</u> reside in the Systems Unit), and one slot from each unit will be occupied by a connector-card to the other unit. This leaves 10 slots overall in the combined system. The Expansion Unit may be viewed as an expensiv and bulky, although neccesary, solution to a design shortcoming.

Another response to the lack of expansion facilities, has been the boards manufactured by non-IBM companies. The multi-function board has become almost a standard among such products. Such a board typically combines from two to six functions or adapters on the same board. Specific features and prices vary, with the most popular combination being the multi-function memory board. This board may hold extra RAM, serial and/or parallel interfaces, and perhaps a real-time clock.

3.1.7 Configuration Switches

On the System Board are two DIP switches. These switches are used to specify the type and number of peripherals attached. It gives the system information on the number of floppy drives, type of display, and wether a coprocessor is installed.

The switches also indicate the amount of memory on the System Board, and on the additional memory installed on expansion boards.

3.2 Floppy Disc Storage

The floppy disc storage consists of one or two 5 1/4" Floppy Disc Drives, and a Floppy Disc Drive Adapter card.

3.2.1 Drives

The major supplier of drives to the PC is Tandon Magnetics Inc. When first introduced, the PC was fitted with Tandon 100-1 used as a single-sided, double-density drive of 160k. In 1982 the drive was upgraded to the Tandon 100-3, giving the PC double-sided, double-density drive capacity of 320k. At present this drive may be used with 360k capacity; a consequence of increased formatting under PC-DOS V2.0 with 9 sectors pr. track versus 8 previously.

The Drives are soft-sectored and with 40 tracks formatted. They use modified frequency modulation (MFM) coding, with a track-to-track access time of 8ms and a motor start time of 500ms - transfer rate is 250k bits/sec. The PC holds one or two such floppy drives in the System Unit. The XT version holds one drive in its leftmost bay, the harddisc occupying the other. Fig.2 shows the inside of the System Unit with the location of floppy drives and adapter card.

3.2.2 Drive Adapter

The 5 1/4" Drive Adapter fits in one of the five expansion slots on the System Board. It attaches to the two drives via an internal daisy-chained flat cable. The adapter has a second connector which extends through the rear panel at the back of the System Unit. This connector contains signals for two additional external drives. thus the adapter is capable of controlling four drives - two internal, and two external.

The Adapter is a general purpose device using the NEC uPD765 Floppy Disc Controller, so that the drive parameters are programmable. DMA on the System Board is used for data transfers with buffering on the system I/O-bus.

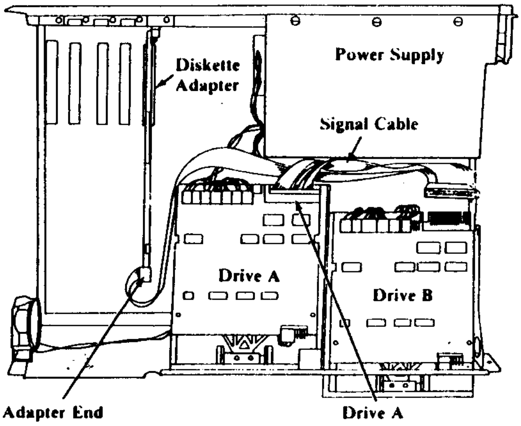

Fig.2 System Unit

3.3 Hard Disc

Hard Disc support was introduced by IBM for the PC with launching of the PC-XT version in spring 83. It is a fixed disc, manufactured by Seagate Technology, and by Miniscribe Corporation with a capacity of 10M-byte. Track-to-track access time is 3ms and transfer rate is 5M bits/sec.

A separate hard disc Controller Board is required, and resides in one of the slots on the System Board. System support for the Hard Disc is provided through updated and new routines in the PC firmware. The PC can have one hard disc located in the Expansion Unit, whereas the PC-XT may have two.

Other hard discs are available, some with greater capacities. These are not directly plug-in devices, unless offered with their own compatible systems support for the PC.

3.4 Displays

There are two displays available from IBM for the PC - a monochrome and a colour display, both have separate display controller cards in one of the System Board slots.

3.4.1 Monochrome Display

The Monochrome Display is a 12" black and green monitor which connects to the System Unit. Power is supplied from the System Unit, and a direct drive video signal from the Monochrome Display Adapter card. The monitor uses highly retentive P-39 green phosphor, has an etched surface to reduce glare, and is designed with brightness and contrast controls on the front of the unit.

The unit displays an 80 character by 25 line screen. This screen is refreshed at 50hz with a resolution of 720 horisontal and 350 vertical dots. Maximum video bandwidth is 16.27 Mhz, and horisontal drive is 18.4 Khz. Characters are displayed with descenders in a 7 by 9 format, in a 9 by 14 dot- (or character) box.

All features of the Monochrome Display combine to yield crisp, flicker-free, easy discernible characters. With a screen refresh of only 50hz, this is largely due to the slow-changing P-39 phosphor. The disadvantage of this phosphor is that it prohibits the use of graphics on the Display. IBM does not support light-pen or mouse as input devices for the same reason. However, several non-IBM products exist which offer these facilities for the Monochrome Display, and many do so with excellent results (e.g. DASH-1. graphics and mouse - see 4.6.2). It is a requirement for good results that the graphical representation is relatively static on the screen.

3.4.2 Colour Display

The Colour Display was introduced in March 83, and is a 13" RGBI monitor. Bandwidth is 14 Mhz, and the horisontal drive 15.75 Khz.

Four different, independant lines are used to drive the display - a red, a blue, a green, and an intensity line. The unit displays an 80 character by 25 line screen. Resolution is 640 horisontal and 200 vertical dots, with a screen refresh of 60 hz.

When the Colour Display is used with the appropriate controller card, 16 different colours are possible. Characters are displayed as a 7 by 7 matrix with a 1 dot descender, in an 8 by 8 dot box.

The characters are not as clearly defined as on the Monochrome Display, where more space is available between the characters and between the lines. On the Colour Display, lower-case letters with descenders appear almost to merge with characters on the next line - thus making it unsuitable for word-processing etc. It is however, one of the first low-cost colour monitors capable of displaying 80 column text with a reasonable quality, and it has sharp, well-defined colours.