

SHOPPING FOR A TIME-SHARING SERVICE

Now that many firms rent time on computers, physics departments may find the prices of these services well within their budgets and computer skills soon within their grasp.

Hussein Elkholy

SMALL COLLEGES, or the small users within large colleges or universities, have recently found that access to a computer is economically within their grasp through computer time-sharing services. Yet the inexperienced may ask how to go about acquiring a time-sharing system and how to decide among the options available from the many firms that now flood the market. I will attempt to answer these questions by describing how a small physics department such as ours, with a faculty who did not know anything about computers, has acquired both a small computer and a time-sharing system. Taking advantage of the competitive situation, we obtained time-sharing services well within our budget. We have introduced computer instruction and have made it an integral part of the physics and mathematics curricula.

Case history

In 1965 we started thinking about introducing computer courses and integrating the computer into existing courses. Two obstacles faced us. The first was financial; our budget was rather limited at the time, and small computers were still relatively expensive. Furthermore, time sharing as we know it now was in its infancy. The second problem was that no one in the department knew anything about computers. All we knew was that computers were becoming such

an important part of our lives that our students should be introduced to them.

In spite of these obstacles, our department took the initiative in contacting the chemistry and biology departments to look into the possibility of jointly applying for a NSF matching grant. A small committee was formed, and, with the help of some colleagues from the nearby industrial research laboratories, we started learning about such things as digital computers, analog computers, teletypewriters, CPU, FORTRAN, memory, core, hardware, software, and so forth. Because there was a limit to how much money our campus could match, we reached the conclusion that it would be cheaper to purchase a small analog computer that was selling for \$12 000 at that time. We proposed to use the analog computer in such courses as kinetics, genetics and differential equations as well as in our physics laboratory courses.

In 1966, just after the proposal was approved by the NSF, Digital Equipment Corporation (DEC) introduced the first digital computer to sell for under \$10 000. (Many other companies now offer computers below \$10 000 and the list of those below \$20 000 is very extensive.¹) Realizing that we should introduce our students first to the widely used digital computer rather than to the more specialized analog computers, I requested



NSF to allow us to change to digital computers instead of the then proposed analog. The request was granted, and we ordered Digital Equipment Corporation's PDP 8/S with a teletypewriter and two off-line teletypewriters (total bill—\$13 400). The unit was delivered in the summer of 1967 and by the fall we were offering one course in computer methods.



Over the past three years, a total of five courses have been introduced. The computer is being used for faculty projects as well.

I wish to stress that when we received the computer we did not know how to operate it or to use it most efficiently. The physical presence of the computer compelled our faculty to play with it and to learn how to use it.

Most of us have learned "on the job." Some of the faculty have contributed significantly to the curriculum.

Computer versus time sharing

This fall we found that we had outgrown the capability of the PDP 8/S and decided to subscribe to time-sharing services that provide more capability. Thus we are familiar with the pros and cons of each system. The advantages of having a small computer are the physical presence of the machine and the effect this has upon the learning process of the students, the possibility of offering some specialized courses such as machine-language courses, the availability of the machine at all times and the possible use of the machine as a program-operated controller in an experiment.

The disadvantages are the limited capabilities of the small computer compared with the more powerful machines employed by time-sharing services, the aggravation of having to wait for service and the cost of service contracts. We find that maintenance problems develop far more frequently on our computer than on the time-sharing terminal. The service contract on a small computer can cost as much as the rental of a time-sharing terminal for an academic year with moderate usage.

An alternative is to purchase an "in-house time-sharing service" together with several other departments. Under this plan, the school would purchase a computer that serves several simultaneous users. One example is the BASIC system² recently announced by Wang Laboratories, which costs between \$20 000 and \$25 000 for a typical configuration for four users. A second example is DEC's FOCAL system for four users on the PDP 8/1 or PDP 8/0. This system can be installed for less than \$17 000.

Timesharing

The growth of the time-sharing industry has been phenomenal. At the time we were considering the introduction of computer courses in the department, only General Electric and

very few other companies were offering time-sharing services. Even these services lacked many of the features found on present systems. Since 1966, the number of companies offering time sharing has mushroomed to a great extent; the situation is becoming very competitive, much to the advantage and delight of users. Companies are trying hard to attract customers by offering a bag of various extras to support their services. These extras may include a variety of programming languages, packages of library subroutines and special programs, and support services such as programming instruction, assistance in debugging and round-the-clock maintenance. In most cases, these features are all comparable. For instance, nearly every firm will offer BASIC or FORTRAN IV or both.

