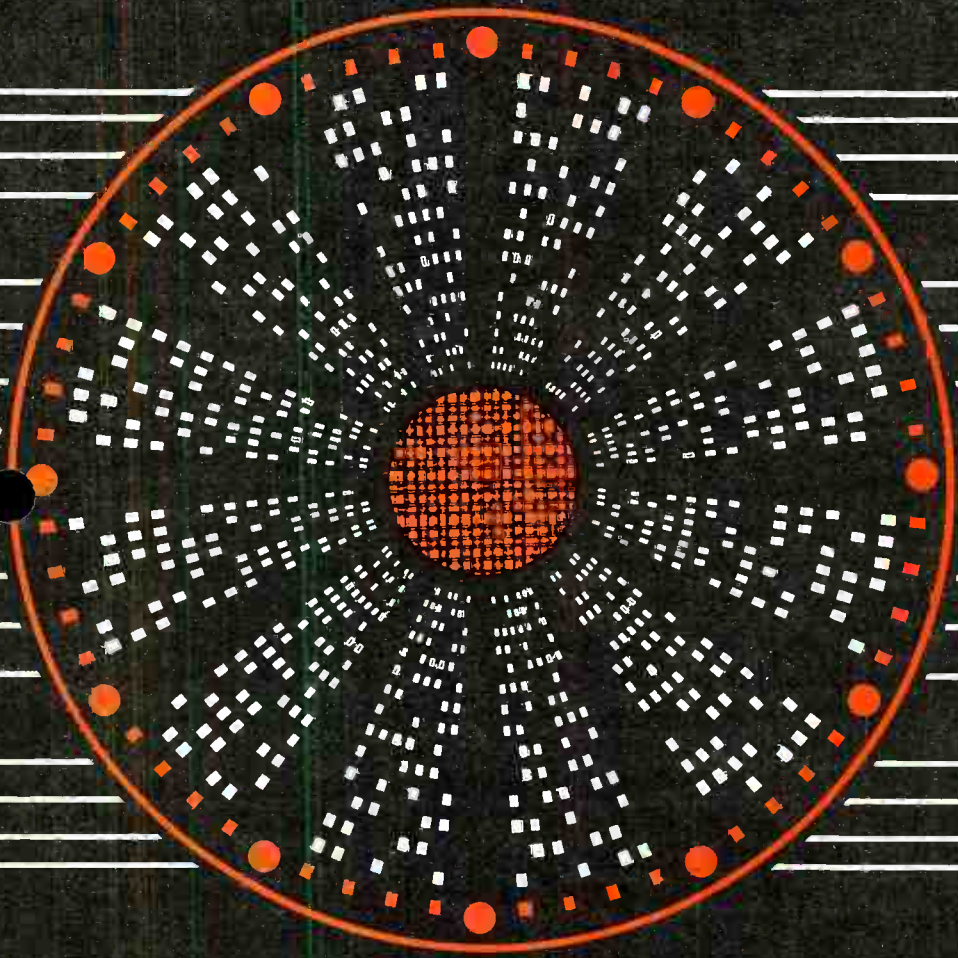
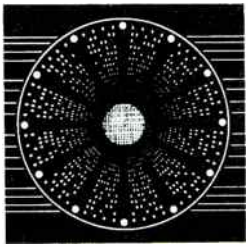
The Lenkurt®

MAY 1968

DEMODULATOR



Computer Time-Sharing



Telecommunications and computers join forces to provide a new service

Until quite recently, only very large organizations – commercial, educational, or governmental – could afford the services of a high-speed computer. Now, however, thanks to the growth of time-sharing, even the smallest private concerns can have access to these multimillion dollar machines.

This revolutionary concept in the field of electronic data processing extends the use of large, general purpose, digital computers into hitherto unfamiliar territory. By serving 20, 40, or even 200 on-line users simultaneously, time-share computers are finding application in virtually every area of commerce.

Computer time-sharing was pioneered at Dartmouth University and the Massachusetts Institute of Technology in the early 1960's; since that time it has mushroomed into an international business. At latest count there were more than 70 time-share companies providing service to some 5000 on-line customers. New systems are entering the market at the rate of three or four a month.

