MICROPROCESSOR TECHNOLOGY FOR PSYCHIATRISTS

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Abstract

Microcomputer programs have been developed for interactive display and data processing of the mental status exam, the past history, treatment plans, progress notes, real time psychological testing, biofeedback training and accounting and billing. Because of their low cost ($3,000 - $8,000) these instruments can be useful in the psychiatrist's office practice.

A funny thing has happened between the pocket calculators and the minicomputers. Beginning with a technology for merging very many transistors together into a small chip, microcomputers burst into hobby stores as kits, then took aim at the small business market and on the way have spawned an ever-increasing number of devices that may well shake and shape the foundations of society in a very few years. This article describes a part of the state of the microcomputer industry as of August 1, 1978 with emphasis on practical and research applications for psychiatry and psychiatrists.

Historical Review

It all began with the development thirty years ago of the transistor: a small low-power amplifier that replaced the large, power-hungry vacuum tube. The advent almost simultaneously of the stored-program digital computer provided a large potential market for the transistor. Batch processing of many transistors on a thin "wafer" sliced from a large crystal of germanium or silicon began to displace the earlier techniques of processing individual transistors. The integrated circuit as developed in Fairchild's semiconductor in 1959 accomplished the separation and interconnection of transistors and other circuit elements electrically rather than physically. An individual integrated circuit on a chip perhaps a quarter of an inch square now can embrace more electronic elements than the most complex piece of electronic equipment that could be built in 1950. Gordon E. Moore was the first to predict the future progress of the integrated circuit. He suggested that its complexity would continue to double every year. Today with circuits containing $2^{18}$ (262,144) elements available, we have not yet seen any significant departure from Moore's Law. By 1976 world consumption has more than tripled to $3.5$ billion worth of integrated circuits.

A microprocessor is the central arithmetic and logic unit of a microcomputer, together with its associated circuitry, scaled down so that it fits on a single silicon chip holding tens of thousands of transistors, resistors and similar circuit elements. A typical microprocessor chip measures 1/2 centimeter on a side. By adding anywhere from ten to eighty chips to provide timing, program memory, random access memory, interfaces for input and output signals and other ancillary functions, one can assemble a complete computer system on a board whose area does not exceed the size of this page. Such an assembly is a microcomputer in which the microprocessor serves as the master component. About twenty U.S. companies are now manufacturing some thirty different designs of microprocessor chips ranging in price from $10 to $300. As in the central processing unit, or CPU, of a larger computer, the task of the microprocessor is to receive data in the form of strings of binary digits, to store the data for later processing, to perform arithmetic and logic operations on the data in accordance with previously stored instructions and to deliver the results to the user through output mechanisms such as an electric typewriter, the cathode ray tube display, or a two-dimensional plotter. At the first level of complexity in the hierarchy of microcomputers are the microprocessor chips representing the large scale integration of tens of thousands of individual electronic devices. At this level there are also more specialized chips: random access memory, read only memories, programmable read only memories, input-output inter-
faces and others. The second level of the microcomputer hierarchy, the module and breadboard systems, represents the simplest true computer systems. They can be created by combining a microprocessor with a limited array of memory chips and input-output chips. At the next level of the hierarchy of capability and functions are the small computer systems that are pre-packaged, stand alone units. Unlike the single board modules, they have a self-contained power supply, the capability for memory expansion and room for a series of plug-in interface modules. Some of the more powerful single board development modules can be expanded with the appropriate hardware to create such a single box computer system. At the next level in the hierarchy we come to the full development system. The full development system is a full capability micro-electronic system that can serve as a vehicle for helping to develop a smaller target system. Whereas the full development system may represent an investment of some $8,000 to $10,000, counting both hardware and software, the target system will be a microprocessor or microcomputer costing perhaps $500 or even less when it is manufactured in volume. The final level of microcomputer usage is a multi-processor system.

The microprocessor represents truly low cost computing. At its commercial stage of development, the user is faced with the purchase of a cathode ray tube, a microprocessor board containing memory chips and input-output devices attached to disc drives through a controller and a printer. It is this type of configuration that psychiatrists are mostly interested in though the more sophisticated users are taking advantage of single board technology for various control applications. For purposes of comparison, the battery that operates the computers at a well-known center cost $50,000 ten years ago. Today, one can purchase a minicomputer system for $20,000 that has more computing and time sharing capability than the duplexed computers still operating on that $50,000 battery!

Hardware - Beware of Con Men!