A typical time-sharing setup consists basically of a terminal, most frequently a teletypewriter TTY 33 or TTY 35, that is connected through a transmission line (the regular phone line) to a computer system that handles several users simultaneously. (Some systems serve over 250 users.) The user dials a number on the phone, identifies himself by a number typed on the teletypewriter and establishes direct contact with the machine thereafter.

If you are lucky enough to be near a big city, take advantage of the competitive situation. Most companies charge, on the average, \$10 to \$15 per hour for terminal-connect time, that is the time you are in direct contact with the computer, \$2 to \$3 per minute for CPU time, that is, computation time, and \$100 monthly minimum. There is also a small charge for storage of programs and data. Where the competition is fierce, some companies have no minimal charge, others offer an educational discount and still others are willing to eliminate the minimal monthly charge and the CPU charge. This last option is significant for educational institutions such as ours that are using the computer solely for teaching, because no fees have to be paid during the summer months

TABLE 1.
Sample survey
of time-sharing
firms

PHYSICS TODAY sent questionnaires to 38 time-sharing firms that offer services over a fairly wide geographical region. The table opposite was compiled from the 23 questionnaires that were returned. Although the survey is not complete (see references 3 and 4), and specifically excludes many local firms of interest in particular regions, it does indicate the range of prices and options from which a customer can choose. The entries in the table require some explanation.

FOOTNOTES

¹The addresses usually refer to the central office; most firms have branch offices in other large cities.

²The entries indicate that in at least one location within each region, only a local phone call is required to obtain services. The entries are coded by number from 1-7 corresponding to the geographical regions shown on the accompanying map.

³Several companies told us that they soon expect to add another central processor; check with each firm for the most current information.

⁴Only the most universal languages are listed; most firms offer additional languages, some with very special applications that may interest particular users.

⁵Terminal-connect time and CPU time charges are frequently lower during nonprime hours, that is, after 5:00 or 6:00 pm, and before 6:00 am, and on weekends. When two prices are quoted, the first applies to prime time and the second applies to nonprime time.

⁶"Dedicated ports" denotes time-sharing terminals for which the customer pays a flat rate, independent of the amount of terminal-connect or CPU time he uses.

⁷All charges apply to rates for educational institutions; commercial rates are frequently higher.



Key to Regions
1 New England
2 Atlantic
3 North Central
4 South Central
5 Mountain
6 Pacific
7 Canada

Corporate Name And Address ¹	Region ²	Central Processor ³	Fast Memory Space (char)	Cycle Time (μs)	No Sim U.
Allen-Babcock Computing, Inc Los Angeles, Calif.	1, 2, 3, 4, 6	IBM 360-50	256K bytes of 1 μs access 2048K bytes of 3 μs access	—	65
Applied Logic Corp Princeton, N. J.	1, 2, 3, 6	PDP-10s; AL/COM DUAL AL-10s	160K	1	200
Axicom Systems, Inc Paramus, N. J.	1, 2, 6	UNIVAC 1108	390K	0.375	64
Burlington Management Services Greensboro, N. C.	2, 3	RCA Spectra 70/46(2)	262K physical memory; >1 million bytes/user program	1.44/2-bytes	48
Call-A-Computer, Inc Minneapolis, Minn.	1, 2, 3, 5, 6	GE 255 GE 265(5)	16K core	6	40/sy
Codon Computer Utilities Waltham, Mass.	1, 2	PDP-10	180 000	1.5	64
Computer Software Systems, Inc Stamford, Conn.	1, 2, 3, 6, 7	IBM 360-67 (3)	262 000 -1 024 000	—	—
Com-Share, Inc Ann Arbor, Mich.	1, 2, 3, 4, 6, 7	XDS 940(9)	67 million	1.75	44
The Cyphernetics Corp Ann Arbor, Mich.	2, 3	PDP-10 (mult sys)	—	1/word	64
General Electric Co Bethesda, Maryland	1-7	GE 265 Mark I GE 635 Mark II	6K 10K	6 1	39 200
Graphic Controls Corp Buffalo, N. Y.	1-6	PDP-10(2) GE-265(2)	32K 36-Bit words 6000 char	1 6	48-64/ sys 40/sy
Honeywell, Inc Minneapolis, Minn.	1, 2, 3, 6	H-1648 (one 416, two 516's)	32 000 in CPU	0.96	48
Interactive Data Corp. Waltham, Mass.	1-6	IBM 360-67	512K	0.2 CPU 0.75 storage	—
I. T. T. Data Services Paramus, N. J.	2, 3, 4, 6	IBM 360-65 IBM 360-67	600K user core	—	100+/ sys
Leasco Response Inc Bethesda, Md.	1, 2, 3	HP 2000 A (mult sys)	20 480; 25 000	1.6	16/sy
Marketing Operations, Inc Boston, Mass.	1, 2	GE 265	18K	6	76
McDonnell Automation Co St Louis, Mo.	2, 4, 5, 6	GE 430 XDS SIGMA 7	45 000 "run normal" 56 000 "run big" 80 000; 180 000 (background)	0.75 0.75	30 56
MegaSystems, Inc Bala-Cynwyd, Pa. New York, N. Y. Los Angeles, Calif.	1, 2, 3, 4, 6	XDS 940(3) IBM 360-67 GE 430	— — —	1.75 0.75 4.2	40/sy 25 32
Scientific Time Sharing Corp Washington, D. C.	2, 6	IBM 360-50 (2)	100 million	2	60
Service Bureau Corp (IBM) New York, N. Y.	1, 2, 3, 4, 6	IBM 360-50	860 000	2	—
Time Share Corp Hanover, N. H.	1, 2	HP 2000A	16K	1.6	16
Tymshare, Inc Palo Alto, Calif.	1-6	XDS 940	96K	1.75	42
Westinghouse Tele-/ Computer Systems Corp Pittsburgh, Pa.	1, 2	RCA-70/46 (3)	1 million bytes	1.44	48/sy