Many of the new, commercial time-share systems began as in-house service functions for large computer manufacturers. Once the effectiveness of the concept was proven within their own organizations, the manufacturers saw the market potential of time-sharing and a new customer service was born.

Teleprocessing Essential

As a concept, time-sharing has existed for a long time. But the reality – the technology itself – is quite recent. Two major developments have contributed largely to making time-share a reality. The state of the computer art itself has advanced to and beyond the third generation. Integrated circuits have made possible speeds, capacities, and program sizes sufficient to allow a single computer to serve large numbers of users simultaneously.

The other major development is not in the computer industry proper, but in telecommunications technology; it is teleprocessing, the ability to transmit data over voice circuits. For time-sharing to have more than narrow geographical applications, there must be a means of communication between computer centers and subscriber terminals. Since they already exist, telephone circuits are the obvious media for the task.

Digital data signals, however, require some conditioning before they can be transmitted over voice circuits. This is done with data modems. Some are interfaced with regular telephone service, and others use dedicated circuits.

In cases where either traffic load, distance, or both make the use of regular switched service prohibitively expensive, many time-share subscribers will find it more feasible to use data

modems and dedicated circuits. Lenkurt's 25A and 26C data sets are designed for just such applications. Depending upon bit rate requirements, the 25A can accommodate from 7 to 25 time-share terminals. The 26C, with its 2400 b/s rate, is designed for high speed transmission such as that required by graphic display units or in computer-to-computer links.

Time-Share Spectrum

Present time-sharing systems range in size and scope from relatively small in-house arrangements (12 to 16 users) to sprawling, commercial networks serving up to 200 on-line terminals. Although there are many different "kinds" of time-share systems in the current market, most have similar features.

```
USER NUMBER--P6300C
SYSTEM--BASIC
NEW ØR ØLD--NEW
NEW PRØBLEM NAME--STEM
READY.

100 LET X1=6*15
110 LET X2=2*10
120 LET X3=3*0.5
130 LET X4=12*(-0.02)
140 LET T=X1+X2+X3+X4
150 PRINT T
999 END

RUN
WAIT.


STEM       14:13

 111.26


TIME:    0 SECS.

BYE

*** ØFF AT 14:14
```

Figure 1. Purely for purposes of illustration, the user's side of the conversation with the computer is printed in red. Note that the line numbers increase by tens rather than singly. This is so that the user may go back and make additions or corrections without disrupting the logic of the program.

Externally, the computer systems used for time-sharing applications have little in common with the batch-processing systems familiar to most office workers. Rather than using stacks of punch cards or tapes, time-sharing operates on a real-time basis and is characterized by one-to-one interaction between man and machine.

Most commercial time-share computers are essentially problem-solving devices. Consequently, the majority of users — at the present state of the art — are scientists, engineers and other similarly oriented groups whose primary concern is the immediate solution of specific problems.

Among the myriad problems for which computational time-share systems might be used are mathematical problems, electronic circuit design, complex chemistry formulas, market analyses, banking and interest rates, and even precision tool design problems.

In addition to the problem-oriented, real-time computers, other time-share systems emphasize information storage and data retrieval; while still others are of the type designed for remote, on-line batch processing.

Probably the most striking feature of time-sharing is that regardless of the number of terminals, service to all users is immediate and simultaneous, although the simultaneity is actually only apparent. This is due to the disparity between computer speeds — measured in microseconds or even nanoseconds — and the relatively low speeds of the input/output hardware.

A computer is an electronic device, whereas terminals (usually teletype-

writers or line printers) are electro-mechanical and operate much more slowly. Hence, a computer is able to switch from terminal to terminal and swap programs so quickly as to give each user the illusion that he alone is communicating with the machine. In a network using teletypewriter terminal devices, the computer is actually able to switch from one to another during the time an operator takes to move his finger from one key to another.

The physical arrangement of most time-share systems is similar to a star broadcasting network. This is illustrated by the diagram in Figure 2. The smaller systems are usually characterized by a small Central Processing Unit (CPU) with a core memory of 14 to 16 thousand characters. These computers may have as many as 16 terminal ports and find most of their application within a single organization.

