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'PERSONAL' COMPUTERS FOR BUSINESS

You probably have been reading about the rapidly growing market for 'hobbyist' micro computers. Rather impressive computers are now available for about $600—computers with 4000 bytes of memory, a keyboard, a CRT display, and a cassette recorder. Such a system can serve a person at a work station, for doing computations, storing some data, and (with a data communications capability added) for connecting to the company's network. A $5000 system can begin to handle the data processing workload of a small business, or a small unit of a big business. There are some caveats, of course (which we will discuss in this report) but micro computers are all set to move into business in a big way. Here is a report on the present status and the near future likelihoods.

We attended three recent computer conferences that have dealt with the very rapidly emerging micro computer technology. One of these, a mini/micro computer conference and exhibition, was held in Anaheim, California. The thousands of attendees and the number of exhibits (almost 200) were impressive. On the basis of the attendance and exhibits, one would have to rank this conference well up among the larger computer conferences of the year.

At one of the technical sessions, Harry Margulies of Beverly Stereo and Electronics, of Los Angeles, described his company's use of a micro computer system. Beverly Stereo is a retail store (with 17 employees) that sells stereo and high fidelity sound system components. Mr. Margulies became interested in computers, from an engineering standpoint, in 1971, and began to investigate them. He started talking to computer salesmen "but they only confused me," he said. He took an evening course in computer technology at a university (UCLA) and was then better able to evaluate what he heard and saw.

In mid 1976, he came across a micro computer system offered by Computer Power and Light Co., a chain of computer system stores with headquarters in Los Angeles. (If that company name tickles you, an executive of the company said in this same conference session, "We almost named it Computer Power and Glory.") Margulies liked what he saw, and ordered a system. It was installed in November 1976.

The COMPAL-80 system that Beverly Stereo received included a processor with 64K bytes of memory, dual floppy disk drives, a keyboard and CRT display, and a Diablo 30 character per second printer. The cost was under $8000, including two application packages. These packages included a payroll system and a word processing system.

"We originally got the computer system to do our accounting," said Margulies, "but our use of word processing now far exceeds the accounting use. When people buy things at our store, we ask for their names and addresses. We then put these on a floppy disk file. Computer Power and Light modified the package so we can write individualized letters to these customers. The computer obtains a name and address from one file and then types the letter from another file. It also types the names and addresses on envelopes or mailing labels. It is not unusual for us to let the computer keep running on these jobs when we close the store for the night. The next morning, the job is done."

"We have found these personal letters to be more effective for promoting new business than either newspaper or radio advertising," he added.

Margulies is working with another company to develop an integrated transaction entry system. The input will be information from each sales slip. The system will pick up the customer's name and address for future promotional letters, the information needed for computing the sales persons' commissions, and make the inventory entries. The system will also flag when items need to be reordered. And the entry of this data will develop the daily cash report.

"The reliability of the system has been excellent," said Margulies. "It runs at least 8 hours a day. Since it was installed, only once was there a breakdown, and that was after an expansion board had been installed. It was fixed in a matter of hours. All in all, we are very happy."

University of California, San Diego

The University of California at San Diego is one of the nine campuses of the University of California. UCSD has over 10,000 students, about 8,000 of which are undergraduates.

We talked to Kenneth L. Bowles, Director of the Institute for Information Systems and professor of computer science, at UCSD, about the new approach being used in the computer science teaching laboratory. Instead of using the campus' central computer system, the laboratory has 20 Terak 8510A micro computer systems, manufactured by the Terak Computer Company of Scottsdale, Arizona.

Bowles began a project for mass education in computer science in 1975. About 500 students take the introductory computer science course each quarter (for a total of about 1500 students per year). Bowles found that conventional approaches were not working well and he wanted to find something better.

The approach now in use includes (a) their own version of Keller's Personalized System for Instruction (PSI), (b) a text book written by Bowles, (c) the PASCAL programming language, and (d) the micro computer systems.

The main motivation for going to a new approach was two major shortcomings in the previous methods. For one thing, Bowles wanted students to learn structured programming from the outset. While FORTRAN can be used, it requires some mental gymnastics to use it in structured programming. Bowles felt that PASCAL was a much more appropriate language. Secondly, many students had difficulty with the algebra word problems used for most programming exercises. These students often remembered (with hate) the word problems they had in high school algebra courses. So Bowles wanted something quite different for programming problems, something that did not involve 'math.' What he selected was (1) line drawings and (2) text editing.

Instead of asking students to solve algebra word problems, the course developed by Bowles asks them to write programs to draw lines on the CRT display. At the outset, these are simple straight lines. Then more challenging figures are demanded. In addition, the students must write programs to do simple text manipulation, such as inserting words, changing words, and so on.

As mentioned earlier, Bowles has written a text book for the course (Reference 1). Together with a work book, these provide the tutorial material and problems that the students are expected to master.