User Languages ⁴	Minimum (/mo)	Terminal Connect Time (/hr) ⁵	Charges ⁷		Dedicated Ports ⁶
			CPU Time (/sec) ⁵	Storage (/mo)	
COBOL, COBOL G, FORTRAN G and H, PL/1 + 6 others	None	None	\$6.25 to \$21.50/min according to core storage resident allocation	\$6.00/100 K bytes (data) \$14.00/100K bytes (disk)	"Available if use demands and justifies"
BASIC, COBOL, FORTRAN IV, LISP/6, SNOBOL + 2 others	\$100	\$10.00	\$0.10	\$0.75/1024 char	No
ALGOL, BASIC, COBOL, FORTRAN, LISP, SNOBOL + 8 others	\$150	\$10/5.00	\$0.28/.19	\$1.20/10 752 char	Negotiated
XBASIC, COBOL, FORTRAN IV, ASSEMBLY	\$100	\$12 (low speed) \$20 (high speed)	\$0.10	\$6.00/25 000 bytes (1st 50 000 bytes free)	Available
ALGOL, BASIC, EDITOR, BASIC II, FORTRAN II	None	\$7/4.50	\$0.04/.02	\$2.00/1500 char (<75 000 char) \$1.50/1500 char (>75 000 char)	Yes
BASIC, COBOL, FORTRAN IV	N/A	\$9/4.50	\$0.01/sec per 1024 36-bit words	\$1.00/3200 char (disk) \$5.00/1600 char (mag tape) \$10.00/3200 char (DECTape)	\$1500/mo
BASIC, COBOL, FORTRAN IV, PL/1, SNOBOL + 8 others	None	\$6.00	\$0.38	\$15.00/120 000 bytes	Yes
BASIC, SNOBOL + 2 others	\$400 (standard contracts only)	\$10/5.00	\$0.05/.03 (less 15% educational discount)	\$0.90/1024 char per day	Yes
BASIC, FORTRAN IV	None	\$10/6.00	\$0.02/1000 words of core memory	\$1.00/1000 char, or less, depending on commitment	Negotiable
ALGOL, BASIC, FORTRAN IV	\$100	\$8.50/4.25	\$0.05/computer resource unit	\$1.75/1537 char (program)	\$1200+/mo
ALGOL, BASIC, FORTRAN IV	\$100	\$7/3.50	\$0.25/1000 I/O char \$0.33/computer resource unit	\$1.10/1280 char (program) \$0.50/320 words (data)	No
COBOL, FORTRAN IV, ADV BASIC + 4 others	\$10	\$10/5.00	\$0.10/.05	\$0.50/640 char	Yes—contract
ALGOL, BASIC, LISP, BASIC+, EDIT, FORTRAN II	\$10	\$7/3.50 (1st 50 hrs)	\$0.04/.02	\$1.50/1536 char	Yes—contract
BASIC, FORTRAN IV, + 3 others	After 90 days, \$90	\$9*/5.00 * 1st 10 hrs	\$0.04/.03	\$1.00/1024 char	\$950
BASIC, COBOL, FORTRAN, SNOBOL, PL/1 + 7 others	None	\$13/8.00	\$0.27	\$25.00/cylinder	Yes
BASIC, COBOL, FORTRAN, ASSEMBLER	None	\$10.00	\$0.03/computer work unit	\$24/120 000 bytes	\$5 000/mo
BASIC, FORTRAN	\$100	\$5.75*/3.00 * 1st 99 hrs	None	\$0.75/1024 char	
ALGOL, BASIC, FORTRAN II	None	\$7.00/4.50	\$0.04/.02	\$2.00/unit (1536 char) \$1.50/unit (>50 units)	\$890/mo + 60 program storage units
BASIC, FORTRAN IV	None	\$10.00	\$0.05 "normal" \$0.10 "big"	\$2.50/1500 char	\$2000/mo
BASIC, COBOL, FORTRAN IV	None	\$8.00	\$0.20	\$0.40/1000 char	\$2000/mo
BASIC, FORTRAN + 4 others	\$100	\$10.00	\$0.0416	\$1.00/1000 char (1st 60K char free)	"Negotiable"; depends on quantity
COBOL, FORTRAN, PL/1, SNOBOL + 2 others	\$100	\$10.00	\$0.30 (system meas. unit)	\$10.00/120K char (1st 128K char free)	\$4000/mo
BASIC, FORTRAN	\$100	\$9.00	\$0.04	\$0.15/180 char	\$1800/mo
PL PLUS	None	\$12.00	\$0.10	\$10.00/32 000 char	\$1200/mo
BASIC, FORTRAN, PL/1	\$100	\$11.00	\$0.15	\$1.50/3440 char	No
BASIC	None	\$8/6.00	None	\$1.00/1240 char	\$300/mo (1/2 day) \$600/mo (24 hrs)
BASIC, FORTRAN IV, SNOBOL IV, + 4 others	Type A: \$80 Type B: \$390	\$13.00 \$16.00	\$0.04 \$0.04	\$1.00/1K char (less after 1st 500 000 char)	Yes
BASIC, COBOL, FORTRAN	\$100	\$10/7.50	\$0.05	\$1.50/2500 char	