For example, a large company might have several home-office departments as well as some in the field. In this case, even the in-house arrangement requires use of a transmission means to link together the various field offices and their headquarters. Using this smaller time-share system, all of a company's offices can have access to one computer – hence, to the same files and records.

At the other end of the time-share spectrum there are systems whose CPU's can accommodate 40 to 50 users (one newly developed system serves 200) spread over a broad geographic area. In these large arrangements, program sizes may go as high as 40 thousand characters with core storage rated at 264 thousand 36-bit words. Moreover, they incorporate huge multi-access libraries of stored data, have loop functions capable of virtually infinite repetitions of mathematical problems, as well as stored mathematical routines.

Figure 2. A data processing system such as this one is specifically designed for time-sharing service.

Through the use of Lenkurt 25A Data Transmission Sets or similar modems, the subscriber terminals are able to communicate with the central system. A switching system in the Communications Controller acts as a "traffic cop" and allows access to the system on some prearranged priority basis. This is the system's executive function.

A computer in itself, the Communications Controller also processes stored programs – tape or disk – and controls the remote terminals.

All the computational problems for which the system is programmed are done by the Central Processing Unit (CPU). This is the workhorse of the entire system. It compiles programs, does floating point arithmetic problems, works out matrices, and any number of other mathematical problems. Depending upon frequency of use, need, and immediacy, programs are stored in either the Disk Storage Unit or on magnetic tapes. Storage in the DSU is on oxide-coated, magnetic disks. Access to both storage areas is controlled by the Dual Access Controller. Usually access is by address code.

Each subscriber to a system is assigned a personal address code. This is for purposes of recognition by the computer, billing, and program security. Stored programs are identified by the same personal address code and are accessible only to the proper user.

Time

Obviously, the whole basis for the time-sharing concept is time. But there is a wide variety of "times" associated with computers – turnaround time, real time, swap time, switching time, and so on.

Real time is applied to a working situation where operator and computer work together concurrently. Swap time is that brief interval required for a computer to transfer data back and forth between primary (buffer) and secondary (core) storage. Switching time is the period during which a computer is switching from one user to another and back again. Often this is the time elapsing between separate key punches on a teletypewriter.

Basically, the time which is shared is the computer's actual operating time. This is, of course, different from terminal time. Typically, a subscriber might be operating his terminal for 30 or 40 minutes while using only 15 seconds of computer time.

Multilingual Machines

To the layman, one of the most intimidating aspects of computer communications is the confusing variety of computer languages currently in use. They bear such mystifying labels as FORTRAN, COBOL, SNOBOL, LISP, and even HELP – to name only a few of the more exotic. While these may be familiar to veteran data processors, they are alien to the average businessman or engineer. This situation has been alleviated in the time-share world by the introduction of much simpler computer languages. They are quickly learned, highly comprehensible, and easy to use. For general use, most time-share systems are programmed in BASIC (Beginners All-Purpose Symbolic Instruction Code). Scientists and engineers on the other hand usually require a more specialized vocabularly than found in BASIC. Consequently they may use ALGOL (Algorithmic Language), a simplified mathematical language specifically designed for solving scientific and engineering problems.

Using these languages, the time-share subscriber becomes his own programmer. This fact alone points up one of the advantages over batch processing systems. Obviously, if companies have their own computers, they are going to have to bear the cost of staffing the data processing section – clerks, programmers, analysts, and management. Often, this cost savings alone is enough to justify subscribing to time-share. Another advantage is the curtailment or elimination of turnaround time. In computer jargon, this is the elapsed time between input and output – that is, query and reply or problem and solution. In companies possessing their own data service, this time is virtually always measured in hours – and sometimes days or even weeks.

The person with the problem – say an engineer – must first translate it into terms acceptable to the computer.