Current hardware configurations range in price from $100 to $15,000. Because microprocessors are continuously expanding their capabilities they gradually are encroaching in the domain that was formerly reserved for minicomputers and can probably be best classified according to price. The overall cost of the system, of course, is a function of the number of components that are purchased and the functions that are desired from the hardware. In discussing these instruments the psychiatrist should be aware that he is entering into the field of business. People who relate to him are intent upon making a profit at his expense and will sell him anything that they have in the store in order to make money. They may take his interests into consideration or they may not. At any rate this is not the land of medicine, but the land of the market place, so the buyer should beware.

As mentioned, a complete microcomputer system is composed of an input device (CRT or keyboard), the microprocessor with associated memory and input-output chips, a disc drive with its controller, and an output device like a printer. Of these elements the disc drive and controller tend to be the most tricky to select and the printer tends to be costly and the part that breaks down and needs repair the most.

For less than complete systems used as control devices and for computations, hobbyists have fun with the KIM and the PET. These are mentioned because they have a 6502 chip and are useful for learning about micros and programming, but they have no practical applications in psychiatry.

The Apple II is the least expensive and niftiest of all the low priced devices. It features a 6502 chip, a compact size with keyboard, can be used with a TV or videomonitor and has a microdisc (half the capacity of the usual floppies that hold 125,000 characters per disc drive). It has excellent programming capabilities and an interface board that enables it to function as an intelligent (very) terminal to a large mainframe by acoustic coupler. A journal called Micro is devoted to the 6502 chip and there are over 30,000 happy Apple users in the country forming interest groups. If your application can fit on The Apple II, it's the machine for you. A double density Per Sci disc, holding 260,000 characters can be attached if you need more storage.

Next in price come machines with a 6800 chip. The 6800 chip is made by Motorola, so many Motorola employees use these instruments for their hobby work. The MSI machine can support four Shugart disc drives with a total capacity of 600,000 characters of disc storage, with dual floppies and controller costing about $2400. Using a SOROC CRT (about $1000), a 779 Centronix printer (about $1300), a 32 K memory MSI machine with dual floppies costs between $4000 and $5000. This price is similar to Radio Shack instruments with micro floppies which are not recommended because of their lack of room for
growth and development.

At the next level of cost one enters a fairly complex array of microcomputers that have their advantages and disadvantages in the $5000 to $9000 price range. These are manufactured by IMSAI (10) ALTAIR (MITS), (11) CROMEMCO, (12) and OHIO Scientific (13) and feature floppy discs made by PerSci, Norstar, Digital Systems and a host of others. The IMSAI has an 8080 chip and a nifty front panel that assembler programmers seem to love because they can toggle their programs in neatly and save memory in tricky ways. IMSAI makes a neat package with a small CRT, an 8085 chip and dual Per Sci discs for $5995.00. ALTAIR (MITS) also makes a complete system in the $8000 range using the 8085 chip. CROMEMCO and OHIO Scientific introduce Z80 chips technology and it is said that the Z80 has a larger instruction set than the 8080. However the buyer must bear in mind that because microcomputers are so cheap, most of the money will be spent in software development and these machines are only a thousand or so dollars less than the Alpha Microsystems micro. (14) It is a 16 bit machine, in some ways similar to Digital Equipment mini's and is simply better than all the other mid-price micros. In addition it has time sharing capabilities, so as a personal opinion, I suggest that before purchasing an IMSAI, VECTOR, (15) CROMEMCO, or OHIO Scientific, you should seriously consider a few extra dollars for the Alpha Microsystem.

Lastly, in the $15,000 range is the LSI-11 from Digital Equipment and the Micro Nova from Data General. Backed by big companies, with service and software support, these micros are great - if you need the capabilities they have to deliver.

Software - Beware of Operating Systems!

The programs that operate inside the hardware are controlled by software called disc operating systems (DOS). The ease of programming is a function of the completeness of the operating system. The operating systems on the microcomputers vary in complexity from fairly low unsophisticated operating systems on the 6800 chip instrument to extremely capable and complex operating systems on the Digital Equipment and Micro Novas. In selecting a computer, probably the most important consideration is the disc operating software and there are several available.

The DOS on The Apple II, while not as clever as the rest of the machine, is adequate and easy to program in Assembler or Basic. The DOS on the 6800 machines is not very complete and makes for hard programming. IMSAI features CPM operating system and this is a major factor in choosing IMSAI over competing S-100 bus systems. It's an excellent operating system. The Z80 has its operating system as does the Alpha Micro systems. The Z80 is not easy to program. The DEC machines (16) have beautiful software developed on the 11 series computers and RT-11 is elegant.