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or holidays, when we are not using the computer.

Comparing costs

Several factors will influence the price tag of various services. The listing of a sample of time-sharing services in Table 1 illustrates the wide range of prices. The companies listed are those that offer time sharing over a fairly wide geographical region. These and other more local firms are included in a recent comprehensive survey.^{3,4} In general, the cost is greater for larger and faster computers. However, because the machine is faster, you may end up paying the same for the same amount of work. Furthermore, your needs may demand the larger core and storage. Other departments, such as ours, will find that they could never use a large computer to its full capacity and will save by using a medium sized computer. We chose a GE 437, offered at a flat rate of \$9.75 per hour by one of the local firms.

The cost of time sharing can be kept low in several ways. The rates drop considerably after 5:00 or 6:00 pm and on weekends. These hours are often the periods when faculty and students do their best work. You can minimize your phone bill by selecting a time-sharing firm that has service in your area, requiring only a local phone call. Or some firms have WATS lines. You can also investigate the possibility of cutting down your transmission cost by asking the phone company to install a special line so that you pay only the rate for local calls.

Many of our students will use an off-line teletypewriter to prepare their programs, thereby minimizing the



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time that they are in actual contact with the computer. It is therefore essential that a sufficient number of off-line teletypewriters be available. They can be rented either from the time-sharing firm itself or from the telephone company. I recommend buying them. The purchase will result in substantial savings. Allow one teletypewriter for every 15 to 20 users. Two types are commonly available—the TTY 33 and the TTY 35. The TTY 35 is more expensive but is more sturdy and resistant to students' abuse than the TTY 33. If you buy a computer, most manufacturers will supply a TTY 33 with the unit. It would be wise to pay the difference and order the TTY 35 model instead. You could also order other teletypewriters from them.

If you decide to invest in time sharing, explore the possibility of a laboratory fee to pay for it. Depending on the amount of use and the number of off-line terminals, you should expect an average cost of about \$25 to \$30 per student per computer course, a figure that compares favorably with fees for laboratory and library services. This charge provided adequate revenue to pay for our time-sharing service. Students are generally willing to pay for lab fees in situations like this one.

Inexperience no barrier

In looking back over our experience, I find that the greatest deterrent to obtaining a computer facility was really not the cost, but rather the unavailability of knowledgeable faculty. If you do not have a physicist in the department with a background in computers, try to hire one. If you do not have faculty openings, delegate to yourself or to one of your present faculty the responsibility for learning about computers, through self teaching, attending a course or having several sessions with a time-sharing service representative. I would even suggest that you go as far as renting a terminal from a time-sharing firm and learning on the job. Most time-sharing firms have educational backing to their services. They will be glad to come and help you, starting from scratch, until you get on your feet.

References

1. Modern Data, 2, 55 (1969).
2. Modern Data, 3, 64 (1970).
3. Modern Data, 1, 34 (1968).
4. Modern Data, 3, 66 (1970). □