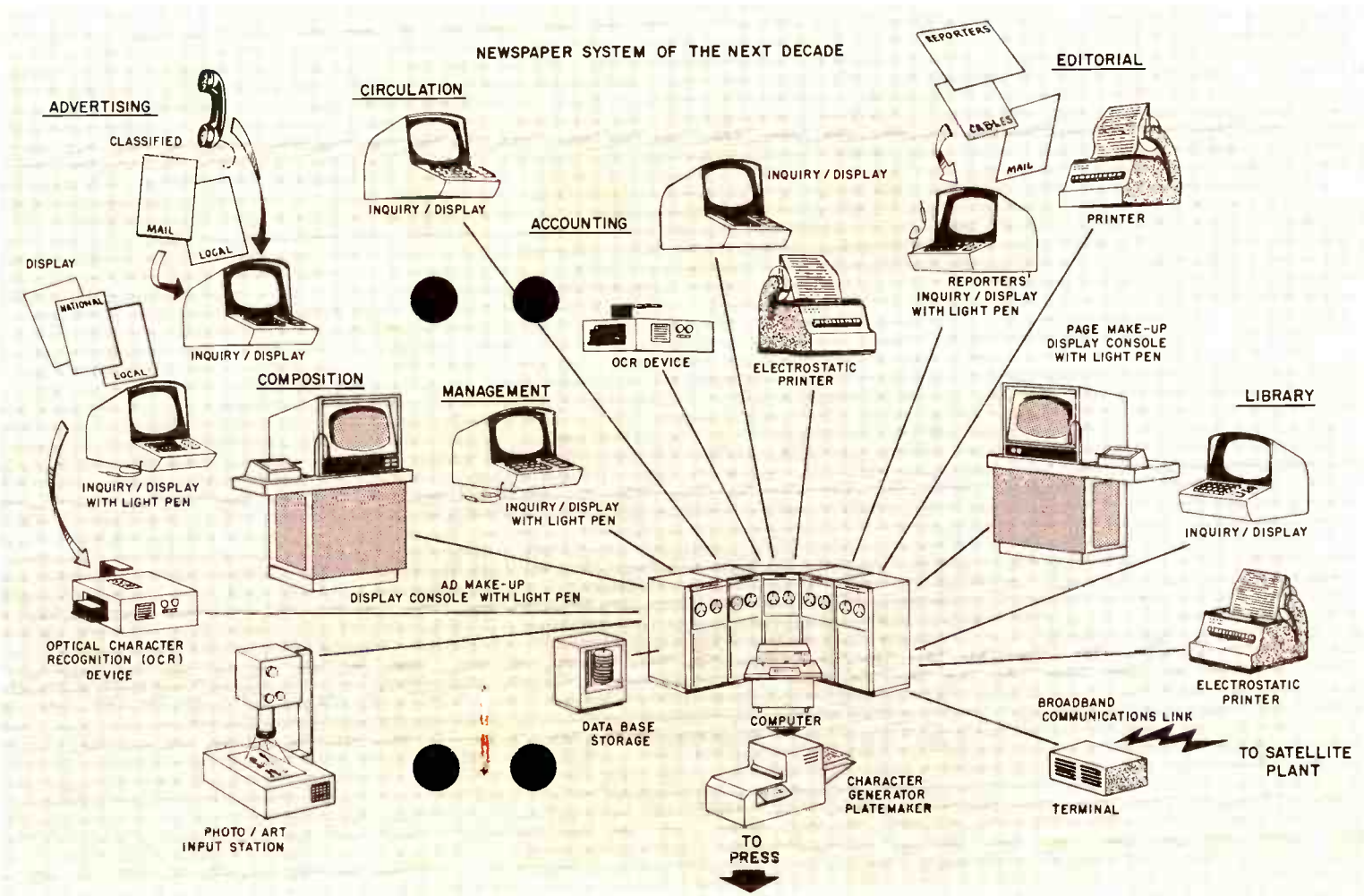


Figure 3. Though still in the future, time-share applications such as this computerized newspaper currently are being given serious consideration.

Courtesy A.N.P.A. Research Institute, Inc.

He then takes it to a programmer who transposes the problem into the appropriate computer language and format for input to the computer. Once this is done there is then a period of waiting in line (called queuing time) if the computer is busy. Since many programs contain errors or "bugs", debugging time is also a factor.

Time-sharing eliminates all these steps. The subscriber simply dials up the computer and is immediately on-line. Programming is automatic, as is debugging; when an unacceptable program statement is fed into the computer, it automatically tells the operator so that he may correct the error immediately. Experience has proven it helpful for the time-share subscriber to rough out his programs before going on-line. A simplified sample program in BASIC is shown in Figure 1.