All of the micros have Assembler and Basic language. These are easy to learn and one has no trouble finding capable Basic programmers. Pascal is being advocated by 8080 owners (IMSAI) as structured and more easily transportable than Basic. Personal versions of Cobol, called Dibol, are available on Data Generals (17) and DEC machines. Of extreme interest is the LISP language for processing symbolic logic on the Alpha Micro system. Since this company resides in Irvine, California, we probably will hear from Dr. Louis Gottschalk with Verbal Behavior Analysis being available on the Alpha Micro system machine in a few years. MUMPS language has been put on the 8080 in a single user rudimentary form with few functions.

Pre-Form Packages Versus Inventing the Wheel-

Beware of Programmers!

Every individual who approaches the array of events called microprocessor industry has his own desires which never seem to match packages that are currently available on the market. If you decide to design and operate your own system, you will become dependent upon a programmer. If you become dependent upon a programmer, or a software house, it is well that you have a specific task in mind and get a specific contract from them. To become programmer dependent is an unpleasant situation and is to be avoided if at all possible.

Programmers are always going somewhere else and they seem to last at a job for less than two years before moving along. They maintain control over you by not documenting their flow charts, code and operations in writing. Don't ever let that happen! Force them to give you a flow chart, code with explanatory documentation and complete operating instructions as part of your contract with them. Since the configuration of your computer never seems to patch that of any other one in the world, you may have to have programs translated. Randall Data Systems, Inc. has a complete accounting
and billing package available for doctors and dentists. Ohio Scientific and Alpha Microsystems have basic packages available for which you write front end entry programs to suit your needs. A generalized program for interactive presentation of medical histories called SELECT is available on The Apple II and MSI. Programs like this are easy to write once you are sure of the input data and output reports that you want.

Specific Applications - Beware of Yourself!

Computers are useful for:
1) computing,
2) communicating,
3) controlling,
4) examining and testing,
5) storing data in retrievable form.

They can perform these functions in different ways. The Alpha Microsystems has a controller for a 65 megabyte Control Data disc (for $16,000 hardly a microcomputer), but other than that the micros are limited to a storage of 600,000 characters today. Tomorrow, with quad density discs, storage will increase. That means be careful in estimating how much data you'll need to save before picking up a micro at your local store. (Parenthetically, I must add that all the database information in all the psychiatric centers that database it may be of very little value to anyone except the programmers that store it!)

Excepting psychotherapy simulations and large databases, all of the computer applications in psychiatry can easily be run on microcomputers.

Financial, accounting, inventory and billing have long been available on LSI, Alphamicro Systems and Randall Data Systems.

The admission work-up including the nurse's admission note, the mental status exam, the physical exam, the past history, the MMPI and the SCL-90 are all easily programmed on any of the micros with disc capabilities. Reports are produced that can be stored in the medical record for audit studies. These are available interactively on CRT's, and using a communication card, data can be dumped to storage over the phone on a larger mainframe.

Taking advantage of the real time functions of the micro, we have programmed Rabbit's Test of Selective Attention, the Continuous Performance Test and The Pattern Reversal Rate Test on The Apple II. These are used to measure attention deficits in psychiatric patients and performance improvement with clinical improvement in hospitalized patients.

Progress notes and treatment plans can be written to satisfy the documentation demands of accreditation agencies and insurance companies, in problem oriented form.

To date computer preoccupied psychiatrists have totally overlooked the use of the computer in patient education. We have recently developed a program called Informed Consent in which data about taking drugs, their benefits and possible side effects along with a contract letter of informed consent can be produced on the MSI merely by typing in the drug name.

Lastly, The Apple II for a cost of $1300 can be used as an intelligent terminal to access by phone databases in mainframes at any distance.

Summary

Enormous computing power is now available for very little cost on microcomputers. These computers calculate, communicate, control and perform real time testing. All of the psychiatric documentary and testing procedures heretofore performed on mini, middle and large mainframes (excepting enormous databases) can now be performed on micros costing as little as $4000, making these machines practical for the doctor's office. For a cost of $16,000 ($560 per month for five years lease purchase) a time sharing micro that supports eight to twelve simultaneous users can be programmed to serve a small hospital or clinic. Though penetration of the clinical process is not yet very significant these data and reports are very useful for the increasing number of events and agencies that form the context in which clinical practice occurs.

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