The Terak 8510A micro system uses the Digital Equipment LSI-11 micro processor with floating point arithmetic, 56K bytes of memory, a single floppy disk drive, a keyboard with numeric key pad, and a 1920 character CRT display with graphics capabilities. In addition, the laboratory staff has developed a graphics software package and a PASCAL compiler. Commercially,

these systems sell for about $7800, but UCSD gets a discount by buying through EDUCOM.

As the approach is now working, the course starts off each quarter with orientation lectures. These are attended by all 500 or so students. The students then schedule themselves into a *teaching laboratory* in which the 20 micro computers are located. Using the text and work book, they get immediate hands-on experience and begin writing their first programs. "In about four weeks time, attendance at the lectures is down to almost zero," Bowles told us. "The faster this fall off occurs, the better the system is working."

The laboratory is kept open at least 80 hours a week and is staffed by at least two persons ('proctors') at all times. The students schedule themselves into the lab, and each student has his or her own floppy disk. In using the micro computer, the student inserts the floppy disk into the drive and then loads memory with the program currently under development. Using the text and workbook, the student continues for the scheduled time, then dumps everything back onto the floppy disk.

The faculty has developed a large file of quiz questions, stored on floppy disks. Typically, three or four students get together and tell a proctor that they want to take a drill and practice quiz. The proctor, using a micro computer, initiates a program that pulls off a random selection of quiz questions from the file and transfers these to a floppy disk which is then given to the students. As a team, the students work on the questions and problems.

When a student feels that he or she has mastered the material being studied, he or she asks to take a formal quiz. Again, a random selection of questions is drawn from the file. This time, though, the student must solve them alone, under quiz monitoring conditions, at one of the micros. The answers are stored on a floppy disk which is given to a proctor at the end of the quiz. Checking the answers is done immediately, on the proctor's micro, so the student gets 'immediate feedback.' If the student has not mastered the material sufficiently, the proctor discusses the difficulties. There is no penalty for having to take a formal quiz over again.

The random selection of the questions helps insure that students do not get the same questions on the formal quizzes that they got on the drill and practice quizzes or on previous formal quizzes covering the same material. But the system goes one step further. For multiple choice questions, choices are presented one at a time. The student must answer yes or no for each choice, before seeing the next choice. Further, the sequence in which the choices are presented is randomized.

In addition to administering the quizzes, the micro systems also do most of the course book keeping. Proctors have thus been relieved of most of these administrative details and can spend the bulk of their time helping the students.

Course grades are not based on qualitative assessments but rather on the number of units that have been mastered.

Bowles sees a number of advantages of this new approach. First, it gives students hands-on, interactive use of a computer on a very economical basis. The cost per student hour of use is about 50 cents, based on a four year amortization. The micro computer has both graphic and alphanumeric capabilities. It provides a 'big system' programming language, and PASCAL may be the language of the near future, Bowles believes. (Most micro computers today are limited to assembler and BASIC programming languages.)

The Institute staff has written a PASCAL pseudo-machine interpreter. The source PASCAL programs are *compiled* into PASCAL object code. The interpreter makes the host machine look like a PASCAL machine. The object code does run about five times slower than the native code for the host machine, and the interpreter does use about 8K of memory. But the advantage is that to run existing programs on other micros, all that is needed (well, almost all) is to rewrite the interpreter. In fact, Institute employees have done this for members of other leading families of micro systems (the 8080, 8085, and Z-80 systems).

For a more detailed discussion of this approach, see Reference 2.

Two other computer conferences

To give a broader picture of what is happening in the micro computer field, let us summmarize some of the high points of two other recent computer conferences.

Compcon Spring 78

The IEEE Computer Society's spring conference this year was held in March in San Francisco. The Computer Society is the professional society of computer engineers and its conferences generally deal with the most recent advances in computer engineering. This particular conference was no exception. Most of the attention was given to LSI—large scale integration. Reference 4 is a digest of the papers presented.

To give an idea of the rate of development, one speaker forecast the number of circuit elements that will be packed on one chip of silicon. In 1977, he said, the packing density was about 16,000 bits per chip, for random access memories. By the end of this year, he said the figure is expected to be 64,000 bits per chip—and by 1980, it might well be 256,000 bits per chip. For read-only memories, the 8,000 bit per chip ROM is here, he said, the 32,000 bit chip is close, and by next year, 256,000 bits per chip seems feasible. Moreover, the cost is dropping to about .01 cents per bit, or 100,000 bits for $10. (This is the price that the chip manufacturer may charge; by the time that a chip is mounted on a circuit board, with all of the necessary connections made and ready to be incorporated in micro computers, the price is much higher.)

This same type of dramatic improvement is occurring for the computer logic chips, as well as for other storage techniques such as magnetic bubble memories and charge coupled device memories.

The silicon chip containing an 8-bit word length computer sells for about $3. It must then be mounted on a circuit board and many connections made to it, so that the end user price is much higher. We gather that the cost for the chip containing a 16-bit word length computer will not be much higher—and the same may prove to be true for 32-bit machines.