Some Limitations

While there are indeed many advantages in computer time-sharing as reflected by its growth, it is unrealistic at the present time to talk of a universal computer utility – that is, a utility in the sense that gas, power and water companies are public utilities. However, this concept may not be too far in the future.

At its present stage of development, time-sharing is not readily adaptable for multi-access batch processing of the type required for such things as payrolling, bookkeeping, inventory and the like. Nor are present generation time-share computers capable of the electronic "brain" functions often ascribed to computers. Obviously, long computer runs, as required by a payroll for instance, are not economically feasible for time share operation. Unless, of course, data modems are used in conjunction with flat-rate leased lines or dedicated circuits, and toll charges are no longer a factor.

Currently the bulk of time share subscribers falls into one of several categories – scientists, engineers, educators, and other researchers. Recently, though, more and more ordinary businessmen are finding applications for computers within their fields of interest.

Illustrative of this broadening trend in computer uses are some of the more highly specialized areas into which time-share has penetrated.

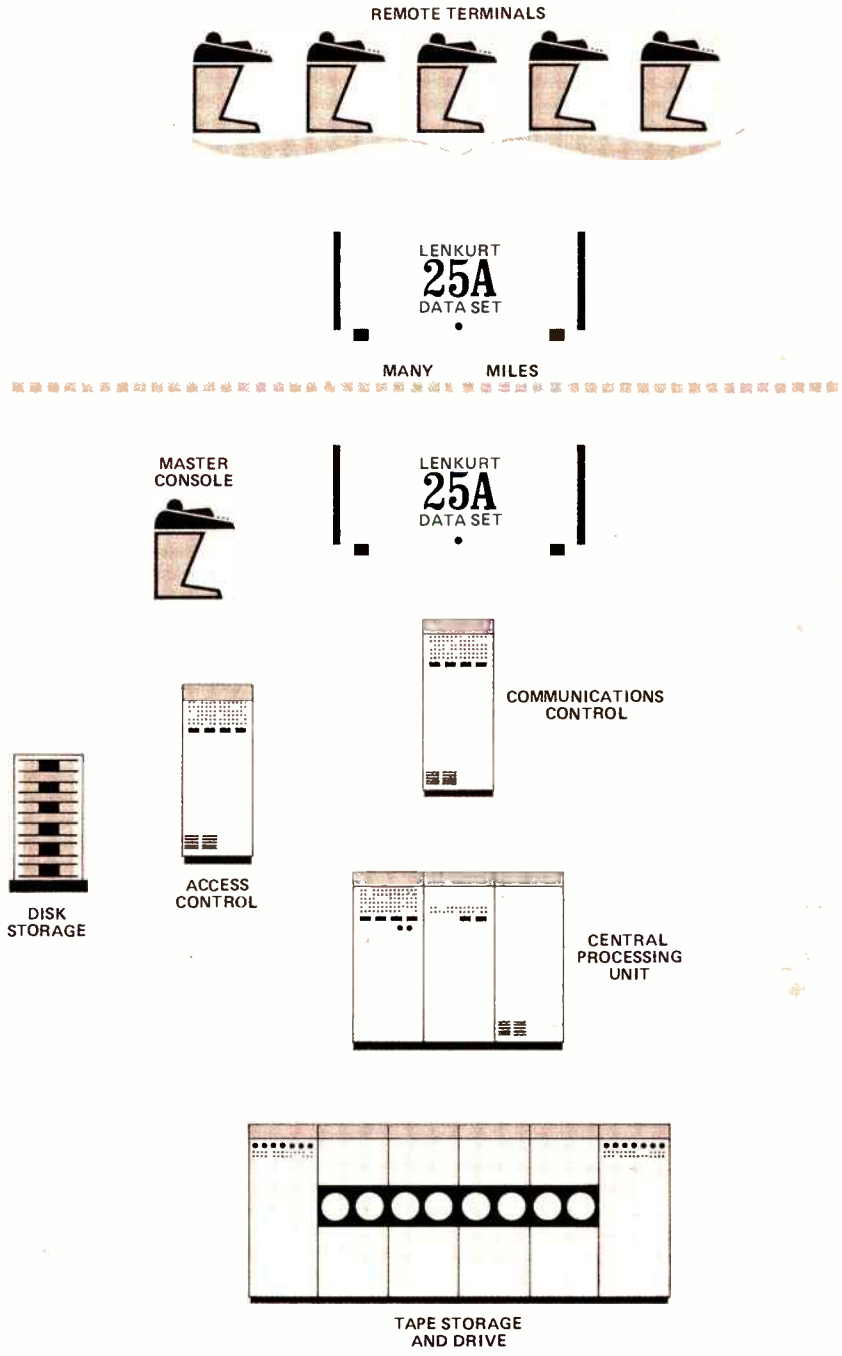
Unusual Applications

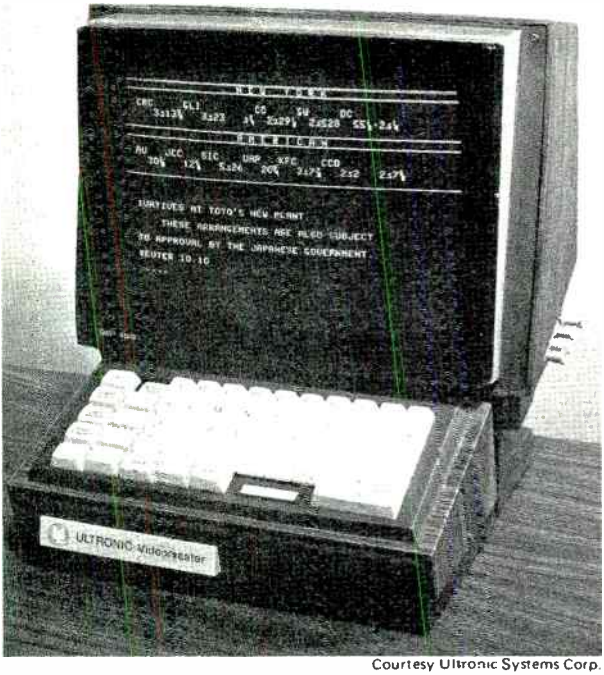
One of the most fascinating areas in which computers are finding new uses is in the publishing business – particularly newspapers. In the near future, the entire mechanical process of producing a daily paper may be aided by a computer. The chart in Figure 3 illustrates one way in which this might work as a new in-house function.

At present, only relatively simple tasks such as character generation and composition are being done electronically. However, some newspaper publishers are seriously studying the practicality of totally computerized publishing.