One session was a panel discussion by micro processor designers from most of the leading micro processor manufacturers—Intel, Zilog, Motorola, Texas Instruments, and National Semiconductor. (This panel discussion, as with the other panels, is not in Reference 4.) The results of the above improvements in LSI can be seen in the architecture of the new micro processors. The ones just coming out have 16-bit word lengths, with the ability to directly address much larger address spaces than the current 8-bit word length machines. In fact, 32-bit word length micros are anticipated in the not-distant future. Because most of the computation time is consumed in instruction fetching, and because the micros will be able to directly address large storage spaces (and not have to use virtual memory techniques), the micros may well gain a speed advantage over the mini computers, it was stated.

The designers of the micro processors agreed on what we thought was a very significant point: they are now able to design into a micro processor all of the features they would like to have. They are no longer limited to designing rather spartan processors. Micro processor architecture has jumped from the low end of the mini computer range to the high end of this range, except for floating point arithmetic. And, in the not distant future, the designers thought that the micros might begin competing with the maxi computers.

What are the limits for LSI developments? One speaker addressed the question: when will physical constraints come into play, as more and more circuit elements are put on a chip? One of the main limiting factors is heat—the number of watts of power that can be dissipated from a chip of silicon that is less than one centimeter square. Even so, he thought that the number of logic elements on a chip can still rise by a factor of 250 and the number of memory elements (bits) can rise by a factor of 2500!

The subject of operating systems for the micros was discussed, but future expectations did not come into sharp focus. Yes, it will be possible to develop multi-tasking operating systems for the micros, some said. But others questioned if this were desirable. With the costs of micros dropping so rapidly, it makes more sense to dedicate a micro to a single user rather than trying to share a micro among a number of tasks.

In the area of disk storage, most of the discussion we heard was concerned with developments in floppy and mini-floppy disks. The dual side, double density mini-floppy disks are a commercial reality now, though not yet widely available. Each disk can store up to 440,000 bytes, with an access time of one-half second and a transfer rate of 125K bps.

West Coast Computer Faire

The 1978 West Coast Computer Faire, held in San Jose, California, in March, was the second such 'personal computer faire'. Reference 5 lists the proceedings of these two conferences, for 1977 and 1978.

This year's conference was held on a Friday, Saturday, and Sunday so that it could be attended by interested people even if they could not get off from work or school to attend. It had technical sessions all three days, as well as some 200 booths of exhibits. The exhibitors were suppliers of the end user products—micro systems, peripheral equipment, software firms, and so on.

The conference opened its doors at 9:00 Friday morning. We arrived at about 9:30 and found thousands of people already there. The exhibit areas were crowded. One attendant at an exhibit booth muttered, "This is starting out just like all of the others." We asked what he meant. He meant that there would be big crowds and lots of questions for all the hours that the exhibits were open, he said.

The exhibits included a wide variety of micro computers, in both fully assembled form and in kits. And there were numerous types of CRT terminals on display for use with the micros, as well as printers (both character printers and line printers), floppy disks, hard disks, cassette units, and so on. There were quite a number of exhibits by software vendors, with packages available for most of the popular micros.

The technical sessions that we visited seemed to be attended mostly by (1) owners of personal micro computers, (2) computer store owners, and (3) hardware and software supplier representatives. There was a good amount of dialog among these groups. If the users were unhappy (as they were with the so-called 'standard' S-100 bus) they let the others know about it. We received the impression that the suppliers were listening and that corrections would be forthcoming quite quickly.

The message of these conferences. These conferences told us that there is a very rapidly spreading use of micro computers. While these computers have been somewhat spartan in the past, they are rapidly becoming much more powerful. The people who are buying some of these computers are buying them with their own money. They are looking for the best values and the least problems. In general, they seem to be very sharp people and they are spurring the suppliers on to offer better products. Business users of micro computers probably will benefit substantially because of the efforts of the owners of personal computers.

What is happening?

In the past few years, we have discussed the general subject of distributed systems on several occasions. And in both our October 1976 and May 1977 reports, we described how mini computers were beginning to be used by small businesses and by small units of large companies. We told, too, how most of these small users did not have and did not want an in-house programming capability. Instead, they preferred to use previously developed application systems or have the programming done on a contract basis.

Many data processing executives have been very concerned about the proliferation of mini computers. They see 'the mess of the 1401 days' being repeated, when every site went its own way, programs could not be exchanged, data could not be exchanged, staffs built up unreasonably, and so on.

These executives have sought to impose controls over the acquisition of mini computers in order to avoid such difficulties. But this control is difficult to maintain, because computer technology can sneak in so many ways. The office administration people are bringing in word processing systems, and some of these have data processing capabilities. The communications people are bringing in computer-based switches and computer message systems. Engineers are bringing in micro computer control systems and monitors. But all of these various types of systems really have no fixed boundaries or limits. They can be expanded into what can be considered data processing areas.