In such a system, a reporter would only have to transmit his story to the computer from his desk; the editor or rewrite man, in turn, edits the material on cathode ray tube (CRT) graphic display units making his changes with an electronic light pen or similar device. Other tasks such as accounting, classified ad placement, space sales, and layout also readily lend themselves to computerization.

Another highly specialized application of computer time-sharing is in the stock market. Ultronics Systems Corporation has developed and marketed a computerized stock quotation service. The system features a network of electronic graphic display units (Figure 4) connected to intermediate, regional





Courtesy Ultronic Systems Corp.

Figure 4. This stock quotation display is typical of the current trend toward graphic display units for time-share terminal devices.

computer systems; these in turn are tied to a central time-share system near the New York Stock Exchange via telephone lines. By simply querying the intermediate computer through his teletypewriter keyboard, a stock broker anywhere in the country can determine the status of as many as eighteen separate stock issues. Typical turnaround time is one second.

Just as time-sharing is an outgrowth of older concepts in the computer industry, it is itself already giving rise to other related kinds of computer enterprises.

Whereas most commercial time sharing firms are in the business of selling computer time, at least one organization, Data Services, Inc., sells computer core capacity on a kind of hybrid time-share basis. Access to a centrally located, multipurpose computer is sold to different businesses on a quota basis. That is, many firms engaged in the same business will cooperate in renting a certain portion of the computer's capacity. Typical of such firms are the multiple-listing realtors.

The computer is used to keep all real estate listings up to date for a given set of agencies. Access to the information is available to all subscribers – the result is that all the realtors in a geographic area might have access to every available piece of real estate in that area. Other subscribers to this kind of computer service are savings and loan associations, hospitals, ambulance services, banks, travel bureaus, insurance agencies, and ticket agencies, among others.