The message of this issue is: *you ain't seen nuthin' yet*. If minis have proliferated, micros will explode, we think. Control will become more and more difficult. We will describe the status today, as well as some things on the near horizon. We will talk about some of the evident problems. And we will discuss some policies you might want to consider.

Now let us look at the range of micro computers on the market today.

Today's micros

G. S. Khalsa gave a talk recently before the Los Angeles Chapter of the Assocation for Computing Machinery, as reported in Reference 3. Khalsa is the managing partner of a retail computer store in Pasadena, California. In his talk, Khalsa gave a good overview of what is happening in the micro computer arena.

Only about 20% of his store's sales are to computer hobbyists, Khalsa said. Another small percentage of sales are electronic games that attach to home television sets. The bulk of the store's sales are to people who are buying micro-based systems for business applications. Many of these people, in turn, know little or nothing about computers and have no desire to learn programming. Because of their unfamiliarity with computers, it takes 4 to 5 hours of sales contact to sell a computer. This is much longer than it takes to sell a comparably priced automobile, said Khalsa.

There are five general classes of micro-based systems sold at his store, Khalsa reported. The least expensive of these classes is the 'bare bones' micro, with a small memory, a keyboard, and an assembler system. The price of these micros ranges from $150 to $400. The purchasers are usually the hardware oriented hobbyists.

Next up the line is a complete system with at least 4K bytes of memory, a keyboard, a CRT display, and a cassette recorder. The price of these ranges from $600 to $3000. The purchasers generally are people who want to put the computer to some use rather than to tinker with the electronics.

The third class is the advanced hobbyist computer. It is much the same as the one just described except that it has a mini/micro floppy disk unit, additional memory, and a typewriter type printer. The price range for this class is $2000 to $5000.

(The mini/micro floppy disks are 5 inches in diameter and store about 90K bytes of data per side; some provide two side recording, for a total of about 180K bytes per diskette. Regular floppy disks are 8 inches in diameter and store about 256K bytes per side. Double density, dual side floppy disks are just reaching the marketplace; they will store over 1 million bytes per regular diskette.)

The fourth class is the low end of the business systems, said Khalsa. These generally use one regular floppy disk drive, serve one terminal, have up to 56K bytes of internal memory, and have a character printer that operates at up to 150 characters per second. The price range here is $5000 to $7000. The market is small businesses such as Beverly Stereo, described earlier.

The most expensive class is the multi-user, multi-tasking time sharing micro system. It can serve 4 or more terminals simultaneously, and uses at least two regular floppy disk drives. The price range is $7000 to $14,000, or even higher, depending upon the peripheral units used. For instance, the application may require a 300 line per minute printer and/or a 10 million byte hard disk storage.

Khalsa said that 1978 will see a rapidly growing number of powerful peripherals for micros. One will be a ten million byte hard disk unit with two disks, one of which is removable, for under $8000. And PASCAL will begin to be adopted as a common programming language for micros, starting to ease out BASIC as the 'standard' language.

Using micros in business

In our discussion, we are concerned with fully assembled micro computer systems with a sufficient set of peripheral devices for serving business applications. Further, such systems are assumed to be (and should be) purchased from organizations that are willing and capable of providing the many types of support and services that a business organization needs. These include programming support, documentation of the system, training, hardware and software maintenance, and so on.

We are *not* discussing a 'hobbyist' approach to personal computers. Many hobbyists purchase the assembled circuit boards for their micro computers, for the fun and experience of assembling the boards (processor, memory, input-output, and so on) into a computer. Some business people may be tempted to take this route (and a relatively few, in fact, may be successful at it) because of the apparent low prices involved. But the average small business will probably find this approach too demanding.

Also, we are not discussing the case where a person or a small business buys a fully assembled micro computer and then hires a hobbyist to do the system design and programming. Again, in a relatively few cases, this might work out satisfactorily. But this approach can lead to much unhappiness, as we will discuss below.

With the understanding that we are concerned with the *business* uses of micro computers, let us look at how the market is responding to meet this demand, as reported in several of the conference sessions we have attended.

Computer stores. A large number of retail computer stores are springing up throughout the U.S. and in some other countries. Originally, most of these were started to serve the computer hobbyists. But that picture is changing somewhat.

As one of the speakers at the mini/micro conference pointed out, there are two general types of retail computer stores. One is the 'computer super market,' where a number of brands of micro computers and peripherals can be purchased. The other is the 'system store' which may carry only one brand of micro and peripherals.

The 'super markets' dominate the scene, at present; one conference speaker estimated that 85% of the retail computer stores are of this type. While these stores tend to serve the hobbyists, more and more of their total sales are to small business users. They tend not to develop proprietary application software packages, but they do sell packages developed by others. If the customer wants application programs for which no package is available, they generally refer the customer to one or more small software firms or software consultants.

The 'system stores' take a different approach. From the outset, the discussions with a prospective customer deal with the *applications* that the customer wants to put on a computer. (At a super market, the discussions generally begin with the different brands of hardware, to identify "which one fits your needs best.") Ideally, the system store seeks to sell a complete package to the customer—the hardware, application software, training, service, and support.

Neither the super markets nor the system stores want to get into custom programming. They prefer to refer customers to small software firms or to individual software consultants for any such programming. But if a prospect represents a possible large market, a system store may decide to enter into a development project to develop the application software, which it would then sell on a package basis. The store attempts to get several customers in that same line of business to participate, in order to generalize the package. The participants are reimbursed for their time and efforts, possibly by getting the package at no cost.

There is speculation these days that IBM may be considering entering the computer store arena. One is bound to wonder what IBM's marketing strategy will be some years hence, as the micro systems invade the regular CPU markets. The idea of IBM computer stores (of the 'system store' variety, it would seem) appears reasonable; it could happen.

The hardware picture. Currently, the micro computer hardware picture for business uses is about as follows. The $600 system (with CRT, keyboard, and cassette recorder) has a very limited application for business. A system with 16K of memory and a floppy disk, priced at about $1500, would be more useful. When a 10 to 15 cps printing mechanism is added, for printing reports, invoices, etc., the price will rise to between $2000 and $3000. (Some reconditioned IBM Selectric terminals with integral modems have been selling for $695.) These are hardware prices, to which the cost of software must be added, as we will discuss shortly.

The current 'upper limit' of micros for business use seems to be as follows. (With the rapid progress in the field, it is hard to be very definite on this upper limit; a lot of changes are expected this year, for instance.) Internal memory currently is limited to 56K bytes, of which 20K to 25K might be used for the operating system and the BASIC interpreter; later this year, internal memories of over 100K will appear. Some of the more expensive micros provide BASIC compilers, since compiled object code runs faster than interpreted source code. An assembler and assembly language might also be available. In some instances, PASCAL is also being provided. Mass storage is provided by floppy disk units. With four regular floppy disks, over one million characters of on-line storage is now provided. With

dual side, double density floppy disks, this will be raised to over 4 million characters. Printing can be done by a 30 cps typewriter type printer, or a 150 cps matrix printer; the price of each is about $3000. The typewriter printer is preferred for correspondence printing, while the matrix printer is suitable for outputs such as reports, invoices, and so on.

Current 'upper limit' systems might handle applications with the following characteristics. A typical master file (customer, inventory, or whatever) might be in the order of 200,000 characters, stored on one regular diskette. The maximum size of an application program that can be stored in memory at one time might be in the order of 30,000 characters, which is a few hundred BASIC source statements. This is generally a program of only moderate complexity and small businesses can easily require programs of greater size. Of course, programs can be segmented so that program size may not be a problem in any particular case. But we are making the point that, say, a 16K byte memory really is not very big for this type of business application. Even a 56K byte memory may impose some problems.

If one assumes that the printer will be operated for an average of two hours per day, after all input has been entered, a correspondence type printer might be able to produce in the order of 40 invoices a day, plus the other documents and reports. We are assuming that any word processing use would be in addition to this data processing use. For a wire matrix printer, operating at 150 cps peak speed, several hundred invoices might be produced in a day.

The total price of such an 'upper limit' system might be in the order of $7000 for the hardware and, say, $3000 to $6000 for the software.

As an indication of the progress in the field, in early 1977, one of the lowest priced *mini* computer systems had the following characteristics. With a 16K byte memory, one keyboard and CRT display, three regular floppy disk drives, and a 200 cps matrix printer, the system was priced at about $18,000 for the hardware alone. Today's micros offer *much* more for less money.

As a further indication of current progress, we have seen two fully formed character (not dot matrix character) line printers, operating at 300 lines per minute, priced in the $4000 to $5000 range. And we have heard of a ten million character hard disk storage system priced in the same range. These are end-user prices; the OEM prices in quantities of, say, 100, are under $2000!

The software picture. Because of the low cost of the micro computers, it is not particularly expensive for an individual consultant or a small software company to set up business for supplying packaged software or custom programming. So we would expect to see a very rapid growth in the overall software picture for micros.

At present, the system software for the micros is fairly limited, as compared with regular computers or even with minis. Utilities, sorts, report program generators, data base management, and programming languages are either very restricted or non-existent.

Application packages are beginning to appear in some volume. As far as we can tell, these often have the same history as the early application packages for big computers. That is, an application is developed for one user. It works well, so someone decides to sell it to other users. The package is not generalized and turns out not to fit any other user particularly well.

Frequently, financial application packages for small businesses can be purchased for $300 to $400 each. On the other hand, we have seen one advertisement for a set of business application packages that was priced at $1000 to $2000 for each package or $14,000 for the whole set. So the price of packages can vary widely.