Generally, time-share is preferable to batch processing systems in applications where immediate access and response are essential and in any multifunctional requirements. In traditional

areas – computing payrolls, inventories, accounts, etc. – where turnaround time is not a critical factor, batch processing is satisfactory. Even here though, general purpose time-share computers may have a role. With attachments, time-share computers can be altered for use in batch processing during off-peak hours of operation. This is particularly true of the smaller in-plant systems.

The primary value of time-sharing is not so much its advantages over batch-processing as is the fact that it has made the services of computers available to a much broader segment of the economy.

A Problem Becomes Progress

Since its inception, the computer industry has been saddled with two major problems – the developmental lag between hardware and software, and the input/output problem. The crux of this I/0 problem is the fact that terminal devices have yet to be designed which can make meaningful use of a high-speed computer's fantastic capabilities. Particularly since I/0 devices are of necessity geared to the relatively low operating speeds of human beings. But, as pointed out earlier, it is this disparity which makes time-sharing practicable – and time-sharing, in turn, is offering a tentative solution to the I/0 problem.

More recently, software developments have been growing apace with the hardware industry. Programs now exist which are of sufficient size and complexity to justify even higher computer speeds. Also, print-out devices are being marketed which have increasingly higher operating speeds; electronic typewriters now print 200-300 words per minute. This in itself is unimpressive compared to computer speeds, but with as many as 200 time-share subscribers working on-line simultaneously, the figure becomes more favorably comparable. Also, there are line-printers available with operating speeds of up to 3000 *lines* per minute.

However, the current interest in output devices is tending more toward electronic graphic display units such as cathode ray tubes. Among the most recent innovations in this area are some highly sophisticated machines – electron beam recorders, computer output microfilming machines, and

Courtesy General Electric Information Systems.

Figure 5. Computer time-sharing systems such as this one are springing up around the world at the rate of three or four a month.

even lasers; these devices provide instantaneous responses in the conversation between man and machine.

It is this aspect of time-sharing – conversation or interaction – which is potentially quite valuable. Not only does time-sharing serve more needs of more users more economically, it may pave the way for truly creative communications – hence, augmenting man's working intellect.

Time-Share Experiments

Scientists at Stanford Research Institute in Menlo Park, California, have been experimenting with computers in this area for the past two years. The system consists of a large, multi-access, general purpose computer with cathode ray tube terminal devices.

For better viewing, the CRT's are interfaced with closed-circuit television cameras; monitors are located in different rooms throughout the engineering department. Input is through an electronic typewriter keyboard. Usually, interaction with the computer is on a one-to-one basis; however, conference arrangements have been tried with considerable success. In such an arrangement, all the conferees have immediate access to the programs of all the others. And they are continually available for cross-reference or checking back. Perishability of data is not a factor; and conceivably then, a problem can be attacked simultaneously by several different men aided by the huge memory of a computer. The possibilities presented by such a concept are impressive, to say the least.

For example, each member of a group of scientists or engineers is given an identical problem. Working off-line and independently, each develops a possible solution; then the statement of the problem together with each of the proposed solutions is programmed into the computer. This done, each man sits down at his console and queries the computer for the problem as well as for each of his colleagues' work on the problem. With refinements, the participants will also be able to communicate directly with each other through the computer.

A Computer in Every Home?

Potentially, the applications for time-share computers are virtually unlimited. Computer hardware and software systems are advancing at an increasingly rapid rate.

Medium and large scale integrated circuitry, along with advanced construction techniques are pointing the way to the future.

Telecommunications engineers are developing ever faster methods of data transmission. Lenkurt's Duobinary technique is one example; PCM offers a broad range of possibilities for data communication. Working with PCM, transmission soon will be reckoned in the millions and even hundreds of millions of bits per second.

Far-sighted people in the computer world have envisioned such novel computer oriented services as automatic credit and banking where no cash changes hands, and networks of computers which enable businessmen to go to their "offices" without ever leaving home. Others foresee a time when movies, books, periodicals, and newspapers will simply be "dialed up" for viewing on the living room TV screen. These may be the first steps toward giving every home a computerized information center – a not unforeseeable situation in the light of current developments in computer time-sharing.

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