One software consultant, a speaker at two of the conferences mentioned above, told of his approach to the problem. A couple of years ago, he was writing custom programs for customers of Wang mini computers. Seeing the rapid growth of the micros, he decided to change his approach. He is writing and publishing books based on his major application packages, such as payroll and general ledger. Each book gives the documentation and BASIC source code for the application. "You can convert my programs, which were written for a Wang computer, to run on your computer so as to fit my documentation," he said, "and presto, you have a documented application system."

Our guess is, though, that small businesses (or small units of large organizations) had better plan on spending at least $3000 to $6000 for

programming services for the first applications that they want to put on micro computers.

The University of California at San Diego is taking a noteworthy approach to micro computer software. As Bowles said to us, "We believe the way to move programs from one micro computer to another is by moving the complete software systems, including the operating systems, compilers, and so on." Their approach is discussed in Reference 2.

The support picture. Numerous speakers and writers, dealing with the use of micro computers in business, have pointed out that business users want and need rapid service and available spare parts when office equipment goes down. This is the type of service that they have come to expect with typewriters, photocopiers, and so on. What they are *not* accustomed to is having to carry computer units to the computer store from which they were purchased or having to remove circuit boards from the computer and mail them back to the computer manufacturer. What business users want is to be able to call somebody local to come and fix the hardware.

Of course, maintenance contracts can be signed with computer maintenance firms. On the other hand, the components of some of the micro systems are proving to be very reliable, we hear, so the hardware maintenance problem may not be a severe one.

The software support picture is currently worse than the hardware picture, say some people. For one thing, there is the lack of utilities, sorts, report generators, and so on, mentioned earlier. And if the user modifies an application package so as to better meet his needs, who does he turn to when the system crashes? Further, the small business user might tend to hire a computer hobbyist to develop an application and this could be a very bad choice. The hobbyist is more interested in the computer than in the business application, and probably does not understand the business. The resulting application system may be a disaster, as far as the user is concerned.

There are other types of support to be considered, of course. One is the documentation of the systems and the programs, including adequate operating instructions for users. Another is training the users in the use of the application systems or packages. Another is fixing software bugs as they come to light. And still another is the addition of enhancements to the systems.

We are not implying that all of these services are being adequately provided for all users of mini computers or even big computers. But the services are far ahead of what is currently available for micros, we gather. With all of the attention being given to the micro market, it is possible that such services will develop rather quickly; that is the impression we received at the conferences discussed above. But this is an area that users must recognize as a potential problem.

Programming the micros

Until recently, the limited memory size of most micros has argued against the use of compiler languages. Instead, languages that can be used interpretively, such as BASIC, or assembly languages have been the ones commonly used.

No one we have talked to argues for the use of assembly language for programming business applications; this is a very poor choice, they say. But assembly languages have been helpful for solving some of the interface problems so common in the early days of the micros.

BASIC is a relatively easy programming language to learn. But there is so far no 'standard' BASIC; most suppliers have made their own variations and extensions. For business use, the fact that only one or two character data 'names' can be used is inconvenient. For this and similar reasons, it is hard for a non-programmer business user to be able to look at a BASIC program and grasp what it is doing.

(Most managers are not accustomed to reviewing programs—so why are we making this point? It seems to us that small business, or small units of large organizations, will not have programmers on their staffs, at least for some time to come. It will help to keep things running smoothly if some managers can grasp what the programs are doing, from the program documentation.)

COBOL programs potentially can be more readily reviewed by the non-programmer business user. We have not heard of any U.S. firms providing COBOL for micros, but Computer Analysts and Programmers, in the U.K., has developed MicroCobol for use on the Intel 8080 and Motorola 6800 micros (Reference 6).

PASCAL, also more readily understood by non-programers, may be the language of the future for the micros. Helmers (Reference 7) sees it as becoming the 'next BASIC.' But PASCAL needs improvements and extensions, so there is a chance that it will 'go off in all directions' as has BASIC. To help guard against this, Kenneth Bowles at UCSD (References 1 and 2) is conducting a working conference next month that will seek agreements on desired extensions to PASCAL. Also, the U.S. Department of Defense reportedly is close to adopting a standard systems programming language that is based on PASCAL. We think you will be hearing a lot more about PASCAL.

So far, we have dealt largely with the positive aspects of micro computers. But they also pose some challenging problems. Let us now consider what some of those problems might be, for a business environment.

Some problems ahead

We have talked to quite a number of people in the computer field about the problems that the wide use of micro computers in business organizations might bring. Here are the most frequently mentioned problems.

Jumping too quickly. People who become interested in micro computers tend to be almost hypnotized by the relatively low price of the hardware. "Just imagine, we can have our own computer for under X dollars," they say, where X might be 600, 5000, or whatever. So they might well buy inexpensive hardware before they understand their needs, only to find that the computer they have bought is inadequate for their needs. Or the application package they are most interested in may not do what they thought it did. If they contract to have the programming done and if a consultant or small software firm takes a fixed price contract to develop a custom application package, it is assumed that the customer knows his requirements. But the history of computer use surely demonstrates that users cannot specify requirements accurately or completely. So even custom developed software may not do what the customer wants.

The result of jumping too quickly can be unhappiness and wasted time.

Waste of time. Maybe micro computers and some of their application packages are inexpensive, but they do represent a large potential 'waste of time.' Users often will be novices in computer use, and will tend to repeat the mistakes of the early days of the computer field. Almost all purchased software packages need some modification, to fit a particular user's needs. The user may spend a lot of time trying to fix up these packages, and may end up only making matters worse. Both the hardware and the software (including packages) may be delivered without adequate documentation, leading to operating errors and difficulties in making program changes. Hardware or software failures will lead to lost time.

Then, too, the computer is a challenging new 'toy.' People will want to play with it during working hours, learning programming, trying out new programming ideas, and so on. Also, computer games are very popular; books are readily available that give the source code for dozens of games. So working hours may be spent in game playing.

As we say, micro computers represent a potentially large waste of employee working hours.

(Accidental) violation of policies. The new privacy laws have caused many companies to search out all of their personal data files. Many have found that first line supervisors are keeping 'desk drawer' files on their subordinates, against company policy and being used in ways in which top management does not approve. With micro computers, this situation is likely to get worse, not better, unless adequate policies are set up, *publicized, and enforced.*

Companies may well find that significant volumes of personal data and company proprietary data find their way into micro systems. Even worse, perhaps, this data can be easily removed from the premises, since a cassette tape or a floppy disk is very easy to carry off.

Poor system design. Inadequate design practices may be followed for both system design and program design, and for both purchased application packages and custom programmed applications. 'Bowl of spaghetti' control structures may make programs error prone and hard to fix. Inadequate backup and recovery procedures may

make operations difficult. Inadequate or non-existent data security may lead to serious disclosure problems.

If the micro computer is used simply to support an employee's work station activities, these design shortcomings, while undesirable, may not be too serious. But if applications are taken off of the central computer and transferred to the micro system, the penalties may be much greater.

Disappearance of software suppliers. Poor system design and program design, just discussed, lead to a frequent and continued detection of bugs on the part of the user. So whoever wrote the software must spend more and more time fixing the bugs, for which no income is received. The point can be reached where the supplier of such software may well have to go out of business, because of all the no-income maintenance work, and the user then loses the source of software support.

Growing costs. The cost of a minimum size micro system is not great, as we have indicated. But as data communications facilities, floppy disks, hard disks, and printing mechanisms are added, the cost grows fairly quickly. To this must be added the cost of the application packages and/or the programming, plus the 'waste of time' discussed above, plus the time of employees for programming, modifying existing programs, operating the computer, and operating the printer. As micro computers proliferate, costs associated with them may very well rise dramatically.

Of course, the benefits of doing the jobs on the micros may outweigh the added costs. It should be recognized, though, that costs may rise precipitously as more and more jobs are put on the micros.

What attitude to adopt?

What attitude should data processing management adopt relative to the likely growth in the use of micro computers in their organizations?

Two of the attitudes that might be adopted are:

- Do not allow 'personal' computers to be used
- Control and guide the use of these computers

We will discuss each of these attitudes briefly.

"Do not allow use of 'personal' computers"

Some data processing executives have persuaded their top managements to set a policy similar to this for the use of mini computers, because of the types of problems just discussed. It seems likely that they will want to extend the policy to cover micro computers. The policy statement will probably say that no employee may bring his or her personal micro computer to work. Also, it will probably insist that no department acquire a micro computer except through the data processing department. Further, all software acquired for a micro computer will have to be acquired through the data processing department.

Even with the substantially higher cost mini computers (as compared with micros), this policy has been difficult to enforce. Computers have crept in under a variety of names, such as word processing systems. When departmental management makes a strong plea for their own computers, on the basis of "lack of response from the central development staff" or "we want to be responsible for our own destiny," top management may find it hard to deny them.

With micro computers, such a policy looks to us to be almost impossible to enforce. The price of the micro computers continues to fall, the capabilities increase, and the packaged application programs will multiply goemetrically. It will be very hard for data processing management to argue against the use of a micro computer for personal work station functions.

We foresee the demise of the conventional office typewriter in most business offices, starting with the larger companies. A micro-based word processing system has just too many advantages for correcting mistakes, making changes, pulling off stored names and addresses for letters, inserting standard paragraphs, and so on. So an executive or a manager might well want to install a micro system to serve both himself and his secretary. If the company's main computer is batch oriented, as most of them are, the stage will be set for introducing many micro computers for this one situation alone.

Parenthetically, we will be dealing with the subject of the 'office of the future' in our September and October issues. The 'office of the future'

is already here for some organizations that we have talked with.

In the long run, then, we believe that the policy of trying to prohibit the use of micro computers, or to greatly limit their use by requiring that all micros and their software be obtained through the data processing department, is doomed to failure.

A better policy, we think, would be: "If you can't beat 'em, join 'em."

Controlled use of personal computers

In this environment, data processing management recognizes that there is no practical way to prevent the growing use of micro computers. What is sought instead is a set of policies which will help achieve the benefits of the micros while at the same time avoiding their undisciplined use. These managers seek to prevent the return of 'the 1401 days.'

We see several possible corporate policies which could help to achieve these goals.

Corporate advice and policies. There is a rapidly growing number of brands of micro computers on the market. In a sense, there are a number of 'families,' because each micro computer uses one (or sometimes more) of a limited number of micro processor chips. The more popular of today's micro processor chips are the Intel 8080, Motorola 6800, DEC LSI-11, Zilog Z-80, MOS Technology 6502, and the Texas Instruments 9900. (Some hobbyist micro systems include two or three of these micro processors, so that the user has a much wider selection of software to choose from.)

The point to be made is that the data processing department can provide a real service to other parts of the organization by supplying up-to-date information on micro hardware and software. It may well take one or more people full-time to do this job properly in a medium size company, because it means not only evaluating the hardware and some of the software on the market but also visiting user departments to get a better idea of their needs.

So one role for the data processing department is to become a source of information and advice on the selection and use of micro computers.

Possible corporate policies. A set of policies dealing with the use of micro computers within the organization would seem to be needed. One possible policy would clearly establish that *all* data is owned by the company and is not to be removed from company premises except under stated conditions. Perhaps every program or every file should include a standard message at the beginning, to be displayed each time the user inserts a floppy disk in a drive.

Another policy might deal with the types of data that must not be stored in micro systems, unless approval in writing is granted and specified conditions are met. These types of data could include personal data about employees and specified types of company data. Further, the policy might state that the data must *not* be encrypted or that the internal audit department must always have the current encryption keys.

A policy probably is needed that clearly states that micro computers are not to be used for playing computer games on company time. The policy also might say that the computers cannot be used for the person's own uses, such as 'playing the stock market.' It would seem that such policies should not have to be spelled out, that people would know they were not supposed to do such things. But the evidence we have seen indicates that the lure of the computer is just too great and these things will occur.

Still another possible policy would be that all micro systems would have to be listed with the internal audit department and would be subject to surprise audits. Disciplinary action or dismissal would result from detected violations of the policies.

Possible corporate standards. If micro computers store company-owned data and use programs procured with company funds, some programming and data definition stadards should be imposed, as well as a standard method for developing and documenting application systems for the micros. Standards may very well be the key to successful use of micro computers—for avoiding some of the problems discussed earlier. Perhaps some standards should be applied to the programming languages that can be used. Almost surely, standards should be set for cassette and floppy disk units that are used, to insure their readability on other equipment within the company.

These standards might tie in with the suggested policy, mentioned above, that all micro

systems should be subject to surprise audits by the internal audit department. Auditors should be able to probe as deeply as they feel necessary, to see that corporate policies are being followed. If a wide variety of programming languages and data formats are used, audits will be much more difficult to perform.

Encourage use of good practices. An internal document, prepared by the data processing department and sent to all department heads, might describe the growing use of micro computers and some of the problems that can arise. Some people might feel that such a document would only encourage the proliferation of micros and that it would be better to 'not say anything.' We do not agree. We believe it preferable to state the benefits and problems of micros in readily grasped terms. Let each of the department managers, as well as the key people under them, know that there *are* problems associated with the micros and what steps can be taken to mitigate those problems.

If the '1401 days' are not to be repeated, then the potential users of micros must be told what problems came about from the practices used in those days, and what to do about it.

Some might argue, of course, that the novice micro computer user is in no position to use the system development practices of professional analysts and programmers. This is probably true. We would think, however, that some reasonably small subset of those practices *could* be used and would help to avoid the most serious problems.

The use of such corporate policies and standards is based on conjecture, of course—what bad things might happen if micro computers are obtained by novice end users. We suspect that our discussion of government regulation, two months ago, could apply here. If one is concerned with the *prevention* of problems, then the regulations tend to become omnibus and sweeping. On the other hand, if one is concerned mainly with the *correction* of actual abuses, the regulations can be much more specific and limited. As far as the use of micro computers is concerned, it would seem sensible to adopt a very limited set of 'preventive' policies and standards, aimed at avoiding the most serious problems. From then on, 'corrective' policies and standards could be adopted as specific problems became apparent.

Conclusion

As we see it, the use of micro computers in business will soon reach deluge proportions. They are beginning to offer 'big system' capabilities, the prices are right, and the hardware and software suppliers are beginning to concentrate on this market. Micro computers have just too many good points going for them for their use to be effectively resisted.

Now is a very good time, we believe, for organizations to think through their attitudes and policies on the use of micro systems. Be ready for the deluge, when it starts.

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